Regional Oral History Office
The Bancroft Library

University of California
Berkeley, California

Wilfred F. Langelier

TEACHING, RESEARCH, AND CONSULTATION
IN WATER PURIFICATION AND SEWAGE TREATMENT,
UNIVERSITY OF CALIFORNIA AT BERKELEY,
1916-1955

With an Introduction by
Erman Pearson

An Interview Conducted by
Malca Chall in 1970

Sponsored by the Water Resources Center,
University of California, Davis

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PREFACE

The development of sanitary engineering in California since the turn of the century is the subject of a series of interviews conducted by the Regional Oral History Office of the Bancroft Library under a grant from the Water Resources Center of the University of California.

The idea for documenting this history was initiated by Henry Ongerth, chief of the Bureau of Sanitary Engineering of the California State Department of Public Health. In a letter to Professor Arthur Pillsbury, director of the Water Resources Center, he suggested that funds be provided to interview Chester Gillespie, the first chief of the Bureau (1915-1947), and Professor Charles Gilman Hyde, head of the Department of Sanitary Engineering on the Berkeley campus from 1905-1944. David Todd, professor of Civil Engineering, provided leads for other interviews and the series came to fruition. Major funding came from the WRC with some additional assistance from the Department of Hydraulic and Sanitary Engineering on the Berkeley campus.

Mr. Hyde was not well enough to interview, but Chester Gillespie, Wilfred Langelier (chemist and water purification specialist UCB 1916-1955), and Percy H. McGauhey (director of the Sanitary Engineering Research Laboratory, UCB, 1956-1969) did tape their memoirs. As a result there is on record information about administration, teaching, and research in sanitary engineering from 1905-1971, a period which spans the time when the major emphasis of the sanitary engineer was prevention of typhoid fever, to today, when concern is with prevention and control of pollution of the total environment.

These interviews have benefited greatly from the expert advice and assistance of Henry Ongerth and professors David Todd, Erman Pearson, and Robert Selleck.

The Regional Oral History Office was established to tape record autobiographical interviews with persons prominent in recent California history. The Office is under the administrative supervision of James D. Hart, director of The Bancroft Library.

Willa Baum, Head
Regional Oral
History Office

22 February 1971
Regional Oral History Office
Room 486, The Bancroft Library
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INTRODUCTION

Professor Wilfred Langelier's contributions to sanitary engineering are outstanding. They range from the development of scientific bases for the design and evaluation of water treatment processes (including their implementation) to the development of fundamental and advanced sanitary engineering educational programs. Additionally, he has been considered an outstanding and inspirational teacher with the unique ability to stimulate his students and colleagues to contribute their best intellectual resources to the advancement and application of fundamental principles in the practice of the profession--from research to final design. Moreover, he advocated and emulated the highest quality of professional practice. Almost every one of his published works has turned out to be a classic in the professional literature.

Following his undergraduate work at the University of New Hampshire (B.S. 1909), he went on to graduate studies at the University of Illinois (M.S. 1911), where Professor Edward Bartow had a dual role as Professor of Chemistry and Head of the Illinois Water Survey, an organization charged with providing assistance in the solution of the state's water problems. This provided him an opportunity to develop his unique bent for the effective application of the newest theories to the processes of water treatment then under development. He remained with the Illinois Water Survey until 1916.

At that time, Professor Langelier was recruited by the University of California, Berkeley, Professor Charles Gilman Hyde, who was the pioneer sanitary educator on the Pacific Coast. Professor Hyde was developing a unique sanitary education program in the Department of Civil Engineering at U.C. Berkeley. This program specialized sanitary engineering within the Civil Engineering curriculum at the undergraduate level, but not at the expense of basic undergraduate civil engineering. It was an "add on option," in that it was an additional program involving considerable chemical and biological theory that students could elect beyond the normal civil engineering program. These additional courses were considerable and more often than not required an extra year of undergraduate work, and were roughly equivalent to what is now (1982) covered in most postgraduate work for the Masters Degree.

Professors Hyde and Langelier soon became one of the most effective engineer-chemist teams in the evolving field of sanitary engineering, especially in the area of water treatment technology. The effectiveness of this team was demonstrated in the early 1920s. Professor Langelier's classic paper, "Coagulation of Water with Alum by Prolonged Agitation," published in 1921, resulted from laboratory studies approximately two years earlier reporting on the design of the Sacramento Water Filtration Plant. This plant employed flocculation in "a series of circular tanks, each equipped with mechanically driven paddles capable of imparting to the water a uniform well-ordered turbulence of an approximately definite and controllable degree."

This is believed to be the first treatment plant designed and built to provide mechanically induced flocculation--which today (1982) is a characteristic of essentially all conventional water treatment plants employing chemical treatment for colloid (color and turbidity) removal throughout the world. This contribution was cited by the late Professor Gordon Fair, himself a distinguished sanitary engineer-educator at Harvard University, in his paper entitled, "Progress in Purification (1913-1963)," published in the 1963 AWWA Journal. Professor Fair stated, "Wilfred F. Langelier and Charles G. Hyde had built mechanical flocculation into the Sacramento Water Treatment Plant in 1921 following bench-scale tests of flocculation of suspensions. Eventually, opportunity for flocculation growth in coagulation plants was incorporated too, in solids contact units which differed much in mechanical and hydraulic ingenuity but little in fundamental principle from otherwise time honored procedures." Moreover, it is not widely appreciated that from these notable studies by Langelier and his students came the universally used--even today--classic "jar test" procedure for determining the optimum dose of a coagulant chemical.

Although Professor Langelier's professed deep interest was in the coagulation/flocculation process, there is little doubt that his greatest contribution is in the AWWA Journal entitled, "The Analytical Control of Anti-Corrosive Water Treatment." From this paper came the internationally known and used "Langelier Index." In the writer's judgement this single engineering parameter of the corrosive potential of water is likely the most widely used single interpretative parameter of water quality throughout the world. It is believed that this 1936 paper is one of the most frequently quoted papers in water treatment technology literature. It is of interest to note that the January 1977 issue of the Journal of the Institution of Water Engineers and Scientists, published in London, contained an article by an English industrial engineer-scientist, which stated that the Langelier Index is "a useful technical control parameter." The paper with a "modern" look is entitled, "An Algorithm for the Langelier Index of Process Water," tangible evidence that Langelier's 1936 contribution is still widely used and studied some forty years after its publication.

Professor Langelier's two formal publications near the end of his active career were as scholarly as those in early years, and were in the emerging field of potable water production from sea or saline waters. The next to last, entitled "The Electromechanical Desalting of Sea Water with Permselective Membranes--A Hypothetical Process," was published in 1952, and provided the first detailed explanation in the water treatment literature of the then developing concept for the promotion of ion permeable (or selective) membranes for the demineralization of sea or brackish waters for potable water production.

One of Professor Langelier's students and a co-author with him in his last publication in 1954, "Mechanism and Control of Scale Formation in Sea Water Distillation," is Walter B. Lawrence. After graduation, Mr. Lawrence had varied experience in industry, finally reaching the position of principal engineer with Bechtel Corporation. In March 1977, Mr. Lawrence returned to the Berkeley campus, appointed to the faculty at a senior professor level, having been singled out as the one most suitable to replace Warren J. Kaufman, whose untimely death in 1973 ended some 23 years as a distinguished member of the Berkeley Sanitary Engineering program. Thus, Professor Langelier's direct influence in the Berkeley sanitary engineering program continues to live through one of his students--a fitting compliment to the creative engineer-scientist.

I shared an office with one of Professor Langelier's distinguished students, Harvey F. Ludwig, Dr. (Hon.), when he and I joined the U.C. Berkeley faculty in 1949, and the ensuing opportunity to work closely with Professors Langelier and Ludwig was one of the most enjoyable and stimulating experiences of my career.

Largely because of his excessive modesty and principled avoidance of self-aggrandizement, Professor Langelier has not received from the profession the accolades that are due him. Nonetheless, among serious scholarly practitioners in water technology, he ranks among the most distinguished contributors to the advancement of water technology during the last century.

Thus, it is a privilege to add a few words of admiration and esteem for this modest and scholarly engineer-scientist to the profession of sanitary engineering and water technology, and I am confident that these comments only echo similar sentiments of his many students and colleagues who do not have this opportunity to express them for his oral history record.

Erman A. Pearson
Professor of Sanitary Engineering,
Emeritus

12 March 1982
University of California, Berkeley

INTERVIEW HISTORY -- Wilfred Langelier

Any history of pioneers in the field of sanitary engineering would have to include Wilfred Langelier (1886-1981) whose teaching, research, and scientific achievements on the Berkeley campus spanned the years 1916-1955. For this reason he was recommended along with fellow pioneers Charles Gilman Hyde, Chester Gillespie, and Percy McGauhey for an oral history project sponsored by the Water Resources Center.

There is a long story, however, connected with this oral history memoir of Wilfred Langelier that stretches from April 1970, when we met for our first planning conference, to March 1982, at which time the memoir was completed.

During the intervening decade, I became well acquainted with Wilfred and Ruth Langelier--their beautiful home and large hillside garden in Berkeley, their always gracious hospitality, their unfailing good humor, Mrs. Langelier's expert knowledge of plants, and Mr. Langelier's ingenuity about the practical aspects of house and garden planning and repair, and everyday economics--that same ingenuity with which he attacked problems of water purification throughout his nearly half-century career in sanitary engineering.

During these years I have also come to understand fully what Erman Pearson told me when I first met with him for background information about both Charles Gilman Hyde and Wilfred Langelier. Professor Pearson talked about Langelier as a distinguished teacher, as a research scientist with a significant international reputation, and as an important consultant to several water districts in the San Francisco Bay Area. But he also cautioned that Mr. Langelier was modest and would undervalue his own significance and role.

Socially, Mr. Langelier was gregarious--outgoing and friendly. He and his wife had always drawn their then-current and former students and colleagues to their home because of their genuine interest in them and their careers, and because of their continuing interest in the ever-changing field of sanitary engineering. Their exceptionally large livingroom was the scene of many lively social gatherings during the nearly fifty years they lived in their home on Alvarado Street, Berkeley.

Yet Mr. Langelier was indeed modest about his reputation. It was this combination of keen perception, verve, and diffidence toward his accomplishments which kept the oral history on the back burner for more than ten years.

