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Sanitary engineering and the small college

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SANITARY ENGINEERING AND THE SMALL COLLEGE

BY

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A

THESIS

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Professor of Civil Engineering

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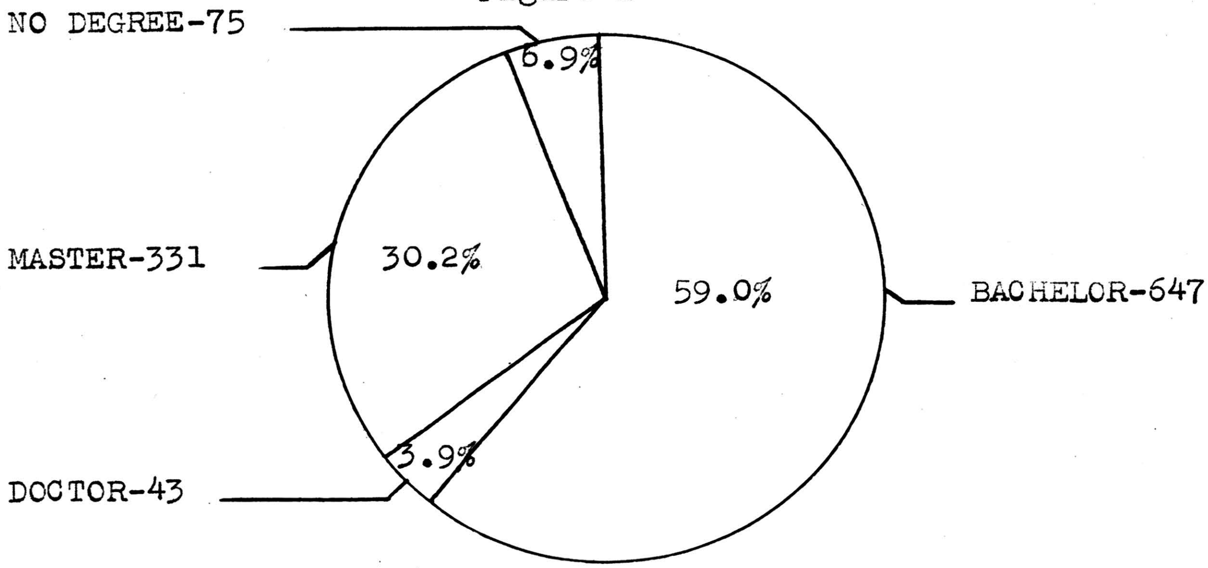
LIST OF ILLUSTRATIONS

Sanitary engineering is more than water, sewage, garbage and rats. Its aim is to controll certain aspects of environment in the interest of public health. To achieve this aim, the sanitary engineer must have broad engineering skills, with knowledge in chemistry, biology and the social sciences.

Sanitary engineering is relatively new and still in the transitional process of evolution. The impact of modern technology in such fields as radiological health, air pollution and industrial wastes offers one of the most challenging fields of engineering. There is ample opportunity for every level of education and experience. Figure 1 shows the distribution of sanitary engineers by educational background.[1]

Figure 1



Distribution of Sanitary Engineers
by Educational Background

[1] "Sanitary Engineers--Their Earnings and Professional Attitudes," by J. C. Bumstead and A. D. Coster, Proceedings American Society of Civil Engineers, Separate No. 773, p. 3 (August, 1955)

Of the sanitary engineers represented in this survey, 59% have a bachelor's degree, 30.2% have a master's degree and 3.9% have a doctor's degree; but 6.9% have no degree at all. Sanitary engineers require more graduate education as a whole than most of the civil engineering profession.

The unprecedented need for sanitary engineers is due to their services in many new and expanding fields of endeavor. Sanitary engineers are increasingly concerned with the industrial developments in the field of nuclear energy. Due to the secrecy limitations for national security, the lack of full exchange of ideas and developments has limited the number of engineers familiar with this work. This has placed the burden for development on government employed and associated research groups. The Atomic Engergy Act of 1954 has aroused the concern of many state and local health groups through its encouragement of peaceful uses of atomic energy. It is predicted that industry will make widespread use of atomic energy in the next few years. Therefore, the sanitary engineer will have to think in terms of radioactivity, as well as chemical, bacteriological and physical factors. In order to do this, most sanitary engineers will have to take short courses and do considerable study on the side to familiarize themselves with radiological terms.

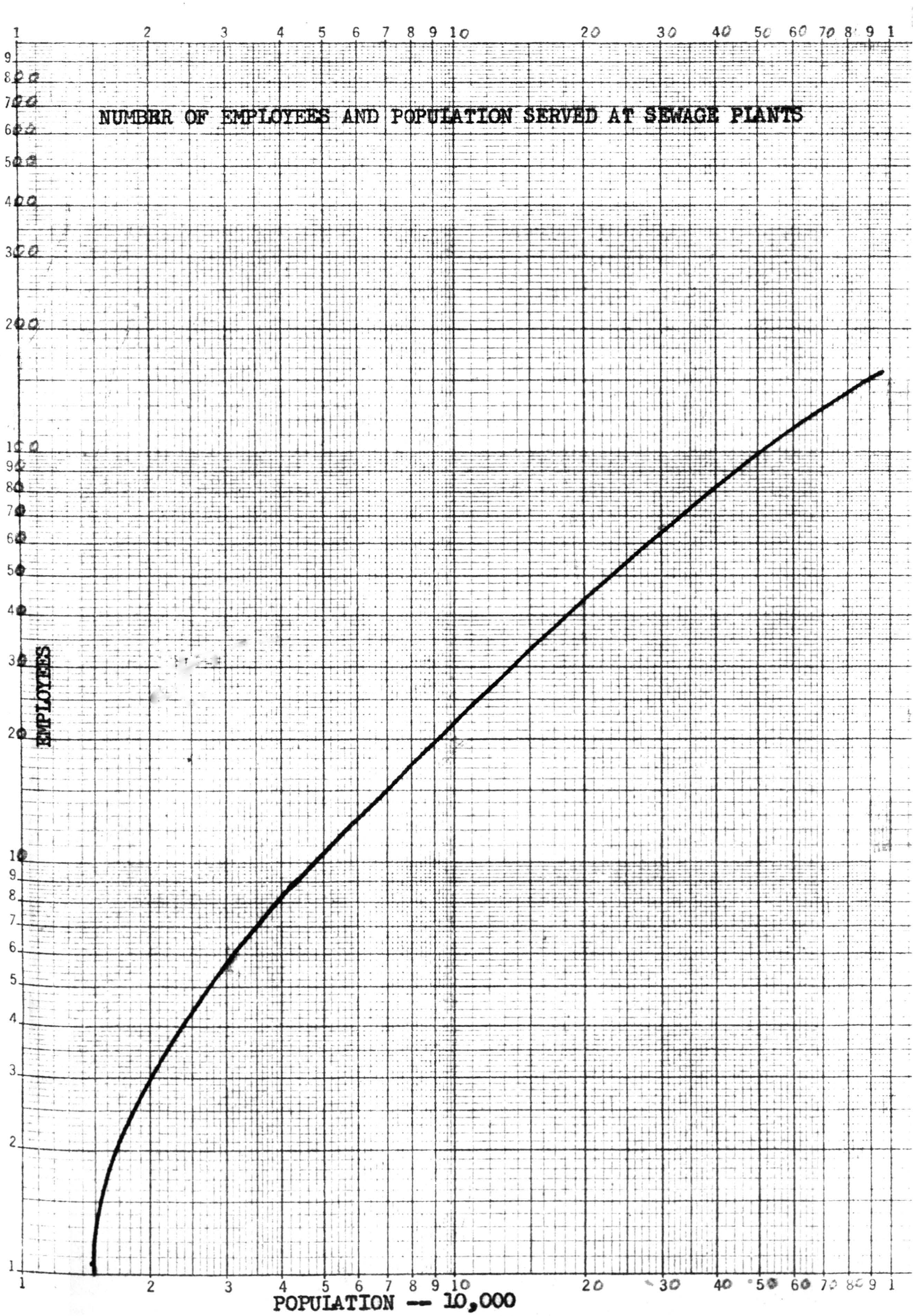
This use of atomic energy will also create an additional demand for sanitary engineers. Many of the water and industrial waste plant engineers will have to be aided by additional trained personnel in order to carry out the operational tests necessary.

It was originally thought that conventional water and sewage treatment methods would possibly handle most radiological health problems but this has not been borne out in the laboratory. These radioactive materials may be in the form of liauid, solid or gas and of extremely minute concentration. The treatment process must be varied according to the substance that is to be removed. The removal of radioactive calcium or barium could be handled by conventional softening processes, as the removal of calcium is a softening process and radioactive elements act chemically as non-radioactive elements. First, it would be necessary to determine the radioactive substances and then to work out a treatment that would precipitate out this substance. This would not be a very difficult job normally if there was only one radioactive element in one compound. This would not ordinarily be the case, as there would probably be several elements in varying compounds. The removal process would be more complicated and considerable laboratory work would be necessary to arrive at a treatment process and then to test and control it during operation. The interfering radioactive substances would be subject to change in the raw supply and the whole treatment process would have to be reworked accordingly. This change could take place in minutes or weeks and would have to be watched constantly.

The radiological waste treatment program is taking a similar path to what the sewage and industrial waste disposal has passed over in the last forty years. Dilution in rivers and oceans or burial under the ground was considered adequate and is still being used by many large cities today. The damage from atomic wastes will be less evident to the human sense but will be with us for a greater period of time. The problem is complicated and much manpower and study will be necessary for its solution. One of the problems it poses is how to dispose of the concentrated radioactive substances recovered in the waste treatment process. Other complexities come into the picture, such as plants and microorganisms that concentrate certain elements many times the concentration in their environment.

It will not be necessary for the sanitary engineer to become a radiological physicist or chemist. He is not expected to be a bacteriologist or chemical engineer today -- only to be familiar with some of the basic information directly concerned with sanitary engineering and to be acquainted with the terminology.

