Conoco
Petrochemicals

CONTINENTAL OIL COMPANY
PETROCHEMICAL DEPARTMENT, V.C.M. PLANT
P. O. BOX 605, WESTLAKE, LOUISIANA 70669
PHONE: 318-433-6311

July 31, 1969

Mr. Jerome Resnick
Monsanto Biodize Systems, Inc.
112-20 14th Avenue
College Point, New York 11356

Dear Mr. Resnick:

Attached for your information and use are copies of letters containing analyses of the Continental VCM Plant effluent water. These analyses cover a shutdown period between May 5 and May 11, 1969 and analyses taken during the month of June 1969 when the plant was in full operation. These analyses should be considered confidential and will be subject to any secrecy agreement which may be consumated.

Very truly yours,

R. H. Gerlach
Chief Process Engineer
Continental VCM Plant

RHG-MC
Attachment

cc: Mr. J. D. Minott
Mr. P. M. Winegar
Mr. L. N. Vernon
Mr. E. A. Peveto
Mr. J. Resnick + 2

CWH 000012042

Plant Effluent -- June 1969

Date	Total Solids	Total Dissolved Solids	Total Suspended Solids	$CrO_4^{=}$	$PO_4^{\equiv}$	Cl^-	Fe	pH	Alpha Color Filter	COD	EDC
6-3	5445	5122	323	3	-	-	5.6	6.1			2221
6-4	7580	7340	240	Tr.	-	3400	5.0	5.5	15		1900
6-10	9360	8760	600	Nil	-	3300	7.2	4.0	5	2880	1303
6-13	5403	5223	180	1.5	-	2420	4.3	4.1	>15	2760	2553
6-16	6824	6614	210	2.3	-	600	10.0	3.7	>15	2800	2158
6-19	10410	9765	645	3.0	-	3680	13.53	4.0	>15	2980	4471
6-26	6108	5900	208	Nil	2	3540	13.0	3.0	15	3220	1146
Average	7304	6961	343	1.4	.3	2823	8.38	4.0	15	2928	2249

March 1, 1972

Mr. A.L. DeVries
Stauffer Chemical Company
Dobbs Ferry, New York 10522

Dear Mr. DeVries:

This is to confirm our telephone conversation today regarding our effluent water characteristics. The following data is based on operation without the steam stripper in service at a production rate of 1.8 MM lbs/day of VCM.

	Max ppm	Avg ppm	Avg lbs/day
BOD	1,520	1,150	4,830
COD	5,200	1,890	7,938
EDC	10,000	1,500	6,300
VCM	200	22	92
EtCl	100	21	88
Formate	892	700	2,940
Copper	5	0.5	2.1

The plant effluent includes cooling tower blowdown so that a direct comparison of concentrations between plants may not be realistic. However, the ratio of pounds of pollutant per pound of VCM should be meaningful.

Our brief experience with the steam stripper in service shows that we can get EDC below 500 ppm.

We hope this data is of value to you. If you have any questions, please contact us.

Very truly yours,

Original Signed By
R. H. GERLACH

R.H. Gerlach
Chief Process Engineer

bs

cc: LMV-DOP-DKP-JDM

CWH 000012044

SECONDARY TREATMENT SYSTEM

I. General Description

II. Layout Diagram

III. Theory of Biological Oxidation

IV. Equipment Description

V. Normal Operation

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VII. Troubleshooting

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I. General Description

The VCM Plant Secondary Treatment System is a biological treatment process designed to reduce chlorinated hydrocarbons, other organics, metals, temperature, color, and to increase pH and dissolved oxygen in the plant water effluent.

The system was designed to handle up to 1200 gpm of water, although the normal effluent water flow rate is about 300 gpm. Because of this extra capacity, the system will not overload during column washes, C-500 emergency dump water use, plant washup operations, or any other normal operation adding up to about 900 gpm of additional water. However, heavy rains can cause the effluent rate to increase to a maximum of 15,000 gpm (at a 3.5"/hr. rainfall rate) which could overload the treatment system. In order to prevent this overload, all water above 1200 gpm is automatically bypassed around the treatment system by means of an "overflow dam" which is controlled by piping pressure drops.

The treatment system has seven main sections as follows:

a) pH control by means of caustic addition.
b) Equalization basin to "smooth out" any pH, temperature, or chemical concentration changes.
c) Biological oxidation in two large, mixed and aerated basins to biologically convert organic compounds to CO_2, water, and solids.
d) A clarifier (or gravity solids settler) to separate out biological solids, plus any silt, precipitated metals, or insoluable salts formed in the process. These solids are also pumped (recycled) back to the start of the two aerated basins.
e) A re-aeration basin with one small aerator designed to increase dissolved oxygen in the effluent water up to levels where fish can live.
f) A sludge-holding basin designed to contain about 1.5 months' production of "excess sludge" from the clarifier.
g) Measuring instruments to measure and record the pH, flow, temperature, and dissolved oxygen content of the water dumped into the Bayou Verdine.

The first section (Item a) the pH control system, is physically located within the plant limits just east of the chlorine compressor building. All the controls for this system are located in the plant control room for ease of operation. All the remaining sections (b through g) are located in a fenced area about 1000 feet southeast of the chlorine compressor building. This area has its own separate power supply and is connected to the plant control room by only a trouble alarm and a Gaitronics system outlet. This area is designed to operate unattended for extended periods of time.

This treatment system is designed to accomplish the following changes to the water effluent.

a) Raise the pH from about 3.0 to between 6.5 and 7.5. (State law requires 6.0 to 8.5.)
b) Lower the water temperature to below 90°F or to within 2°F of

the average daily air temperature. (State law presently requires 96°F or 5°F approximately.)