When we first planned the project on the history of sanitary engineering at Berkeley, it was assumed that I would also be interviewing Professor Charles Gilman Hyde. He had been the only professor of sanitary engineering at Berkeley from 1905 until 1916 at which time he brought Mr. Langelier to the campus specifically to teach chemistry to students of sanitary engineering. Firsthand knowledge of these legendary and important Hyde and Hyde-Langelier years on the Berkeley campus was important to record. Throughout the interviewing period with Mr. Langelier, he expected that I would be able to get all the information I wanted about the early years in Berkeley from Professor Hyde, but the latter's failing health prevented it. Professor Hyde died September 1971.

Preparatory to the interviews, I called on former students and colleagues of the two men for briefing. There is a close bond among many of the sanitary engineers I have met; the foundations of their own distinguished careers they understandably attribute to their teachers. Henry Ongerth, retired chief of the California State Bureau of Sanitary Engineering, remembered his student days and found old pictures and reports while he was preparing to assist me with the interview of Chester Gillespie, first chief of the bureau, and one of Hyde's earliest graduates.

Frank DeMartini, who had recently retired from the U.S. Public Health Service, and when a student had collaborated on some research with Langelier, carefully prepared an outline so that we would be sure to cover the significant features of Langelier's career. He also lent me pictures from his scrapbook for use in the volume.

Erman Pearson, who at that time was chairman of the Department of Hydraulic and Sanitary Engineering, covered the history of sanitary engineering at Berkeley and the Bay Area from both first and secondhand knowledge, and provided interesting personal observations of both Hyde and Langelier and their importance as pioneers in sanitary engineering. As a long-time friend and admirer of Langelier, he ultimately agreed to write the introduction, thus putting on the record the valuable background which I could only absorb in a few hastily-taken notes.

Four interview sessions with Mr. Langelier took place at weekly intervals during April and May, 1970. Because he suffered from emphysema and usually felt stronger in the afternoon, we worked from about 2:30 to 4:30 in a sunny corner of the livingroom. Mrs. Langelier sat quietly with us, occasionally commenting. She always served tea and cookies during a pause in the taping, at which time we talked of the whereabouts and activities of former students, gardening, and matters pertaining to the oral history process itself.

Mr. Langelier often experessed concern about whether he was worth the effort of an oral history interview. Yet when he spoke about the past--about his former teachers, his students, his colleagues, his research and consultation--he did so with that great zest which was characteristic of him. Even years later, although he was much weaker from emphysema his mental acuity and the energy with which he talked about matters of interest caused one to forget his infirmity.

When he received his edited transcript in January, 1971, he declared it "a total disaster." He could not accept the digressions to bring the past into the present, nor what he considered irrelevant stories about totally unscientific matters. He attested strongly that his publications clearly laid out his scientific work and that no further discussion about it was necessary. He suggested that instead of the oral history, an almost complete set of his monographs, including those by Frank DeMartini, Charles Hoover, and Gordon Fair in which Langelier's research is discussed, be placed in the archives. In the summer of 1974, Harvey Ludwig, his friend and former student, photocopied these articles; Professor Percy MaGauhey, a friend and former colleague, wrote a detailed introduction; the Regional Oral History Office arranged for the binding; and copies of the complete set were deposited in many libraries throughout the country. The original publications were given to the Water Resources Center Archives on the Berkeley campus.

Important as was this excellent collection to the field of sanitary engineering, it was not a satisfactory resolution of the oral history project. Still necessary were those firsthand accounts of Mr. Langelier's experiences in what was a very new profession. Motivated by Mrs. Langelier and others who realized the value of his recollections, he finally agreed to totally revise the transcript to his own satisfaction. But time spent with holidays, visiting friends and relatives, work around the garden and house, and annual income tax reports, always offered opportunities for procrastination.

Eventually he set himself the task of dictating his revised story to Mrs. Langelier who wrote it out in longhand. This method was necessary because of Mr. Langelier's failing eyesight. It is a beautifully stated and handwritten document; few young people today could duplicate the work of these exceptional octogenarians. (A sample can be seen on page 6a) Nonetheless, through his very scholarly approach, Mr. Langelier succeeded in distilling out not only his personality (except for modesty), but many of the firsthand insights about his career which are so vital a part of an oral history. I persevered. So, in November 1976 when he had completed his revision, he gave me permission to add, at my discretion, a few carefully selected excerpts from the interview transcript. I promised that I would be fair.

Being fair meant balancing the legitimate concerns of Mr. Langelier about his transcript and the meaning of his career with the legitimate needs of those who have come, increasingly, to use oral history as another form of primary source material. That balance has been achieved in the following way:

The volume is comprised of three sections. Part I is the carefully written historical record prepared by Mr. and Mrs. Langelier. Part II is made up of selected excerpts from the original transcript (perhaps one-tenth of the whole) which shed some additional background on his career and provide some of the local color he was wont to dismiss as either unscientific, or "bragging." Although he could not review these segments, I have assumed, knowing how keen was his memory, that they are accurate. The Appendix includes related material on Mr. Langelier.

Although the oral history was essentially completed by January 1977 it was missing an introduction because Mr. Langelier had not approved one written in 1973 by Percy McGaughey. Nor would he, in March 1977, approve a draft written by Erman Pearson. In each case he felt that the writers had been too generous in their praise of his accomplishments as teacher and scientist. Professor McGaughey's draft has been deposited with the Langelier collection in the Water Resources Center Archives and a revision became the introduction to the collection of the monographs. Professor Pearson decided to put aside his draft until such time as he could no longer be required to withhold his praise. With the death of Wilfred Langelier September 13, 1981, it became possible for Mr. Pearson to pull together the many suggestions that colleagues had made regarding his first draft, write his introduction, and thereby complete this memoir. Mrs. Langelier graciously approved it.

Finally, therefore, this history of a first-class scientist, a warm and engaging human, respected and cherished by many men and women of all ages and cultures for nearly a century, can be released. Through it many others will come to know this remarkable individual and his achievements. Additionally, it is hoped that it will serve those of us who sometimes lose sight of the many significant events and personalities which are the links in the continuum between the past and the events of the present.

Malca Chall
Interviewer/Editor

March 1982
Regional Oral History Office
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PART I MEMOIR AS WRITTEN BY MR. AND MRS. LANGELIER

BACKGROUND IN SANITARY ENGINEERING, 1886-1916

Education in New Hampshire

Chall: Could you tell me something about your background prior to your coming to Berkeley?

Langelier: I came to Berkeley directly from the University of Illinois in Urbana, Illinois. Prior to that I was an undergraduate student majoring in chemistry at New Hampshire College in Durham, New Hampshire. I was born in Nashua, New Hampshire--just thirty miles north of Boston.

Chall: What was that date, by the way--your birthday?

Langelier: I was born in 1886 of French Canadian parentage--grew up in Nashua and graduated from Nashua High School in 1905. In the fall of that year I enrolled in New Hampshire College--a state agricultural school located in Durham. I selected "State" because tuition was free and it was reputed to have a good chemistry course.

Then too--I was influenced by an older brother who had attended Durham for a year or two in the late nineties--lured, I think, by the opportunity to play football and baseball. He left to enlist in the army during the Spanish American War.

I had considered Hanover--even in those days we substituted location for the name of the college--but I thought chemistry with Professor Parsons would be better. The common reference to "Cow College" did not deter me. At that time, New Hampshire had a

Langelier: very small enrollment, only a few hundred. Today it is the University of New Hampshire and has about ten thousand students, and recently I read in the "Alumni News" that the in-state tuition is one thousand dollars--the highest of any state university.

I experienced a few surprises during my first year at Durham. The fact that it was so easy to enroll--a high school diploma was more than adequate--made it difficult to stay in. I don't remember the exact figures but I am positive that at least fifty percent were dropped at the end of the first term. I know that among ten men who joined my fraternity only one graduated at the end of the fourth year.

Chall: The college curriculum was tough?

Langelier: It was difficult in chemistry because enrollments were limited due to lack of laboratory space. Professor Parson's laboratory could accommodate only six students in each class of the upper division years and the schedule called for more units of laboratory work than is common today. My grades were none too good the first two years, but my interest in chemistry kept me in and I was fortunate enough to be one of the six.

I look back upon my four years at Durham with fond memories. Student life was a happy life, not involved with external affairs as it is today. Politics and protest movements were not a part of our lives. Imagine going to college before radio and television--not even a campus newspaper. We didn't have a telephone in our fraternity house. Silent movies were new. The nearest movie theatre was five miles distant in Dover. There was only one student on campus who owned an automobile--a Steamer. We depended largely upon athletic contests for our entertainment. My roommate for the first three years was Charlie Cone of Nashua--a three letter man.

I never tried out for any of these sports. I was more interested in music. My 1909 year book "The Granite" lists me as second tenor in the glee club, drum major of the band; first violin in the orchestra, and first mandolin in the Mandolin Club.

Chall: Have you ever revisited the campus at Durham?

Langelier: Yes, but not until 1957 just two years prior to the fiftieth anniversary of my graduation. I went in response to an invitation

Langelier: to attend the commencement exercises and to receive an honorary Doctor of Engineering degree.

Chall: You graduated in 1909 and then you moved to Illinois. How did that come about?

Langelier: Yes, I received a B.S. degree in naught nine and in the fall of that year through the efforts of Professor Parsons I joined the staff of the Illinois Water Survey.

The Illinois Water Survey, 1909-1916

Chall: Tell me about the water survey.

Langelier: It was an institution which at that time was housed in the chemistry department of the university. The survey was directed by Professor Edward Bartow. I was to do laboratory routine in the survey half-time and was free to carry on graduate work. This arrangement was similar to that of a present day graduate assistant. I received a Masters Degree in chemistry in 1911, following which, I became a full-time member of the survey staff engaged in field studies in water supply.

I know of no institution similar to this Illinois Water Survey. It is peculiar, I think, to that state. Its function was to survey the public and private water supplies of the state. Its routine involved the systematic analysis, chemical, and bacteriological, of both public and private water supplies. Field investigations were made and corrective measures were recommended where indicated.

In most states, this field of investigation, greatly expanded, is carried out within bureaus of state departments of health. However, these bureaus in recent years of rapidly growing interest in environmentalism are being supplemented with state and federal boards or agencies, with police power adequate to enforce their regulations.

I remained with the survey from 1909 to 1916. During those seven years important studies of water purification and sanitary disposal of sewage were in progress throughout the world. During this short interval four truly great processes in water purification

Langelier: and sewage treatment had their most rapid advances in technology--(1) The practice of disinfecting public water supplies with chlorine, (2) The introduction of rapid sand filtration of turbid river waters incorporating the use of coagulant chemicals, (3) The zeolite or ion exchange process for reducing the hardness of water and (4) The discovery in England of a new and complete process for the conversion of sewage into clean water of low organic content, known as the activated sludge process.

