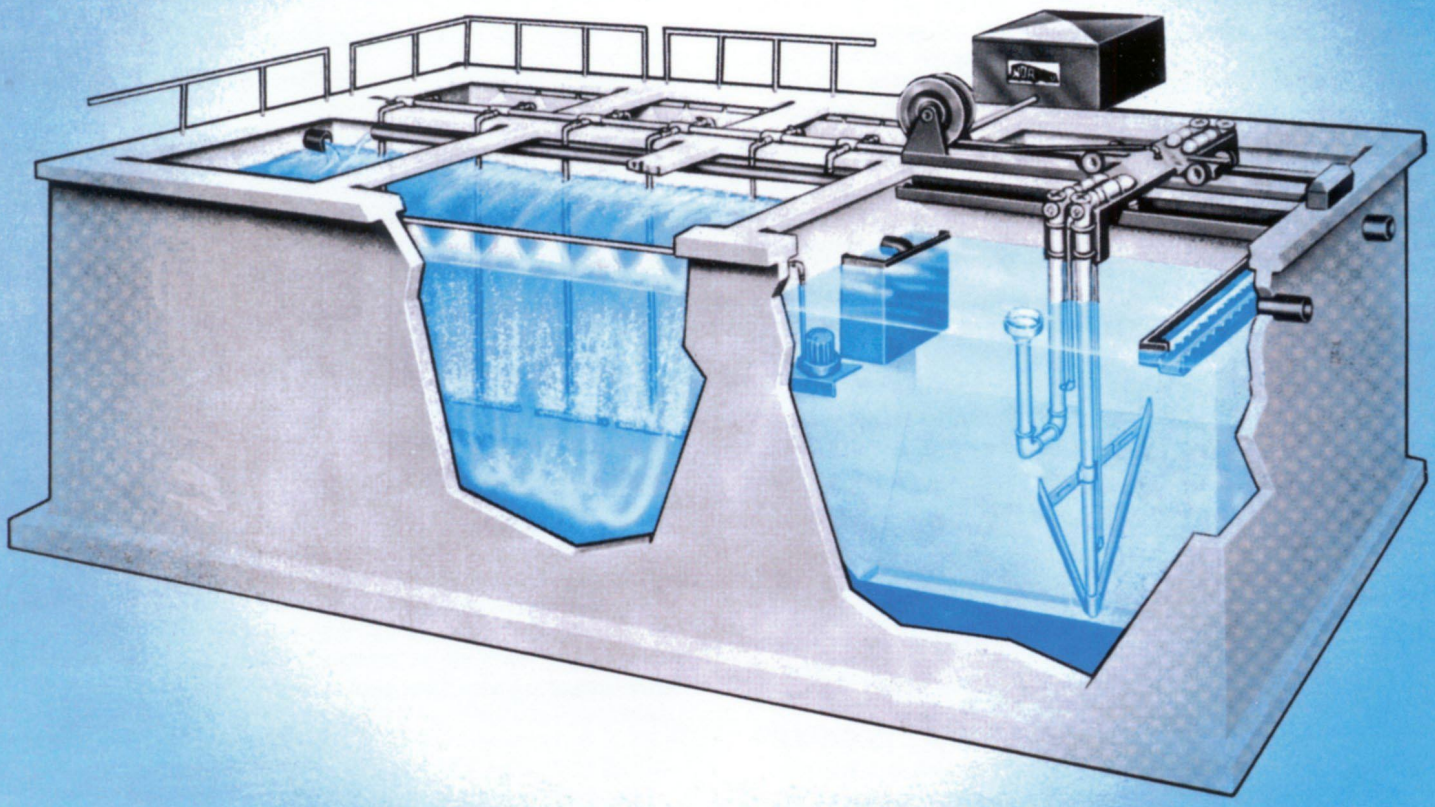
NORWECO

PLANT OPERATOR'S MANUAL



Progress Through Service Since 1906

I. FOREWORD

Daily care and operation of a wastewater treatment system plays a major role in determining the degree of treatment attained. Plants may be properly sized and adjusted yet produce sub-standard results because of a lack of operational control.

Complete instructions for operating your Norweco wastewater treatment system are given in this manual. By familiarizing yourself with the system and the contents of this manual you will be able to obtain superior treatment results.

Originally founded in 1906, Norweco has years of experience in the pollution control field. “Progress through service - since 1906” sums it up nicely. Norweco equipment is currently in use in thousands of places throughout the world - hundreds of manufacturers in the pollution control field, large and small alike, are now using Norweco equipment.

Norweco systems are installed and serviced only by factory trained dealers. A quality product - serviced by a local expert - has earned Norweco a reputation for excellence.

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Norweco Operation and Maintenance Manual

III. INTRODUCTION

Norweco wastewater treatment plants operate on the Extended Aeration principle using microscopic organisms, in the presence of oxygen, to destroy organic compounds in the sewage. Incoming wastewater passes through three progressive stages of treatment before being discharged from the plant. In addition, a number of accessory treatment devices may be added to the basic system to provide even higher purification. These optional devices vary according to individual requirements and are described in the "Optional Equipment" section of this manual. However, the basic treatment process does not change and is as described in the following pages.

PRE-TREATMENT

First, incoming sewage passes through a conditioning device that removes untreatable objects and prevents them from entering the aeration chamber. Pre-treatment or conditioning may be accomplished by using a comminutor, bar screen or trash trap. Trash traps are holding tanks used to settle out untreatable objects, bar screens merely screen incoming sewage and comminutors grind and screen the sewage before passing it to the second phase of treatment.

AERATION

After pre-treatment, the conditioned wastewater enters the aeration chamber of the plant where the bulk of the organic compounds are eliminated. Norweco's aeration chamber is designed to hold the wastewater for twenty-four hours while aerobic bacteria, present in the chamber, destroy the organic material. To obtain such complete treatment in just twenty-four hours it is necessary to provide just the right environment for the bacteria. This is accomplished by the controlled introduction of oxygen into the chamber. Norweco's unique "Evenair" diffusers are designed just for this purpose. They are installed in the bottom of the chamber to provide even distribution of oxygen into the aeration tank. Stimulated by the abundant supply of oxygen, the bacteria multiply rapidly and are thoroughly mixed with the tank contents to insure complete oxidation of all organic material.

CLARIFICATION

After twenty-four hours in the aeration chamber the liquid flows into the settling/clarification chamber. Settling is provided to remove activated sludge and small organic particles suspended in the liquid so the purified effluent may be discharged from the plant. The lower sidewalls of the chamber are slanted to form a hopper. As the suspended particles settle toward the bottom they are guided into a small area in the center of the hopper by the slanted sidewalls. Here the particles are picked up by the airlift sludge pump and returned to the aeration chamber for final treatment. This process of removing the activated sludge and suspended particles from the liquid leaves only a clear, highly treated water at the top of the chamber. It is this clear, odorless liquid at the top of the tank that is discharged from the system.

IV. INSTALLATION

Norweco wastewater treatment systems are sold, installed and serviced by factory trained Norweco distributors. They are fully trained regarding installation of Norweco products and are able to provide all necessary job coordination to insure a simple, economical installation.

Norweco systems are sold as complete installations including delivery, tank setting, equipment installation, start-up and service. This unusual "complete sales policy" greatly simplifies plant installation for the owner and eliminates hidden charges for items such as freight, equipment start-up, tank installation, etc.

Work that is not included with the Norweco system must be checked for completion by the owner before start-up of the plant. Plant excavation, tank pad, backfill, influent and effluent sewer lines, electrical power to the equipment, filling of tanks with water, finish grading, landscaping and seeding are not included with the plant. Generally, they are the responsibility of the general contractor or excavating contractor and the plant owner must insure that these items are taken care of prior to equipment start-up.

Excavation for the wastewater treatment plant should be coordinated with the Norweco distributor to insure that the system is installed as soon as possible after completion of the excavation. Generally, the excavation should be at least two feet wider and two feet longer than the treatment plant and at least four inches of sand should be placed in the bottom of the excavation.

The excavation should be free and clear of all obstacles on at least two sides to permit entrance and setting of individual tank components. Be sure to consult your local Norweco distributor prior to plant excavation if this causes any unnecessary problems.

SAND LEVELING PAD

Four to six inches of sand or very fine stone should be placed in the bottom of the excavation to provide a leveling course for the individual tanks in the treatment system. This will permit speedy installation of the components and eliminate the excess work, time and expense required to manually level the bottom of the excavation. The pad permits the bottom to be leveled perfectly so that all tanks and components will align at grade in the completed system. It also provides protection for the bottoms of the individual tanks and prevents any unnecessary strain on the tanks after they have been filled with water.

In special cases where soil conditions are particularly poor it may be necessary to install a poured concrete pad in the excavation. This, of course, must be determined with regard to your particular location.

BACKFILL

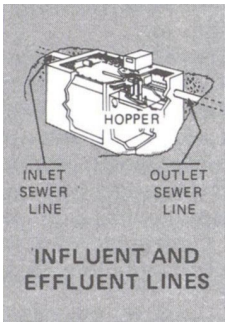
After the tanks have been set, the contractor must backfill between each tank and around the outside of all tanks. All fill between individual tank sections must be sand or very fine stone. Backfill around the outside of the tanks can be with the original material. However, care must be taken to insure that no large clumps of earth or rocks are pushed in against the tanks. Caution the excavating contractor to take care while backfilling in and around all tank sections of the wastewater treatment facility.

FILLING of TANKS WITH WATER

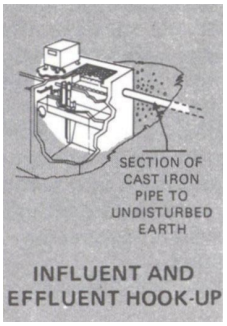
Individual tank sections and components of the treatment facility should be filled with water as backfilling is taking place. Tanks should not be allowed to sit overnight without water in them because they may float if large volumes of surface water enter the excavation. If possible, the tanks should have water in them to a level equal to the level of the backfill. By backfilling and filling the tanks with water at the same time you will eliminate all unnecessary pressure on the tank and related structure.

SEWER LINES

Installation of influent (inlet) and effluent (outlet) sewer lines are the treatment plant owner's responsibility. All lines must be installed in accordance with State and local codes and several precautions should be taken in the immediate area of the wastewater facility. First, be sure all lines to and from the plant, as well as other sewer lines connecting individual elements of the plant, are installed on good solid fill. Loose fill that might settle later on may create a low spot or leak in the line. Be sure to discuss hook-up of the lines to the tanks with your Norweco distributor. Check to insure that all lines are installed at the correct location and the proper elevation. Where possible, a one piece section of cast iron should be used from the tank wall to a solid section of undisturbed earth beyond the limits of the plant excavation. Although in certain cases this is not possible, special precautions should be taken to insure that the lines are on solid fill with as few joints as possible.