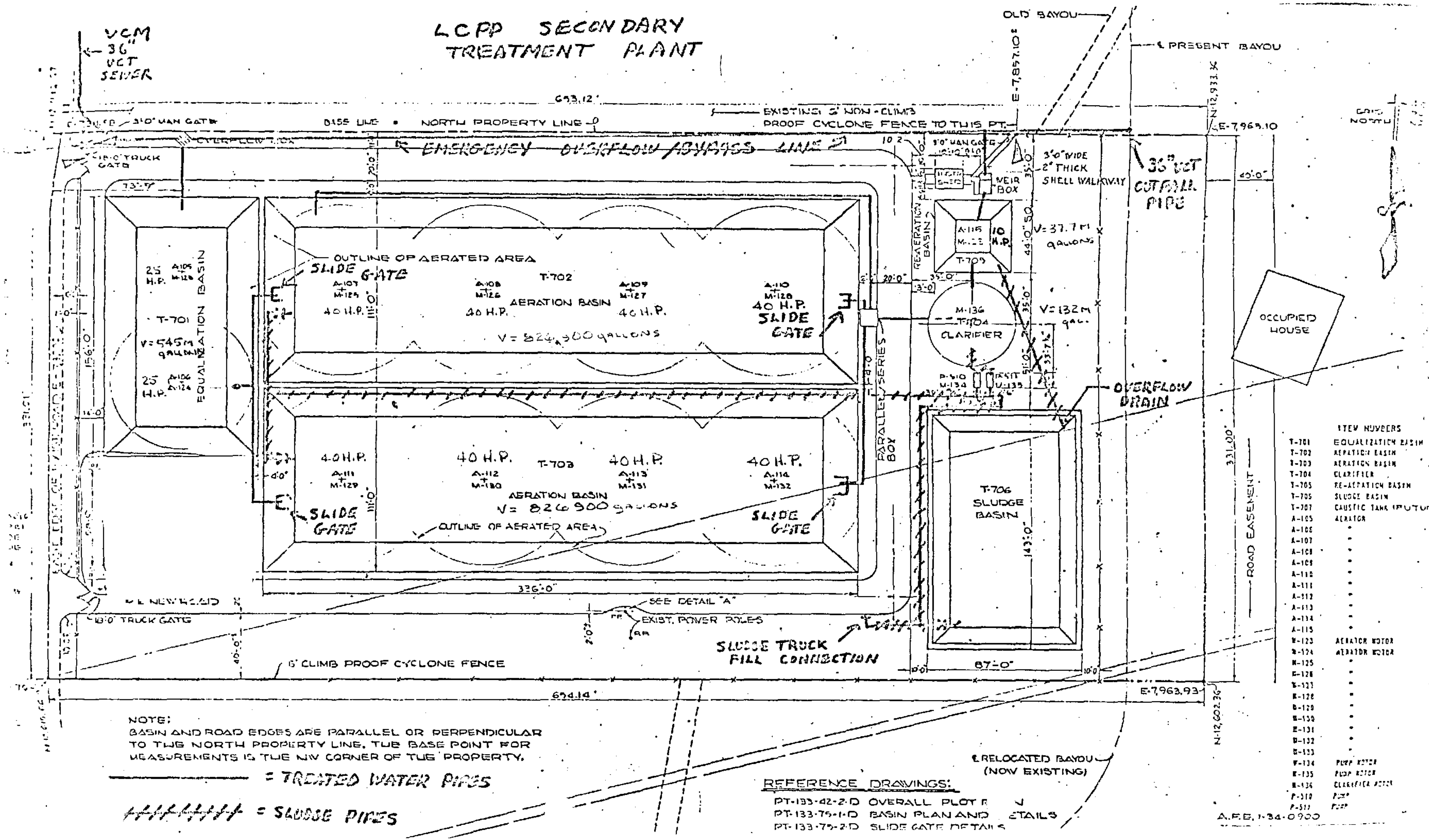
c) Reduce suspended solids in the water to below 100 ppm by weight. (No state law yet.)

d) Reduce the color of the water to under 50 APHA. (Equivalent to a very faint yellow color - no state law yet.)

e) Reduce the BOD of the water by over 85%. BOD is a measure of the organics present in water and refers to the oxygen required to convert the organics to CO_2 and water. (State laws require only that an "effective" secondary system be installed.)

f) Reduce the EDC, formic acid, and other toxic (to fish) organics in the effluent to less than 1/10th of the toxic concentration. (State law requirement. These levels are: EDC = 31 ppm, Formic acid = 12 ppm.)

In addition to the above improvements, this system will retain the effluent water for 5 to 15 days which will essentially eliminate any rapid changes in the final treated water.



LCPP SECONDARY TREATMENT PLANT
VCM 36" VCT SEWER
OLD BAYOU
℄ PRESENT BAYOU
E-7,857.10
N-12,933.36
E-7,965.10
GRID NORTH
693.12'
EXISTING 6' NON-CLIMB PROOF CYCLONE FENCE TO THIS PT.
BASE LINE • NORTH PROPERTY LINE
3'0" MAN GATE
OVERFLOW BOX
EMERGENCY OVERFLOW/BYPASS LINE
10'0" TRUCK GATE
3'0" MAN GATE
WEIR BOX
3'0" WIDE 2" THICK SHELL WALKWAY
36" VCT OUTFALL PIPE
40'0"
EQUALIZATION BASIN
T-701
25 H.P. A-105 M-123
25 H.P. A-106 M-124
V=545M gallons
156'0"
331.01'
OUTLINE OF AERATED AREA
SLIDE GATE
T-702
AERATION BASIN
A-107 M-125 40 H.P.
A-108 M-126 40 H.P.
A-109 M-127 40 H.P.
A-110 M-128 40 H.P.
V= 824,900 gallons
SLIDE GATE
RE-AERATION BASIN
A-115 M-123 10 H.P.
T-705
V=37.7M gallons
35'0"
44'0"
M-136 T-704 CLARIFIER
V=132M gal.
PARALLEL/SERIES BOX
P-510 M-134
P-511 M-135
OCCUPIED HOUSE
OVERFLOW DRAIN
T-703
AERATION BASIN
40 H.P. A-111 M-129
40 H.P. A-112 M-130
40 H.P. A-113 M-131
40 H.P. A-114 M-132
V= 826,900 gallons
SLIDE GATE
SLIDE GATE
OUTLINE OF AERATED AREA
T-706 SLUDGE BASIN
143'0"
87'0"
336'0"
331.00'
ROAD EASEMENT
NEW ROAD
10'0" TRUCK GATE
SEE DETAIL "A"
EXIST. POWER POLES
SLUDGE TRUCK FILL CONNECTION
6' CLIMB PROOF CYCLONE FENCE
694.14'
E-7,963.93
N-12,602.36
NOTE:
BASIN AND ROAD EDGES ARE PARALLEL OR PERPENDICULAR TO THE NORTH PROPERTY LINE. THE BASE POINT FOR MEASUREMENTS IS THE NW CORNER OF THE PROPERTY.
= TREATED WATER PIPES
= SLUDGE PIPES
℄ RELOCATED BAYOU (NOW EXISTING)
REFERENCE DRAWINGS:
PT-133-42-2-D OVERALL PLOT PLAN
PT-133-75-1-D BASIN PLAN AND DETAILS
PT-133-75-2-D SLIDE GATE DETAILS
ITEM NUMBERS
T-701 EQUALIZATION BASIN
T-702 AERATION BASIN
T-703 AERATION BASIN
T-704 CLARIFIER
T-705 RE-AERATION BASIN
T-705 SLUDGE BASIN
T-707 CAUSTIC TANK (FUTURE)
A-105 AERATOR
A-106 "
A-107 "
A-108 "
A-109 "
A-110 "
A-111 "
A-112 "
A-113 "
A-114 "
A-115 "
M-123 AERATOR MOTOR
M-124 AERATOR MOTOR
M-125 "
M-126 "
M-127 "
M-128 "
M-129 "
M-130 "
M-131 "
M-132 "
M-133 "
M-134 PUMP MOTOR
M-135 PUMP MOTOR
M-136 CLARIFIER MOTOR
P-510 PUMP
P-511 PUMP
A.F.E. 1-34-0900

III. Theory of Biological Oxidation

The "secondary treatment system" for the VCM Plant is designed to upgrade the water effluent in many ways. The heart of the system involves "biological oxidation" of organic compounds in our effluent into harmless carbon dioxide (gas), liquid water, and biological cells. This "biological oxidation" is different from most other chemical plant operations, so it will be described in detail in this section.