In April, 1955, questionnaires were sent by the civil engineering department of New Mexico A. and M. to fifty-four selected sewage plants in the United States. The purpose was to collect general information on type and frequency of testing, number and kinds of employees, laboratory equipment, type of treatment and number of persons served. From this information the following graph was made. Figure 2 shows the relative number of persons served and the number of people directly employed at the sewage treatment plants. The values range from 1 for about 10,000 to 1 for about 4,500 people served. This represents the municipal sewage treatment plants and in many


NUMBER OF EMPLOYEES AND POPULATION SERVED AT SEWAGE PLANTS
EMPLOYEES
POPULATION -- 10,000

large industrial areas there will be private plants with their operators. Based upon the 1950 census and an average of 1 plant employee for every 6,000 persons in cities of over 2,500 population, there are about 17,000 people employed at sewage treatment plants by municipalities in the United States. Due to the large number of communities with only 1 or 2 employees at the sewage plants, the number of technically trained personnel form a high percentage of the total employees. There is probably a similar relationship between water treatment plant employees and number of persons served. Expand these values with the needs of industry, state and federal regulatory agencies, teaching and research; the number of sanitary engineers needed in the foreseeable future is far greater than the number being graduated today.

In 1949, 8.0% of the college students were taking engineering and by 1954 this had dropped to 7.5%. Again, in 1949, 12.8% of the new freshmen in engineering were taking civil engineering and by 1954 only 10.5% of the freshmen engineers were taking civil engineering. From the number of freshmen enrolled in civil engineering, the indication is that the number of civil engineering graduates will decrease in the next four years. We are probably graduating now fewer civils than are necessary to replace losses by retirement, death and changes in occupation.

The sanitary engineering branch of civil engineering is the only branch of engineering which depends on the biological sciences as well as the physical sciences. Students with an interest in biology, as well as a competence in chemistry and physics, should find this field of endeavor of interest to them.

There is an unprecedented need for sanitary engineers. College students should be informed of the need and of this general field at an early stage in their education so that proper guidance can be given in the selection of electives to those interested.

Colleges must re-appraise their sanitary engineering offering and expand their programs to meet the needs of society.

One of the most difficult jobs facing an expanded sanitary engineering program is securing the students with proper background. Most of the freshmen entering college have some ideasas to what vocation they want to strive toward. This idea of their future might be the product of parental influence, an article in the newspaper or a thorough search on the part of the prospective student. Many of the rapidly expanding fields of engineering have considerable glamor attached to them from all the publicity of atomic energy, jet planes and electronics. Sanitary engineering has had little publicity in lay publications and few people have any idea as to what sanitary engineering means. Most people have visions of grandeur when they associate the terms "electrical engineer, engineering physicist, aeronautical engineer or chemical engineer". They have read articles in their daily newspapers, seen pictures in the magazines and read promising recruiting posters put out by the major industries. Sanitary engineers are hired by these same industries, and indirectly by most of the people, but they are spread through the nation and not in large enough concentration to attract attention. Sanitary engineering educators have the task of informing potential students, as well as expanding their offerings, in order to satisfy future needs. Much of this publicity should be directed at high school seniors. A good contact should be through high school science teachers. Science teachers have close association with students interested in engineering. This contact should be made through direct association with the science teachers if possible. They should be told of the need and opportunities in sanitary engineering and frequently supplied with literature. Each school should engage in a well planned publicity program. This is a portion of the school's job because one must first secure students in order to educate them. This type of advertising program would arouse the student's interest before college and give sanitary engineering departments a chance to compete with the other fields on a more equal basis.

The main problem facing the small college is usually money. Money is a problem with most schools regardless of size, but it is especially true of the small engineering school. It is possible to do an outstanding job in many fields of education, including engineering, with a high caliber faculty and little physical plant. Graduate study in engineering requires laboratory facilities and these facilities are becoming more specialized and costly every day. The large college or university can show a favorable cost per student hour because of large classes and multiple use of laboratory facilities. The small college, in order to be competitive, must have basically the same facilities and use them one or two times a week. The large school can have the same investment in plant and use it to its fullest advantage.

In the fall of 1953, the civil engineering department of New Mexico College of Agriculture and Mechanic Arts felt that more emphasis should be placed on sanitary engineering. This conclusion was brought about after a study of the area needs which were not being supplied by A. and M. or nearby colleges. It was necessary to travel over 800 miles from State College to obtain a course in sanitary engineering other than the beginning water supply and sewage disposal courses. (Figures 3 and 4)

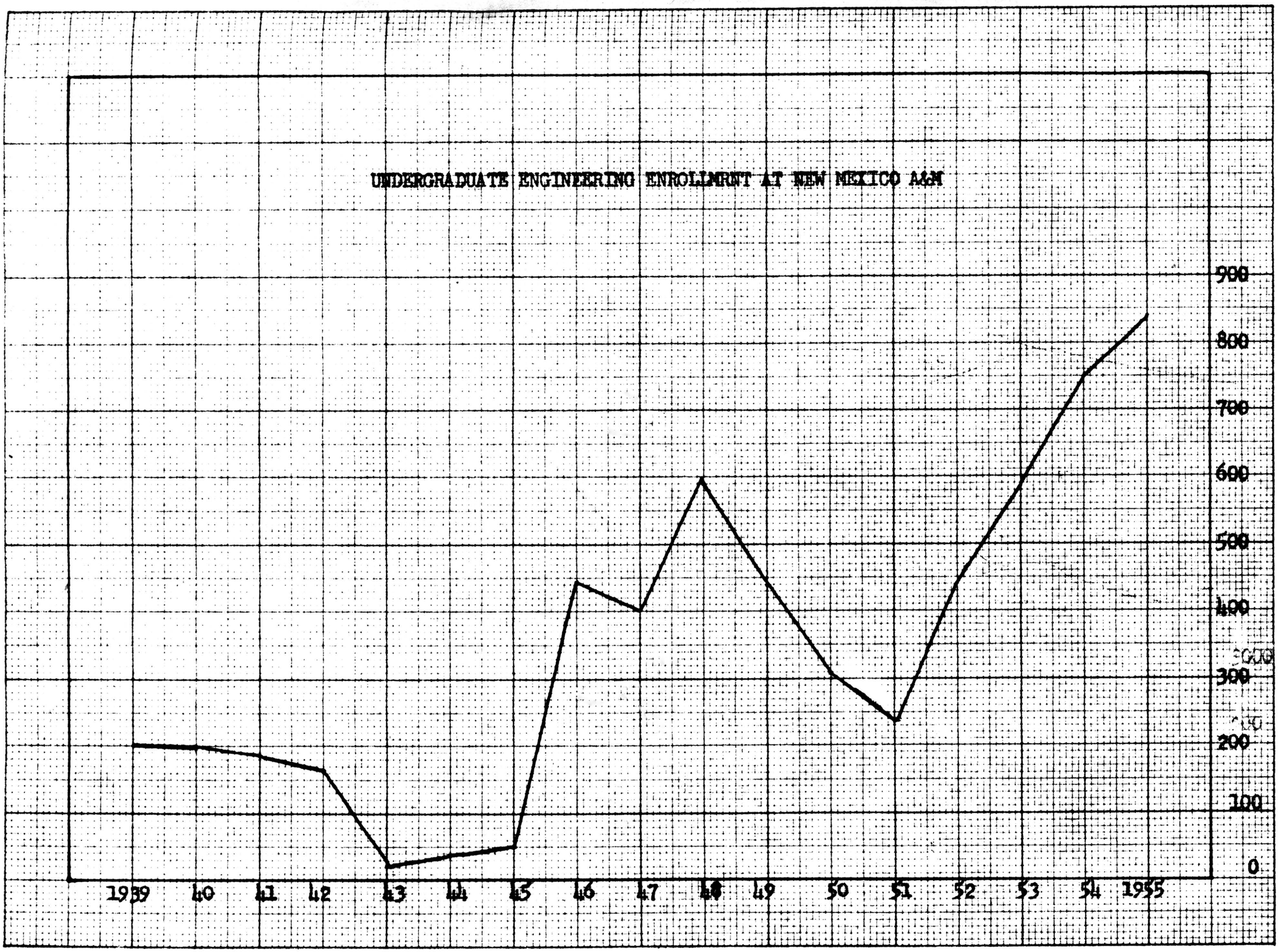
The civil department was faced with the usual problems, small equipment and operating budget and extremely old laboratory buildings. The first major problem was to secure laboratory space. The problem was further complicated by preliminary plans for a new engineering building being drawn up at this time, with considerable uncertainty as to when or how much building would be built. The over-all engineering enrollment was going up at a rapid rate (Figure 5) and additional space was needed by all departments. It was decided to go ahead with plans to build a sanitary laboratory, but on a temporary basis so that a maximum of the money spent could be incorporated into the laboratory in the new building when it became a reality. A section of the hydraulics laboratory was partitioned off, 18' x 38', and work space, chemical storage, sinks, reagent

Figure 3

Map of Southwest

Figure 4

Map of New Mexico


UNDERGRADUATE ENGINEERING ENROLIMENT AT NEW MEXICO A&M
900
800
700
600
500
400
300
200
100
0
1939
40
41
42
43
44
45
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47
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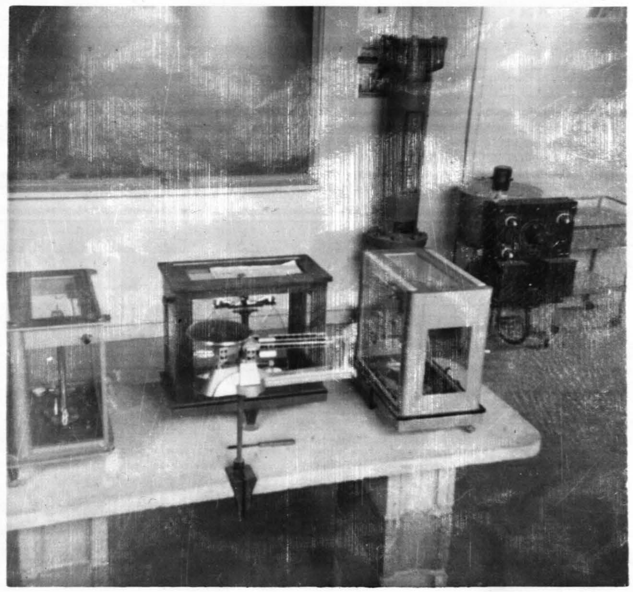
49
50
51
52
53
54
1955