INFLUENT AND EFFLUENT LINES



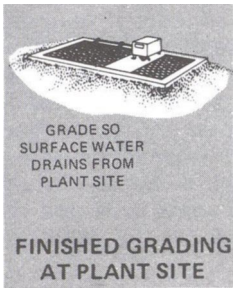
INFLUENT AND EFFLUENT HOOK-UP

ELECTRICAL POWER

Underground electrical power must be brought to the plant site for hook-up of the individual treatment plant components. General information as to the overall horsepower rating of the system and related equipment, as well as other electrical needs, should be obtained from the Norweco distributor. In most cases, it is desirable to bring the electrical power to the plant site underground and up and out of the ground immediately adjacent to the treatment plant. Here a master disconnect switch must be provided to cut power to the entire facility. Ask your Norweco distributor about the electrical requirements and be sure a properly sized disconnect is provided. Detailed instructions for distribution of power from the master panel to the individual components of the wastewater facility will be provided by your distributor. Individual wiring diagrams of the control panels and other elements within the system will also be provided by the Norweco distributor. Have your electrician complete the electrical hook-up but do not have him place any of the equipment into operation. After the electrical hook-up is complete and the other elements of the plant installation are taken care of contact the local Norweco distributor and have him start-up the individual elements.

GRADING, LANDSCAPING, SEEDING AND FENCING

Finishing touches and earth work around the sewage treatment system are important parts of the overall installation. Grading, landscaping, seeding and other related items will make a difference in the finished appearance of the plant and also may have an effect on the operation of the system.



FINISHED GRADING AT PLANT SITE

Grade around the treatment plant must be set up so that surface water does not drain to the treatment plant area or into the top of the treatment plant proper. The elimination of surface and storm water from the sanitary sewage flow and treatment facility must be considered prior to installation.

Fencing should not be overlooked when a system is installed. A fence protects the system from malicious damage and eliminates entrance by unauthorized persons. It may also eliminate an accident with domestic animals or children in the area. Many plant owners construct attractive red wood or lattice work fences and completely conceal their treatment system. When the plant is located in an area that does not require special landscaping the use of a seventy-two inch chain link fence is recommended.

JOB RESPONSIBILITIES

Prior to the installation of a plant a clear definition of responsibility should be given to all of the parties involved. It is an important factor and will affect the overall cost and time required to install the plant. The best way to save time, money and headaches when purchasing or installing a wastewater treatment facility is to have a meeting with all of the parties involved prior to the start of any work. The owner should contact the engineer in charge, the general contractor and/or the excavating contractor, the electrician and the Norweco distributor. Exact requirements for the excavating contractor and electrician may be obtained from the Norweco distributor. Have him work with the project engineer to insure that all equipment is provided as detailed in the original plan and approved drawings.

PLANT OPERATOR

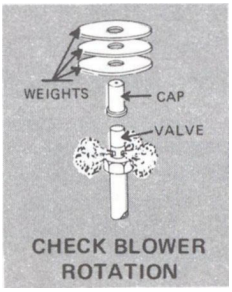
The owner must appoint a qualified person as the operator of the wastewater treatment facility. During the first twelve months of plant operation the Norweco distributor will make at least ten inspections of the facility to adjust equipment and service the system. The operator should meet with the distributor during each visit to get a clear understanding of the overall system and the function of each element within the system.

Several types of standard service policies are available to provide regular qualified service after the initial one year policy expires. However, it is still necessary to provide routine maintenance and service of the system on a daily basis.

Day to day operation of the system will be the main factor involved in determining the treatment results. It is most important and should never be overlooked when a system of this type is installed.

V. PLANT START-UP

Start-up of a wastewater treatment system must be completed before it will provide the results intended. Although a treatment plant is selected for a particular application and accessory elements are added to enhance its operation, it must be adjusted and each element must be set to function correctly for the particular conditions existing in the facility it is serving. Plants may be properly sized and accessory equipment may have the proper capacity but unless each element is adjusted to suit the situation, the equipment will very likely not do its job as well as intended.



CHECK BLOWER ROTATION

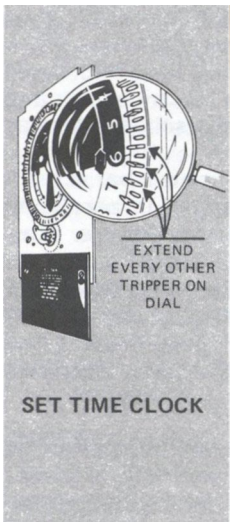
Aeration rates, sludge return rates and mixing velocities must be adjusted within the system to provide the best possible treatment results. Chlorination stations must apply just the right amount of chlorine at the right time to provide the disinfection required. Tertiary filters must be dosed with the proper volume of effluent to provide optimum filtration. Lift stations must be adjusted to automatically dose at levels that will not surcharge other elements of the treatment facility and at intervals that will not cause unnecessary wear on the pumps and related equipment. These items and many others like them must be considered during start-up. Each individual element of the facility must be adjusted to enable it to provide the best possible results.

Norweco distributors spend a great deal of time and money in the care and start-up of a plant. They adjust the equipment on a bi-weekly basis for the first eight to twelve weeks of plant operation to insure that all phases of start-up have been completed. The operator must understand the role these adjustments play in the operation of the system and recognize the various conditions that may be encountered.

The first thing that must be accomplished during start-up of a wastewater treatment facility is the proper adjustment of all mechanical equipment. Blowers should be rotated by hand several times to insure that they will turn freely. Then the weight and cap on the pressure relief valve should be removed and the blower switch turned on. If the blower is running in the proper direction, air will be pushed out of the pressure relief valve. If the rotation is backwards, air will be drawn in the valve and it will be necessary to reverse the rotation of the motor. To do this, remove the electrical cover from the motor and reverse the motor leads as shown on the wiring diagram inside the cover. Be sure to shut off electrical power to the system at the master control box before working on the motor.

Related mechanical equipment such as comminutors, pumps and others should also be checked before being placed into operation.

ELECTRICAL EQUIPMENT



Electrical controls for the system must be checked and set before the system is placed into operation. Shut off the main disconnect at the power source before testing or setting any of the individual electrical controls.

Turn all switches to the “Automatic” or “On” position. Set the time clock to the proper time of day. The initial time clock setting should be fifteen minutes on and fifteen minutes off. There are ninety-six individual trippers on the dial of the time clock and each tripper indicates fifteen minutes of operation in the daily cycle. Be sure to extend every other tripper around the entire circumference of the clock dial to insure that the plant will have a constant fifteen minute cycle throughout the day. This setting should not be altered until the daily and weekly loading of the facility is established.

SLUDGE RETURN

The airlift sludge return system is used to pump settled sludge out of the hopper in the settling tank and back to the aeration tank to complete the treatment process. During initial start-up of the plant the sludge return should be set to operate at maximum capacity. Completely open the air supply valves on the sludge return and check to see that the large valve in the horizontal sludge return line is open. Norweco sludge returns are capable of pumping in excess of 200% of the daily flow. Although the wide open setting is used initially it should be reduced as soon as the plant begins to develop solids and normally will be adjusted to operate at a considerably lower level.

SURFACE SKIMMER

A surface skimming system is provided with each Norweco sewage treatment system. They are provided to remove floating particles from the surface of the final settling tank and return them to the aeration chamber of the treatment plant. Skimmers are useful maintenance tools, but are not considered a standard part of the system and should not be in operation continuously. Norweco skimmers have an adjustable plastic inlet fitting that is set level about 1/8 of an inch under the surface of the final settling tank. They operate on an airlift principle and draw off a thin layer of liquid from the surface of the tank. This draw off creates a minor up-flow in the tank and, if the skimmer is allowed to operate continuously, the settling function of the final tank will be reduced. Therefore, surface skimmers should only be turned on for short periods of time, as required, to remove any material that has accumulated on the surface. This should be done on a daily or weekly basis. The exact frequency should be determined by daily inspection of the surface. Operators must remember that skimmers are not a standard part of the system and, therefore, should not be continuously in operation.

FOAM SPRAY SYSTEM

Foam control spray systems are provided on all larger installations and most of the smaller ones, especially if the plant is expected to be underloaded or if it is to receive a high detergent flow. Foam spray devices, like surface skimmers, are a handy tool and may be used for routine plant maintenance and elimination of a nuisance.

The presence of foam in an extended aeration plant indicates that the organic loading of the system is low. An extremely high detergent flow may also cause foaming although this is not normally the case. Most sewage treatment systems develop foam during their initial start-up because the solids level in the plant is lower than intended. Usually this foaming will subside after several weeks - once the solids level in the plant comes up to the anticipated level.

Foam in a plant that has been in operation for some time normally indicates loss of solids or lack of solids coming into the plant. The foam itself has no effect on the operation of the system or its ability to treat the wastewater.

However, if it develops in relatively large quantities it may become a nuisance by accumulating on tank walls, piping and possibly even coming out the top of the tank. For this reason, a foam control spray device is provided.

The foam spray pump is installed in an isolated section of the settling tank and it pumps clear liquid back to a series of spray nozzles located above the surface of the aeration chamber. A wash water outlet is installed above the discharge of the pump so that the spray nozzles may be shut down and the outlet may be hooked up to a hose and opened to provide wash down water for the plant. Like the surface skimmer, the foam spray system should not be in operation on a continuous basis. It should be placed into operation only when it is needed for wash water or when foam accumulates to a level where it becomes a nuisance.

HOPPER MAINTENANCE

Final settling tanks in the treatment plant are designed to remove activated sludge and organic material from the contents of the plant. They are, as their name indicates, settling chambers where the tank contents are held about four hours to permit all solid material to settle to the bottom of the chamber. The lower area of the tank is designed to form a hopper. Sidewalls are slanted into the center of the tank to provide a small area where the sludge will accumulate. Here the settled sludge is picked up by the airlift sludge return pump and pumped back to the aeration chamber for final treatment.

Activated sludge in the plant has a tendency to be stringy and sticky during its initial development. Once it reaches a level of maturity it is relatively easy to settle and separate from the liquid. Because of its sticky characteristics initially it does not do a good job of settling in the hopper portion of the tank and it is necessary to gently scrape the hopper sidewalls with a squeegee. Plant hoppers should be scraped at least daily during the start-up phase of operation. Several weeks later when the solids level in the plant reaches maturity it may be possible to scrape the hoppers at less frequent intervals. This, however, should be determined by observation of the plant. Although scraping may be required at less frequent intervals the hopper should never be left unscraped for longer than a week.

DIFFUSERS (Mixing Rates)

It is necessary to continuously mix the contents of the aeration tank with the incoming raw sewage to insure that the activated sludge within the system is brought into constant contact with the incoming sewage. The amount of air being introduced and the distribution of the air along the sidewall of the tank will determine the degree of mixing within the aeration chamber.

Individual diffuser bar assemblies must be “balanced” to aerate evenly with other diffuser bars in the tank. To “balance” the mixing rate adjust the individual air control valves on each drop pipe leading to the individual diffuser bars. Do not use the control valves to reduce the amount of air being introduced! Air reduction should be accomplished separately by adjusting the time clock. Remember, individual air control valves should be used only for minor adjustments.

Each air control valve on the air header should be placed in the open position when the plant is first started. Observe the surface of the aeration chamber and the roll of the contents to determine if individual diffusers are getting too much air or not enough. Where the mixing is most violent the air valves should be turned down until even mixing is obtained. Before doing this be sure that the air valves in the area where mixing is least active are completely open. Adjustment of the individual valves should be made at the time of equipment start-up so the tank roll is even along the length of the aeration chamber. After this has been done the actual aeration rate may be established.