"Biological oxidation" takes place by the following chemical reaction:

Gaseous Oxygen	+	Neutrients	+	Liquid Organics	=	Carbon Dioxide	+	Liquid Water	+	Hydrochloric Acid	+	Solid Biological Cell
O_2	+	Phosphates & Ammonia	+	EDC VCM ETCl, etc.	=	CO_2	+	H_2O	+	HCl	+	$C_5H_7NO_2$

The basic process can be seen to be a conversion of organics such asEDC from a liquid form into a larger sized organic molecule in solid form. Once solid organics are formed, they can be settled (decanted) from the effluent water in a special settling tank (called a clarifier) and removed as a concentrated solid organic containing some entrapped water. The effluent water will normally contain about 0.4% of organics by weight and the solids stream about 1.0% of organics. This solids stream (dead biological cells) is usually called "sludge" and the process used to form it (our secondary treatment process) is called an "activated sludge" process. Our particular type of activated sludge process treats the effluent water for much longer time than usual and therefore, is called an "extended aeration" type of activated sludge process.

Biological oxidation very simply stated is the process of growing tiny bacteria (animals) from organic wastes (equivalent to food) and nutrients (similar to fertilizer or vitamins). The tiny bacteria grow very fast under the proper conditions (double in number every 15 minutes), then later die off after all organic material is gone (starvation), and are removed as a solid, dead, bacterial sludge which is fairly easy to handle and is non-toxic.

However, several conditions must be met before the bacteria will grow rapidly. These conditions are:

1) Temperature - Not over 130°F nor less than 50°F. (90 to 100°F is the ideal condition).
2) Food - There must be some organics available to allow bacteria to grow, the more organics, the faster the growth rate.
3) pH - The pH of the water must be between 6.5 and 8.0 for cell growth. The optimum is between 7.0 and 7.5.
4) Nutrients - There must be sufficient phosphates and ammonia to permit fast cell growth. Without these nutrients, cell growth is very slow. For every 1000 ppm of organics, 60 ppm of NH_3 is needed, plus 30 ppm of phosphates (PO_4) to obtain optimum growth.

5) Mixing - To get rapid bacterial growth the water must be completely mixed so that oxygen, organics, nutrients, and bacteria all contact each other frequently.
6) Oxygen - There must be enough oxygen (obtained from air) dissolved in the water to oxidize the organics into bacteria. This requires about 1.5 ppm of O_2 for each 1 ppm of organics removed and is provided by high speed agitators which mix air and water together.
7) Toxic Materials - Several metals are toxic to bacteria and kill them off. Copper and chromium are slightly toxic in the amounts found in our effluent. Some organics such as phenols and chlorinated benzenes are also toxic in concentrations of about 100 ppm. Most bacteria will get used to toxic materials if the concentration is not extremely high and is fairly constant.
8) Time - Usually 8 hours is the minimum time needed to convert organics into bacteria. However, longer retention times imrpove the conversion rate. Anything over 3 days is considered good, over 10 days is considered excellent.

If all of the above 8 items are optimized, then the organics conversion into bacteria will be almost complete. The VCM Plant system is expected to get over 90% conversion and may reach 95% at some times. This conversion is <u>only</u> of organics into biological solids, most inorganic materials are not affected by this process. Since both ammonia and phosphates are consumed in biological cell growth, these two inorganic chemicals will be partly removed from the effluent water.

IV. Equipment Description

The VCM Plant's secondary system has seven main sections as listed in Section I of this writeup. The purpose of each section is as follows:

1) The pH Control System (See Section X for details)

This system will change the plant effluent pH from about 3.0 to about a 7.0 pH (the best value for activated sludge treatment systems). In addition, this system can compensate for any pH change caused by breakdown of chlorinated organics into hydrochloric acid. Additional caustic can be added in the pH control system so that the effluent from the treatment system is still 7.0 even with HCl formation in the system.

2) Equalization Basin (located south of the VCM Plant)

This pit will contain over 16 hours of plant effluent water (depending on flow rate) and has two 25-H.P. mixers floating in the middle of the basin to mix the water completely and also add air to it. This mixing blends out most pH, organics, or temperature surges caused in the plant and allows the "biological oxidation" to operate at steady conditions without any upsets.

3) Aeration Basins (2 units-located next to the Equalization Basin)

These basins are the heart of the activated sludge process. It is in these basins that organics are converted into biological cells. Each basin has four 40-H.P. mixers which provide strong mixing of the entire basin plus add the oxygen required by this process. The two basins are piped up so that they can be operated in parallel, in series, or either one separately. Normally they will be used in series operation since this gives a two stage reaction which should improve conversions. Each basin will hold 2.1 days' of water at a 700 gpm effluent rate or 4.2 days each at the normal 350 gpm effluent rate. With both basins in service, retention time will be from 4.2 to 8.4 days. Biological sludge (separated in the clarifier) is recycled back to the inlet of these basins to give a "seed" or small bacterial concentration to allow rapid bacterial growth in the basins. All aerators in these basins are connected to timers which allows them to be automatically cycled on and off to allow for varying organic loads on the system. Turning off individual aerators for periods of up to 30 minutes will reduce electrical cost, will add less oxygen to the water, but will not affect mixing very much. By proper sequencing of the timers, each basin can be kept well mixed but with a varying amount of oxygen added (and electrical power used). Expected operation will be with each aerator on 50% of time but cycled to start at different times.

4) Clarifier and Sludge Pumps

This device is a 50-foot diameter, 9-foot deep, circular, concrete tank which settles out the solid biological sludge plus any inorganic precipitates present. The solids will settle to the bottom of this tank and are then pumped out as a 1% by weight slurry by one of the two horizontal centrifugal pumps. A motor-driven rake rotates very slowly inside the bottom of the clarifier to plow sludge into the pump suction line. The pumps can pump up to 800 gpm each but will normally return about 200 gpm of sludge and water to the inlet of the aeration basins. The clarifier tank has a 2-hour residence time at design conditions (700 gpm effluent rate and 300 gpm sludge recycle) or 4 hours at the normal conditions of 350 gpm flow and 200 gpm recycle. One pump will normally be a spare. Intermittently, some sludge will be diverted to a sludge holding basin for disposal. Both pumps are piped up to allow valving to either of the aerated basins or the sludge holding basin.

5) Re-aeration Basin

This basin has a simple 10 H.P. aerator designed only to add oxygen to the clarifier overflow stream. In order to meet state water quality standards, effluent water must have at least 4 ppm of O_2 dissolved in it. The re-aeration basin will hold the clarifier effluent water for 50 minutes to 1-3/4 hours while the aerator adds extra oxygen to the water.

6) Sludge Holding Basin

This is a dirt-lined basin designed to hold about 45 days' output of excess sludge removed from the secondary system. Since bacteria are formed in the aeration basins, some method of removing them from the system must be provided. This is done by occasionally (about once/shift) pumping a definite volume of clarifier sludge into the sludge holding basin. This basin will allow the sludge to compact or settle further so that the sludge density may increase to 2.0% by weight solids. The excess water will overflow into a pipe leading to the re-aeration basin where it is blended in with the main effluent stream. Sludge will then be pumped into tank trucks by means of the spare clarifier sludge pump (which can also be valved to take suction from the sludge basin). It is expected that about one truck/day (5000 gals.) will have to be removed from the plant. However, the exact volume of sludge will depend on the concentration of organics fed into the aeration basins each day.