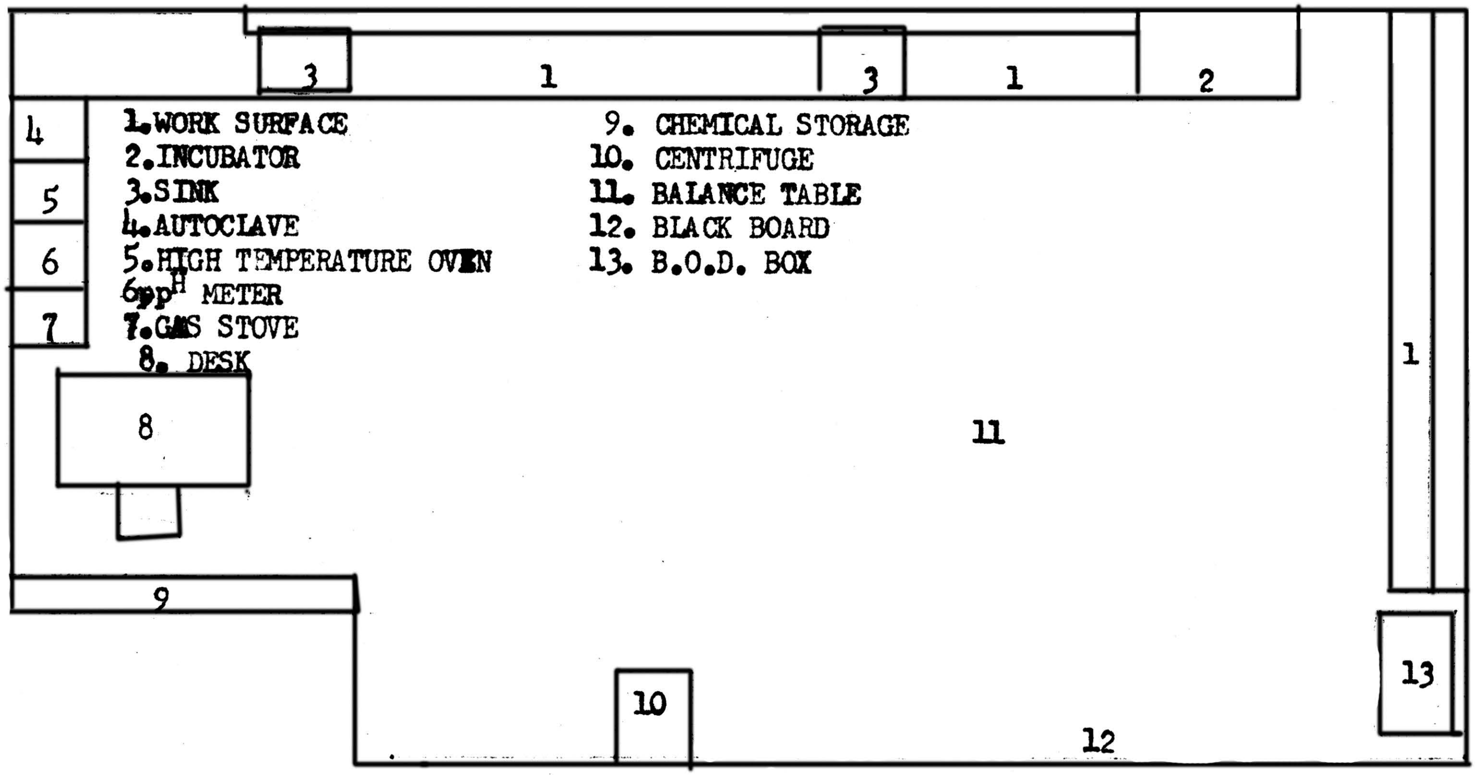
shelves, blackboard and analytical balance space made around the walls. The long rectangular room with all work space at the walls was decided upon after studying several laboratory furniture arrangements at colleges and in industry. Most designs use the island arrangement with most of the wall space clear but that is probably a carry over from chemistry laboratories. Careful study was being given the temporary laboratory in order to work out maximum efficiency in design of the laboratory in the new building. After moving tables and other pieces of equipment around in the room, a final arrangement was decided upon for the temporary laboratory and for the new laboratory. The arrangements for the two are not the same, as it was found that the laboratory should be a minimum of 20 ft. wide in order to accomodate center computation tables and have laboratory work space along the walls. In order to accomodate sixteen students in a lab section, the minimum inside dimensions of 20' x 40' was decided upon. Four 4-man parties are the maximum number of students that one instructor can properly handle in the laboratory and four 3-man parties seem to be best from the student standpoint.

After the temporary laboratory was constructed, the next problem was equipment. Nothing was on hand and everything had to be secured from the civil department budget except $1,400. that came from the president's personal account. These expenditures might seem small to most college personnel but New Mexico is a sparsely populated state and has the common problem of many states, too many state supported institutions of higher

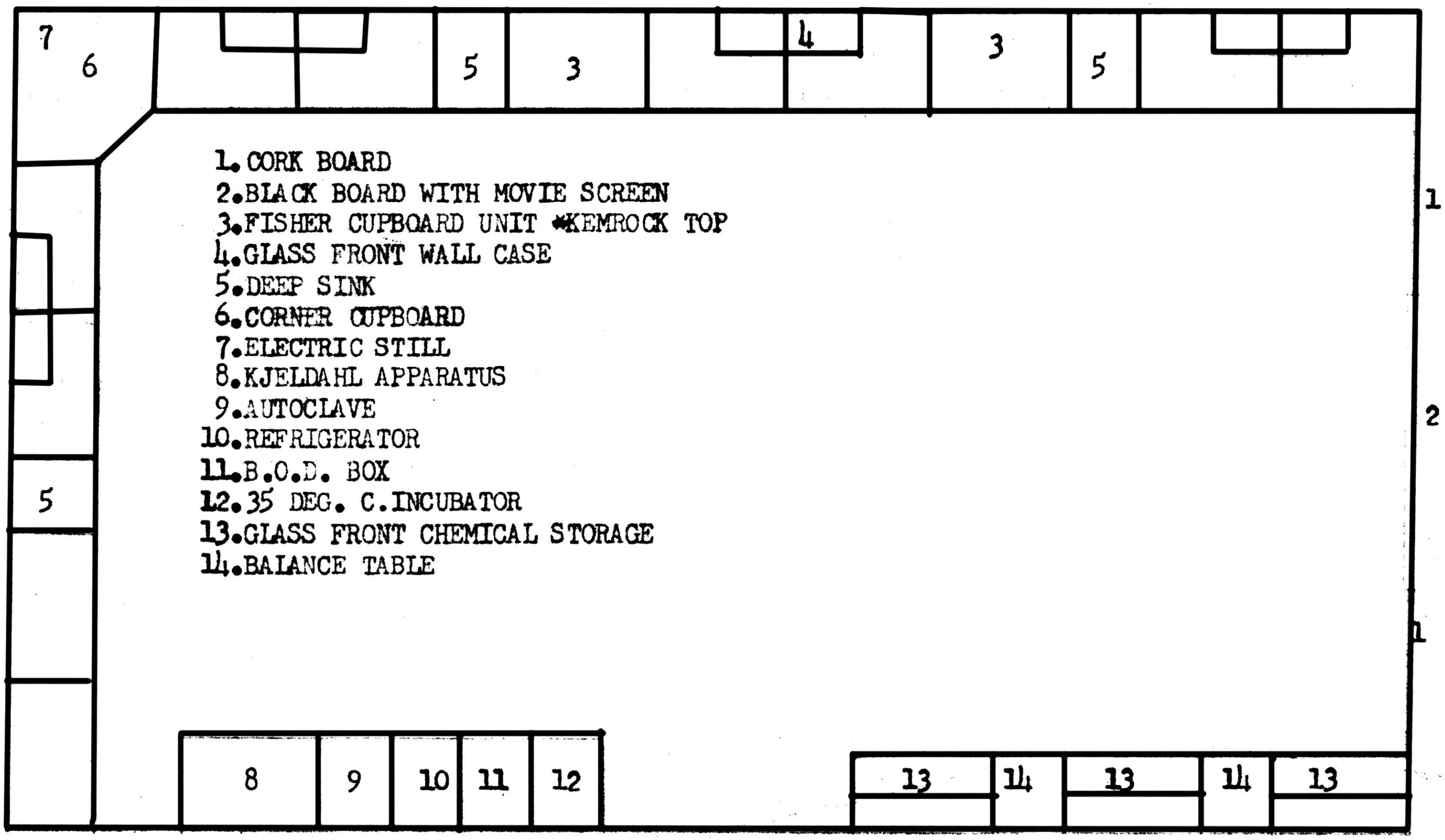
Figure 6



Temporary Sanitary Laboratory



OLD SANITARY ENGINEERING LABORATORY
18'X38'



NEW SANITARY ENGINEERING LABORATORY
20' X 40'

learning. Considerable savings can result if all chemicals are ordered at the same time with the chemistry, chemical engineering and other departments. The chemicals should be ordered in containers sized for each department and not in one large container. The time spent in packaging and possibility of contamination is greater than the savings from bulk lots. Ten to twenty-five percent can be saved on glassware orders placed with other departments to make up case lots. On most of the other equipment no apparent savings would result in combination of orders. Some savings result from placing the order out for bid but the time spent on more exact specifications and delays about eats up any gains. The main items of equipment outside of glassware and chemicals needed are as follows:

Autoclave
37°C Incubator
20°C B.O.D. Box
Colony Counter
Microscope
Analytical Balances
Precision Balances
Weights
Centrifuge
Hand Operated Centrifuge
Pipette Boxes
Cylinder of Chlorine Gas
p^H Meter-Line Voltage
Turbidity Meter (Jackson)
Jar Test Equipment (coagulation)
Gas Meter
Imhoff Cones
Refrigerator
Muffel Furnace
High Temperature Oven
Photo-Spectrometer (with Flame Attachment)
Vacuum Pump
Water-Still (good--no copper)
Kjeldahl Nitrogen apparatus

Permanent Chlorine Standards
D. O. Sampler Assembly
Membrane Filter Apparatus
Steam Bath

An autoclave is necessary for the sterilization of organic substances and liquids, as well as sample bottles and some glassware. A large twenty quart pressure cooker, equipped with a temperature and pressure gage, is satisfactory for emergency use. It was decided for economy's sake not to purchase a regular autoclave and use a pressure cooker. After three semesters' use, the need for a regular autoclave has been evident and a new Barnsteed electric one ($1200.) is in the process of being purchased.

A good 37°C incubator is necessary for routine quantitative and qualitative bacteriological examinations of potable and nonpotable waters. The incubator should maintain a uniform and constant temperature in all parts of the chamber. It should accomodate 140 to 180 petri dishes with at least a 1 inch space between adjacent stacks of dishes. "Standard Methods" [3] recommends minimum dimensions of 20" x 20" at the base and 24" high. Hot spots cause the media to dehydrate with consequent failure of colony formations. Improperly insulated incubators cause uneven temperature distribution and variation in colony formations. Incubators suitable for sanitary engineering work can be purchased from $500. up. If the laboratory

[3] "Standard Methods for the Examination of Water, Sewage and Industrial Wastes", U. S. Public Health Service, Waverly Press, p. 363.

plans to be certified or if important research tests are planned, the incubator should have a recording thermometer immersed in a liquid on a middle shelf. We are using a Denver Fire Clay incubator, inside dimensions 24" x 24" X 30" high without a temperature recording mechanism. This will adequately handle a sixteen man laboratory but the tests run for a period of 48 hours, so that the incubator is tied up for a minimum of two days by one class. This incubator is not suitable for graduate work and a larger one is hoped for at a later date.