CYCLE OF OPERATION

Twenty-four hour time clocks are used to cycle operation of the equipment and obtain proper aeration rates. The plant time clock has ninety-six individual tripper prongs and each prong represents fifteen minutes in the overall twenty-four hour period of operation. Initially it is set to operate fifteen minutes on and fifteen minutes off. This is just a temporary setting - in most cases the time cycle will be adjusted during the bi-weekly visits so that optimum treatment may be obtained. For example, in the case of a treatment facility serving a school, the unit may begin to run continuously in the early morning (4:00-5:00 A.M.) and run nonstop through 7:00-8:00 P.M. Then intermittent operation may be continued throughout the night at fifteen minutes to a half hour out of every hour. Secondary or weekend time clocks may also be employed to switch control over to another unit that will change the aeration rate. The ultimate time cycle and aeration rate must be determined by working closely with each individual system and adjusting it to best serve its particular facility. Some systems may have changing flows and not reach their ultimate cycle for months or, in some cases, even years. If this is the case it is especially important to observe and adjust the aeration rate as required by the wastewater load.

Individual adjustment of each element in the wastewater treatment facility must be based on the performance of the plant during the start-up cycle.

VI. PLANT OPERATION

An Extended Aeration Wastewater Treatment plant is made up of two basic elements and a third element, pre-treatment, is normally added. There are also a number of accessory items that may be employed but the basic elements must always be installed to provide adequate treatment.

The added element, pre-treatment, is the first device the sewage enters. Pre-treatment may be provided by using a trash trap (holding tank), comminutor (sewage grinder) or a bar screen (sewage straining device). Any of these elements may be employed - they are all designed to accomplish the same task. That is, to pre-treat or condition the wastewater before it enters the aeration chamber of the treatment plant.

Trash traps are holding tanks that are designed to trap floating material and they have a space at the bottom so they will trap solid material before it enters the aeration tank. Normally they are sized to provide about 15% of the rated treatment plant capacity.

Comminutors are sewage grinders that shred the solid material in the raw wastewater flow into small particles. They are equipped with an electric motor and hardened steel cutters that reduce the solids in size as they pass through the comminutor.

The third type of pre-treatment device is a bar screen. It is made up of a series of bars arranged in parallel to trap large objects that may be in the wastewater flow. Bar screens are usually installed with a comminutor to protect it from large untreatable or metal objects that might damage the cutters. Bar screens may be used by themselves, however, they require manual cleaning and disposal of the screenings on a daily basis. Because of this maintenance factor they are normally not used alone.

Aeration is the next step in the treatment process. Incoming wastewater enters the aeration chamber where it is held for twenty-four hours. During this period the organic material is intimately mixed with the activated sludge and oxygen is introduced to support the life of the bacteria. The bulk of the organic elements are eliminated in this chamber in the first three to five hours, the remainder of the twenty-four hour period is used to oxidize the remaining organic material and to eliminate excess activated sludge produced.

Final clarification (settling) is the third stage in the treatment process. After being aerated for twenty-four hours the liquid flows into the settling chamber where it is held about four hours. The settling tank is a still chamber that allows the activated sludge and organic material to settle to the bottom. Only clear, odorless liquid is left at the top of the system where it can be discharged from the plant. When the sludge settles to the bottom it is pumped back to the aeration chamber by an airlift pump. This pumping action supplies a constant flow of activated sludge to the incoming raw sewage and returns the partially treated particles to the aeration chamber for final treatment.

Plant operation on a day to day basis is primarily a good housekeeping policy that insures all equipment is kept clean and operational. Plant odor and appearance usually tell what results are being obtained. A good chocolate brown color in the aeration chamber, no odor and at least twelve inches of clear water on the top of the settling tank indicates good operation. This is a general guideline and actual treatment results must be obtained by testing the plant effluent (see the "Testing and Evaluation" section of this manual).

Visual inspection of the effluent is another fast way to evaluate the performance of the system. Effluent should be clear and odor free and should not contain any suspended material. Evaluations based on the appearance of the system and its effluent may be easily determined by a seasoned operator who is familiar with the conditions and performance of the plant.

OVERLOADING

Some wastewater treatment plants receive more wastewater than they were intended to treat. They may be hydraulically overloaded or organically overloaded. Obviously the best solution for adjustment of a plant that is overloaded is to expand it to a point where it is capable of handling the extra load. Although extreme overloading makes expansion of the facility a necessity, many wastewater systems are overloaded and are adjusted to provide respectable treatment results. If the plant is not overloaded to a large degree it may be adjusted to introduce more oxygen and return more sludge. An organic overload makes it necessary to supply more oxygen and mixing. It may even require installation of an aerated sludge holding tank and drying beds to dispose of excess sludge. On the other hand, hydraulic overloading is nothing more than too much liquid going through the system. It causes a wash out of the activated sludge and reduces the retention in the settling tank to a point where it is unable to adequately settle out the solids. Hydraulic overloading may be eliminated by adjusting the sludge return to obtain more settling. If either type of overload is too great it will be impossible to correct and expansion of the system will be the only solution. All Norweco systems have a built in safety factor to enable them to handle reasonable overloads.

UNDERLOADING

Most wastewater treatment plants, at one time or another, will receive less organic material or liquid flow than they were originally designed to receive. Usually the underload is nothing more than a low flow period from the sewage source. But, in some cases, it may be caused by an unintentional underloading of the system. For example, a mobile home park may plan to ultimately serve 200 units, the full size system may be installed and yet it may be one or even two years before the park is fully developed. During this period the facility may be underloaded, that is it may not receive the flow it was designed to handle. This type of underloading may be a nuisance because of foaming in the aeration chamber and the sludge may be stringy and sticky. Usually an underloaded system can be adjusted to provide satisfactory results. The aeration rate and time cycle of the plant should be reduced and constant use of the squeegee to scrape the hopper will probably be necessary.

In most situations underloading is only a temporary problem and the sewage flow will change. For this reason, it will be necessary to observe the operation and appearance of the system and readjust its individual elements to bring the plant operation up on a progressive basis.

SLUDGE PROBLEMS

As stated before, the purpose of the final clarification tank is to settle out and separate the solids that pass through from the aeration tank. To accomplish this the contents of the clarification chamber must remain relatively still. Sludge in a newly started or underloaded system may be stringy or sticky. As it settles to the bottom of the clarification chamber it may accumulate on the sidewalls and slanted walls of the hopper. If the sludge is not soon removed it will build up and become a semi-solid mass that will fill the lower portion of the hopper. When this happens the mass will stop the normal movement of sludge and gas will begin to form. As the gas builds up it will float chunks of sludge to the surface where they will accumulate as a scum layer. To eliminate this problem the plant hoppers should be scraped every day during the first few weeks of operation. The hopper begins about three to five feet below the surface and it should be gently scraped in a slow, easy, downward motion to help move the sludge toward the bottom where it will be picked up by the sludge return pump. Care must be taken not to stir up or agitate the sludge because it may float to the surface. If this happens, the sludge must be dipped out and placed back into the aeration chamber.

In addition to sludge build-up there may be other associated conditions that need attention. For example, a sludge return may be discharging clear liquid while there is sludge in the bottom of the hopper. This can happen if soft sludge is allowed to pack in the bottom of the hopper except for a narrow channel that runs down through the sludge mass to the pump intake. Clear liquid from the surface will be pulled down the channel and through the pump without disturbing the sludge mass. For this reason a visual check of the sludge return may not be sufficient and slow gentle scraping with the squeegee may be necessary.

Another possible condition is a plugged sludge return. When the sludge return is adjusted to pump less than 1/3 of a pipe full it may allow sludge to pack around the bottom of the hopper and pump intake. If this happens the sludge may build up inside the pump tube until it completely stops the pumping action. This problem may be corrected by backwashing the sludge return.

Backwashing is a simple operation where the air and sludge flow are forced out the inlet end of the pump. Procedures for backwashing the sludge return are given in the "Sludge Return" section of this manual. Caution: Backwashing stirs up the liquids in the tank and increases the solids level near the surface! For this reason, airlift sludge return pumps should not be backwashed unless they are completely plugged and cannot be reopened by increasing the return rate.

Dirt and mud from backfilling around the tanks should never be allowed to enter the system. If mud gets in it will mix with the sludge and form a heavy, solid, sludge mass. The sludge return pumps will not handle heavy mud - it may completely clog the airlift.

To determine if mud has entered the system place the end of the squeegee into the bottom of the hopper. Gently lift it back out and check the edge of the blade for mud. Its depth and density may be determined in the same manner. If mud has entered in any quantity it will be necessary to pump the tank and remove the mud from the hopper.

If mud enters the system special care must be taken to insure that air lines are not clogged. If mud enters the air lines the operator must remove and clean the air piping. Remember to readjust all air valves after doing any service.

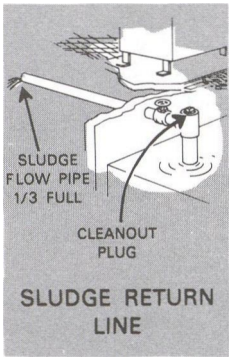
EVEN AERATION

All plants must be adjusted to provide even aeration (mixing) of the tank contents. This is done by "balancing" the air flow of individual diffuser bar assemblies until the mixing is even throughout the aeration chamber. Each diffuser bar assembly has a separate air control valve that must be adjusted to balance the air flow.

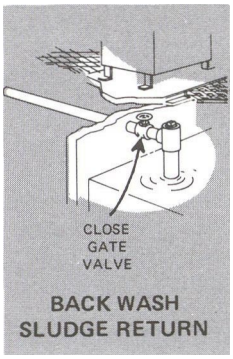
Even mixing must be maintained to insure that short circuiting of the sewage flow does not occur and that no sludge accumulates in the bottom of the aeration chamber. An even aeration rate will keep all sludge in constant suspension and will constantly bring the organic material into contact with the activated sludge. Providing an even, circular mixing pattern will also reduce the possibility that sewage may enter the clarification chamber before it has been retained in the aeration tank for a sufficient period of time. Although the wastewater flows from one end to the other in the aeration tank, in reality, it will flow in a spiral pattern and be retained for a considerable length of time before getting to the outlet end of the aeration tank.

SLUDGE RETURN

The sludge return is an airlift pumping device that uses air produced by the blower to pump settled sludge back to the aeration chamber. Individual airlifts are equipped with air control valves to permit adjustment of the pumping rate. Liquid sludge valves are also provided and should be left in the full open position unless the operator is backwashing the system.



Sludge returns should be inspected daily to insure that they are returning at least 1/3 of a pipe full. This is the minimum amount that can be pumped without increasing the chance of plugging the airlift. Any adjustment above 1/3 full may be used if it improves plant operation.



Sludge returns may become plugged if the hopper has not been properly maintained. When this happens the airlift sludge return must be backwashed. To backwash the sludge return first adjust the air supply valve to the full open position. Now shut off the liquid sludge valve in the horizontal line of the sludge return. This will force air out of the intake end of the pump and blow out any stoppage. If backwashing does not work it may be necessary to supply additional air by shutting off other air supply valves in the plant. Do not use this method unless normal backwashing fails. Be sure to adjust all air and sludge valves back to their original position once backwashing has been completed.