As I look back on my years in the survey, I realize that it was my good fortune to have started in a field that was making rapid strides and that seemed to insure a promising future. In one way or another, I was rather intimately exposed to these interesting developments.

Water Disinfection

Chall: Let us begin with water disinfection.

Langelier: One of my first assignments was to visit and report upon the Union Stock Yards plant in Chicago where an enterprising eastern contractor had installed a standard water filtration plant. The water there came from a very highly polluted stream called Bubbly Creek. The contractor had guaranteed the stock yards company that the water would be suitable for watering stock, and that at no time would the filtered water contain more than one hundred bacteria per cubic centimeter. When tests were made, the plant failed to comply with the guaranteed reduction in the number of bacteria present, and a consultant named George Johnson was brought in to attempt to solve the problem.

The use of chlorine in the form of bleaching powder (calcium hyperchlorite) as a disinfecting agent was well known. It had been used intermittently for disinfecting water mains following waterborne typhoid epidemics, and in other instances where gross pollution was suspected, but it had never been applied continuously to an existing water supply.

Because this water was to be used for watering stock and not for human consumption, Johnson decided to experiment along this line. He arranged to feed a solution of bleaching powder

Langelier: in a very small amount, continuously, as it flowed from the filter. The results of these experiments were amazing because it was found that a minute amount of chlorine could induce almost complete sterilization. A permanent installation comprising duplicate solution tanks and an accurate feeding device was all that was needed to meet the performance guaranteed.

This plant and a similar installation in Boonton, New Jersey were really the beginning of water chlorination which today is practiced throughout the world. Nothing has done more to eliminate typhoid fever and other waterborne diseases, which were very prevalent at that time.

Chall: Was there much objection to putting chlorine, a chemical, into the drinking water?

Langelier: Yes, on two counts. In those years the addition of any chemical in processing food and drink was very controversial. An example was the use of benzoate of soda in the preparation of catsup. It was claimed that preservatives in general permitted the use of inferior raw material, and secondly, in the case of water chlorination, even a slight overdosage could impart a very disagreeable taste. However, the results from the use of free chlorine in water were so startling that the prejudice against the use of this chemical disappeared rapidly.

In the years immediately following these experiments, emergency hypochlorite plants were built in rapid succession throughout the country.

Two such plants with which I had direct experience were built--one in Council Bluffs, Iowa, another in Omaha, Nebraska, to disinfect the water supplies of these two cities. Both supplies were taken from the Missouri River. In the summer of 1911, I substituted for the operator of these two plants for a period of two weeks and saw for myself the remarkable effectiveness of this simple treatment.

In March of the following year I was sent by Dr. Bartow to arrange for the construction of an emergency plant of this type in Cairo, Illinois. This city, spelled Cairo and pronounced Kāro in that area, is located at the southern tip of Illinois immediately above the junction of the Ohio and Mississippi rivers. The city was protected from both rivers by levees. The one on the Ohio side was about twenty feet high. The water supply taken from the Ohio River had become endangered because of an exceptionally high flood in that river.

Langelier: I started the trip from Cairo by train but because of the flood we were stopped some several miles short of the city and had to continue the trip by boat. The emergency disinfection plant was rapidly put together with wood barrel solution tanks, and an orifice/box for accurate feed. It was touch and go for several days but the levees held and no epidemic resulted from the use of the polluted flood waters.

The numerous emergency hypochlorite plants throughout the country were soon replaced by mechanized, completely automated installations capable of feeding pure chlorine gas directly into the water supply. These plants, with only minor refinements, are being used in large water supplies throughout the world. They, more than any other factor, were responsible for the almost complete elimination of infectious waterborne diseases prior to the nineteen twenties.

I should mention here that for many years, a single manufacturer, the Wallace Tiernan Company of Belleville, New Jersey, researched and almost without competition developed the equipment used in the practice of water chlorination. Many of our Berkeley graduates in sanitary engineering in the early years found employment with this firm.

Water Filtration

Chall: You have referred to water filtration during a period when some exciting and very notable experimentation was taking place.

Langelier: When I began work in Urbana there were two methods of filtering water for municipal use--one was called the English method, or the slow sand filtration method, where no chemicals were used, and the other process was called the American process or rapid filtration, where alum was used as a coagulant. It had been found that the old English method was not well suited for the muddy river waters in the United States. Engineers under the direction of George W. Fuller, a prominent eastern engineer, were largely responsible for the development of the rapid sand filtration method as used today.

Chall: Mr. Gillespie [Chester] spoke very highly of Mr. Fuller.

Water Filtration.

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Langelier: Yes. Mr. Gillespie was very fond of him. He worked with him for several years as a resident engineer of construction. It was largely through my meeting with Mr. Gillespie at Evanston, Illinois, where he was employed during the construction of one of the Fuller-designed plants that I was invited by Professor Hyde [Charles Gilman] to come to the University of California.

Chall: Is alum still used?

Langelier: Yes, we use alum as a coagulant, that is, to aglomorate the tiny bacterial and clay particles in the raw water. After this aglomoration most of these impurities are permitted to settle out before the water reaches the filter. This permits high rates of filtration through relatively coarse sand and is essentially the heart of the rapid sand process. Good coagulation is essential to effective filtration. Coagulation, or flocculation, as we speak of it today, has been one of my special research interests throughout my entire career.

Chall: What was the status of filtration in Illinois and the middle west at this time?

Langelier: In those days most of the water purification and sewage treatment plants were sold to cities as package deals. They were contracted for on the basis of claims by enthusiastic salesmen without regard to the differences in the waters to be treated. However, this state of affairs was in process of change. Several large cities had made plans to build well-engineered plants designed to meet local conditions. Three such cities were Evansville, Indiana, on the Ohio River, Quincy, Illinois, on the Mississippi River, and Evanston, Illinois, taking water from Lake Michigan. It was my good fortune under Dr. Bartow to participate in making the acceptance tests at the Evansville plant in the summer of 1912 and the Quincy plant in 1914.

Chall: What were acceptance tests?

Langelier: Because of the widely differing characterof the available raw water in various cities, engineers would frequently choose to experiment with a small pilot plant prior to design. The uncertainties were choice of coagulant, quality of sand available, and other problems. To make certain of the design the cities asked for guarantees of successful performance and to meet this condition acceptance tests were the usual practice.

Langelier: In the test of the Evansville, Indiana, plant, the coagulants used were ferrous sulfate and lime. The Quincy, Illinois, plant used alum as coagulant. Each of these acceptance tests covered a period of three months. We made daily physical, chemical, and bacteriological examinations of raw, settled, and filtered waters. In both instances the plants were found to be efficient in all respects and were duly accepted.

Water Softening

Chall: You have made reference to water softening. Were city water supplies subjected to such treatment?

Langelier: Throughout the middle west many of the smaller cities obtained their supplies from both shallow and deep wells and almost invariably these waters contained excessive dissolved salts of calcium and magnesium which impart hardness and react unfavorably with soap in laundry operations. Hard waters also form scale in vessels in which the waters are boiled.

At that time, there were no large municipal softening plants in Illinois. There was much interest in the subject because in addition to the smaller cities, the entire rural population was dependent upon the use of hard ground water. It was a condition that had to be endured because there was no suitable method for removing the hardening salts from small private supplies.

However, a breakthrough in the solution of this problem was not long in coming. I remember Dr. Bartow's association with a company engaged in the processing of a claylike mineral deposit located in Iowa. Upon contact with hard water this mineral--they had named it Refinite--was capable of softening water by yielding a portion of its sodium content in exchange for an equivalent amount of hardness and most important, this chemical reaction was found to be a reversible, in that the mineral could be regenerated at intervals. Silicate minerals exhibiting this capacity to a high degree are called zeolites.

We learned shortly thereafter, that the zeolite process of water softening had been patented in Germany as early as 1906. The development of this process was slow at first but

Langelier: gained rapidly in the twenties and thirties, until today, completely automatic plants for home installation can be purchased through mail order supply companies.

In 1941 a zeolite plant of this type was built at La Verne, California, to soften the very hard water from the Colorado River to supply the Metropolitan Water District, a large coastal area of southern California. Its original capacity was 100 million gallons per day. This plant has since been enlarged to a rated capacity of 400 million gallons per day (400 MGD) and is the largest plant in the world employing zeolite exchange softening.

Sewage Disposal

Chall: What was the status of sewage disposal in Illinois previous to the time you left there in 1916?

Langelier: It was the general practice in the river cities in Illinois to discharge untreated sewage into the nearest stream. Where dilution was unavailable, land disposal was practiced after passage through a simple one-story septic tank. These tanks were soon to be replaced by two-story Imhoff tanks--tanks which led to what is now termed separate sludge digestion, in wide use today and called primary treatment.

Chicago: Solutions to Water and Sewage Problems

Chall: Did the city of Chicago have a sewage disposal problem?

Langelier: Yes, the story of how the city of Chicago, over the years, has solved its problems of water supply and sewage disposal is to me a classic in the literature of sanitary engineering. Someday a second Upton Sinclair should write a book on this subject.

Going back to the early nineties, hundreds of people in many of our midwestern cities were dying each year from drinking polluted water. In Chicago, the city drew its water supply from and discharged its sewage wastes into Lake Michigan, both without

Langelier: treatment of any kind. In the four years preceding 1893 the typhoid death rate for the city averaged 97 per 100,000 population and the death rate from other intestinal diseases was estimated to be double this number.

The first corrective measure was an attempt to avoid sewage contamination by extending the point of water supply intake to a distance some five miles from shore. This project which involved tunneling under the lake was completed in 1892. The effect was to reduce the death rate from typhoid fever and other waterborne diseases by approximately one half. The rate was still too high though, and in the following year a second major engineering project was started. This was a spectacular undertaking involving the construction of a 28-mile canal which enabled the diversion of all the city sewage, together with diluting water from the lake, into a different watershed, where it ultimately was discharged into the Illinois River, an important tributary of the Mississippi.

The canal was designed for a flow rate of 3.5 cubic feet per second per 1000 contributory population. This was estimated to be the minimum dilution required to prevent objectionable environmental conditions in and along the banks of the canal. The opening of the canal in 1900 resulted in a further lowering of the waterborne disease death rate by about another 30 percent.

It is interesting to note that the city of St. Louis some 300 miles down stream on the Mississippi, anticipated increased pollution at its raw water intake and immediately after the canal was opened, the state of Missouri brought court action against the state of Illinois. During this action, Dr. E.O. Jordan, Professor of Bacteriology at the University of Chicago, and several other eminent scientists of the country, testified and introduced chemical and biological test data. Missouri lost its case because the test data failed to confirm any damage to the St. Louis water supply.