Biochemical Oxygen Demand, B.O.D., of polluted water and sewage is probably the most important single test run for sewage and industrial waste treatment. The test determines the amount of oxygen required during stabilization of organic material by aerobic digestion. The complete test requires more than 100 days at 20°C but the usual test is 5 days at 20°C. The B.O.D. test has many interferences such as free chlorine, mineral acids and copper. The difficulties encountered have caused many prejudices for and against the two common B.O.D. boxes. A regular refrigerator type box with air circulating fan and heating coil is used and relied upon by many experienced personnel. Others like a water bath with cooling and heating coils with water circulation equipment. Comparable results can be obtained with either type of box if directions are followed properly and the temperature is controlled at 20°C ± 1°C. We purchased the air incubator type box because it could double for refrigerator media storage.

when not in use as a B.O.D. box. A B.O.D. box of some type that will hold the temperature at 20°C ± 1°C and exclude light is necessary for a sanitary engineering undergraduate or graduate laboratory.

A colony counter is a device to provide a dark field light source and grid to facilitate in the counting of bacteria colonies in petri dishes. Some form of magnification is necessary to pick out the smaller colonies. A counter could be home made by any one handy with tools. This would not be practical however, as a serviceable Quebeck counter can be purchased for $55.00. A colony counter is necessary for graduate and undergraduate laboratories.

A microscope is used in sanitary engineering to identify and/or count coliform organisms, plankton samples, bottom fauna, microscopic organisms and differentiation and counting of colonies by use of membrane filter technique. Most compound binocular or monocular microscopes would find some use in a laboratory. The following ocular and objectives should be provided in the undergraduate laboratory:

Ocular

10 X

Objectives

1.8 mm (oil immersion)	98 X
4 mm	44 X
16 mm	10 X

The microscope should have a mechanical stage and source of artificial light. In addition, the graduate microscope should have a 7.5 X Ocular and an 8 mm Objective and be fitted with a reticule for calibration purposes. An attachment for showing microscopic images on a screen would be beneficial. Photographic attachments would be very desirable for research work. We use a monocular microscope with mechanical stage and artificial light with 980, 440 and 100 magnification and find that this satisfies most normal needs. Rebuilt microscopes are available from several manufacturers that incorporate all the necessary features and effect a 50 to 60% savings. The undergraduate microscope as listed is necessary but the other features are optional equipment, dependent upon the type of research planned.

Analytical balances are necessary to weigh the minute quantities of material in some quantitative analysis and general laboratory preparations. Most standard analytical balances would be suitable for undergraduate laboratories. The type of research work undertaken would vary the balance requirements but most work could be properly accomplished on standard balances if proper procedure was used. We find that 3 balances are satisfactory for sixteen students in an undergraduate laboratory. One analytical balance per six men in the laboratory should work without undue interference.

Precision balances of the triple beam or straight balance type with a sensitivity of at least 2 grams at a load of 150 grams are useful for rough weights in preparation of standard solutions. One balance per party of 3 or 4 people is satisfactory.

A hand operated centrifuge with a 15 to 1 gear ratio is all that is needed for undergraduate work. It is convenient and necessary for certain procedures to have an electric centrifuge. It is useful for fast settling of particles, concentrations of plankton, and separation of certain liquids. We have an International #2 centrifuge that goes up to 6,000 R.P.M. and was originally built for a soils laboratory. The centrifuge has declined in its use with soils and so it was transferred to the sanitary laboratory. The only modification necessary was to change heads and buckets to accomodate test tubes. The centrifuge cost about $800.00 and is not warranted unless specific research utilizing the instrument is being done.

A one pound cylinder of chlorine gas is useful for rapid preparation of chlorine solutions. A larger cylinder is not recommended as the small cylinder is quite easy to handle and not so apt to be damaged or to cause injury to the students. The rent on the small bottle is nil and one pound of chlorine will normally handle four laboratory sections for a semester. Larger bottles would be warranted if research work required it.

p^H is the reciprocal of the hydrogen-ion concentration in moles per liter. It is used extensively in chemical analysis and plant operation in both sewage and water treatment plants. The electric p^H meter is being put to more uses every day and is necessary in both the graduate and undergraduate laboratory. The line voltage operated meter is best suited for general work in the laboratory. If voltage fluctuations are common, a voltage regulator might be worth while. Usually the instrument can be standardized so easily that the regulator is not warranted. If it is desired to take the meter into the field the battery operated set could be used. We use a Beckman line voltage regulator and find it quite satisfactory for both graduate and undergraduate work. Care must be exercised in cleaning and using the electrodes for best results.

Turbidity is an expression of the optical property of a liquid which causes light rays to be scattered and absorbed rather than transmitted in straight lines through the liquid. The Jackson turbidity meter makes use of the depth of liquid necessary to make the light from a standard candle disappear. It is inexpensive ($30.00) and more dependable than instrumental methods using photoelectric cells. Turbidity is a property normally checked in water analysis and the equipment should be available in all laboratories.

The Jar test is a procedure for determining the most efficient and economical dosages of coagulants. It is a good operational test for water plants and some sewage plants where chemical precipitation is used. The apparatus consists of a series of glass jars (usually greater than 1 liter) with equal interconnected stirring mechanism. Varying dosages of coagulant are added to each jar and jointly stirred for a period of time. The stirring is stopped and the jars are observed to calculate the coagulant dosage necessary to produce the desired results in the treatment plant. Makeshift stirring apparatus can be made in several ways or student power can be used individually on each jar to demonstrate the procedure. The cost of the equipment ($150.00) is not justified unless it is to be used in connection with research.

A laboratory gas meter of the positive displacement type is necessary for many investigations on digestion and aeration. It is not necessary for undergraduate instruction. A gas meter is one of the pieces of equipment that go to make up the research laboratory and should be placed on the "must" list, for it will be used in connection with many research problems.

Imhoff cones are a standard fixture around sewage plants of all sizes. They are used to measure the settlable matter in sewage but their results are of doubtful value, although that would raise an argument from old timers and plant operators. Every laboratory should have a pair in a stand, if for no other reason than appearance' sake.

All water and sewage treatment laboratories should have a refrigerator for storage of media, water blanks, certain reagents, samples prior to testing and as a source of ice cubes. Any standard domestic refrigerator is suitable for laboratory use.

A muffle furnace is necessary for a graduate laboratory and fine but not essential for undergraduate laboratories. The muffle furnace should be electric and produce a temperature of 600°C. The volatilization of organic matter is subject to a great many errors. We use a bunsen burner and comparable results can be had with practice.

A high temperature oven (170-180°C) is necessary for the sterilization of glassware. Most any electric oven that will produce and hold the desired temperature is satisfactory. One inside dimension should be 20 inches or more in order to handle conveniently pipette cylinders for sterilizing pipettes. The temperature should be taken at the exhaust air part so that the minimum temperature would be observed. All laboratories should have some type of oven for dry sterilizations. In addition, each party of 4 students should have a small 103°C drying oven.

Many laboratory pocedures depend upon the matching of colors either by eye or with a photoelectric instrument. Both methods have their place in analysis and each has advantages and disadvantages. Photoelectric equipment is more versatile than eye comparison and usually more accurate, as they do not depend upon an outside light source. Photoelectric instruments will usually give a reading whether it is meaningful or not. Therefore, they must be used with care and frequently checked. Flame photometry is becoming an important analytical tool in water and sewage analysis. The use of arc and spark spectrography is quite helpful in determining trace elements and for certain determinations not easily done by other methods. The colorometer type instrument is suitable for undergraduate use and should be a standard piece of equipment ($256.00). The spectrophotometer is necessary for many graduate class analyses and a time saver and versatile tool on many research projects. They are rapidly coming down in cost and we are in process of purchase of one ($1200.00) suitable for flame attachment and plan to purchase the flame attachment at a later date ($800.00).

A portable combination vacuum pump and air compressor is necessary for certain filtrations and aerations. If a laboratory has central vacuum and compressed air piped around, that would serve the purpose but the portable apparatus is considerably less expensive ($55.00) and just as serviceable for low pressures and vacuum ranges. If high volumes of air or low vacuum ranges are necessary, the larger equipment would have to be installed. We find the portable equipment indispensable in both the undergraduate and graduate laboratory.

Distilled water is used in varying amounts for many different purposes in the sanitary laboratory. Distilled water is necessary for the preparation of standard solutions, rinsing of glassware and equipment and general use in all phases of laboratory work. It is necessary and one of the basic items on the reagent shelf. Some purposes require doubles or triple distilled water, as some of the colorometric tests respond to even the minute traces of impurities which may be found in ordinary distilled water. For many purposes water which has been demineralized by passing through ion exchange mixed bed resins will serve in place of distilled water. Every laboratory should contain a still that does not have any copper in contact with the water. The still should be in the sanitary laboratory because it is necessary to distill the water under varying conditions, dependent upon its use. Amonia can be removed by distillation from acid solution, carbon dioxide can be removed by distillation from an alkali hydroxide solution or by boiling. If ammonia and carbon dioxide are both present at the same time, boiling is not effective. The still need not be too large, as 1 gallon per hour is ample capacity for a small department.

Kjeldahl apparatus for both digestion and distillation is convenient if many nitrogen determinations are to be made. For just an occasional test, makeshift equipment can be used without additional cost. The complete apparatus is an excellent piece of equipment and quite suitable for a good graduate laboratory where much sewage research is going on. It is costly ($1800.00) and occupies considerable space and the exhaust is semi-permanently attached. We do not have the complete apparatus but plan to make the purchase when funds become available.

Permanent chlorine standards are standard equipment in the smallest of laboratories. The permanent standards are inexpensive ($15.00) for the normal ranges and additional color disks can be purchased at nominal cost to extend the range. Every laboratory party should have access to a set of standards and they should be checked in the laboratory each semester by comparison with fresh temporary standards. Some of the plastic disks tend to change color slightly and effect the results.