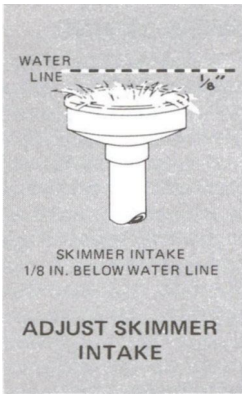
A constant return of activated sludge to the inlet of the treatment plant is an important function in the operation of the system. This constant pumping of sludge improves the contents of the settling tank by removing solids and provides a constant supply of activated sludge to incoming sewage.

Inspect the sludge return rate and condition of the sludge being returned on a daily basis. If the sludge is held in the bottom of the hopper too long it may loose its chocolate brown color and appear dark or in extreme cases even black. If this condition exists, increase the sludge return rate and step up the scraping schedule of the hopper so that the sludge will not remain in the bottom of the settling tank too long. If the returned sludge is light or clear it normally indicates that it is not being returned as it should be and is accumulating in the settling hopper. Increase the frequency of scraping if this occurs.

SURFACE SKIMMER

Surface skimming devices are provided as a standard part of each Norweco system. Although they are not required they are a very handy maintenance tool and should be used on a regular basis.

Like sludge returns, skimmers operate on the airlift principle. They are used to draw floating material off the surface of the settling tank and return it to the aeration chamber. Norweco skimmers are equipped with an adjustable plastic intake that is set 1/8 of an inch under the surface of the water.

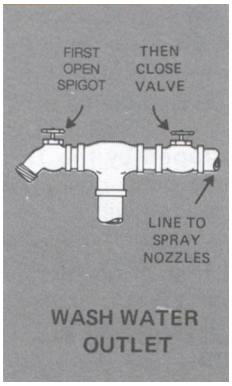


Skimmers should not be used continuously. They should only be turned on when necessary to remove floating material from the surface of the clarifier. Once the surface is clean they should be shut off until more material has accumulated on the surface.

Occasionally a skimmer may become clogged. If this happens it must be backwashed just like a sludge return. To backwash the surface skimmer, shut off the air supply valve and remove the plug at the top of the tee in the vertical airlift assembly. Inflate a plumber's stopper below the tee in the airlift line. Be sure to place a cover over the skimmer inlet because it will force liquid out the intake and it may spray up into the air a short distance. The easiest way to do this is to place a sheet of plywood on top of the grating above the skimmer inlet. Next open the skimmer air supply valve to the full open position. Any stoppage should be blown out the intake of the skimmer line by the reverse air flow. Now shut the air off again and remove the plumber's stopper. Replace the plug in the top of the tee and readjust the air supply valve. If the backwashing was successful the skimmer will resume normal operation. If not, the stoppage may be in some other portion of the line and it will be necessary to clean out the skimmer lines.

FOAM SPRAY SYSTEM

Spraying systems to control foaming in the aeration chamber are usually installed with extended aeration sewage treatment plants. They consist of a spray pump mounted near the surface of the final clarification chamber and a series of piping and spray nozzles arranged above the surface of the aeration chamber. The pump draws clear liquid out of the settling chamber and sprays it down on the surface of the aeration chamber to knock down the foam before it has an opportunity to accumulate. Norweco spray pumps are wired into the controls of the blower so they operate only when the blower is running. However, they can be controlled manually to simplify maintenance of the plant.



Foam spray systems should not be kept in operation unless foaming in the plant is creating a nuisance. A wash water outlet is installed at the top of the pipe coming up from the spray pump. It is there to provide hose down water for sidewalls and piping in the plant. A valve is installed between the wash water outlet and the spray nozzles so the operator can shut off the liquid flow to the nozzles and supply additional water to the outlet for washdown purposes.

Norweco spray nozzles are machined from solid brass and have a tapered orifice to reduce clogging. Many operators use the wash water outlet and hosing facilities more often than the spray system. Like the surface skimmer, spray systems should not be used except when necessary. Foam on the surface of the aeration chamber indicates light loading of the plant or a lack of solids in the plant. However, if the foam is not creating a nuisance it is not necessary to eliminate or reduce it by utilizing the spray system.

Chemical defoaming agents are available but they are expensive and not recommended for general use. If foaming becomes a problem in a plant that does not have a foam control pump it is generally more economical to install a spray system than it is to purchase defoaming agents and related chemical feed equipment.

POWER FAILURES

Although electrical power should be supplied to the plant on a continuous basis there may be an occasional power failure caused by lightning or a break in the line. When power has been off to the plant or any element within the plant the electrical controls should be individually checked. First, check the main fuse box at the power source. Replace any of the fuses that appear to be blown. If the equipment does not resume operation when this has been done the individual electrical controls must be checked. Replace the fuses that appear to blown, reset the breakers and push the reset button on each of the starters. If the equipment does not resume automatic operation contact your Norweco distributor.

VII. PLANT MAINTENANCE

PRE-TREATMENT

When a bar screen is used for pre-treatment it must be cleaned at least once a day. Norweco bar screens are equipped with overflows, and will continue to pass sewage even if they are clogged. However, it is important to insure that they are kept clean at all times. Therefore, the operator should clean the bar screen at least once a day and dispose of any screenings that have accumulated. Screenings may be disposed of by burying them or storing them in a sealed container for pick-up by a sanitary disposal service.

When a comminutor has been provided for pre-treatment the cutters should be cleaned daily to insure maximum efficiency. Check the cutting efficiency and lubrication system once each month. The number of hours it has been in operation and the care it has received will determine if and when an overhaul is needed. Do not open the comminutor for inspection of internal parts unless there is definite evidence of internal trouble. The rotor assembly may be removed for inspection or cleaning.

If the comminutor becomes noisy or begins to vibrate it may indicate improper adjustment of the cutters. It may also indicate a worn bearing in the unit or a worn gear in the gear box. If the cutters are clean and free of debris and the operation is noisy or vibrating, contact the local Norweco distributor for service.

When a trash trap is used for pre-treatment it should be checked at least twice a year. Remove the inlet and outlet covers to be sure nothing is obstructing the flow in and out of the tank. Do not clean them unless the sludge or scum layer is within three inches of the bottom of the outlet tee.

The sludge layer thickness can be measured with the plant squeegee or any device that can be used to feel out the bottom of the scum mat. Force the squeegee down through the mat and raise it until resistance from the bottom is felt. The distance to the bottom of the outlet device can be found with the same tool.

A rough white towel wrapped around the squeegee handle and lowered into the bottom of the tank will show the depth of the bottom sludge layer. Lower it behind the outlet baffle to avoid scum particles. Wait several minutes and carefully remove the squeegee - the sludge depth will be shown by the particles clinging to the towel.

Never wash the tank or use disinfectant on the inside after the trash trap has been cleaned. Do not try to improve operation of the trash trap by adding a disinfectant or chemical. Although some products are sold to clean or activate trash traps, most contain chemicals that cause sludge bulking and increase the alkalinity within the tank.

AERATION

Mixing in the aeration chamber should be inspected daily. To check the mixing, simply observe the top surface of the chamber to see if air is rising evenly along one side and the tank roll is constant and evenly distributed. Also check the daily cycle on the time clock at least once a week to see that it is set to the proper time of day.

"Evenair" diffuser bars should be removed and inspected only if the mixing in the tank is uneven. It may be possible to correct uneven mixing by adjusting individual valves on the air header. This should only be done to balance the air flow. It should not be necessary once the plant is in operation unless someone has readjusted the valves. If the mixing is uneven and the valves are properly adjusted there may be a stoppage in one of the air lines or diffuser bars. If so, they should be removed and cleaned.

If a foam spray system has been provided, the nozzles should be checked weekly to be sure they are not clogged. This routine check will not be necessary after plant start-up unless the spray system is being used.

Individual air valves should be checked for leaks twice a year. To check a valve for leaks, simply spray it with a light coat of leak detector.

The aeration chamber should also be checked and cleaned on a regular basis. Sidewalls above the liquid level should be hosed down every week or as required. The color and odor of the chamber should be inspected daily. Daily observation by a qualified operator will enable him to quickly evaluate the condition of the system.

SETTLING

Inspect the sludge return daily to see that it is returning at least one-third of a pipe full. Also check the surface skimmer inlet adjustment and return rate on a daily basis. The skimmer inlet should be set 1/8 of an inch under the surface and the return rate should be at least 1/3 of a pipe full. Turn the skimmer on if floating solids have accumulated since the previous day. Let it run long enough to collect and return the floating particles to the aeration chamber and then shut it off.

Inspect the effluent weir weekly to see that it is level and skimming along both surfaces. Use the squeegee provided with the plant to scrape the hopper in the lower portion of the settling tank. This should be done each day unless visual inspection of the plant permits less frequent scraping. Never allow the hopper to go unscraped for longer than one week.

The inlet screen on the spray pump should be inspected and cleaned twice a year. If the spray system is not in use, this item should be omitted from the maintenance schedule.

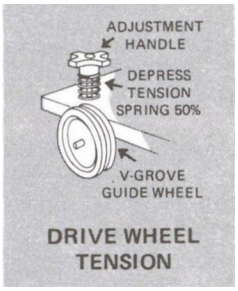
CORROSION PROTECTION

All metal surfaces on the plant and accessory equipment should be wire brushed and painted as required. Operators should go over the entire system and touch up paint once each year.

VIII. SPECIAL INSTRUCTIONS for TRAVALAIR™ UNIT

Norweco Travalair™ wastewater treatment plants are designed to automatically collect the settled sludge in the hopper of the final clarification chamber. The Travalair unit moves automatically from end to end scraping the hopper and, at the same time, a surface skimming system installed as an integral part of the Travalair unit, continuously and automatically cleans the surface of the tank. A squeegee is connected to the lower portion of the Travalair unit and it scrapes the slanted sidewalls of the hopper to eliminate sludge in the bottom of the tank. This exclusive feature eliminates daily hopper scraping as required with conventional systems.

The drive unit for the Travalair system is mounted on the Travalair unit and travels on the track connected to the top of the treatment plant. The scraper blades and skimmer inlet fittings of the Travalair unit are adjusted during the initial installation and it should not be necessary to readjust them after the system has been placed into operation.



The air supply valves for the individual sludge return and surface skimmer systems should be adjusted so that each airlift is pumping at least 1/3 of a pipe full. Individual liquid sludge control valves are provided for the skimmer and sludge returns. They should be used for backwashing any of the individual airlifts whenever necessary.

The air supply and power hose reels located at opposite ends of the track are maintenance free and require no periodic maintenance or lubrication.

The Travalair mobile unit is motor driven and with the exception of periodic lubrication it requires no maintenance. Fill the gear box on the gear motor twice a year with 90 weight gear lube. Bearings in the gear motor are prelubricated and sealed and require no further lubrication. The wheels on the mobile unit and both drive wheels underneath it should be lubricated once a month. There are two grease fittings on the drive bar and one for each wheel on the unit. Use a grease gun and good grade lubricant (GED6A2C5 or equal) to refill all six fittings at thirty day intervals.

Tension on the drive wheels may need to be periodically adjusted. To determine if additional tension is necessary, inspect the tension spring under the adjustment handle at the back of the mobile unit every thirty days. The tension spring should be depressed 50% to insure adequate tension.

End walls in the hopper are not scraped by the Travalair unit. For this reason, they have been designed with a much steeper angle so that sludge will not accumulate on them. Plant operators should use the squeegee to scrape both end walls in the tank at least once a week.