At a future date, further modifications will probably be made to this sludge disposal system.

7) Measuring Instruments

In the electrical building there are four recorders to measure (not control) the final effluent water as it passes out of the system. There is a rectangular box directly behind (east) the electrical building which contains a "V notch weir" for flow measurement plus probes for temperature, pH, and dissolved oxygen. These recorders will have ranges as follows:

a) Flow - 0 to 1000 gpm - alarm on increase above 800 gpm.
b) Dissolved O_2 - 0 to 15 ppm O_2 - alarm on decrease below 5 ppm.
c) Temperature - 25° to 125°F - alarm above 90°F.
d) pH - 2 to 12 pH - alarm above 8.5 pH or below 6.0 pH.

All of these alarms are tied into a common trouble alarm circuit which will give a general trouble alarm in the main VCM Plant control room. In addition an alarm for high motor load and/or motor shutdown on the clarifier drive and sludge pump shutdown is tied into this general trouble alarm. A Gaitronics outlet is also provided at the electrical building for communication purposes.

V. Normal Operation

The usual operating system will be:

a) pH control at 7.0 within the plant by caustic addition.
b) Baffles set in the system so that flow is in series through the aeration basins.
c) Both aerators (A-105 and 106) on in T-701 (Equalization Basin).
d) 50% of the aerators in T-702 and T-703 (1/2 to each basin).
e) Clarifier rake rotating at 2 RPH full time. -2RPD - 10/13
f) One sludge pump (either P-510 or 511) recirculating about 200 gpm back to the inlet of T-702 and T-703 (1/2 to each basin).
g) The reaerator (A-115) in operation.
h) Sludge pumps diverted to the sludge holding basin for 10 min/shift.
i) One tank truck/day filled with sludge from the sludge holding basin (or 7 trucks in a single day each week).

The pumper/loader will be responsible for control of the secondary system except for the in-plant pH control system which will be operated by a boardman. The pumper/loader will be expected to visit the secondary system at least once/shift in order to visually check all moving equipment, take recorder readings, check motor ammeter readings, and to visually inspect for proper system operation. During each visit he will have to divert the sludge recycle to the sludge holding basin for about 10 minutes; the exact time will depend on analytical tests. During the day shift visit, any sludge truck(s) should be loaded, water sampling done (to be described in Section IX, and any aerator timing changes made. It is expected that the day shift visit will take about 1/2 hour while the night visits will take about 1/4 hour, if everything is operating well. A data sheet (see attachment) will be filled out on each visit and kept in the control room. Area lighting will be automatically switched on by photocell as needed, except for the building interior lights.

The basis for making adjustments is as follows:

1) <u>pH of Input to Secondary System (Effluent of pH Control System)</u>

During startup of the secondary system or after any upset, the pH should be held at 7.0 as closely as possible. If the secondary system effluent pH rises above 8.0, the input pH should be lowered in order to get below pH 8.0. If the effluent pH decreases below 6.5, then the input pH should be increased to stay above 6.5. The ideal effluent would be about pH 7.5. The input pH should generally be kept as low as possible without exceeding the pH limits (listed above) for the secondary effluent. This should be done in order to minimize caustic used by the pH control system.

2) <u>Flow Pattern through the Two Aeration Basins</u>

Valve the series/parallel box for series operation if possible. This will give the best possible operation of the basins. If trouble develops in either basin it can be isolated, or valved in parallel to minimize the upset in the other aeration basin. The last wooden baffle in the series/parallel box will be used to hold a constant level in the equalization and aeration basins and acts like a calibrated weir (or dam). Be sure the correct baffle is used in this box. Isolating a single basin can be done by inserting baffles in the slide gates at each end of the aeration basin which will be out of service.

3) Equalization Basin Aerator/Mixers

The basin is designed solely to smooth out rapid changes in pH, temperature, and dissolved organics. If foaming problems develop, one of the mixers should be shut off. Both mixers can be turned off if severe foaming problems develop. Frequent checks of the basin should be made to make sure that no floating material is present which could be sucked into the mixers and damage them. If a mixer develops a strong tilt or sinks lower in the water (indicating a water leak in the float) it should be immediately shut down and removed from the basin by maintenance.

4) Aeration Basin Aerator/Mixers

These aerators (the same type as in the equalization basin) serve two purposes, adding oxygen to the water plus mixing the basin. So long as any two adjacent aerators are not shut down for over 15 minutes no loss of mixing will occur. Therefore, the percent onstream time of these aerators (as set by the individual motor timers) is changed based on the organics content of the input water. Increasing organics content in the feed water will require a greater percent running time. If a major organics spill is known to occur, all aerators should be turned on full time for the next two to four days. Very good plant operations (i.e. organic levels very low in input water) may allow operation with only a 25% aerator operation. Each aerator (in the aeration basins only) is provided with a one hour recycle timer to permit adjusting each unit to the desired time cycle. Less than 25% on-stream time for all aerators should never be attempted, due to loss of mixing action within the basins.

5) Clarifier Operation (Solids Settling)

The clarifier is simply an open settling tank or decanter in which biological solids formed in the aeration basins (plus any precipitated salts) can settle to the bottom, be raked to the center of the clarifier's sloped bottom, and then be pumped out as a concentrated water/sludge mixture. The clarifier also has a skimming device to remove a limited amount of floating solids which are blended with the settled solids stream. The clarifier has only one moving part, the rake or settled sludge scraper system. This rake (similar to several plows) turns slowly (at 2 RPH) so that sludge settling is not disturbed, and pushes any settled sludge toward the clarifier center sludge outlet so that the sludge pumps can suck it out. Under normal conditions there will be a 2 to 3 inch thick layer of this sludge on the clarifier bottom. The clarified (sludge-free) water overflows from the outside upper rim of the clarifier through a sawtooth overflow dam. The saw teeth serve to distribute the water flow evenly around the rim to assist in sludge settling. Water to the clarifier enters through a center vertical pipe delivering the water at the top center of the clarifier.

One of the major problems in the secondary system will be floating sludge. If proper aeration basin conditions are not maintained, the first indication is usually a floating (or "bulking") sludge. Since the clarifier skimmer is quite limited in capacity, it will rapidly overload allowing sludge to overflow the clarifier rim instead of being recycled back to the aeration basins. If floating sludge (or foam) is noticed in the aeration basins or clarifier, the aeration basin conditions should be immediately checked to see what upset caused this trouble. Sudden pH, temperature, organics, or heavy metals changes can cause "die-off" of bacteria due to lack of mixing or dissolved oxygen. There are no adjustments to be made on the clarifier itself, all changes must be made either at the sludge pumps or the aeration basins.

6) Sludge Pumps (Two Units)

There are two identical centrifugal pumps designed to recycle sludge from the clarifier to either the aeration basins or the sludge holding basins. Either of these pumps can deliver up to 1000 gpm maximum at a 9 psig discharge pressure or 0 gpm at 16.5 psig (dead head conditions). Normal operation will be with one pump operating at about 200 gpm flow which will give a discharge pressure of 16.1 psig. Since no flow measuring device is available, the actual sludge flow must be estimated visually at the inlet pipes to the aeration basin. The exact flow rate is adjusted by throttling the gate valves on the sludge recycle lines. This adjustment will be based on experience after the system is in operation.