The data showed that the bulk of the pollution had disappeared within the first 150 miles of flow. The remarkable capacity of a river to rid itself of gross organic pollution very rapidly had again been strikingly demonstrated.

Because of many favorable conditions for the study of self or natural purification, I suspect the Chicago Drainage Canal and the river below, is the most thoroughly researched stream

Langelier: anywhere in the world. A possible exception might be the Ruhr River--tributary of the Rhine in Germany, where it is known that some of its flow is used over and over again by successive industrial cities down stream.

Chall: You attach considerable importance to the natural or self purification which occurs in flowing water.

Langelier: Oh yes. All large cities throughout the world are dependent, at least in part, upon dilution for the ultimate stabilization and disposal of liquid wastes. Resort to artificial treatment of sewage occurs only to the extent that the available diluting water is inadequate to meet the reasonable needs of the cities located down stream.

At the present time, 1970, House and Senate committees in Washington are seriously considering for the first time so-called clean water bills which call for zero discharge of pollutants into lakes and streams by the year 1985. It is questionable in my mind whether the environmentalists backing these bills have given adequate consideration to the tremendous economic cost which would result if the stipulation for complete exclusion of liquid wastes into bodies of fresh water should become law. That is something to ponder.

Chall: Did these two projects suffice to solve Chicago's water supply and sewage problems?

Langelier: Oh no, additional projects and improvements of the older installations have been necessary right down to the present day. Chlorination of a portion of the water supply was started in 1912 and when extended to the complete supply in 1916 the typhoid rate had dropped to a level of about four or five and was comparable to the rate for the entire country. Pasteurization of most of the city's milk supply which occurred at about this time also played a part in the reduction.

Because the Great Lakes form an international boundary, there was concern in Washington that the withdrawal of water for the dilution of the Chicago sewage was actually lowering the level of Lake Michigan. This was denied by the city, but in 1925 the U.S. Supreme Court held that jurisdiction over the amount of water that could be diverted from the lake for the purpose of sewage dilution rested with the secretary of war. He, almost immediately, limited the Chicago Sanitary District to a fixed

Langelier: withdrawal which did not allow for the rapid population growth which the city was experiencing during these years.

Accordingly, the district was forced to build first one, then another sewage treatment plant in order to hold constant the pollution load of the canal. Also a growing demand to meet higher drinking water standards resulted in the adoption of water filtration. Actually, the city has recently been celebrating the completion of two plants, the latest word in automated water filtration. Plants of this modern type which embody the use of several chemicals, i.e., alum and silicate for flocculation, chlorine for disinfection, lime for corrosion control, and activated carbon for taste removal, all as adjuncts to filtration might better be called water "processing" plants. The two Chicago plants today rank one and two throughout the world for both size and automation.

Sewage Treatment

Chall: You spoke about a new development in sewage treatment which occurred while you were in the water survey.

Langelier: Yes, in the summer of 1914 Dr. Bartow was visiting in Europe and was detained by the outbreak of the war. While there, he visited a laboratory in London where two chemists, Messrs. Arden and Lockett, were experimenting with a new and apparently very efficient process for the secondary or final treatment of sewage. They called it the activated sludge process. Dr. Bartow was so impressed with what he had seen that he asked for and was given permission to carry out similar studies upon his return to the survey.

The graduate student to receive the assignment for this research was Floyd Mohlman, who in due time was awarded a Ph.D. and immediately thereafter joined the staff of the Chicago Sanitary District, where he remained to serve a distinguished lifetime career.

During the last three years of my stay in the survey in Urbana it was my pleasure to closely observe the development of this process from simple bench experiments on a batch basis in Urbana through successively larger scale field experiments, Langelier: culminating in a fair sized pilot plant operated on a continuous flow basis in the city of Milwaukee, Wisconsin. This city on the shores of Lake Michigan, with water supply and sewerage problems similar to those of Chicago was, I believe, the first large city to experiment with and to adopt this process for the treatment of its entire sewage flow.

An interesting feature of this plant, as originally built, is the by-product recovery of an excellent fertilizer called milorganite--a name derived from the words, Milwaukee, organic-nitrogen. The activated sludge process essentially as developed in these early test runs is today the universal choice wherever the highest degree of secondary sewage treatment is required.

Edward Bartow's Long-range Influence

Chall: In looking back upon your stay in Urbana, is there an anecdote relating to Dr. Bartow that comes to mind?

Langelier: Yes, an interesting coincidence which I like to tell relates to the deep interest which Dr. Bartow held for each one of his students. His faculty associates often referred to a Bartow student as being one of "Bartow's boys." Many of these have since enjoyed distinguished careers in the field of water supply technology.

Upon my arrival in Berkeley in 1916, following the Bartow teachings to the best of my ability, I myself, in time had built up a small following of interested students. They were not known as my "boys," but in 1931 on the occasion of a visit from Dr. Bartow, who as president that year of the American Chemical Society, came to San Francisco to address the local section of the society, it was my pleasure to introduce my group to him. I commented that they were his "grandchildren."

There is little point to this story except for an incident which occurred twenty years later at a conference of the American Water Works Association held in Miami, Florida. The association is composed of some twenty-five or more sections, each of which, each year, honors one of its members with an award known as the George Warren Fuller Award. The name of this award has been changed recently to the Utility Man of the Year Award. Several

Langelier: of Dr. Bartow's former students, I know at least six, have won this award since its inception in 1937. The interesting coincidence however is that the list of the twenty-five awards made in the year 1951 included the following: Edward Bartow, Iowa Section; myself, California Section; and Dario Travaini, Arizona Section, who was one of my students--thus each a representative of three successive "generations."

Chall: I think that's an exceptional tribute to good teaching. From the way you have spoken about Dr. Bartow, I judge him to have been a most interesting person.

Langelier: He was a fine person and of course a first rate scientist. He graduated from Williams College, Class '92 and received a Ph.D. in Göttigen in '95. In those days chemists usually went to Germany for advanced degrees. After serving several years as professor of chemistry at the University of Kansas in Lawrence, he went to Illinois to serve in a similar capacity, and in addition, as director of the Water Survey. He was very active in several professional organizations, particularly the American Chemical Society--which he served in many capacities over many years.

It was in this service that his contact with Professor Parsons led to my going to Urbana. Professor Parsons left New Hampshire soon after I graduated and became full time secretary of the American Chemical Society. He remained in this position throughout the formative years of the society. While at New Hampshire he saw to it that all of his chemistry graduates joined the society. I was no exception. I joined in 1909 and retained membership until '59 at which time I received a fifty-year membership award. I am still a member and am ante-dated only by Professor Joel Hildebrand who joined one year earlier in 1908.

Chall: That's quite a record.

Langelier: Well, somewhat related to that is the odd fact that in a fifty year working career I've had only two continuous employers--the University of Illinois with Professor Bartow and the University of California with Professor Hyde. And would you believe it, that as long as I've been here at the University, I've never seen a salary check? When we arrived in Berkeley in 1916, I made arrangements with the bank to collect my salary check, and it's never been changed in all these years. And I'm still drawing

Langelier: my retirement the same way.

Chall: Not many people are happy with their bosses for many years. You have been fortunate.

UNIVERSITY OF CALIFORNIA AT BERKELEY, 1916-1955

The Department of Sanitary Engineering

Chall: How did you happen to come to Berkeley?

Langelier: During the years that I was in Illinois, Professor Hyde here in Berkeley, in addition to having set up a Municipal and Sanitary option in the Department of Civil Engineering, was cooperating with the State Department of Public Health in the establishment of a Bureau of Sanitary Engineering. In the spring of 1916 this bureau was housed on the Berkeley campus, in the Civil Engineering building in an office immediately adjacent to that of Professor Hyde. The bureau was headed by Chester Gillespie, one of Hyde's former students. His staff included Frank Bachman, chemist and bacteriologist, and Ralph Hilscher, sanitary engineer, both of whom had recently transferred from Bartow's staff in Urbana. Both had been my associates in the survey and thought of me when an opening occurred for a teaching position under Professor Hyde.

I was also acquainted with Gillespie, having met him earlier in Evanston, Illinois, to which I have already referred. Professor Hyde was looking for a replacement of an engineering assistant in his department. He had come to the conclusion that this person should be, first of all, a chemistry major with experience in the laboratory control of municipal water supply and sewage disposal, but one who would also be qualified to take a section in surveying, lecture to architectural and engineering students on the principles and practice of plumbing, and finally to give a general sanitation course to women students in domestic science.

Messrs. Bachman, Hilscher, and Gillespie--all three--wrote to me about the opening for a water chemist and indicated they thought me uniquely qualified for the job. Soon thereafter, I received a telegram from President Wheeler [Benjamin Ide] offering

Langelier: me an assistant professorship in sanitary engineering in the Department of Civil Engineering. I had never thought seriously of a teaching career but it was a challenge and I accepted without much hesitation. I think now there had been no other applications. In fact, several years later, Dean Derleth [Charles] confided to me that Professor Hyde's specifications for the job had been, to say the least, exceptionally broad.

Chall: I take it that you were still unmarried.

Langelier: Yes, but I soon corrected that. Throughout her last three years as an undergraduate at Illinois, I had steadily dated Ruth Davison of Marshall, Illinois. We were married in July, 1916 and came to Berkeley as bride and groom. We celebrated our fifty-eighth anniversary this year.

We came west by train of course. It being our honeymoon we selected the most scenic route from Chicago. This was the Canadian Pacific Railroad with stopovers at Lake Louise and Banff. The last leg of our trip was by the S.S. Great Northern from Seattle to San Francisco. We crossed the Bay to Berkeley by ferry, where we were met by Professor and Mrs. Hyde who drove us in their model T Ford open touring car to their beautiful home in the hills a few blocks north of the campus. Their redwood house was one of the many which burned to the ground in the Berkeley fire of 1923. We stayed with them until we found a small house in the outskirts of north Berkeley on Cragmont Avenue.

Chall: What were your first impressions of the Berkeley campus?

Langelier: My first visit to the campus shortly after my arrival, left me with mixed feelings. I must confess that I found it and my immediate surroundings somewhat different than I had expected. The campus in Illinois was totally different from what I found here. In Illinois, the large flat campus had seemed almost perfection to me. There were expansive areas of green lawns with many flower beds, large elm trees bordering broad walks, light and airy buildings each readily accessible. The Water Survey laboratories had been ample in size and equipment and were housed in a large building devoted exclusively to chemistry.