IX. MECHANICAL EQUIPMENT MAINTENANCE

BLOWERS

Positive displacement blowers are used to supply air to the individual elements within the treatment facility. The blowers contain two impellers mounted on parallel shafts and they rotate in opposite directions. As one impeller passes the inlet of the blower, it traps a quantity of air and carries it around to the outlet where it is discharged. Timing gears are installed on the end of each shaft to regulate the position of the impellers and maintain the clearances they need to insure maximum efficiency. Always be sure the pulley on the blower is properly aligned with the motor pulley so that no undue stress or wear is placed on the blower.

MOTORS

Electric motors are used to drive the individual blower units. When they are well maintained they normally do not require repair. However, if a problem does develop with a motor, fast, dependable service can be obtained from the local Norweco distributor. All dust should be cleaned away from the ventilating openings in the motor shell at least once a month. At the same time be sure to check the pulley on the motor shaft to see that it is aligned with the blower pulley and properly tightened.

AIR FILTER

An inlet air filter/silencer is installed on each blower unit in the treatment plant. It is installed on the inlet of the blower to filter the air and trap foreign objects that might enter the blower. To enable the blower to produce the air intended, the filter must be kept clean at all times. Check the filter element once a month and clean it as necessary.

The best way to clean an air filter is to purchase a second one and rotate operation of the filters. This will permit the operator to install a clean filter and keep the plant in operation while the dirty element is soaked in kerosene and cleaned.

PRESSURE RELIEF VALVE

A pressure relief valve is installed in the air discharge piping of the mechanical unit. The relief valves are weighted type valves that lift up to discharge air if the pressure in the system becomes too great. The proper number of weights are placed on the system when it is installed and they should not be removed or changed. Remove and oil the inside of the relief valve cap once a month to insure free operation of the valve.

AIR VALVES

Inspect the air valves in the treatment plant daily to be sure they are properly adjusted. After the plant and equipment is adjusted and running as intended each valve in the system should be marked so that it is easy to determine if the valves are correctly set.

DIFFUSERS

"Evenair" diffuser bars in the treatment plant should be inspected once a year. Disconnect the union at the top of the individual air drop pipes and lift out the entire assembly. Check to be sure that all fittings are in place and properly tightened and that each air opening in the diffuser assembly is clean and free of any foreign material.

SLUDGE RETURN

Inspect the airlift sludge return daily to be sure it is returning at least 1/3 of a pipe full. Any return rate above the one-third mark may be used if it improves operation of the plant. Sludge returns should pump continuously - the plant should never be in operation unless the sludge return is operating.

SURFACE SKIMMER

Check the skimmer inlet fitting weekly to see that it is set level 1/8 of an inch under the surface of the water. It should not be set deeper because it will pump too much liquid and be less effective. Skimmers should return only about 1/3 of a pipe full. Turn them on long enough to remove solids from the surface of the settling tank but do not let them run on a continuous basis.

FOAM CONTROL SPRAY SYSTEM

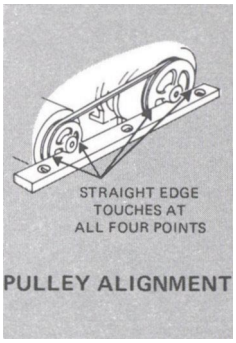
The spray system should be inspected weekly to insure that all equipment is operational. Check the spray pump first, turn the pump selector switch to the "Hand" position. All of the spray nozzles should begin spraying. While they are on, inspect them individually to be sure they are not clogged. Remove and check the pump inlet strainer once every six months. If the spray system is not in use omit this item from the maintenance schedule.

EFFLUENT WEIR

The final effluent weir in the settling/clarification chamber of the treatment plant should be cleaned each day. Any sludge or grease particles that have accumulated along the edge of the effluent weir should be removed with the squeegee or a dip net. The degree of settling obtained in the clarifier is, to a large degree, dependent upon the size and adjustment of the weir. Inspect the weir at least once a week to be sure that it is level and skimming evenly along the entire length on both sides. To adjust the weir, loosen the bolts on the side of the weir plate. It is not necessary to pump the tank down or use special tools for this adjustment. Once a year the weir should be wire brushed and painted as required.

V-BELT & PULLEYS

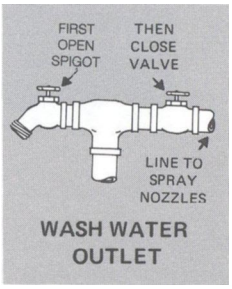
Pulleys on the motor and blower connected by a v-belt are used to drive the unit and provide the air required for the treatment process. The pulleys should always be kept in perfect alignment to eliminate unnecessary wear on the v-belt and bearings. To check the pulleys for alignment, place a straight edge against the front face of the motor pulley and let it extend over and against the front of the blower pulley. Slide the straight edge down so that it is resting on top of the motor and blower shaft. If the pulleys are properly aligned the straight edge will touch all four points along the front face of the pulleys. If they are improperly aligned they can be adjusted by loosening the mounting bolts on the back of the motor and shifting the motor until they align. Check the pulleys for proper alignment once a month and, at the same time, inspect the v-belt for wear. Once a week check the v-belt to insure that it is not slipping. To do this, shut the motor off and let the unit come to a complete stop. Now turn the unit on momentarily. If the v-belt is loose, the blower pulley will not begin to turn until after the motor pulley has turned several revolutions. If this happens the motor mounts must be loosened and the motor must be moved away from the blower to obtain more belt tension. Naturally, when this is done it will be necessary to recheck the pulleys for proper alignment. Most plant operators find it convenient to keep a spare v-belt on hand so they can replace the belt when necessary without interrupting operation of the plant. One spare belt is supplied with each Norweco system and it should be kept in a convenient place for the operator. New v-belts have a tendency to stretch slightly and wear during the first few weeks of operation. Therefore, operators must always check for v-belt slippage in any new system.