When excess sludge is to be put in the sludge holding basin, the block valves can be changed to divert the flow and a timed discharge into the holding basin will be used to estimate the amount transferred. The amount which must be transferred (or "wasted" as this operation is usually called) will be determined by two tests made on the aeration and the recycle sludge's volume percent solids. The exact volume percent required will also be found by trial and error after the system is in operation.

7) Re-aeration Basin

The clear overflow from the clarifier drains into a separate concrete lined basin containing a single 10 H.P. floating aerator. This basin will hold water for 50 to 100 minutes (depending on flow rate) while the aerator adds oxygen to the water. The sole purpose of this system is to increase the oxygen content of the effluent water from about 1.5 ppm O_2 up to the state requirement of 4.0 to 5.4 ppm (varies with effluent water temperature). The 5.4 ppm is required at a 40°F effluent temperature and the 4.0 ppm at 72°F or higher. An alarm on the effluent dissolved O_2 meter is set at 5.0 ppm which should easily be attained with this system. The aerator will run constantly and is expected to produce a 5.5 to 6.0 ppm dissolved oxygen concentration. No adjustment is possible on this system, except to turn off the aerator. A low dissolved oxygen alarm will usually be caused by lack of aerator operating time in the aeration basins, not a fault with the re-aeration basin.

Any water overflowed from the sludge holding basin is drained into the re-aeration basin and is blended into the plant effluent. Overflow of sludge through the overflow line should be prevented by pumping down the sludge holding basin into tank trucks.

8) Sludge Holding Basin

This basin is only dirt lined and has a capacity of about 450,000 gallons or an estimated 1.5 months' waste sludge production. Fresh sludge is pumped into the southwest corner of the basin intermittently by the operator and any displaced water, which has been clarified by settling, overflows into the re-aeration basin through a pipe set in the north end of the basin. Overflow of water should only be allowed if the water near the overflow pipe is clear and relatively solids free. If the water is full of sludge, then all excess water should be pumped into tank trucks for disposal as land fill elsewhere. The amount of "wasted sludge" which must be disposed of by truck will depend greatly on the "settleability" of the sludge and also the amount of sludge generated each day. Trucks should be loaded by the east sludge pump which can be valved to take suction from the north end of the sludge basin without interrupting the sludge recycle stream from the west pump. If the west pump is down for repairs, sludge recycle will have to be stopped while trucks are filled. Any sludge pumping from the clarifier to the sludge basin, must be done using the east pump. The west sludge pump can be left on or shut down during sludge basin filling, whichever is desired.

9) Instruments

All instruments except basin levels and sludge pump discharge pressure are in the electrical building. Ammeters are provided for all motors so that operating loads can be estimated. The clarifier rake drive has two microswitches set to alarm at 20% above normal torque and a shutdown of the drive at a still higher torque. All area lighting is photocell controlled with a manual override switch. Building lighting is manually controlled. A thermostatically controlled ventilator is installed in the electrical building roof which will keep the electrical gear from overheating.

SECONDARY TREATMENT SYSTEM
DATA SHEET

Week Starting

Day	Shift	Effluent Water Flow	Effluent Water Temp	Effluent Water pH	Effluent Water D.O.	Influent pH Before Control	Influent pH After Control	Electrical Data KWH Meter	Electrical Data Clarifier Drive,amp	Electrical Data Reaerator Amps	Electrical Data Pump Amps	Max. Aerator Amps	Pump Disch. PSIG	No. of Aerators in Service	Suspended Solids Vol % Clarifier Feed	Suspended Solids In Recycle Sludge	Sludge Transfers Gals into Hold Basin	Sludge Transfers Bbls Removed By Truck	Sludge Basin Level
	11-7																		
	7-3																		
	3-11																		
	11-7																		
	7-3																		
	3-11																		
	11-7																		
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	11-7																		
	7-3																		
	3-11																		

Special Remarks:

VI. Startup/Shutdown Procedures

1. Startup

No special precautions are required for startup. Normally the aerators should be started first, the clarifier drive soon after, and the sludge pump last. Time between starting each motor is not critical. After all motors are operating and water is flowing through the basins, the aerators should be put on time cycle and basin water level checked. Care should be taken to make sure that all floating materials are removed from the basins before starting the aerators.

2. Shutdown

No special sequence is required. In case of a power failure all motors will trip out and must be manually restarted. An alarm will be activated if either the clarifier drive or the sludge pump is not operating. After over a 4-hour power failure, all aerators should be run continuously for a few hours to resaturate the water with oxygen. Water flow will continue during power failures, since no pumping is used. It is possible that a clarifier drive overload could occur after a long power failure, due to large amounts of sludge settled out in the clarifier during the shutdown period. Operating both sludge pumps at high flow for a few hours should cure this problem.

3. Cold Weather Precautions

The water in the secondary system is fairly salty but will freeze at 28 to 30°F. If the weather drops below 28°F for over two hours, freeze precautions should be taken. The only equipment which can freeze is the sludge pumps and sludge piping. Sample valves should be bled as required and particular care taken to drain the idle pump (or else operate it) and to check the truck filling connection and the sludge line to the sludge holding basin. Ice in all the basins will be broken up by the aerators and the clarifier skimmer arm.

VII. Troubleshooting

1) Excessive Flow Rates

If over 1200 gpm of water enters the secondary system, the amount over 1200 gpm will bypass the treatment system by overflowing a weir in the inlet box (northwest corner of secondary system). This is unavoidable during heavy rainstorms, but should be avoided during normal plant operations. About 800 gpm of excess capacity (above normal effluent rates) will allow for washing columns, hosing down the area, or hydroblasting exchangers. However, rates above 1200 gpm should be avoided since some untreated water will bypass the secondary system. A high flow alarm is connected to the control room alarm circuit to warn of this problem.

2) Sludge "Bulking" or Floating

If the aeration basins (the two largest ponds) are upset, the sludge may tend to float or may not settle out properly in the clarifier. This is known as "sludge bulking" and is usually the first indication of an upset or bacterial die-off in the aeration basins. If bulking occurs, special laboratory tests will be needed to determine the cause of the upset. The only quick action which can be made is to put all aerators on 100% of the time. This will increase basin oxygen levels and may help the basins to restabilize. Any change in the color or density of the sludge in the aeration basins is a sign of a pending upset. When the basins are operating well, the water should appear cloudy or "milky" in appearance. The milky effect is caused by the bacterial sludge suspended in the water. Any change in the degree of cloudyness or its color indicates some change in the way or speed at which bacteria are growing.

3) Damaged Aerators

If any of the aerators "pick up" or pump any solids they will probably be broken. Special care should be taken to check all the agitated basins for any floating wood, plastic, bottles, etc. to prevent aerator damage. Minor damage will probably result in a noisy or heavy vibration of the aerator. An ammeter is provided for each aerator and normally should indicate a fully loaded motor (full load is approximately 1.2 amp/nameplate H.P.). Unusually high or low ampere readings should be investigated to determine the trouble.