A dissolved oxygen sampler assembly should be in every laboratory. This equipment can be purchased or home made. There is not much difference in a factory model and a good home made set and comparable results are easily obtained.

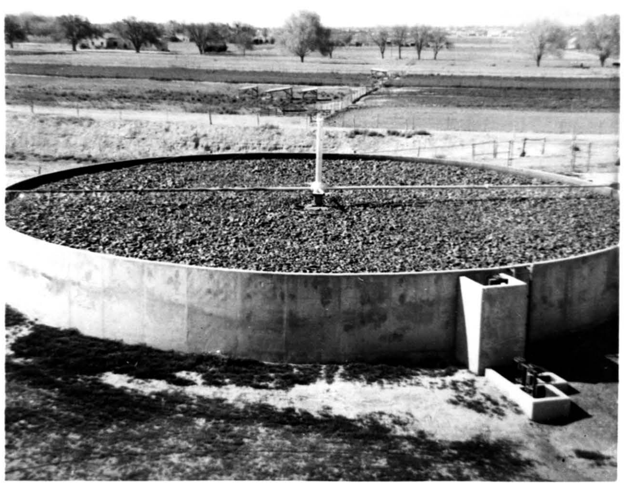
The problem is to obtain a sample of liquid without aeration and the least disturbance. Every laboratory should make or purchase a dissolved oxygen sampler.

Membrane filter equipment would be excellent for undergraduate demonstration and graduate research. Much remains to be done in this field but to be active, the graduate program must keep up with this sort of thing. We do not have the filter equipment but plan to purchase Millipore Filters and accessories. Their value in the laboratory will depend upon the research being carried on.

There are many other pieces of specialized equipment and glassware that would be convenient to have. A research laboratory should have a large backlog of odds and ends of equipment that can be used to expedite preliminary experiments on research projects. Much time is lost by competent research personnel because of the necessity to order or improvise preliminary equipment in the initial stage of an investigation.

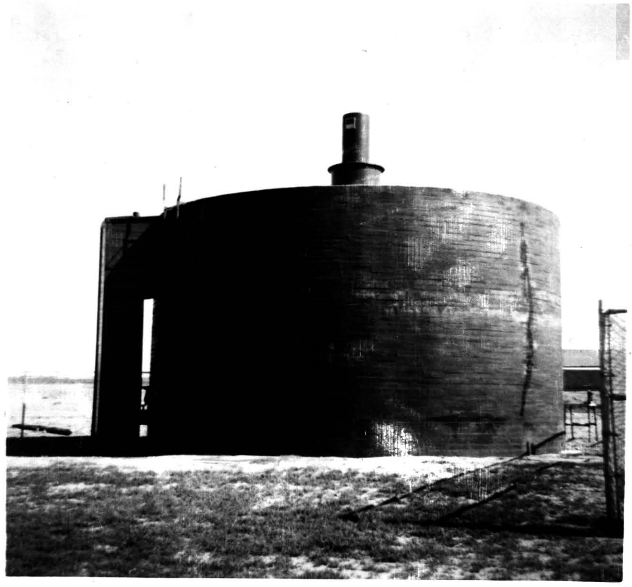
The college owns and operates its sewage disposal plant. The plant is primary sedimentation with standard rate trickling filter and sludge digester designed for 0.3 million gallons per day. This plant was completed in 1951 and serves only the college campus, with an average time of concentration of 15 minutes. In the fall of 1953 we decided to do some research at the sewage plant. The first phase of study was centered around the digester. In this southwest portion of the United States, the days are warm and the nights are cold (3,900 feet elevation) but most small digesters in this

Figure 9



Pictures of Sewage Plant

Figure 10



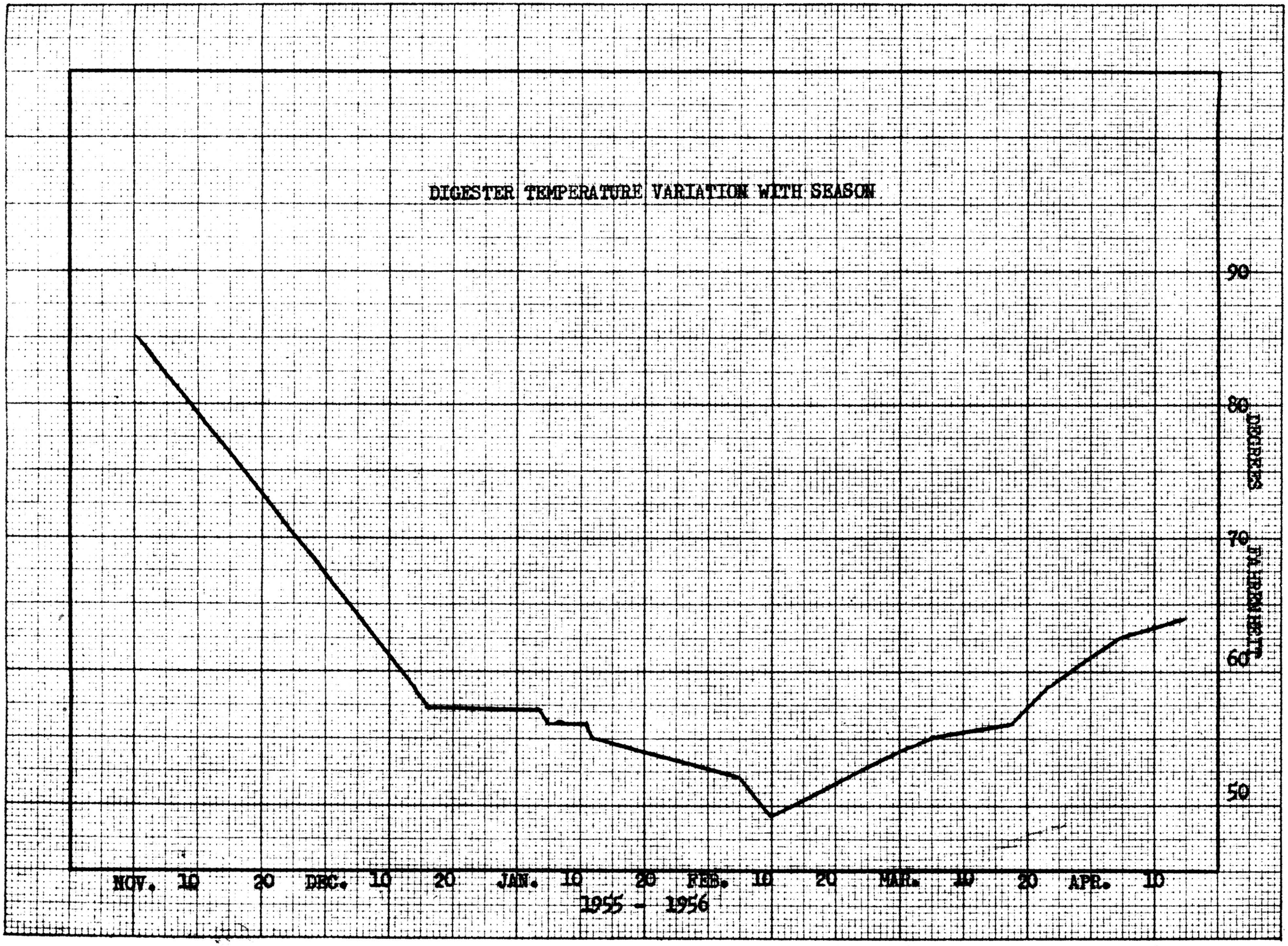
Pictures of Sewage Plant

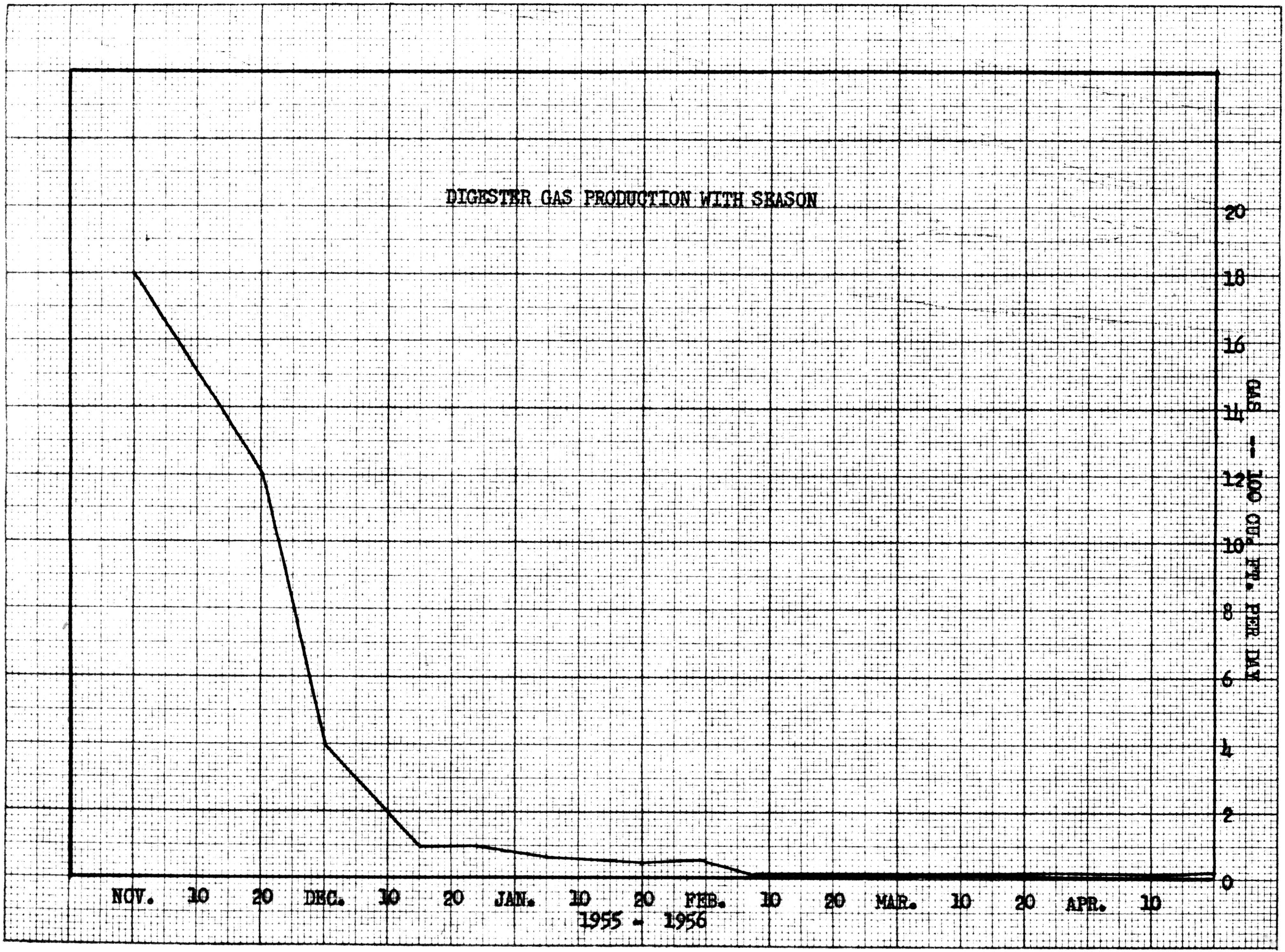
vicinity are designed without heat exchangers. The purpose of the study was to determine the rise and fall in digester efficiency with the seasons and to calculate design capacities of unheated digesters in this locale.