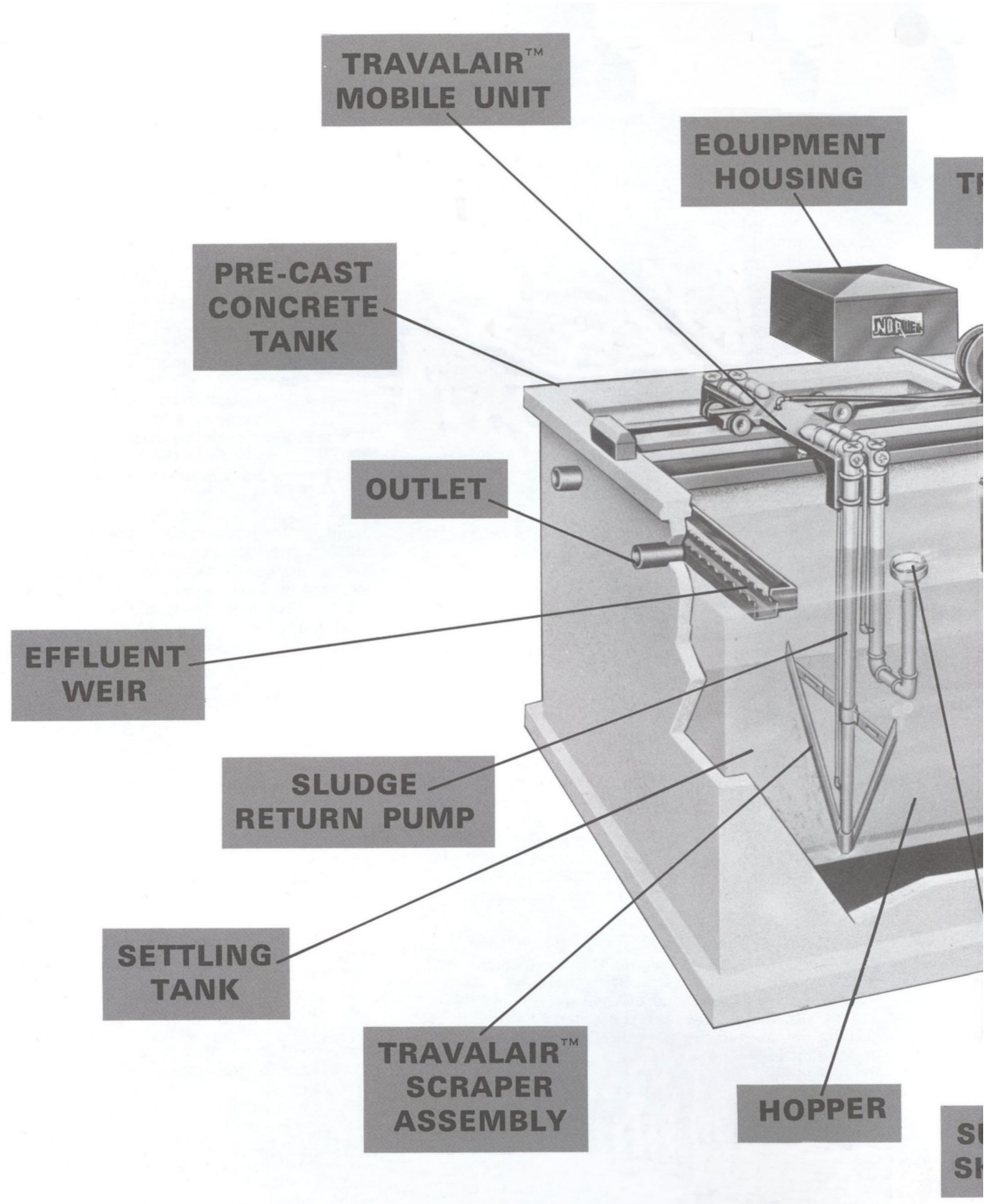
PULLEY ALIGNMENT

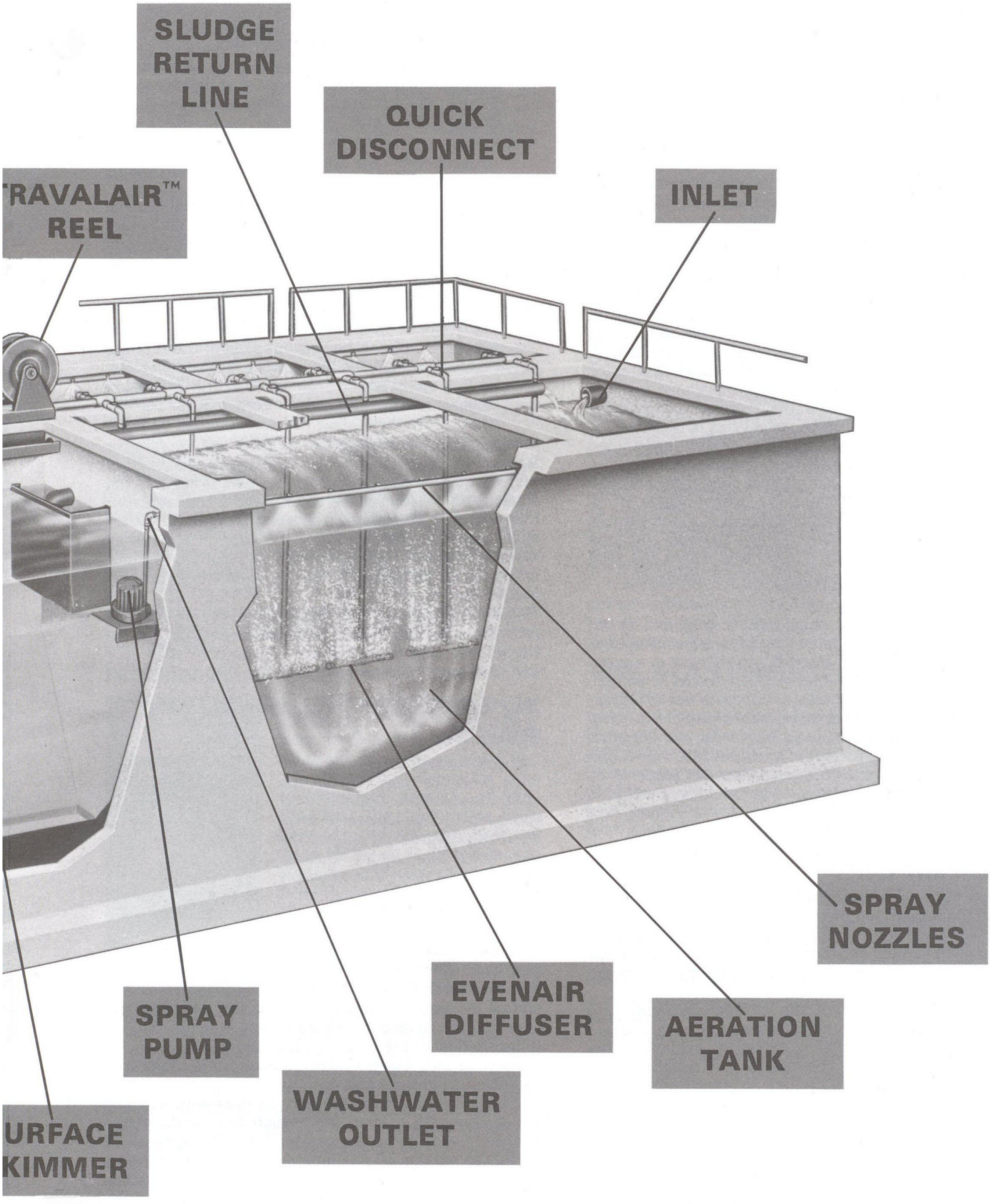
WASH WATER SYSTEMS

Norweco plants that are equipped with foam control systems have a wash water outlet located on the discharge piping of the spray pump. The foam control spray pump is located near the surface of the final tank and has a vertical discharge line that runs near the top of the treatment tank. At this point it turns and goes through the wall to the aeration chamber and spray nozzles. The wash water outlet is installed near the elbow where the vertical pipe turns to enter the aeration tank. A conventional lawn or garden hose may be hooked to the outlet and a shut off valve is provided between the outlet and the spray nozzles so the liquid flow may all be diverted to the wash water system. Most plant operators find it convenient to connect a garden hose to the wash water outlet and use it daily to hose down the tank walls, piping, baffles and other elements within the system. When the spray system is not in use it is still possible to wash the system by turning on the spray pump and shutting off the valve to the spray nozzles. Plant operators should remember that liquid obtained from the wash water outlet is partially treated wastewater and should not be used except for internal cleaning purposes. It is not potable water and must not be used for anything except routine hosing of plant components.



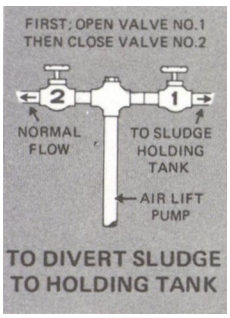
WASH WATER
OUTLET


TRAVALAIR™
MOBILE UNIT
EQUIPMENT
HOUSING
PRE-CAST
CONCRETE
TANK
OUTLET
EFFLUENT
WEIR
SLUDGE
RETURN PUMP
SETTLING
TANK
TRAVALAIR™
SCRAPER
ASSEMBLY
HOPPER


SLUDGE RETURN LINE
QUICK DISCONNECT
RAVALAIR™ REEL
INLET
SPRAY NOZZLES
EVENAIR DIFFUSER
SPRAY PUMP
AERATION TANK
WASHWATER OUTLET
URFACE KIMMER

SLUDGE HOLDING TANKS

Sludge holding tanks are used when the level of solids in the aeration chamber gets too high. Holding tanks are provided only as a temporary holding facility to retain excess sludge during high flow periods. Sludge may be diverted from the return sludge line to the sludge holding tank by shutting off the valve in the normal sludge return line and opening the valve on the auxiliary piping leading to the sludge holding tank. Be sure to open the valve on the auxiliary piping before closing the valve on the normal sludge return line. If the valves are not opened and closed in this manner the entire sludge flow will be shut off for a short period of time and will cause the airlift to backwash.



As mentioned before, backwashing stirs up the settling chamber and should not be done unless required to open an airlift line.

Sludge holding tanks may be installed as aerated or non-aerated tanks. Aerated holding tanks have auxiliary piping from the air header of the treatment plant proper as well as the sludge return. When this is the case, be sure the aeration of the sludge tank is well distributed and keeps the tank contents in constant suspension. Non-aerated sludge holding tanks should be checked once a month to determine if the level of sludge within the tank is too high. When the sludge in a non-aerated holding tank fills more than 1/2 of the chamber, the tank should be pumped. The sludge level within the tank may be determined by probing with the squeegee.

STAND-BY UNIT

Stand-by mechanical equipment is provided on all large treatment plants and in many cases, the smaller ones as well. Norweco stand-by equipment is a complete second set of motors, blowers and electrical controls supplied to provide a duplicate set of equipment for operation in case of a mechanical or electrical failure. Plant operators should perform maintenance on the stand-by equipment at the same intervals specified for the primary unit in the treatment plant. Most systems are wired to alternate automatically and it is generally accepted that the best way to obtain long equipment life is to permit the units to alternate operation.

COMMINUTORS

Daily care for a comminutor is outlined in the “Plant Maintenance” section of this manual. In addition, they may occasionally require mechanical maintenance. Normally, it is most economical and convenient to have the mechanical maintenance performed by a Norweco distributor.

Monthly inspections of the cutting efficiency and lubrication system should be made. Lubrication is covered separately in the “Lubrication” section of this manual. Occasionally a comminutor will require a complete overhaul but this should not be attempted by anyone other than a Norweco distributor unless they have had prior experience with the equipment. The operator should not open the comminutor for inspection of internal parts unless he is sure the trouble is inside the unit. The rotor assembly may be removed for inspection or cleaning.

Plant operators should clean the cutters daily and adjust and sharpen the stationary and rotating cutters as needed.

To adjust the stationary cutter proceed as follows:

1. Remove the rotor assembly.
2. Rotate the screen by hand until one rotating cutter edge engages the stationary cutter.
3. Insert a feeler gauge in the vertical space between the cutter bar and the edge of the stationary cutter nearest the rotating screen. This space should not be more than 0.002 inches.
4. Loosen the socket head screws on the bearing housing arm until they are finger tight but the cutter should not move freely.
5. Insert the 0.002 inch feeler in the upper vertical space between the rotating cutter bar and the stationary cutter. Force the stationary cutter bar snugly against the feeler strip. Repeat this procedure with the lower adjustment screw.
6. Tighten the socket head screws that hold the stationary cutter to the bearing housing arm.
7. Rotate the screen by hand until all of the rotating cutters have passed through the stationary cutter. Repeat operation #3 on each of the remaining rotating cutter bars and be sure that no vertical gap is more than 0.002 inches.

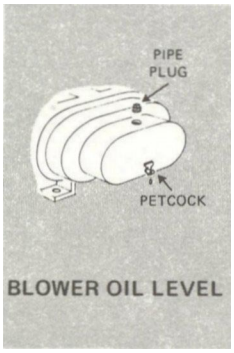
Never sharpen the turned faces of the rotating or stationary cutter bars. Only the sides of the bars or teeth should be sharpened. To sharpen, grind only the surfaces on the front of the cutters with a fine carborundum wheel. It is recommended that a spare stationary cutter and four rotating cutters be kept on hand at all times to permit replacement of dull cutters without interrupting operation of the comminutor for an extended period.

The rotating cutter bars have double life and can be removed from the screen and turned end for end so the unused side faces the front. Once both edges are dull they must be resharpened.

XI. EQUIPMENT LUBRICATION

BLOWERS

Check the oil level in the blower once every thirty days. To do this, open the small brass petcock on the back of the blower and remove the square pipe plug on the top of the blower gear housing. With the unit idle, pour oil slowly into the pipe plug opening until it begins to drip from the open petcock. Leave the petcock open until the oil has stopped running out. This will avoid overlubrication. Too much oil causes heating and oil leakage. Remember to close the petcock after checking the oil level or filling the unit. Use only SAE40 lubrication oil in the blower gear housing.



Bearings at the gear end of the blower are lubricated by splash from the gears but the bearings at the drive end are packed with grease prior to shipment. Replace the grease with a good grade, high temperature, ball bearing grease (drop temperature of 275º F or better) at regular thirty day intervals. If the unit is fitted with a grease cup, remove the grease drain plug on the bottom of the bearing housing and turn the cap gradually until fresh grease appears at the drain. If the unit is fitted for a pressure gun, do not pack the bearings too tightly. Remember to replace the drain plugs.

MOTORS

Norweco motors, used to drive the blowers, are pre-lubricated for the life of the unit. Operators should clean all the dust away from ventilating openings on the motor every thirty days and check the motor mounting fasteners to be sure they are tight. If trouble with a motor does occur the operator should contact his Norweco distributor immediately. The distributor will isolate the problem and provide fast, dependable service for the unit.

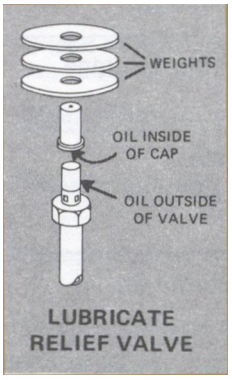
COMMINUTOR

One lubrication fitting is located on the upper bearing cover of the comminutor. It should be filled with grease every six months. Use the grease gun supplied with the unit and be sure to apply a good grade, waterproof, mineral base, ball bearing grease (Lubriplate 130-AA or equal).

The motor section of the gear motor should be lubricated once every five years. Remove the end plate from the motor and apply the grease by hand. A good grade, high temperature grease (GED6A2C5 or equal) should be used. The inboard motor bearing is located adjacent to the gear box and is lubricated with oil splash from the gear section.

Check the gear motor every thirty days to see if oil needs to be added. Be sure the unit is at a complete stand still when adding oil to the gear motor. Remove the fillerbreather bushing from the top of the filling elbow and the level plug at the side of the unit. Use a funnel to pour oil in the filler elbow until it begins to run out of the level hole. There may be a slight time lag from the time the oil is poured into the filler hole until it becomes level with the surface of the unit so be sure to fill the unit slowly. Replace the level and breather plugs and tighten them securely when the proper oil level has been reached.

PRESSURE RELIEF VALVE



Pressure relief valves are installed on the discharge piping from the blower to eliminate the possibility of pressure build up. The valves are simple in construction and require very little attention. They should be kept clean and checked periodically to make sure rust or dirt does not interfere with their free operation. At least monthly the relief valve weight and cap should be removed from the valve body (lift straight up) and the inside of the cap and outside of the body should be covered with a light coat of oil to insure free operation of the valve.