The Berkeley campus in the summer of 1916 was not exactly the well-groomed campus that it is today. The buildings were a mixture of old brick, new granite, and temporary wood, one of

Langelier: which, the Philosophy Building, was on rollers being moved to a new location. The ground covering was mostly ivy and covered with white dust.

Civil engineering was housed in one of the original red brick buildings then in existence and was located at the top of the campus across the road and just below the Greek Theatre. The office assigned to me was on the north side of the ground floor, conveniently adjacent to those occuped by Mr. Gillespie and Professor Hyde. A single, large window looked out upon the beautiful Hearst Mining Building and Circle.

In one corner of the room was a coal-burning stove, which was regularly tended by a well liked and popular janitor named Mike Dillon. Mike remained with us until after we moved into new quarters in the Engineering Materials Laboratory Building in 1930.

Two items of furniture which I inherited and which I continued to use with much satisfaction throughout my forty years of activity in the department were a well worn golden oak roll top desk and chair, and within reach, a tall matching revolving bookcase, both of which are still in use, I understand. I have heard that these are in demand in antique shops today.

My laboratory was located in a separate wooden building in the rear of the brick building. This building, on the ground floor, housed a materials testing laboratory, and the office and work shop of Val Arnsen, machinist and instrument repairman of exceptional ability.

A second story, or attic really, had been used for storage. A few years prior to my arrival, a portion of it had been set apart and equipped for chemical and bacteriological work. The Sanitary Engineering Bureau used one-half of this space for the routine testing of water and sewage samples and was under the direction of Frank Bachman. The other half was equipped with laboratory desks sufficient to accommodate about eight or ten students. Large skylights provided adequate lighting, and except for the rather limited plumbing, the equipment was adequate and served us well until 1930, when we moved to the north edge of the campus into a Class A structure with much new equipment.

In this new building which was named the Engineering Materials Laboratory, now called Davis Hall, sanitary engineering had moved from rags to riches. The main laboratory provided excellent

Langelier: accommodations for up to eighteen students, and in addition an office and four rooms well equipped for laboratory research. These new facilities were soon put to good use beginning with the early thirties when students began to show increased interest in the sanitary option.

Chall: I presume you found Professor Hyde much to your liking.

Langelier: Yes, indeed. From the very beginning to well beyond his retirement in 1944, he was of the greatest help to me in the furtherance of my career. His tremendous interest in his engineering specialty which was the entire field of municipal and sanitary engineering, his exceptional energy and enthusiasm, and his constant willingness to go out of his way to help his students and associates were well known traits throughout the campus community.

He had had the good fortune to have graduated from the Massachusetts Institute of Technology in the class of 1896, where he studied under the founders of the sanitary branch of civil engineering. He had come to California in 1905 after some nine or ten years of excellent experience in various engineering projects in Massachusetts and Pennsylvania. I believe he was the first well trained and experienced sanitary engineer to locate west of the Mississippi. Certainly the first on the Pacific Coast.

At that time throughout the entire west, crude one-story septic tanks were the usual means of sewage treatment, and in general, community water supplies were untreated. Fortunately, the larger cities were able to obtain good clean water from well protected impounding reservoirs and death rates from typhoid fever and other waterborne infectious diseases were among the lowest in the country.

In San Francisco, for example, the privately owned Spring Valley Water Company, which was taken over by the city in the late twenties, had prided itself that its water supply was safe for drinking without any form of treatment. However, in some of the smaller cities and towns there were problems in water supply, sewerage, mosquito control, and general sanitation.

Following the setting up of his University program, he worked in close cooperation with the officials of the State Department of Health, looking forward to the formation of a

Langelier: bureau with staff adequate to make systematic studies toward the permanent solution to these problems. The results of his early planning began to take effect in earnest following the end of World War I, at which time many of his former students were finding responsible positions in sanitary engineering throughout the state.

Chall: I judge that your teaching assignments precluded much interest in research in the early years.

Langelier: That is right. I had all I could do in making the transition to new engineering surroundings. The laboratory instruction was no problem, but the lectures that had to be prepared for the peripheral courses given mostly to non-engineering students kept me busy during the first few years. In addition to my upper division courses, I had a class in surveying for freshmen, and a course in Sanitation of Buildings to three different groups--to sophomores in engineering, and juniors in architecture, and domestic science.

My third year--'18-'19--was a war year and many of the faculty obtained leaves of absence to enter government work of one kind or another. Professor Hyde was commissioned in the Sanitary Corps of the U.S. Army. I joined the Emergency Fleet Corporation and was transferred later to the U.S. Public Health Service for general sanitation control work in Pacific Coast shipyards. I worked mostly with local health officers in checking drinking water supplies and food sanitation. I found the work to be routine and not too rewarding.

This was the year of the great influenza pandemic. It's sudden onset and high mortality rate was a shock throughout the country. Health officers and other medical authorities were powerless to stop its ravages. I remember hopefully carrying a vaccine prepared by a medical officer in the Bremerton, Washington navy yard to an eagerly waiting city health officer in Portland, Oregon. Later, it appeared doubtful that its use had been effective. I remember also with amusement that the Seattle natives had firm convictions that the epidemic would pass with the arrival of normal seasonal rainfall. I began to look forward to my return to Berkeley.

Chall: With the war over, I imagine the Berkeley campus was a pleasant place.

Langelier: Oh yes! I remember it very well. At the start of this period our good and well-liked president, Benjamin Ide Wheeler, became emeritus after a tenure of twenty productive years, and a returning soldier, Professor Prescott Barrows took over his duties.

The campus came to life rapidly and for several years or until the depression of '32, was a busy and exciting place. You may have heard that our football teams were the greatest.

Course Structure in Sanitary Engineering

Chall: Did the sanitary engineering group share in these activities?

Langelier: Yes, each year we managed to attract a few boys into our option, but the going was difficult. Sanitary engineering was still a minor specialty in the field of civil engineering training, and freshmen entering college with thoughts of ultimately building dams, railroads, bridges, and freeways, and other structures of steel and concrete were not easily diverted into a new field requiring a total of nine extra units of lower division chemistry and biology.

Chall: Was Professor Hyde the first to recognize the need for a graduate chemist in his own department?

Langelier: It is my belief that Professor Hyde originated a trend which has become firmly established today. The chemistry department here in Berkeley, then under the head of Dean Gilbert N. Lewis, insisted that other University departments wanting specialized, or any form of applied chemistry should develop their own facilities. He and his entire department staff seemed to me to favor teaching pure or general theoretical chemistry. I believe they were right in this, but at the time I noticed a marked difference between Berkeley and Urbana.

Chall: Did Professor Hyde's schedule of courses for the Sanitary option include any courses offered in the chemistry department?

Langelier: Oh yes, Professor Hyde had noted several recent advances in water technology and wanted more, not less chemistry. He realized the difficulties of getting everything he wanted into

Langelier: an undergraduate program. He had decided that with his own instructor and the almost complete elimination of free elective courses it could be accomplished.

The civil engineering curriculum at that time required 144 credit units for graduation on a basis of eight semesters. Students in the Sanitary option, in addition to two semesters of freshmen or general chemistry, were required to take three units of quantative analysis, three units of organic chemistry, two units of general bacteriology, and one unit of a special course in aquatic biology offered in the zoology department. Within our department, we were the only option that began specialization in the sophomore year.

Many of our students, especially those coming from junior colleges, found it necessary to devote an extra semester, or a full year, in order to complete all requirements for graduation. In the later years, we benefited from two undergraduate scholarships--McDonald--available only to students in our option.

Chall: I presume from your remarks, that at the time of your coming to Berkeley, college programs in sanitary engineering were just coming of age. What other institutions were involved?

Langelier: I looked into this matter just recently. My principal reference is a report on a survey made in 1929 by the U.S. Public Health Service. First in the field was the Massachusetts Institute of Technology, which began graduating students in sanitary engineering in 1892. A year or two later the University of Illinois followed suit. I believe that in both of these institutions the graduates received a B.S. degree in sanitary engineering. The University of California in 1905 was third to fall in line. The degree of specialization was about equal in each of these institutions, but here in Berkeley the course was offered as an option granting a degree in civil engineering. At the time of my arrival in 1916, Harvard, Penn State, Ohio State, University of Kansas, and the University of Michigan in that order, had joined the group. During the following ten years the number of institutions offering courses in this special field doubled in number bringing the total to sixteen.

In 1926 which was a typical year, a total of only 48 students, rather evenly distributed among the sixteen institutions, majored in sanitary engineering. Many reasons have been offered to account for this slow rate of growth during this early period.

Langelier: The most important reason was the exceptionally broad base of undergraduate science courses required. This was more than the average prospective student could safely undertake in a four-year undergraduate program.

Later in the thirties and especially following World War II, prospective students were often advised to spread the work over a five-year period with a possibility in some cases of acquiring an M.S. in addition to a B.S. degree.

Chall: What was your feeling about postgraduate study?

Langelier: In sanitary engineering particularly there had been two schools of thought regarding postgraduate study. In the American Society of Civil Engineering these opposing views had been expressed by Professor Thomas R. Camp of M.I.T. and Professor Gordon M. Fair of Harvard University. Professor Camp believed in the older method of training such as Professor Hyde had installed here in Berkeley. He was not against graduate schools per se, he merely opposed graduate study in sanitary engineering for students who had completed conventional undergraduate courses in civil engineering that lacked several units in chemistry, biology, etc.

Professor Fair favored postgraduate instruction in a limited number of institutions for graduates enrolling from conventional civil engineering courses.

Chall: I take it Professor Gotaas [Harold B.] favored the Harvard view.

Langelier: Yes, definitely so. He favored the graduate school and designed an excellent program toward this end. Professor Gotaas proved to be an excellent administrator.

Professor Langelier's Research

Chall: What were your activities in the years between the two world wars?

Langelier: My year's absence from Berkeley following an introductory two years of teaching had given me an opportunity to evaluate my future prospects. Sanitary engineering was still a specialty field dominated almost exclusively by civil engineers. I have

Langelier: already mentioned the fact that for various reasons beginning students were not readily attracted to it.

I had begun to wonder if the department could continue to support a second instructor in the option. This had worried me to some extent and I remember discussing the problem with Dean Derleth, who at that time, as well as throughout his career, ran a very tight ship, and almost single-handedly made the decisions. He, together with Professor Hyde, gave me their assurances that the program for sanitary engineering was bound to succeed and that an excellent opportunity for me lay ahead. This was the encouragement that I needed because I really wanted to stay.

Chall: Did you have thoughts of possible research studies?