The giester temperature tends to follow the average daily temperature with lead or lag depending on the season of the year. The gas production varies as the temperature and the amount of sludge in the digester. From the preliminary research thus far, the present digester capacity could be reduced by 50% if heating equipment were installed.

Besides the investigations at the sewage plant, the writer is engaged in a laboratory problem. Many studies have been carried out on anerobic digestion along conventional lines and the maximum efficiencies have probably been achieved. Bacteria seem to offer the most economical means of waste disposal. High temperature and pressure chemical oxidation experiments have been run but the equipment and energy requirements are far beyond economical limits. Many types of sludge incinerators are in operation, both in industrial and municipal plants. The high cost of sludge dewatering and drying, plus the occasional smoke and odor problem, has limited its use. Many experiments are being carried on using composting methods in the laboratory and on a full plant basis. The most difficult task is to dewater the sludge and handle it through the composting process. The amount of water in compost appears to be one of the most critical factors.

The work currently being carried on at New Mexico


DIGESTER TEMPERATURE VARIATION WITH SEASON
90
80
70
60
50
DEGREES FAHRENHEIT
NOV. 10 20 DEC. 10 20 JAN. 10 20 FEB. 10 20 MAR. 10 20 APR. 10
1955 - 1956


DIGESTER GAS PRODUCTION WITH SEASON
GAS -- 100 CU. FT. PER DAY
20
18
16
14
12
10
8
6
4
2
0
NOV.
10
20
DEC.
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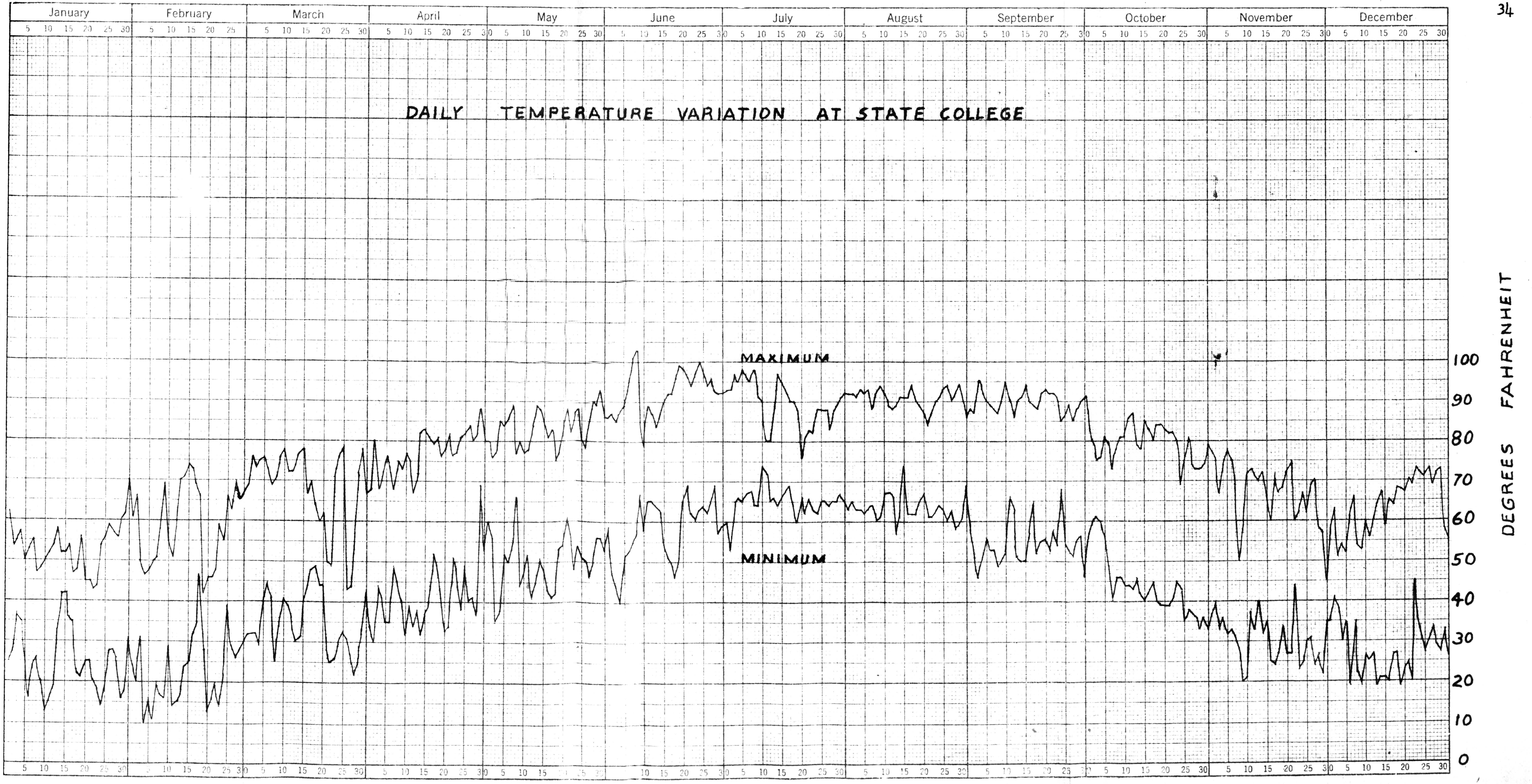
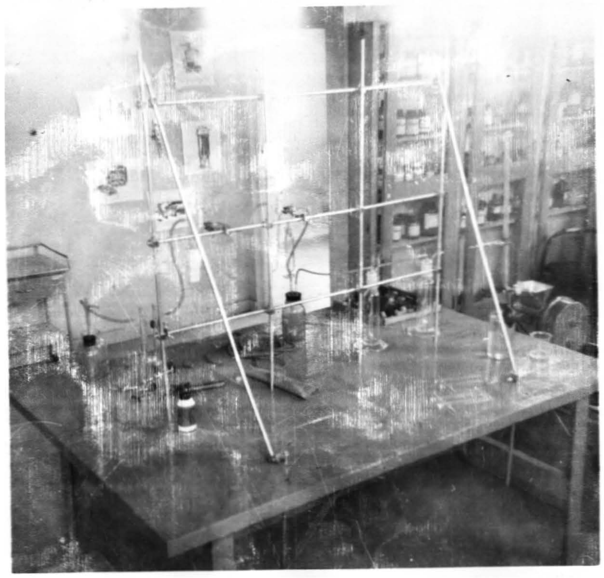
10
1955 - 1956


DAILY TEMPERATURE VARIATION AT STATE COLLEGE
January
February
March
April
May
June
July
August
September
October
November
December
MAXIMUM
MINIMUM
DEGREES FAHRENHEIT
100
90
80
70
60
50
40
30
20
10
0

A. and M. sanitary engineering laboratory is based on aerobic digestion but in a liquid state. This is not new in sewage disposal because it is the basis for the activated sludge process that has been in use nearly fifty years. It is the most common method of waste treatment in large domestic and industrial plants. Basically, the process is to bubble air through the raw sewage in order to increase aerobic bacterial digestion of suspended and dissolved organic material. This is more variable and gives a finer end product than the conventional trickling filter process. The plan being studied in our laboratory is to use aerobic digestion in the liquid state in closed digesters. In order to establish the high oxygen gradient necessary to keep dissolved oxygen in the liquid, the use of oxygen gas is necessary. Very little oxygen is absorbed by a liquid from bubbling gas through it and most of the gas passes off at the surface. In order to gain the greatest efficiency from the oxygen, it is being recirculated.

The end products of aerobic digestion are carbon dioxide and water. The carbon dioxide gas can be absorbed by several methods. Sodium hydroxide either in power or liquid form is suitable. The oxygen and carbon dioxide gas are passed through a scrubbing tower and the carbon dioxide gas is absorbed by the sodium hydroxide and the oxygen is recirculated back through the liquid sludge. Some other substances offer difficulty, such as the introduction of methane gas from anaerobic digestion that takes place in areas of poor

Figure 14



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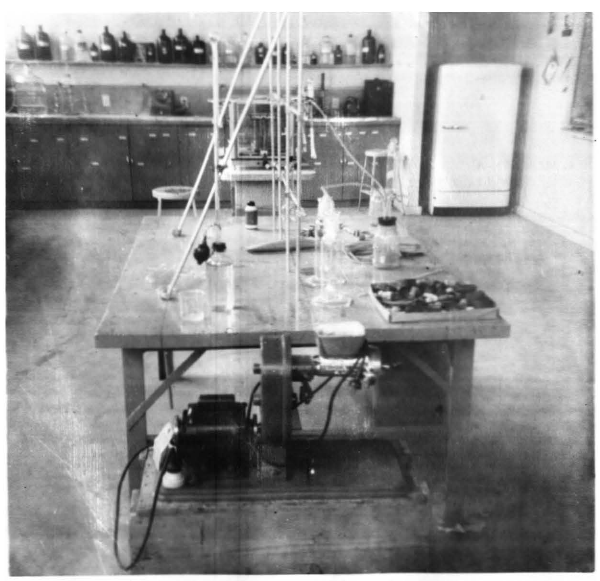