4) Clarifier Rake Drive

The clarifier rake turns at 2 RPH and has both a skimmer on top and sludge plows at the bottom of the clarifier. The drive motor has a 20% torque overload alarm which will activate if excessive sludge buildup occurs in the clarifier bottom. The sludge pumping rate can be increased to rectify this problem if it occurs. There is also a motor shutdown alarm to warn of drive breakage or failure which could be caused by rocks or heavy trash in the clarifier bottom, or binding of the gear reducer system. An ammeter is provided to give an indication of the motor load (and therefore the drag on the rake arms).

VIII. Sludge Disposal

All activated sludge (biological oxidation) systems convert dissolved organics into a solid bacterial sludge. This sludge must eventually be removed from the secondary system as a by-product and is called "Waste sludge". In the VCM Plant's particular type of activated sludge system, about one pound of sludge will be formed for each five pounds of organics destroyed. The density of the sludge will vary greatly depending on the exact operating conditions in the aerated basins, but it usually is a very fluffy, jelly-like material which very slowly settles downward. When operating properly, the recycled clarifier sludge will be 5,000 to 10,000 ppm by weight sludge (must be measured in the laboratory) and the aerated basins will be 1000 to 3000 ppm by weight sludge. In order to get a quick check on proper operation, the laboratory will develop a relationship between % by weight of sludge and % by volume sludge. This will allow the pumper/loader to make a simple % volume sludge check (using 1 liter glass cones) each day and then pump the required excess sludge to the sludge basin based on the daily test. The required amount of "wasted sludge" can be determined as follows:

a) Find the ppm by weight % sludge in the recycle sludge system = A.

b) Find the ppm by weight % sludge in the aeration basins (clarifier feed = B).

c) Determine the ppm reduction desired in the aeration basins C = (B) - 3000 ppm.

d) Determine the "sludge wastage" required by:
Wastage (in 1000 gals) = $4200 \frac{C}{A}$

Example:

A = 1000 ppm (by operator test and lab chart)
B = 3100 ppm (by operator test and lab chart)

Therefore:

C = B - 3000 ppm = 100 ppm

and

Wastage (in thousands of gallons) = $4200 \frac{C}{A} = 4200 \frac{100}{10,000} = 42$
Wastage = 42,000 gallons of sludge.

At a sludge pump flow rate of 500 gpm this would require pumping the clarifier sludge to the sludge basin for a total of 84 minutes which should be divided equally into the next three shifts or 28-minutes/shift. This would represent a very large amount of waste sludge and would represent almost 1/10th of the sludge holding basins' volume.

When pumping out waste sludge from the clarifier, care should be taken not to pump too fast. Ideally, the waste sludge should be pumped at the same rate that the recycle sludge was being pumped when the recycle sludge was checked for ppm solids. Innage readings on the sludge basin can be used to give an accurate measure of the total sludge pumped each shift (see attached chart). These same readings can be used to determine how many sludge trucks must be hauled away each day. Each tank truck should hold about 5000 gallons of waste sludge.

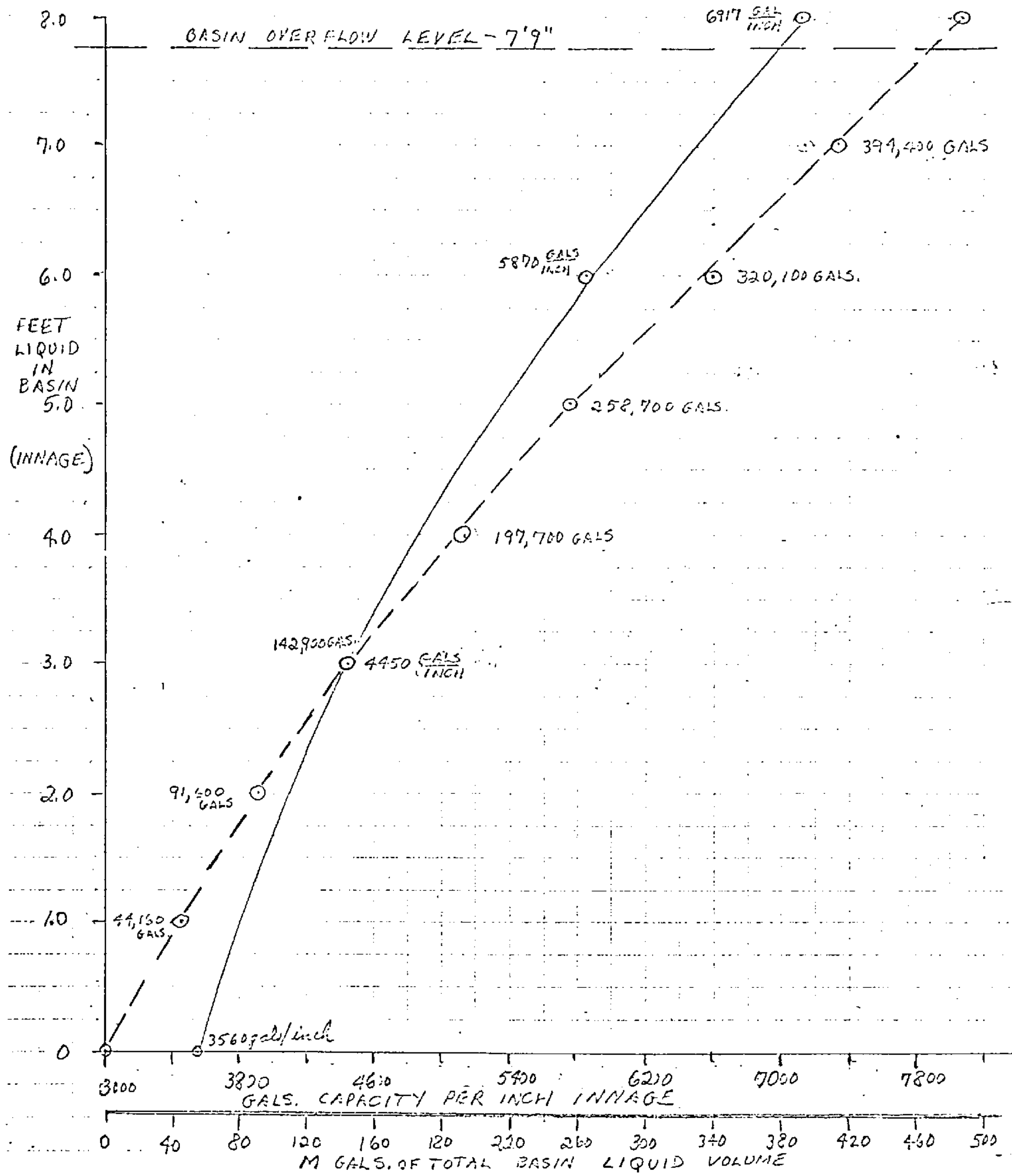
5) Major In-plant Spills

If a known major spill of any toxic chemical occurs, it can be trapped in one of the two large aeration basins. After the spill is trapped in an aeration basin, that basin can be isolated, and the other basin can handle the entire effluent stream. The isolated basin can then be treated in several ways before it is put back on line. If a basin is to be isolated, its sludge flow should be stopped well in advance of isolation. The aerators will normally be left on in the isolated basin. Simply holding the basin contents for several weeks under aeration will probably purify the water. Special laboratory tests will be used to determine the best treatment method to handle a spill after it has been contained.