Langelier: Yes. Even before leaving Illinois, lectures by Professor E. W. Washburn on the chemical behavior of ions under ideal conditions in dilute solutions, had given me an idea that these relatively new theories and formulations might be used to advantage in the solution of problems arising in the processing of natural waters and sewage. I felt also that the study of colloids, at that time a rapidly emerging branch of chemistry, would prove interesting. A broad field in physical chemistry was wide open to us and I was anxious to carry out a few simple experiments.

Chall: What directed your first experiments and when did you start?

Coagulation

Langelier: I was very fortunate. Almost immediately after my return in 1919, Professor Hyde asked me to look at some preliminary drawings he had made for the design of a water filtration plant for the city of Sacramento. The plant was to be supplied with water from a new intake in the Sacramento River at a point upstream and just below its confluence with the American River. He asked me to check the plans particularly with a view to suggesting changes if any seemed desirable to me in the provisions which he had made for the coagulation of the raw water with alum prior to filtration.

Langelier: I readily agreed to do this because I had previously expressed to him very definite views on the subject, gained from my earlier experiences while in the Illinois Water Survey. On several occasions I had observed unsatisfactory performance of small filtration plants usually traceable to poor coagulation. On one occasion I had collected a sample of a relatively clear filter effluent only to find that upon stirring the sample with a pencil, it had become clouded. It was obvious that either insufficient mixing or insufficient time had elapsed between the addition of coagulant and passage of the water through the sand. In this instance we found quantities of alum sludge in the water mains.

The plants at Evansville, Indiana, and at Quincy, Illinois, which I had tested for short periods in 1913 and 1914, were not in this catagory; each functioned well, and at all times had produced a brilliantly clear and stable final effluent. In both cases I had attributed the good results to adequate initial mixing of the coagulant solution with the raw water and to a proper detention period to afford sedimentation of the coagulum prior to filtration.

The preliminary plans for the proposed Sacramento plant showed ample detention time but provision for thorough mixing following the addition of the alum solution was lacking. It immediately occurred to me that I could demonstrate in our laboratory the advantages of thorough mixing in effecting good coagulation. I proposed this to Professor Hyde who readily agreed with my suggestion. I devised an apparatus for the demonstration. It consisted of six in-line, one liter, clear glass jars, each provided with a slowly revolving paddle. The paddles were driven by a motorized shaft equipped with mitre-gears.

The first test runs were made with muddy water from the Sacramento River, and from the very beginning our results were strikingly successful and far beyond our expectations. The multi-jar feature made it possible to observe the effect of any one variable; as for example, the coagulant dosage, mixing time period, or rotational speed on the effectiveness of floc formation and subsequent clarification through sedimentation. The simplicity of the tests coupled with the reproducibility of the results were amazing to all of us.

Langelier: We soon ran out of river water and were forced to use tap water which we made turbid by the addition of fine clay and a trace of eucalyptus leaf extract. We also found it desirable to reduce the size of the test jars. We found that 8 oz. water tumblers suited our purpose best.

In these early tests, the outstanding observation was that in the absence of prolonged agitation or stirring beyond that required to instantly diffuse the added coagulant chemical solution, visible coagulation did not occur for several hours and clarification often required an overnight settling period. With prolonged stirring, tiny flocs began to form within a few minutes and as time progressed up to about ten minutes, the individual floc particles continued to grow in size and ultimately became widely separated. When the stirring was stopped the flocs settled within a few minutes leaving a clear water above. After many repeated tests, it was concluded that adequate clarification with least chemical for a given water, normally required a mixing period of about ten to twenty minutes.

Chall: What determines the amount of chemicals required?

Langelier: Using synethetic waters, we noted a moderate increase in required coagulant with increased turbidity, but more significantly, and much to our surprise, we noted that the alum demand increased more directly with the bicarbonate alkalinity of the water. This intrigued us very much and we tried increasing the bicarbonate content of the water by adding small increments of bicarbonate of soda.

In all of these tests we noted optimum flocculation occurred when a definite fraction of the total alkalinity had been neutralized. Without going into chemical theory too deeply, this indicated that optimum flocculation was occurring at a constant hydrogen ion concentration or pH. slightly above true neutrality. We had arrived at an important conclusion in a round about way.

At the time of these tests there was no method of accurately measuring the pH. of water. We reasoned that the hydrogen electrode which was the standard method for the measurement of pH. could not be used successfully in the presence of free carbon dioxide. Within a few months, however, the Clark and Lubs series of indicator dyes became available and we were able to prove the validity of our earlier conclusions.

Chall: Did you succeed in convincing Professor Hyde?

Langelier: Yes, indeed. The first few series of the jar tests proved very convincing and he immediately arranged for a small continuous flow pilot installation in Sacramento for the following summer.

Chall: I notice you use the terms coagulation and flocculation interchangeably. Do they have the same meaning?

Langelier: In our first paper dealing with the general subject we used the term coagulation throughout except in one instance. The term flocculation was used only once, and then to describe the appearance of the coagulated water in the clear glass jars during tests. In all subsequent papers we abandoned the term coagulation in favor of flocculation because we believed it described the alum clarification process more accurately. We felt justified in this because the term coagulation had been borrowed from colloid chemistry on the false assumption that the water particles causing turbidities were completely colloidal.

In defining coagulation, colloid chemistry does not limit the coagulant to the type commonly used in water clarification. Neither does colloid chemistry specify the desirability of agitation. We believe flocculation is ordinarily a two-stage process in which coagulation is the first step and probably plays only a minor part in most instances.

We were to compare results of mechanical mixing with the so-called gravity mixing wherein the water is made to flow in a restricted channel with frequent changes in direction.

A description of these tests and the conclusions derived from them was published in Engineering News-Record, Vol. 86, June, 1921. My recollection is that the Sacramento city filtration plant, the first to use prolonged mechanical agitation to induce flocculation was placed in service in January, 1924. A year or so thereafter, the Upper San Leandro plant of the East Bay Water Company supplying East Bay cities, also using mechanical agitation, was put into operation.

Joseph DeCosta, one of our early graduates in sanitary engineering, acted as resident engineer during the construction of this plant and remained in the employ of this company and its successor, the East Bay Municipal Utility District, as chief engineer until his retirement a year or two ago.

Chall: Did your interest in the study of coagulation phenomena stop with the construction of these plants?

Langelier: Oh no. We had just begun. Our simple method of attack had solved our original problem and had led to several unforeseen conclusions, but it was obvious that there remained a number of variables still to be investigated. The diverse character of raw waters from different environments indicated interesting possibilities.

Little was known of either the physical or chemical properties of the turbidities occurring in natural waters. Also, the nature of the coagulating chemical itself needed further investigation. Whereas the colloid chemists who had developed the basic theories of coagulation had confined their studies to the use of non hydrolizing salts as the coagulating agent, the inventors of the water purification process had found it necessary to use only hydrolizing metallic salts--that is salts which in buffered natural waters react to form a metal hydroxide gelatinous precipate.

Our plan for future work involved standarizing our test procedure and taking up, one at a time, the several variables.

Chall: That sounds like a rather long and involved investigation requiring funding. Did you have a research grant or did you plan to do the work yourself, possibly with the help of students?

Langelier: As of today, it probably would be easy to obtain a research grant from one of the several federal agencies, willing and sometimes eager, to make grants for research work of this kind, but prior to World War II, colleges and universities did not lean heavily on the federal government for research funds. At Berkeley, at least in engineering, it was the practice of professors to work with their students on their own time. Our total allowance for laboratory equipment was less than $1,000 per year.

The coagulation research was spread out off and on over some thirty years. The final and complete review of the subject was undertaken by two brothers of a remarkable family of four topflight students. The family name is Ludwig. The brothers in the order of graduation were John, Harvey, Russell, and Gordon.

Langelier: The first three were in civil engineering. Gordon was in agriculture but soon found employment in the U.S. Public Health Service and ultimately became a sanitary engineer. In 1941, Harvey F. and Russell G. elected to carry on the studies in coagulation begun in 1919, and to submit their findings for credit toward the requirements for their master's degrees.

I cannot speak too highly of the work these two boys accomplished. The first publication of their work "The Mechanism of Flocculation in the Clarification of Turbid Waters" was delayed until after the war and appeared in the Journal of the American Water Works Association, Volume 41, 1949. Later, a second paper reviewing the conclusions reported in the earlier paper, and including additional data amplifying the concepts previously developed was published. It was titled "Flocculation Phenomena in Turbid Water Clarification," and can be found in the Transactions of the American Society of Civil Engineers, Volume 118, 1953.

I am genuinely proud of these two students who did all the work and a good part of the thinking. I consider one or both of these papers required reading for all students majoring in sanitary engineering.

Chall: You referred to the interval between your original coagulation studies and the Ludwig research. I imagine during those years you engaged in other research work?

Langelier: Oh yes. In reviewing the then current literature on water sanitation I found it very limited in volume and much of it far out of date. The important theory of electrolytic dissociation and its far reaching implications which had evolved during the past two decades and from which chemists, in various fields were finding important applications, had been almost totally ignored by the few chemists specializing in water sanitation. New ideas for research came from preparing lectures given to eager students and also from consulting engagements outside the University.

Consultation

Chall: Did the University administration look with favor on off campus consulting practice?

Langelier: The restrictions varied in the different colleges. In the pure science departments, as for example in chemistry, there were restrictions toward which adherence was variable. In the several branches of engineering the off campus work was less frowned upon.

Perhaps the greatest latitude was in sanitary and irrigation engineering, especially in water and sewage treatment plant design. Because of its highly specialized technology, there were few experienced practitioners competing for the work. The services of both Professor Hyde and myself were sought from time to time for work in several cities.

Chall: Can you mention specific examples?

Langelier: Professor Hyde was asked at different times to serve in a consulting capacity on various water supply and sewerage projects in the cities of Berkeley, Oakland, Sacramento, Santa Cruz, Watsonville, Martinez, San Francisco and in other more distant cities.

My own participation in off campus work was of a more limited character, advisory in nature, and usually pertaining to problems relating to water quality technology.

Chall: Do you remember your first assignment of this outside work?

Langelier: Upon completion of my association with Professor Hyde on the Sacramento project, I was invited by the East Bay Water Company to advise and assist in the solution of an operating problem in connection with a recently completed 12 MGD filtration plant located in north Berkeley and to work with their engineering staff in the design of a second plant of equal capacity to be built in South East Oakland.

The output from these two plants was to meet a rapidly increasing demand, and in part to replace existing ground supplies of inferior quality. This association lasted for several years, until 1928, when this privately owned company was taken over by the present East Bay Municipal Utility District.