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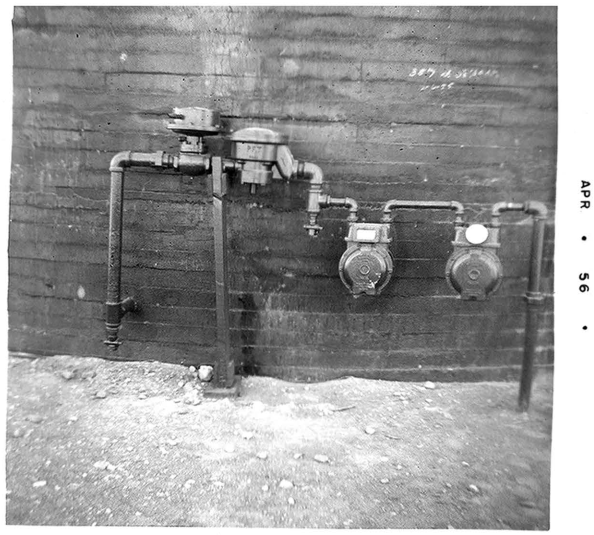
Preliminary Experimental Apparatus for Aerobic
Liquid Sludge Digestion

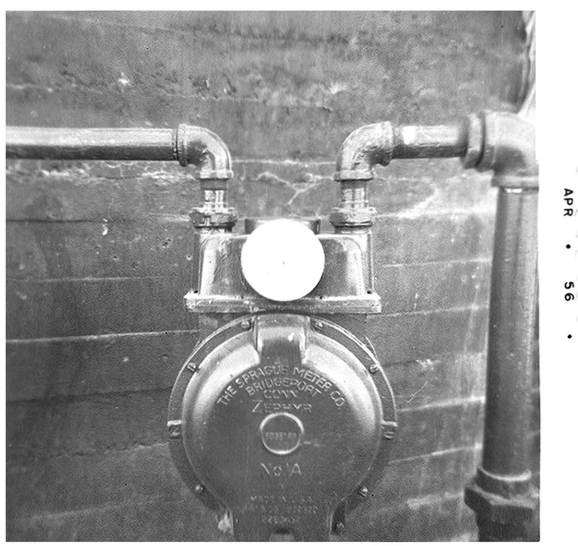
circulation, the draining off of nitrogen from the liquid in the early stages of operation and the accumulation of nitrogen from the commercial oxygen, as it only runs about 95% pure. It is necessary to vent off all of the recirculated oxygen mixture in the early stages of operation at decreasing intervals in order to maintain a high oxygen balance to keep the sludge from going septic.

The writer is working one quarter time for the spring semester, 1956, on this project and a request has been sent to the National Institute of Health for a research grant of $7,000 per year for a four year period. The project will be continued from department funds as long as it appears feasible if the grant is not received.

We found that it was difficult to carry on properly controlled research without complete control of the operation of the sewage plant. In july, 1955, the sewage disposal plant was placed under the civil engineering department as a sanitary engineering laboratory. A program is underway to instrument the plant completely and operate it as a model for the area, as well as a laboratory. The job of operation is demanding and occasionally inconvenient when mechanical failures occur, but the advantages the plant offers as a laboratory far exceed the disadvantages. We feel that the sewage treatment plant serves as an excellent purpose for both the undergraduate and graduate program. The plant is within a five minute walk from the engineering building and definitely a part of the laboratory. Sewage studies can be set up with

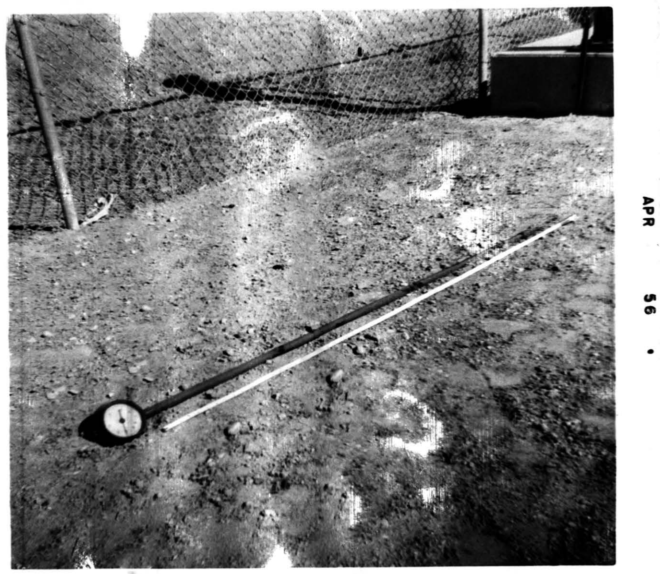
Figure 15





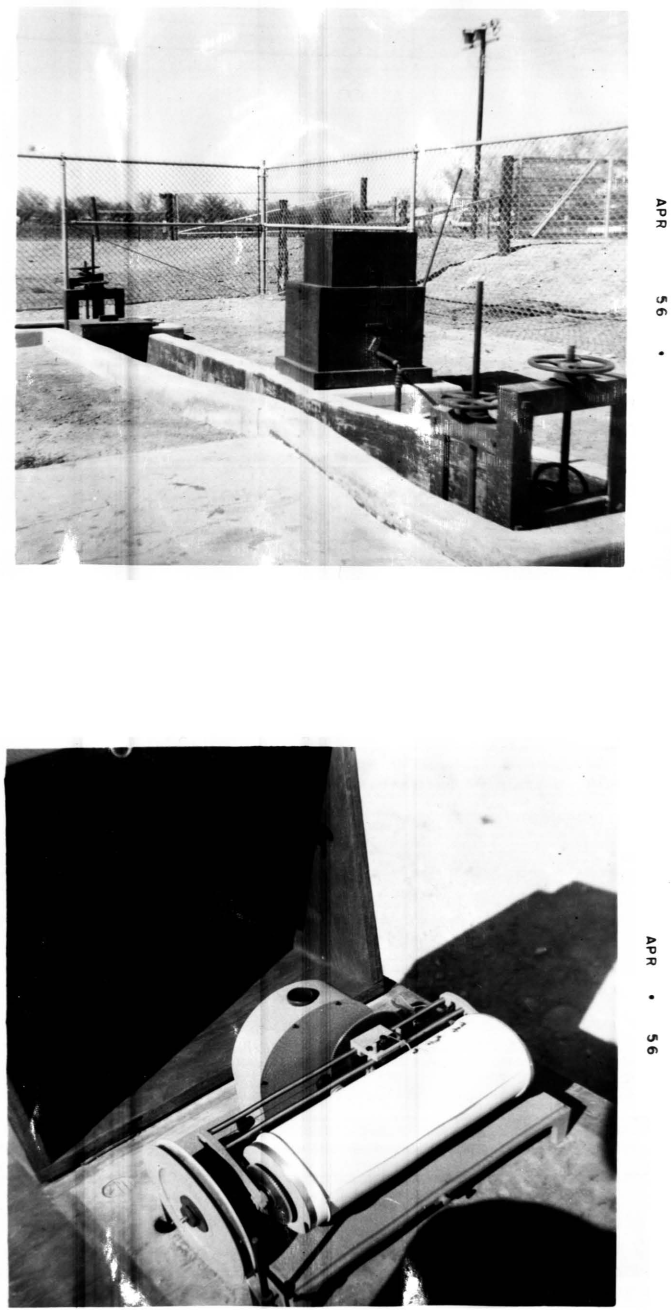
Gas Meters

Figure 16



Thermocouple Installations

Figure 17



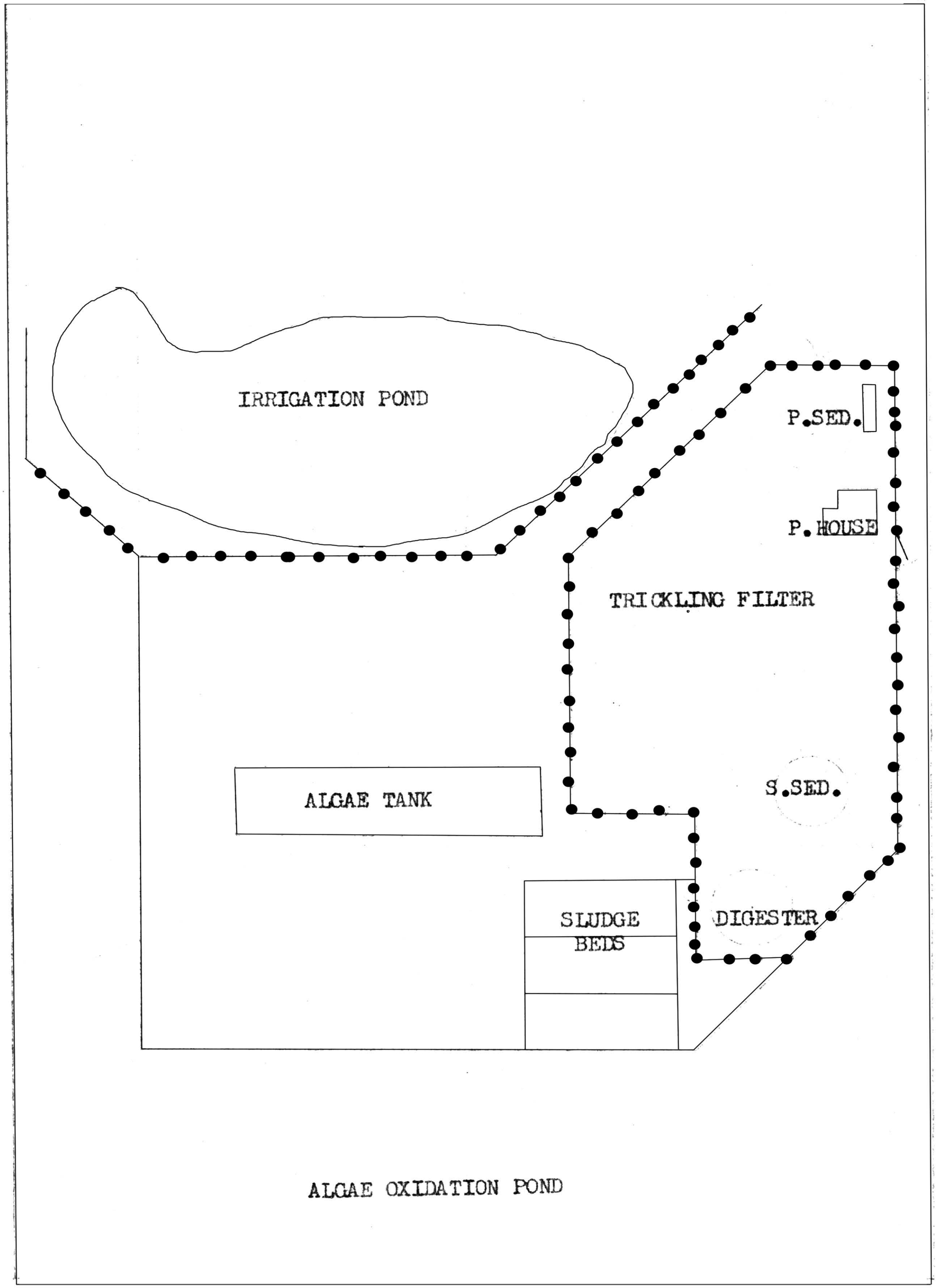
Flow Recorder Installation

a minimum of effort and without inconvenience or nuisance. This plant is small enough to be used as a pilot plant and large enough for intelligent design discussion. If at all possible, the sanitary engineering department should operate a small sewage plant or have large pilot plant facilities. Access to a plant, regardless of its size, is far short of complete operation for the conduct of research.