VALVES

All air and sludge valves in the treatment plant should be checked twice a year for leaks. Naturally, any leak in the sludge return valves can be detected by visual inspection. Air valves, however, may need to be sprayed with leak detector. Although leak detector is commercially available, a rich solution of soapy water will do the job. Any valve that is leaking should be disassembled and repacked with grease or, in the case of the small air valves for the sludge return and surface skimmer, it may be necessary to install a new rubber washer. Be sure to note all valve settings before repacking so they can be quickly readjusted after the maintenance is complete.

AIR FILTERS

Inlet air filter/silencers are installed at the inlet of each blower to reduce the noise level and clean the incoming air. They must be kept clean so they will not create resistance to the free air flow into the blower. The wire mesh screen on the air filter should be coated with oil after each cleaning. It is recommended that plant operators keep an extra filter on hand so that it can be placed into service while the dirty unit is being cleaned. To clean the wire screen in the filter, remove it from the filter body and place it in a container of kerosene. After it has soaked for a day or two blow it dry with an air gun and recoat the mesh with oil. Inspect each air filter every thirty days for cleaning.

XII. ELECTRICAL EQUIPMENT MAINTENANCE

Generally, maintenance of the electrical apparatus should be performed by an electrician. If any of the electrical equipment malfunctions, contact the Norweco distributor and he will have his electrician repair the equipment.

Electrical leads should be checked once a year to be sure they are not frayed or subject to undue vibration. In addition, the time clock should be checked once a week to see that it is set to the proper time of day. At the same time, all circuit breakers, fuses and resets should be inspected. Circuit breakers should be reset as necessary and blown fuses should be replaced by the operator as required. CAUTION: Shut off all electrical power at the power source before replacing fuses or inspecting electrical wiring.

REMEMBER: Repair and replacement of electrical equipment should be done by a qualified electrician. If you do not have an electrician available your Norweco distributor will provide the service needed!

XIII. PLANT SHUT DOWN

Occasionally it is necessary to shut down a wastewater treatment system for an extended period of time. For example, plants serving schools located in rural areas are often shut down for the entire summer period. Recreational areas such as campsites may be shut down during the winter months in colder regions of the country. Any plant that will be shut down for longer than seventy-two hours should receive special care. When the shut down will be for a relatively short time, such as a week to two, it is only necessary to flush the inside of the blower unit with a 50-50 mixture of kerosene and oil. To do this simply remove the air filter from the top of the blower unit and pour the mixture into the top of the blower while rotating it by hand. Be sure to reinstall the air filter. Do not leave the top of the blower open or exposed during the shut down period! If the shut down is to be extended, several additional precautions should be taken.

Remove the blower unit and chlorine pump and store them in a dry place. In the case of plants installed in colder regions, it is also recommended that individual drop pipes and diffuser bar assemblies be removed so that they will not be damaged if the contents of the tank freeze. Naturally, any shut down whether short or extended, requires flushing of the blowers with kerosene and oil. Always rotate the blower several times by hand before placing the system back into operation. If the system has been down for an extended period it will be necessary to readjust the equipment and go through the procedures outlined in the “Start-up” section of this manual.

XIV. VISUAL CHECK

CONDITION	APPEARANCE	COMMENTS	ADJUSTMENT
Good operation	Chocolate brown color, little or no foaming	Plant properly adjusted	None
Exessive foaming	Foam accumulating on surface of aeration chamber	Plant underloaded	Install or operate foam control spray system.
Solids in effluent	Solids going over edge of effluent weir	Sludge not settling or insufficient settling rate	Shut off surface skimmer and spray system. Reduce sludge return rate. Increase frequency of hopper scraping.
Floating solids in settling compartment	Lumps of sludge floating to surface of settling tank	Surface skimmer improperly adjusted. Sludge buildup in hopper	Place skimmer into operation. Scrape hopper.
No sludge return	Good except plant is not returning sludge	Insufficient air to airlift or clogged sludge return	Increase sludge return rate. Backwash sludge return.
Overmixing	Large amounts of slimy brown sludge on surface of settling tank	Plant may be underloaded	Reduce aeration rate.
Insufficient aeration	Black or dark brown aeration chamber. Septic odor	Aeration rate too low or a diffuser bar may be clogged	Increase aeration rate. Open all valves to individual diffuser bar assemblies.
Floating grease in settling tank	Gray material on the surface of the settling tank	Too much grease is entering plant	Install or clean grease trap. Operate surface skimmer.
Sludge blanket too high	Layer of sludge near surface of settling tank	Sludge return inadequate	Scrape hopper. Increase sludge return rate.
Plant underloaded	Light brown color in aeration, floating slime in settling chamber	Not enough solids	Reduce aeration rate. Skim surface by hand.
Inadequate return of sludge	Return sludge dark brown or black	Heavy black sludge in bottom of hopper	Increase sludge return rate. Scrape hopper.
Uneven tank roll	Air is not rising evenly along entire sidewall of aeration chamber	Check valves for proper adjustment	Clean individual diffuser bars.
Overaeration	Light brown sludge with finely divided particles that do not settle	Strong musty odor	Reduce aeration rate.
No air rising - blower not running	Tank contents black, no mixing or sludge return	Mechanical failure	Check for electrical failure. Press reset button on motor starter, check v-belt.
Septic sewage	Black sewage coming into plant	Influent sewage has septic odor	Maximum aeration rate. Check incoming flow for toxic material.

XV. MAINTENANCE SCHEDULE

CAUTION: Shut off all electrical power before working on mechanical or electrical equipment.

ITEM	DAILY	WEEKLY	MONTHLY	SEMI - ANNUALLY	YEARLY
Go through visual check	X				
Clean bar screen	X				
Clean comminutor cutters	X				
Check comminutor cutting efficiency			X		
Inspect trash trap				X	
Check mixing in aeration	X				
Check time clock setting		X			
Clean spray nozzles		X			
Check valves for leaks				X	
Wash plant sidewalls		X			
Check aeration for color and odor	X				
Check sludge return	X				
Check effluent weir level		X			
Clean effluent weir	X				
Repaint effluent weir					X
Scrape hopper	X				
Operate surface skimmer	X				
Clean spray pump screen				X	
Lubricate Travalair gear box				X	
Grease wheels on Travalair unit			X		
Adjust Travalair drive wheel tension			X		
Scrape end walls in Travalair tank		X			
Clean dust away from motor			X		

(Continued)

XV. MAINTENANCE SCHEDULE *(Cont.)*

ITEM	DAILY	WEEKLY	MONTHLY	SEMI - ANNUALLY	YEARLY
Check pulley alignment			X		
Clean air filter			X		
Oil pressure relief valve			X		
Check air valve settings	X				
Check diffusers				X	
Check skimmer inlet setting		X			
Inspect v-belt for wear			X		
Inspect v-belt for slippage		X			
Check sludge holding tank			X		
Check electrical leads				X	
Inspect breakers, fuses and resets			X		
Check blower oil level			X		
Grease blower bearings			X		
Check motor mounting bolts			X		
Grease comminutor				X	
Check comminutor oil level			X		
Clean and repaint metal surfaces					X
Sample and test effluent	X				
Optional:					
Optional:					
Optional:					
Optional:					

Note: Replace and lock all panels, covers and gates after performing maintenance on the plant.

XVI. TROUBLE SHOOTING

CAUSE	CORRECTION
BLOWER NOT WORKING	
Motor overloaded	Push reset button
Fuses blown	Replace fuses
Power failure	Have electrician check
Timer cycled off	Turn timer on
Broken v-belt	Replace belt
EXCESSIVE FOAMING	
Overaeration	Reduce time cycle
Lack of solids	Reduce time cycle
Plant start-up	Normal - continue operation
UNEVEN AERATION	
Clogged air line	Clean air line
Clogged diffuser	Clean diffusers
Valves not properly adjusted	Adjust valves
SPRAY SYSTEM NOT WORKING	
Clogged spray nozzles	Clean nozzles
Clogged pump screen	Remove pump and clean screen
Spray pump not running	Repair pump
Spray line valve shut off	Open valve
FLOATING SOLIDS	
Skimmer not working	Turn skimmer on
Sludge return not working	Backwash sludge return
Excessive solids in hopper	Scrape hopper
Excessive grease	Clean grease trap
SOLIDS IN EFFLUENT	
Sludge return too low	Increase sludge return rate
Sludge return clogged	Backwash sludge return
Plant overloaded	Check hydraulic and organic loading
Excessive flow through tank	Reduce sludge return rate. Shut off spray system and skimmer
SLUDGE RETURN NOT PUMPING	
Clogged sludge return	Backwash sludge return
Clogged air line to sludge return	Clean air line
Air valve out of adjustment	Open sludge return air valve
Blower not running	See “Blower not working”
CHLORINATION NOT WORKING	
Empty solution tank	Fill tank
Pump not running	Repair pump
Pump plugged	Clean pump
Pump not primed	Prime pump
SURFACE SKIMMER NOT SKIMMING	
Blower not running	See “Blower not working”
Clogged skimmer	Backwash skimmer
Clogged air line to skimmer	Clean air line
Air valve out of adjustment	Open skimmer air valve
Inlet fitting out of adjustment	Adjust inlet fitting
COMMINUTOR NOT WORKING	
Blown fuses	Replace fuses
Jammed cutters	Clean cutters
Improper cutter adjustment	Adjust cutters
Worn cutters	Replace cutters
Excess solids in casing	Clean casing
Low voltage	Have electrician check
LIFT STATION NOT PUMPING	
Clogged pump	Remove and clean pump
Pump not working	Repair pump
Pump overloaded	Push reset button
Power failure	Have electrician check
Control failure	Have electrician check

XVII. OPTIONAL EQUIPMENT

TERTIARY TREATMENT

Tertiary treatment or "third stage" treatment is provided after primary and secondary treatment of wastewater and may be accomplished in a number of ways. Wastewater plant effluent may enter an effluent lagoon that is sized to hold the liquid for five to seven days or even up to thirty days. In extreme cases it may even be necessary to provide a ninety day impoundment lagoon so that no effluent will be discharged from the treatment facility during extremely dry periods. Tertiary treatment may also be accomplished by using a sand filtration device. They are designed to filter treatment system effluent through sand before discharging it to the receiving stream. Micro strainers have also been used. They are mechanically operated devices that automatically strain the final effluent. Generally they must be installed in a heated building and therefore, are limited to use on large systems.

Of the above listed devices, the most commonly used are the smaller effluent lagoons and surface sand filters. Both are widely used and of the two, generally surface sand filters are preferred because of the land loss involved in construction of an effluent lagoon. Many elements come into play when selecting a tertiary treatment device - the size and condition of the receiving stream, use of surrounding land, location with respect to urban areas and others. For this reason, tertiary treatment equipment must be selected on an individual basis for each job. Normally the agency in control and the design engineer will work together to arrive at a satisfactory tertiary device.

SLUDGE HOLDING TANKS

Sludge holding tanks are sometimes provided with wastewater treatment plants. They are installed to store excess sludge until it can be disposed of or returned to the treatment plant during low sludge periods. Normally, sludge holding tanks are sized to provide 10% of the rated treatment plant capacity and are equipped with air diffusion equipment. As such, they are called aerated sludge holding tanks and will provide odorless sludge storage and digestion. Conventional non-aerated tanks are usually more troublesome and not widely used.