Langelier: I remember several matters which engaged my attention. First off, was the matter of laboratory control of water treatment operations. I found that water samples from various parts of the system were being collected weekly and were analyzed bacteriologically by an outside laboratory under contract. This service was designed to insure the safety of the supply against contamination, but I found it to be totally inadequate in supplying needed information for optimum plant operation.

Overdosing with chlorine was often the cause of consumer complaints of objectionable taste and odor. A new program for the adequate control of these plant operations and provision for wider and more frequent sampling throughout the system was indicated and started immediately. A notable feature of the program was that it was to be started and conducted by the then existing operating personnel. Minimum equipment necessary for the routine chemical and bacteriological analyses was purchased and set up in the new San Pablo filtration plant.

I should state here, that earlier I had prepared for Mr. Gillespie and the State Bureau of Sanitary Engineering the manuscript for a brochure giving directions for a "do it yourself" water testing laboratory to be distributed to water departments throughout the state, especially to those which had adopted or were contemplating chlorine treatment.

In the beginning, the San Pablo plant laboratory was used primarily for instructing the plant superintendent in making simple routine tests for turbidity, color, odor, taste, chlorine residual, coagulant demand, etc. Later, we added simple bacterial plate count and lactose fermentation tests.

In time, we took on a sample collector and a laboratory technician. It was not long before we were collecting samples for bacterial analyses from the entire system and sending in mimeographed copies of our results to the six city health departments in the area. This practice not only brought about better control of our chlorine disinfection plant operations, it materially reduced the frequency of consumer complaints.

It was during this period that the company was engaged in constructing an earth dam on San Leandro creek to form Upper San Leandro Reservoir, a new source of supply. Also during this period plans for the design of the filtration plant to treat

Langelier: this supply were in preparation by the engineering staff of the company.

I assisted in the design of this plant and two of my earliest students participated in most important ways. William W. Wurster, Dean Emeritus of the College of Environmental Design, now deceased, was the chief architect, and Joseph D. DeCosta, chief engineer, East Bay Municipal Utility District, now retired, was the first district sanitary engineer charged with operation of the plant.

Sanitary Engineering and the Current Environmental Movement

Chall: You spoke of the cooperation with the School of Public Health. Does the future of the profession of sanitary engineering promise a closer relationship in this field?

Langelier: As of today, unfortunately, the name sanitary engineer is in a sense inappropriate. It connotes coverage of all matters pertaining to the public health but in practice now it has little to do with air pollution, industrial hygiene, etc.--the problems associated with public health.

Chall: Do I understand that control of the environment about which we hear so much today was not even in the minds of practicing sanitary engineers at that time?

Langelier: Yes, that is correct. In 1920 sanitary engineering was concerned primarily with the solution of problems related to the transmission of infectious diseases such as typhoid and malaria. There was no organized public clamor against all forms of pollution such as exists today. Sanitary engineers advocated and the public demanded only that drinking water supplies be clean and safe to drink and that sewage and industrial wastes be disposed of into waterways with a minimum of local nuisance. Encouraged by the remarkable advances in water quality technology of the recent past the engineering profession was far ahead of the general public and was definitely the leader in advocating the highest standards for environmental sanitation.

Langelier: Today, the conditions are reversed, the public is ahead of the engineers in demanding zero pollution in all waterways, practically unattainable cleanliness in the air, and extravagant demands in the use of land. This reversal in public opinion began in the forties as a result of the rapid increase in air pollution around large urban centers, caused mostly by the increased use of automobiles.

Not long ago, the federal government began an anti-pollution movement of the complete environment. This movement grew to such a degree that Congress has passed since 1970 various bills dealing with standards for clean air, water, and land use with remarkably little opposition. A large part of the engineering profession believes these demands to be entirely too restrictive and economically unsound.

I fear the public does not comprehend the tremendous costs of removing the last few degrees of pollution. Much of the public and many government officials do not appreciate the exorbitant cost involved in replacing nature's self-purifying capabilities.

Chall: What do you think of the environmental movement in its relation to engineering?

Langelier: I think the environmental movement is a most fortunate one and that every university should have at least one course dealing with this subject, and that a limited number of universities should offer many courses. It is important that the general public should have a better knowledge of environmentalism and its many facets than obtain now. I hope that our California universities will develop adequate courses of instruction in this direction.

PART II EXCERPTS FROM WILFRED LANGELIER'S ORAL HISTORY TRANSCRIPT

Professor Langelier's First Office and Laboratory

Langelier: When I came here in 1916 we were housed in one of the four red brick buildings of which North Hall is still standing. Bacon Hall was another one, and then there were two more, I think--South Hall was one. This building that I'm speaking of was the red brick building directly opposite from the mining building, across the circle. In my office, 103, there was a coal fire, no steam heat, even. The janitor came in every morning and started the fire in the stove. My laboratory was in a wooden building in the rear of this brick building in an attic. I came home and told my wife, "My first official duty was to order some paint to paint a lot of laboratory furniture." [Laughter]

Then in 1930 we moved into a new building, which is now called Davis Hall. It was then called Engineering Materials Laboratory. That was, I think, 1930. We moved into a first-class laboratory.

Chall: Do you mean to tell me that from 1916 until 1930 your laboratory was in an attic?

Langelier: That's right, yes. In the attic of a wooden building which has been torn down. When Lawrence started his work in the cyclotron, the first building that was built was on the location of that wooden building.

Langelier: I had room for about eight students in that laboratory; there were just a few desks and one sink, and things like that. [Laughter] There were just very poor facilities, but we got along all right.

I can think of three students, off-hand now, that took my laboratory course in that attic. One was Ed Reinke [1917], who later became chief engineer of the Bureau of Sanitary Engineering of the California State Department of Health; another one was Joe DeCosta [1924], who became chief engineer for the East Bay Municipal Utilities District, and was just retired a few years ago, and now lives in Carmel; and a third one was Andrew Gram [1924], who was an architecture student that came to us for some now forgotten reason, but I remember him in that little laboratory. He worked around in the Bay Area for awhile and later he became secretary of the Metropolitan Water District of Los Angeles, and remained there until he retired--I think just recently. He had a son that graduated from here.

I had two or three father-son combinations that took work with me, and he was one of them. He was a genius--brilliant--one of the most brilliant students we ever had. I don't know just what he's doing. He may be teaching in southern California, I'm not sure. I'd like to look into that. Pearson [Erman] would know.

When we moved in 1930 we had really good, first-class facilities. But my allowance--when I think of my allowance! [Laughter] I got $800 a year and I was just tickled to death. That was my budget to equip and keep the laboratory facilities and everything going. We got $800 for several years.

Chall: How many students could you accommodate in the new lab?

Langelier: I could accommodate about eighteen, I think, in the main laboratory, and then I had, separate, three other laboratories where I could do my own research, and graduate student research, and things like that. We had four or five rooms there.

Chall: I understand that Mr. Gillespie of the Bureau of Sanitary Engineering had his offices on the campus.

Langelier: Yes. Now they were in the attic, too. But they'd gotten here a couple of years before I had, and had it all fixed up. You

Langelier: know, painted up white. And so I got some white paint, too, and painted my half. [Laughter]

Chall: I see. So you shared the attic in separate laboratories--is that it?

Langelier: Yes. When I think of that laboratory, I can't help but think of one of the boys that washed dishes there; his name was Cornelius Herb. And he owned one of the first motorcyles in Berkeley. He would drive his motorcycle up to the laboratory--he'd enter the Oxford Street entrance and come right up--he'd whiz up through there with the exhaust--no muffler, you know, and you could hear it all over the campus! [Laughter] And at night he'd always quit right on the dot! Four-thirty, or whatever the hour was, he'd crank up his motorcycle, and he'd shoot down through the campus! [Laughter] There were no automobiles--very few automobiles at that time, of course, and everybody on the campus knew that it was quitting time. [Laughter]

Well anyway, that boy--although he had no training, he was just a high school boy--had learned enough chemistry and the biology so that when they built Professor Hyde's famous water filtration plant at Sacramento, Cornelius Herb was appointed to take over the laboratory chores there. He retired from that job not too long ago. Very effective--did a very satisfactory job.

Chall: An interesting career. And Mr. Bachman continued to work in the lab up there?

Langelier: Frank Bachman. I think he left during the First World War, but I'm not sure. After the First World War instead of coming back, I believe that he went with the Dorr company, which is today a company listed on the big board, the stock exchange--Dorr Oliver Company. They build water purification plants, sewage treatment plants. He had wide experience; he became one of their salesmen, retired a number of years ago to Florida. But he was one of Gillespie's men.

He left his bacteriology and went into salesmanship with this company, and probably it will be one of the companies, along with Zurn, that'll build a lot of these plants that everybody's talking about.

Chall: Did Mr. Hilscher remain with the Bureau of Sanitary Engineering?

Langelier: He was made acting chief of the bureau when Gillespie was working with Professor Hyde in Sacramento on the filtration plant. Then Gillespie returned and took back his position as chief. Sometime afterwards Hilscher resigned and set up a fruit and walnut ranch in San Ramon. He gave up engineering. He was a good draftsman and a very good writer. He could write excellent reports. Recently he wrote a little volume of poetry which Ruth and I both enjoy.

Teaching a Few Unusual Courses

Chall: Now, I'm not sure whether I've got it straight in my mind, yet, exactly what you taught.

Langelier: I wasn't always too pleased with my teaching schedule, because of course they couldn't hire me just to teach the chemistry to our civil engineering students. One of the courses that gave me a great amount of enjoyment and which I retained almost up to my retirement years was to a class of girls--anywhere from twenty to fifty girls--taking domestic science, they called it in the early days. They wanted a course which dealt with--when I came it was called Heating, Lighting and Ventilation, I think. I changed the name to Building Sanitation. [Laughter] For a few years the classes were so large that I had to give it in two sections, I remember. Of course a lot of that was new to me.

Chall: What was it all about?

Langelier: Just heating, lighting, ventilation, and plumbing! And some of them called it plumbing. I gave a similar course to engineering students in the sophomore year, an elective, not a required course. It was required for our sanitary engineers, but not required for other students. I had quite a few students in that class, which I called Building Sanitation.

And then I had a course, much of the material very similar, but taught to an entirely different group--the students in public health. That was an upper division course.

Chall: Didn't you tell me once that you taught a course to architects?

Langelier: Yes. They wanted me to teach plumbing to architects because plumbing was considered a part of sanitary engineering in those days. I had that course, but I kept it only a couple of years, and without speaking to Dean Derleth or anyone else, I just got rid of it. The School of Architecture was teaching a course in heating and ventilating. A consulting engineer from San Francisco who specialized in heating and ventilating was giving these lectures. I saw him one day, and I said, "Say, can't you add plumbing to your course?" He said, "Yes, sure!"