Water in our immediate area is from deep wells. The Rio Grande River is not a dependable supply as it is dry for six months out of the year. The river water is impounded in Elephant Butte and Caballo Dams for release during the irrigation season. The reclamation of sewage plant effluents for use as irrigation water or for domestic use is being studied.

Money was allotted in the current engineering budget for a graduate assistantship in each of these studies but the positions are not filled at this time. It is hoped that suitable students will be located in the near future so that the problems may be started this summer. The procurement of qualified graduate students to fill assistantships is difficult in this area. We are so far away from densely populated areas that the initial move is prohibitive to many potential students.

We have one of the highest sunshine areas in the United States and this being an agricultural college, it seems like a logical place to carry on algae experiments, especially on cattle feeding. In view of this we are building oxidation ponds for the growth of algae, in hope that some cooperative


IRRIGATION POND
P.SED.
P.HOUSE
TRICKLING FILTER
ALGAE TANK
S.SED.
SLUDGE BEDS
DIGESTER
ALGAE OXIDATION POND

experiments will develop through the agricultural people. There are two ponds, each 25 feet wide by 50 feet long by 3 1/2 feet deep. They are constructed as flow through ponds and empty into a large earthen lagoon used as irrigation storage. No results are available at present on this problem.

Sanitary engineering is quite new in New Mexico and we, as a state, lag the more densely populated areas in organized programs. Our problems are not as acute as they are in most places. A majority of the sewage treatment plants in New Mexico have been constructed since 1945. In order to provide a service, being a state supported school, a program was launched last year to operate an annual water and sewage short school at State College. There was some opposition to this move from supporters of the State University at Albuquerque but that was short lived, as they were not willing to promote and support the program actively. The first New Mexico Water and Sewage Short Course is planned for March 26-28, 1956, at State College, with the writer a general chairman and organizer.

The short course is a good way to advertise the sanitary engineering department over the state. Sponsored research is usually necessary for the propigation of an active research program. It is helpful to show the people over the state that are engaged in water and sewage work that you are interested and capable of doing a job. It is believed that their support will eventually bring the problems to State College for study and in so doing, help build a solid graduate program.

A SCHOOL FOR WATER and SEWAGE WORKS PERSONNEL

New Mexico College of A&MA
State College, New Mexico

March 26-28, 1956

CONDUCTED BY.....

CIVIL ENGINEERING DEPARTMENT—NEW MEXICO COLLEGE OF A&MA
NEW MEXICO DEPARTMENT OF PUBLIC SERVICE
UNITED STATES PUBLIC HEALTH SERVICE
NEW MEXICO WATER AND SEWAGE ASSOCIATION

Preliminary Schedule

Monday, March 26

8:30—**Registration**—Lounge, Milton Hall
9:30—**Assembly**—Sun Room, Milton Hall
Welcome—Dean Thomas
Introductions
10:15—**Health Aspects of Water and Sewage**—Holy
11:45—**Lunch**
1:15—**Fundamentals of water and sewage Treatment**—Caldwell & Lowe
2:30—**Arithmetic Review**—Bromilow
3:45—**Water Course**
Fluoridation—Striffler
Sewage Course
Sewer Maintenance—S. W. Sewer Tool Company

Tuesday, March 27

8:30—**Hydraulics**—Clark
10:15—**Chlorination**—Holy
11:45—**Lunch**
1:15—**Chlorinator Operation and Repair**—Henley
2:30—**Water Course**—**U. S. P. H. S. Drinking Water Standards**—Holy
Sewage Course—**Operation of Sewage Treatment Plants**—Lowe
4:00—**Laboratory Terminology and Demonstration**—Street

Wednesday, March 28

8:30—**Water & Sewage Activities at New Mexico College of A&MA**—Clark
9:30—**Maintenance and Repair of Water and Sewage Systems**—Price & Miller
10:45—**Inspection and Discussion of the College Water & Sewage System**—Clark
11:45—**Lunch**
1:15—**Public Relations**—Panel
Umbenhauer
Gonzales
Martinez
McGillis
McClean
Eaton
2:45—**Maintenance of Pumps and Motors**—Cannon
4:00—**Presentations of Certificates**—Caldwell

Banquet — Tuesday Evening, March 27

Know Your Speakers

Frank Bromilow—Professor and Head, Civil Engineering Department, New Mexico College of A&MA.

Charles G. Caldwell—Director, Environmental Sanitation Services, New Mexico

Malcolm O. Cannon—Industrial Supply Company, Albuquerque

J. W. Clark—Associate Professor of Civil Engineering, New Mexico College of A&MA

Tom Eaton—Superintendent, Construction, Public Service Company, Santa Fe

Conrad Gonzales—Chief Water Engineer, Albuquerque

Charles P. Henley—Wallace and Tiernan Representative

William E. Holy—Assistant Regional Engineer, U. S. Public Health Service, Dallas,Texas

Robert P. Lowe—Associate Engineer, Environmental Sanitation Services, New Mexico

Ernest Martinez—Manager, Taos Municipal Water and Sewage System

F. McClean—Water and Sewage Superintendent, Carlsbad

J. D. McGillis—Manager, Board of Public Works, Raton

Chester L. Price—Superintendent, Sewerage System, El Paso, Texas

Fred Miller—Superintendent of Water Distribution, El Paso, Texas

Haskell R. Street—Superintendent, Water and Sewage Treatment, El Paso, Texas

Dr. David Striffler—Director of Dental Health, New Mexico

M. A. Thomas—Dean, School of Engineering, New Mexico College of A&MA

E. J. Umbenhauer—Superintendent, Water and Sewage Departments, El Paso, Texas

Figure 19

Purpose

This short course is offered to acquaint men concerned with water and sewage treatment with the proper practices essential to the safe and efficient operation of their facilities. It will provide an opportunity for city officials and plant operators to become better acquainted with the fundamental aspects of water and sewage treatment.

Preventative maintenance measures for the protection of facilities and equipment will be stressed along with the operation of specialized equipment. This will ultimately result in increasing plant efficiency, and will also ensure less pollution of our waterways, reduce nuisances, and generally have a beneficial effect on public health and welfare.

FOR WHOM

The course is open to all interested persons, but is primarily for treatment plant operators and others in charge of municipal, industrial, and institutional water and sewage treatment plants. Previous technical training is not required, as this course will be presented at the basic level.

REGISTRATION

A $5.00 fee will be required of all persons registering for the course. This fee will cover course expenses and the banquet.

Meals may be obtained in the New Mexico A & M Cafeteria or elsewhere as desired. Arrangements have been made so that those who wish to stay in college dormitories may do so for $1.00 per night. Cost of meals is variable but will average about one dollar.

A certificate will be awarded to those who satisfactorily complete the course.

Short Course Program (cont.)

The small college is faced with a continual uphill battle in order to establish a growing sanitary engineering department. Every advantage must be taken in order to accomplish this on limited funds.

The outlook for sanitary engineering is very promising. It is necessary for sanitary engineering departments at all educational institutions to expand their operations in order to meet society's needs in the immediate future.

BIBLIOGRAPHY

Bumstead, J. C. and Coster, A. D. Sanitary Engineers--Their Earnings and Professional Attitudes. Proceedings American Society of Civil Engineers. Separate No. 773, p. 3 (August, 1955)

VITA

John William Clark, Jr. was born on May 29, 1920, at Centralia, Illinois, the son of John William and Ida (Bozarth) Clark.

He received his elementary and high school education in the public schools of Centralia, Illinois, graduating in 1938.

After graduation from high school he worked as an electric welder for the R. G. Le Tourneau Company, Peoria, Illinois, until August, 1940.

In September, 1940, he enrolled in the Centralia Jr. College and graduated in 1942, completing two years of pre-engineering.

He entered the U. S. Navy as a Seaman in June, 1942, and served four years during the war as Seaman 2d class, Aviation Cadet, Ensign, Lieutenant Jr. Grade and Senior Lieutenant. Twenty-seven months were spent overseas, during which time he was awarded the Navy D. F. C. for aerial action off Guadalcanal.

Upon receiving orders to inactive duty in the Navy in April, 1946, he returned to Centralia, Illinois, and purchased half interest in a local hardware store and worked in that capacity until November, 1947, at which time he sold his hardware interest.

In April, 1946, he was elected Finance Commissioner of the City of Centralia, Illinois, for a four year term, during which time considerable progress was made by the city in public improvement.

He helped organize the Clinton County Sand and Gravel Company to dredge sand and gravel from the Kaskaskia River near Posey, Illinois, in the spring of 1948. This company was severely crippled by summer floods in 1948 and 1949 and was dissolved in August, 1949.

He entered the Missouri School of Mines, Rolla, Missouri, in September, 1949, and completed the requirements for the degree of Bachelor of Science in Civil Engineering in January, 1951. He immediately started working on the requirements for a Master's degree.

He received the Mid-Missouri Section, American Society of Civil Engineers award for the outstanding civil engineering graduate in 1951.

He was employed as a hydraulic engineer by the U. S. Geological Survey, Water Resources Division, Rolla, Missouri, in August, 1951, and served in that capacity until August, 1953.

He received the Master of Science Degree in Civil Engineering from the Missouri School of Mines, Rolla, Missouri, in June, 1953.

In August, 1953, he resigned from the U. S. Geological Survey to accept a position with the New Mexico A. and M., State College, New Mexico, as Assistant Professor of Civil Engineering teaching sanitary engineering and hydraulics.

He was registered as a Professional Engineer and Land Surveyor in New Mexico, Number 1784, in May, 1954.

During the summers of 1954 and 1955, he did research on the Elephant Butte Irrigation System, New Mexico.

He was promoted to Associate Professor of Civil Engineering at New Mexico A. and M. in June, 1955, in which capacity he is still working.

He was united in marriage on May 19, 1946, in St. Louis, Missouri, to Jacqueline Delores Milz. Their children are Douglas William, born June 7, 1949, and Scott Hurley, born January 23, 1953.