6) Poor Organics (BOD) Removal in Treatment System

If laboratory tests indicate a high organics level in the final effluent water, several things can be wrong. These may be too little aerator operation in the two large ponds. This can be checked by a dissolved oxygen reading (special laboratory test) of the water entering the clarifier. If the dissolved O_2 is less than 0.5 ppm more aerators should be turned on. Poor sludge settling in the clarifier will also cause a high organics level in the effluent. This can also be checked by noting the suspended solids in the effluent water. This can be tested by taking an Imhof cone sample of the effluent water (outlet of reaeration basin) and checking the vol % solids. Any reading above 100 ppm (0.01 vol %) would indicate settling problems. A lack of rapidly growing bacteria in the aeration basins will also cause high effluent BOD levels. This can also be checked by an Imhof cone settling test, to determine if the re-aration basins' solids concentration has decreased recently. Major spills, pH changes, or heavy metals in the water can cause bacterial "die-off".

During VCM Plant catalyst outages, there is a strong chance of poisoning the ponds with copper from oxy catalyst washings if the in-plant copper removal system is not operating properly. Washing of columns can generate large amounts of nickel, chromium, and copper which can also poison the secondary system. Unusually large cooling tower dumps (such as the emergency dump system in C-500) can dump large enough amounts of chromium (cooling water treatment chemical) to possibly poison the secondary system. Special laboratory tests can determine any of these if they are suspected.



CONTINENTAL OIL COMPANY
CALCULATION SHEET

MADE BY J. D. MINOTT

CHECKED BY

DATE 2/3/72

JOB NO.

TITLE SECONDARY TREATMENT SYSTEM
SLUDGE BASIN INNAGE TABLE

CWH 000012062

IX. Laboratory Analyses

The pumper/loader will be responsible for getting a 24-hour composite sample from the secondary system effluent. The sample should be taken from the effluent weir box (behind the electrical building) using the sampling pump. The sample pump timer should be adjusted to give about two gallons in the plastic jug in a 24-hour period (about 3/4s full) and the jug should not be allowed to overflow. This composite sample should be taken on Sunday and given to the laboratory on Monday afternoon.

Each day shift the pumper/loader will also have to make a % solids (by volume) test on the recycle sludge and the aeration basins (or clarifier feed). These tests are made by taking a one liter sample (must be well mixed when sampled) into Imhof cones and letting the sample settle for 30 minutes. Plastic Imhof cones and a rack will be kept in the electrical building for these solids test. After settling the % by volume of sludge can be visually measured. This volume % measurement can then be converted to weight % using a chart which will be developed later from plant laboratory measurements. Until this chart is completed, laboratory weight % measurements will have to be used directly.

Plant Effluent pH Control System

A) General Description

In order to operate a secondary waste treatment system, the VCM Plant effluent must have a well controlled pH of about 7.0. Since the VCM Plant effluent presently has a 2.0 to 3.5 pH, it is necessary to add caustic solution to raise the pH up to the desired 7.0 value. This caustic addition is controlled by a fairly complex, two-stage pH control system in an agitated pit near the chlorine compressor building. The system is composed of the following equipment.

1) An acid/caustic resistant brick-lined pit located just east of the chlorine compressor building.
2) A 3 HP Lightnin agitator of Hastelloy construction located in the above brick-lined pit.
3) Three Foxboro caustic addition valves which discharge to the inlet of the above agitator. These valves are piped so that they are normally connected to the slops caustic tank (T-423) and its pump (P-424).
4) Three Foxboro pH controllers, board-mounted.
5) One 3-pen Foxboro pH recorder, board-mounted.
6) Three Universal interlock pH probes, all located near the brick-lined pit in the effluent water pipeline. These three probes supply the signal to the three Foxboro recorders/controllers and have local indicators in the chlorine compressor building.

This fairly complex control system is necessary in order to get a constant plant effluent pH. Rapid, large pH changes and large flow changes in the plant effluent will require a very rapid and accurate control system. The control system which has been installed, represents a new type of pH control developed by the Foxboro Company, and is called a "feed forward-feedback" control system. The system operates as follows.

1) pH probe No. 1 measures the incoming pH to the control system, reads out this pH on the indicator in the chlorine compressor building, records this pH on the 3-pen recorder in the control room, and also sends this pH signal to PHC No. 1.

2) PHC No. 1, a board-mounted pH controller in the control room, calculates the caustic needed to bring the effluent pH up to the set point on this recorder and opens PHCV-701 A&B to accomplish this. The set point on this controller should be set at 1 pH unit below the final desired effluent pH. Valve 701A is a small valve used for small changes in pH (up to 1 pH unit), 701B is about 10 times larger and is used for large pH adjustments (2 to 3 pH units). PHC No. 1 is also known as the "feed forward" pH controller.

3) pH probe No. 2 measures the outlet pH from the agitated pit after all caustic has been added and blended in. This pit will give a 3 to 10-minute average holding time and is highly agitated by a 3 HP propeller type agitator. This pH is indicated in the chlorine compressor building, recorded on the 3-pen control room pH recorder, and is also sent to the PHC No. 2 controller and the PHC No. 3 controller.

4) PHC No. 2, which is known as the trim pH controller, which will normally have its set point 1 pH unit higher than PHC No. 1 (i.e. the desired final pH), calculates the additional caustic required to attain its pH setting and opens PHCV-701C enough to get the desired pH. Note that the 701C caustic is added before this pH control loop, in the same place as valves 701 A&B. Valve 701C is the smallest valve of the three and is about 1/1000th of the capacity of the largest valve (701B). In order for the controller to be able to correct for both high and low pH errors above its set point, it must always be adding some caustic, so that high pH's can be corrected by closing off valve 701C. This is the reason for the different set points on controllers PHC No. 1 and No. 2.

5) PHC No. 3, also known as the feedback pH controller, does not control any caustic valves. Its function is to "feedback" or correct any errors in PHC No. 1 control. It sends a signal to PHC No. 1 which will compensate for any flow changes and helps to "smooth" out sudden over-corrections of pH in the agitated pit. The set point on this controller will be the same as on PHC No. 2. Since PHC No. 3 directly adjusts PHC No. 1, the valve opening indicators on these two controllers do not indicate an actual valve opening. A dial meter just below these two controllers indicates the combined position of caustic valves 701A&B, so that an estimate of caustic usage can be made.

6) pH probe No. 3 is located in a second pit (not agitated) about fifteen feet downstream of probe No. 2. This probe is used only as an indication of final "controlled" pH and is only indicated in the chlorine compressor building and recorded on the control room 3-pen recorder. This probe is the "smoothed" pH and should be used as the basis for setting all the controllers. The only reason for this probe is to get a steady (smoothed) pH signal averaged over several minutes time. The volume of the connecting piping and the second pit will "smooth" out most sudden pH changes so that system performance can be observed.

B) Startup Procedure

1) Turn on agitator (A-116). Switch is next to motor.

2) Check that all three pH probes are recording on the control room 3-pen recorder.