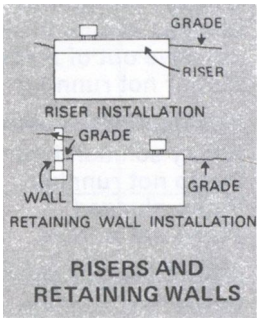
In either case, the sludge holding tanks are fed by auxiliary piping connected to the sludge return line in the treatment plant. Plant operators must monitor the suspended solids in the plant and when the solids level gets too high they should divert the sludge return flow to the holding tank to adjust the solids level down to a normal level. All Norweco systems with sludge holding tanks are designed to provide extra capacity in the treatment plant blowers so that the sludge holding tank may be aerated on a continuous basis without reducing the air supplied to the treatment facility. In addition, the holding tanks are equipped with overflows to permit the sludge to return to the aeration chamber of the treatment plant. If drying beds have been provided, airlifts are also installed in the sludge holding tanks so that excess sludge may be pumped to the drying beds. Sludge need only be wasted to the holding tank when the sludge level in the treatment plant gets too high. Normally an extended aeration treatment plant should have a mixed liquor suspended solids that ranges between 2,500 and 5,000 parts per million. As long as the solids in the plant stay in this range, it should be easy to obtain reliable treatment. However, if the solids level gets above 5,000 parts per million, sludge should be diverted to the holding tank until the suspended solids in the aeration chamber drop to 2,500-3,000 parts per million.

SLUDGE DRYING BEDS

Beds for drying excess sludge are almost always provided for plants that have sludge holding chambers. Sludge drying beds are sized to provide one square foot of drying surface per 100 gallons of treatment plant capacity. The beds are made up of twelve to eighteen inches of filter media with underdrains and the sludge is taken out of the holding tank and placed in thin layers on top of the beds. The liquid drains out of the sludge and down into the underdrains which lead back to the inlet of the treatment facility. The beds have precast or poured-in-place concrete walls and allow twenty-four inches of storage space above the surface of the sand. Usually two beds are provided and used alternately. After the sludge layer on top of the bed is dry and has built up to the point where more sludge cannot be stored, the beds are cleaned and the dried sludge is disposed of. Sludge drying beds are not used on a regular basis. Normally, excess sludge can be diverted from the plant to the sludge storage tank on a regular basis and digested there without being disposed of. However, if the solids level in the plant requires sludge wasting on a regular basis for any period of time, it may be necessary to remove sludge from the storage tank and place it on the drying beds.

Most privately owned or operated systems have sludge drying beds to be used by the plant operator as needed. Public systems, operated by governmental agencies, are often not equipped with beds because enough equipment is already available to adequately handle and dispose of the sludge.

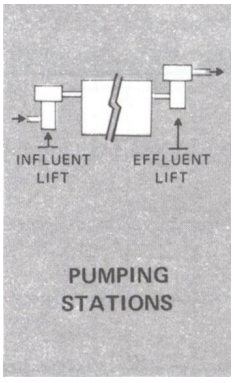
RISERS



Precast or poured-in-place concrete risers are sometimes provided for wastewater treatment systems, or individual elements within the system, to extend the sidewalls to grade. They hold back surface water or are used to retain the grade around treatment systems that are sitting too low. They may be installed as extensions of individual sidewalls within a system or as one large retaining wall around the entire treatment facility. Although risers have been used widely in the past, it is generally felt that pumping stations to lift the wastewater are a better answer to plants that are set too low or have high surface water. Risers, particularly the kind that are extensions of the treatment plant wall, generally make it more difficult to maintain the equipment and therefore, pumping stations are preferred.

LIFT STATIONS

Wastewater pumping stations or "lift stations" are often used ahead of or behind a wastewater treatment system. They are used to pump the incoming sewage up to the treatment plant if it is sitting higher than the inlet sewer or to lift the plant effluent to a point of discharge higher than the treatment facility outfall. Because of the degree of reliability needed with wastewater pumping stations, two



alternating pumps are installed, and each one is individually capable of handling the wastewater flow. Automatic electrical alternators are used so that each time a pump runs an automatic switchover insures that the next time a pump comes on it will be the stand-by pump. By alternating the pumps in this manner, it is possible to obtain extended equipment life and have a back up pump ready for operation with the primary pump during high flow periods.

A number of different types of pumping stations have been used. Norweco manufactures a complete line of pumping stations - six different models utilizing two entirely different styles of pumps are available. A number of accessory devices are available with each model and the Norweco line covers virtually every wastewater pumping application that might be encountered.

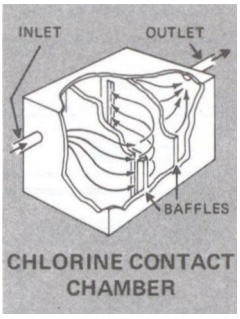
The size, style and type of station used is normally governed by the pumping application, volume, location and reliability needed within the system. Naturally, each Norweco station is sold as a complete installation including equipment, tanks and installation with a single source warranty and service policy.

FLOW METERS

Flow meters are provided to record the wastewater treatment flow on a continuing basis. Norweco flow meters are simple in construction and provide the accuracy and reliability that is needed to be able to put the recorded data to valuable use. Many operating cycles in the wastewater facility are derived from records of the flow. Flow records allow the plant operator to compare performance of the system with the flow characteristics. Time clock settings, aeration rates and other related elements are based upon the performance of the system and performance is usually a direct function of system loading. Complete Norweco flow meters and recorders are available to record and totalize the volume of wastewater flow on a continuous basis.

CHLORINATION

Chlorination stations are used to disinfect final effluent as it leaves the wastewater treatment plant. Chlorine, a highly oxidizing agent, kills any bacteria that may be in the treatment plant effluent. Generally, the type of chlorine device to be used is selected on the basis of the quantity of chlorine required, its cost and the size of the treatment facility being served. Chlorine itself may be applied in a gaseous, liquid or dry form. Gas chlorination equipment is generally more expensive than the other two types. For this reason gas chlorination systems are usually used on larger wastewater treatment plants. Chlorine solution, which can be as strong as 18%, or dry chlorine tablets are easier to handle and the equipment is less expensive initially. Therefore, these two forms are usually used on smaller treatment systems. However, chlorine in a liquid or dry form costs more per pound of available chlorine. Because of this, gas chlorine is almost always used on larger systems that consume higher quantities of chlorine and liquid or dry systems are limited to use with smaller systems that have limited chlorine needs.



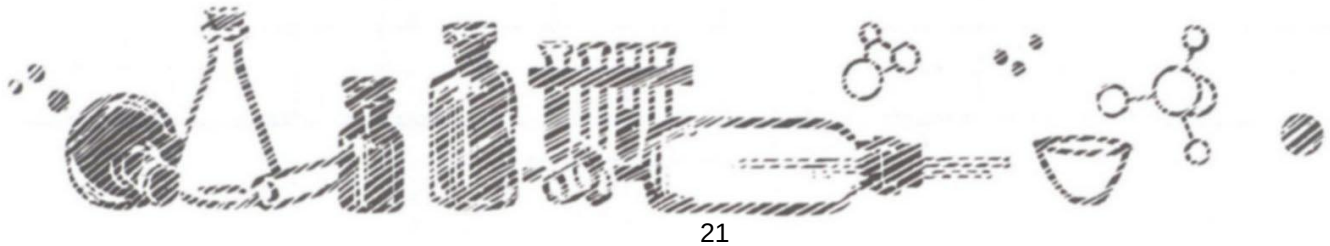
Chlorine contact chambers are provided to mix the final effluent with the chlorine. They keep the chlorine and effluent in contact for at least thirty minutes. Contact chambers are built as a baffled tank that is installed in the final outlet line. Here the chlorine is introduced at the inlet end of the tank and the baffles insure complete mixing of the chlorine with the final effluent. The tank itself is sized so that the flow will be retained in the contact tank for at least thirty minutes during normal flow periods and fifteen minutes during peak flow periods. Complete gas, liquid or dry chlorination stations are available from Norweco and replacement chlorine may be obtained from the Norweco distributor as needed.

XVIII. TESTING & EVALUATION

The effluent from the treatment facility should be inspected daily for odor and clarity. At the same time, plant operators should check the condition of the contents of the aeration and settling chamber in the treatment plant. The appearance, odor and color of the aeration chamber, clarification chamber and return sludge should be noted. At least once a week, the plant operator should conduct a relative stability, dissolved oxygen and chlorine residual check. The tests are simple and the equipment and chemicals needed for each individual test may be obtained from the Norweco distributor. Plant operators should also test on a bi-weekly basis the influent and effluent BOD and the influent mixed liquor and effluent suspended solids.

Individual test kits and chemicals for each of the above tests as well as complete sewage test kits are available through the Norweco distributor. The individual test kits and the overall test kit are complete and will enable the plant operator to evaluate the performance of the system on a regular basis. Naturally, each kit is supplied with instructions for the individual tests and all of the supplies and equipment necessary to conduct the tests are included.

The following chart may be used to maintain a test record for your wastewater treatment facility. It provides not only a complete chronological record of the tests, but also a good reference that will enable the operator to make evaluations of various conditions within the system on the basis of actual test results.



WASTEWATER TREATMENT TEST RECORD

	FOR WEEK OF _____							FOR WEEK OF _____						
	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
EFFLUENT														
ODOR														
CLARITY														
AERATION TANK														
ODOR														
COLOR														
SETTLING TANK														
ODOR														
COLOR														
RETURN SLUDGE														
ODOR														
COLOR														
RELATIVE STABILITY														
DISSOLVED OXYGEN														
CHLORINE RESIDUAL														
BIOLOGICAL OXYGEN DEMAND														
INFLUENT														
EFFLUENT														
SUSPENDED SOLIDS														
INFLUENT														
MIXED LIQUOR														
RETURN SLUDGE														
EFFLUENT														

(Additional Copies Free of Charge)

IXX. MAINTENANCE RECORDS

DATE	PRE-TREATMENT	AERATION	CLARIFICATION	LUBRICATION	ACCESSORIES	COMMENTS

Warranty

All Norweco, Inc. wastewater treatment equipment includes a single source one year warranty and service policy. The equipment is warrantied against defective materials and workmanship, under normal use and service, for a period of one year from the date of installation. The warranty is limited to the replacement of any item that proves to be defective during the first year and expires 12 months after the equipment is placed into operation or 15 months from the date of shipment, whichever occurs first. Repair charges will apply if the equipment has been disassembled by unauthorized persons, subjected to external damage, improperly wired or flooded.

The initial one year warranty and service policy includes periodic inspections for which performance reports are filled out and filed with the health department. Ten service inspections are made during the first twelve months of operation. Initially they are made on a bi-weekly basis and after completion of the start-up period, on a bi-monthly basis for the remainder of the year. Operators are instructed regarding routine operation and maintenance of the equipment during each inspection.

Norweco Inc. offers a number of service policies to provide continuing equipment supervision and maintenance after the first year. The warranty and service policy are designed to provide single source reliability for all equipment and service needs. Your complete Norweco wastewater system is covered by the warranty and service program.

NORWECO

NORWALK, OHIO 44857