3) Start up slops caustic pump (P-424) if not already on, and valve caustic to the control valves. This same caustic line feeds the T-252

pit neutralization system, the chlorine vent absorption system, and drains in the T-1 and T-500 pits. If no slops caustic is available, 50% caustic solution can be valved into the pump suction. Pump discharge pressure should be 15 to 20 psig.

4) If cold weather is possible (below 50°F) turn on the 4-steam tracing feeds to the caustic line. Caustic temperature can be noted on the thermometer next to the control valves. Steam tracing should not be turned on unless required. Caustic temperatures over 150°F should never be permitted, or rapid line corrosion will occur.

5) Put all three controllers on manual in the off (caustic valve closed) position. Slowly add caustic manually by PHC No. 1 unit until the desired pH is reached (1 pH unit below final desired), then put this controller on automatic.

6) After PHC No. 1 has lined out; repeat the same procedure with PHC No. 2 (the trim controller) and set its pH set point at the final desired pH. Put the controller on automatic when lined out.

7) Put PHC No. 3 (the feedback controller) into service last and check that its operation does not upset the other two controllers. The set point should be the same as PHC No. 2.

8) Check the reading on the "smoothed" pH recorders and adjust the setting of the "trim" and "feedback" controllers as required to get the "smoothed" probe pH to read 7.0 (or whatever other pH is desired).

C. Special Problems

1) This system cannot control surges of pH above 7.0 since only caustic is used for control. If above 7.0 pH's occur, it will be necessary to add anhydrous HCl to the T-252 pit neutralization system so that the effluent drops down to 7.0 or less. This condition should only occur during extended shutdowns of the oxy system or bad upsets in the caustic wash system.

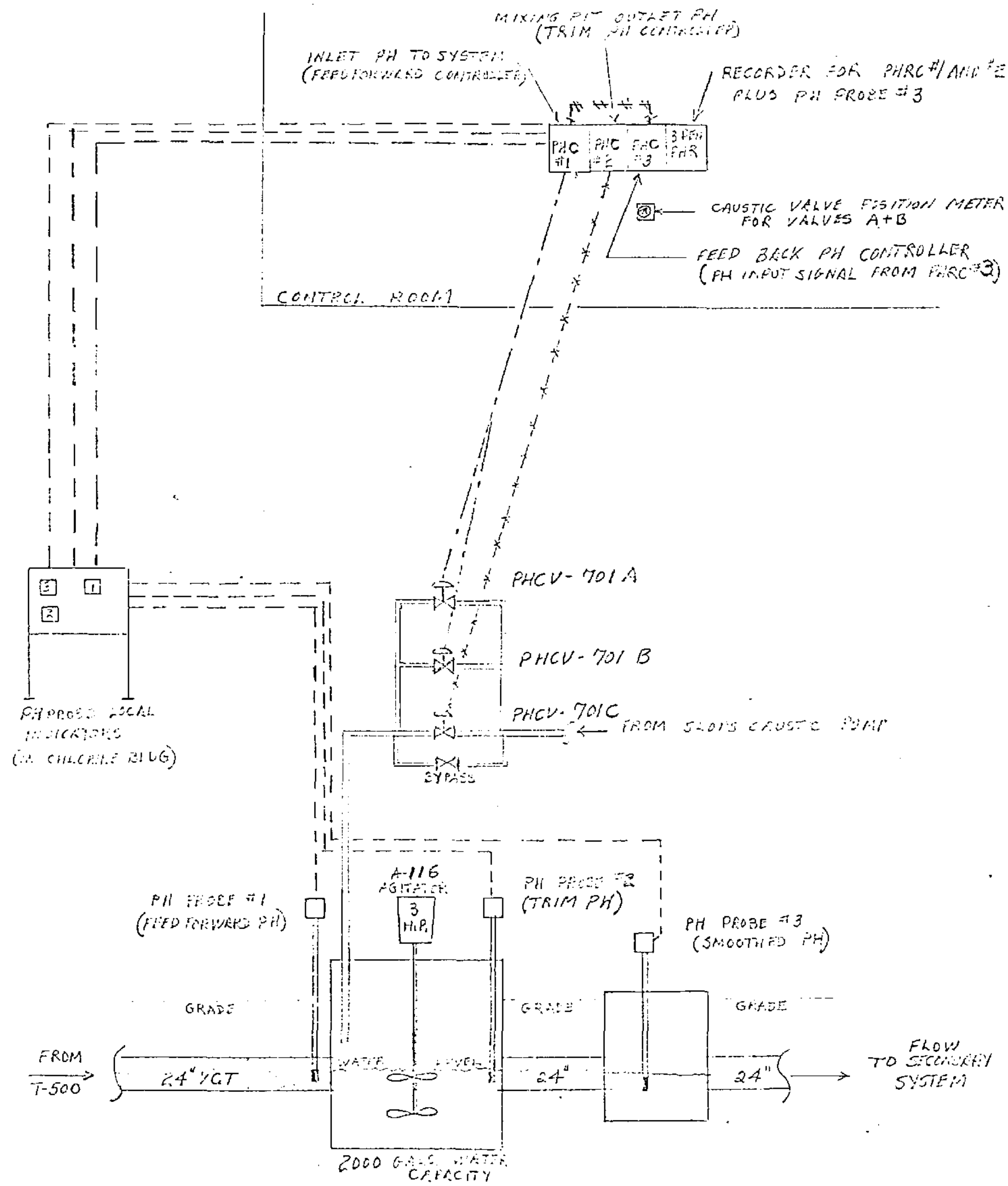
2) The exact pH required by the plant secondary treatment system will change slightly from time to time. During secondary system start-ups (or if the secondary system is not operating) a 7.0 pH should be used as the control point. After the secondary system is lined out well, attempts will be made to operate with lower pH's. These lower pH's will be buffered out in the secondary system by the natural alkalinity formed during biological oxidation of the effluent. The lower pH values will also reduce caustic consumption greatly, thus reducing the amount of purchased 50% caustic solution. The exact pH desired for any period will be specified in the daily instruction book.

3) Either of the pH controllers can be operated manually if necessary. The "trim" controller does not have enough caustic valve capacity to adjust more than 1 or 2 pH units, but the "feed-forward" controller can handle any load. The combined system should be able to raise a 1.0 pH up to 7.0 ± 0.5 pH units when in good control.

4) This control system has no effluent water flow measurement device installed, so the caustic addition calculators (built into the controllers) will be in error any time a major effluent flow rate change occurs. The "feedback" controller will compensate for this error, but will take several minutes to do so. Since pH measurement is a logrithmetic function (each pH unit lower is actually 10 times as much acidity) and flow changes are only a linear change, a flow change would have to be very large to even equal a pH change of 0.5 units (i.e. - a pH change of from 3.0 to 2.5 would be equal to a flow increase of 3.15 times at a constant pH). The pH control system will be calibrated for the present normal plant flow of about 250 gpm.

5) If the A-116 pit agitator is out of service, the system can be operated, but will probably "overshoot" on pH control badly. It will probably be necessary to operate by manual control only.

6) Since EDC fumes and splashed caustic can be present inside the mixing pit, special care should be taken if the pit cover is opened for inspection. Normally the agitator should be turned off before the top is removed.



C.I. MINOTT

6/24/71

PLANT EFFLUENT PH
CONTROL - FLOW SHEET

CWH 000012068