I'd been here only a year or two and I did it without consulting. Today, of course, it would be unheard of to do that; but I just, on my own, said, "Well you take it over!" [Laughter] And I told Professor Hyde I'd transferred the course to this fellow and took it off the list.

But in that first class that I had was William Wurster, who later became dean of architecture at MIT and dean of architecture here.

We were all required in civil engineering--everyone was required to hand in a written thesis, even four-year students. That was quite a chore in the senior year, and every instructor had to take his share of thesis students.

Chall: Did they do pretty good research work?

Langelier: They did pretty good. Dean Derleth thought it was very necessary, and it was good practice for the boys. Very few of the theses ever got into print! But it was interesting work, and quite a chore for the teacher, especially if you had several of these, because you had to take quite a bit of time to direct a student's research.

When I came I put in a lot of chemistry. Professor Hyde was teaching a course in water purification--a one-unit course. I said, "Let's make that a two-unit course. You take them for eight weeks and I'll take them for eight weeks." And that's what we did--gave one course both in water supply and in sewage treatment. So that meant more science--more chemistry.

You know, most civil engineering students kind of fight shy of chemistry; but most of them are bright students--they have to be--they can take it and do well in it. We've turned out a few men that went into chemistry.

Langelier: For example, we had a boy named Sanchis [Joseph M., 1929], came here from Spain, took engineering, but his work ever since he graduated was chemistry. In other words, he got interested in chemistry.

Same way with young Oswald [William J.], who's on the staff of the Department of Hydraulic and Sanitary Engineering. He came to me from mechanical engineering. He took a general course with me, and got interested in the sanitary field, and now he teaches, I think, half-time in the School of Public Health. All of his research is in biology, in sewage treatment, and that sort of thing. Biological work.

Interruption of World War I

Langelier: I took a leave of absence in June, 1918, and went with the Emergency Fleet Corporation. We had to build a lot of ships, you know. And there were shipyards all up and down the coast here. The Emergency Fleet Corporation wanted a sanitary engineer to inspect all these shipyards, and see that the workmen would get safe water to drink and all that sort of thing. So I agreed to do that work. I took leave from the University for one year, and during that year I visited all the shipyards up and down the coast that were building ships, all the way up to Seattle.

Professor Hyde, at the same time, you probably know, was in the sanitary corps of the army and went to Camp Meade. So we were both away during that year. And that was the year, you'll remember, of the great influenze pandemic, all over the world, and the mortality that year was very, very high.

I was a little disappointed in my work in the shipyards because there was just nothing to do--inspecting restaurants, and that sort of thing--just general sanitation. But this influenza epidemic came along and stirred me up a little bit, and I went to Bremerton Navy Yard and talked with the surgeon there in charge of their work. He had developed this vaccine that he was certain was the real thing. And he wanted me to take some down to Portland.

Langelier: I remember carrying it, and to keep it warm, putting it in my pajama coat suit to incubate the sample when I took it down to the city of Portland to the health department.

I'd made very good friends with the city health officer in Portland, where there were a number of shipyards. So I spent a good deal of time with these health authorities from that time on until the end of the year.

But, of course, like all the other vaccines that were developed, they just didn't work, although we thought at the time that they were pretty good. We had to try, you know; but my recollection is that none of those early vaccines were effective.

Although I felt that the work that I was doing wasn't very important, yet, I could see that there was work that should be done that I wasn't allowed to do. That was in the building of the ships themselves. Where they're building steel ships, the men are working with the polluted air, really. The rivetting process, for example. The men worked in the heat and they needed better ventilation in the ships. I wanted to work on those kinds of problems, but that was outside my jurisdiction. I was only to do work in the yards themselves, you know, not in the ships.

During the course of that year the work of the Emergency Fleet Corporation, or at least the sanitary division, was taken over by the United States Public Health Service. So I filled out the year in the Public Health Service. And later on, because of the contacts that I made, we sent men to the Public Health Service.

Some Students Who Have Done Well

Chall: Your students are doing well throughout the country and in different parts of the world. You've already mentioned several. Without doing injustice to others you may forget at the moment, who are some you can remember today?

Langelier: I've talked about Harvey Ludwig and his brothers.

Chall: Yes.

Langelier: We have had for many years some of our graduates in the Public Health Service. I think there's a man named Nasi [Kaarlo W., 1937] that's still with them, and a San Francisco boy named DeMartini [Frank, 1927] who has been with them all these years, and I think just retired a few years ago. Most of the time I think he was located in their Cincinnati laboratory. They have big offices and laboratories there. DeMartini was one of my favorite students--a very good student and did very well after he graduated.

Chall: I understand you collaborated on some research.

Langelier: Yes. We collaborated on a paper.

Chall: As a matter of fact, I'm going to talk to him tomorrow.

Langelier: Oh are you! I haven't seen him for years. You just remember me to him, because we get Christmas cards from him every year. Oh, that's one of the nice things about teaching. Comes Christmas! I have one boy that graduated in '20 that hasn't missed a year yet in sending us a Christmas card. Fifty years. And we get so many cards from our students.

Chall: That should make you feel that you've had some influence with them.

Langelier: It does. Well, that's one of the nice things, I've always felt, about teaching. You make these friends, and then you watch their progress through the years. I've always been disappointed that we didn't get more students taking our courses; nevertheless we did get some good ones--very good ones. Quality.

And another one is David Caldwell [1938], in San Francisco, who has done some very promising, very successful, sanitary engineering work, way out as far as New Zealand, Auckland, where he built large sewage disposal plants, treatment plants. He's worked in Australia too.

Chall: He's in a firm called Brown and Caldwell?

Langelier: Yes.

Chall: Was Brown [Kenneth W.] one of the Cal students?

Langelier: Brown was a chemist who graduated at Stanford and opened a laboratory in San Francisco, making water analyses, and things like that. He needed an engineer. He looked around, and he found Caldwell, who was working with me until the time that he left to go with Brown. And today it's really a first-class engineering, consulting operation. They employ a number of our students, and have been very successful.

Another one of my Ph.D. graduates, Moulton [Edward C.], came to us from the University of Michigan, and after getting his degree here, went to teach sanitary engineering at Ohio State University--stayed there several years. I saw him in my driveway one day, I recognized his face, and I couldn't place him. But I knew he'd been a former student. He said, "My name is Moulton." I said, "Oh!" And I greeted him; I was watering the lawn. He said, "I'm on my way to South Dakota. I've been appointed president of the University of South Dakota."

Chall: Quite a career for a sanitary engineer. [Laughter]

Langelier: So he's president--he got in just about when all these campus problems were erupting [1966-1968].

The chief engineer of that Chicago Sanitary District today is Vinton Bacon, who is another one of our star students [1940]. He has a country-wide reputation as a sanitary engineer, and it's a very important job. You know what Chicago is like--someone put a bomb in his automobile.

Chall: Really, a sanitary engineer?

Langelier: One summer, not too long ago--in the fifties--Ruth and I were in Milwaukee, and I picked up the Chicago Tribune and saw big headlines, "Bacon to Stay" in letters that high [gestures]. I didn't know what... And I said, "That's a curious title," and I read on and found that Bacon referred to Vinton Bacon. I didn't even know that he had that job at that time! [Laughter] And there he was in charge of this whole business, the canal operations, the pumping plants, sewage treatment plants, everything.

Chall: There must have been a controversy about him.

Langelier: Yes, the mayor had gotten into some kind of controversy. They wanted to fire Bacon. Where there are a lot of men employed, Langelier: working for a city, it can sometimes be tough; especially if it is in Chicago, because it's politically oriented. But Mayor Daley retained Bacon. Bacon is a good, honest, thorough, conscientious worker, and he was a brilliant student here. We are fortunate in having men in very important jobs all over now.

When I thought of fathers and sons and mentioned the Grams, I remembered a few other stories about fathers. When I was in Chicago, in connection with working with the Chicago Sanitary District, an engineer by the name of Hommon, to entertain a group of us that were in attendance at a meeting of the American Public Health Association, took us down this river into which all this sewage was discharged, in a launch.

He was then with the Chicago Sanitary District, and then later with the Public Health Service, and they sent him out here in charge of this area. He represented sanitary engineering for the United States Public Health Service, and his son [J.B. Hommon, 1937] attended the University and took up sanitary engineering and he's now a sanitary engineer with the state in connection with all the parks, the sanitary facilities in the state parks.

Chall: Of course the Fosters were father and son. [Herbert B., 1907, Herbert B., Jr., 1931]

Langelier: Yes. I never had the father--he was here, active when I came, in the University, but I had the son.

Professor Langelier's Methods of Research and Teaching

Chall: How did you do this research along with teaching and consulting?

Langelier: I worked like a dog getting material for my lectures, and once you have those, there isn't a great deal more required. In fact, I spent a lot more time in research than I did in classwork. We all had to take what they called eight or nine hours of work, and part of mine was a laboratory, so that meant three afternoons a week just devoted to the laboratory alone. But while I was working in the laboratory I could do research--carry on my own studies while I had a class working in the laboratory. I'd meet them for a lecture at the beginning of the hour, and was always available.

Mrs. Lang: Also Saturdays and Sundays? [Laughter]

Langelier: Yes, there were times there when I got interested...

Mrs. Lang: Mornings at six?

Langelier: After World War I, when I got interested in flocculation with Professor Hyde, and I'd demonstrated to him that it'd pay us to make studies of the use of prolonged agitation, I used to get up at six o'clock and go up there in the attic and work on those things. [Laughter] Yes, I worked from six-to-six pretty near every day. I did for a number of years.

Mrs. Lang: I was a laboratory widow, not a golf widow! [Laughter]

Langelier: Today, you know, they think more of striking than they do of working.

Chall: I suppose there are always some people who really love their work so much and it's so exciting to them, that as long as they have the facilities nearby they'll use them.

Langelier: I enjoyed my work, and mostly I got interested in research primarily to equip myself to teach students what they wanted to know. Because the literature was very, very scant in those early days.

When Professor Hyde came to California the most elaborate sewage treatment plant was a septic tank. Nobody knew how it worked--they just knew that it worked and it was suitable for certain areas, and entirely unsuitable in many places that had bought these for municipal treatment. It was necessary to do a lot of reading, and studying, and experimenting in those early days. As I have said, Professor Hyde was the first of the sanitary engineers here in the state and I believe I was the first sanitary chemist. We had to work, and Hyde was a worker.

Chall: Mr. DeMartini, along that line, felt that you were a very important influence in stimulating other people--including your colleagues--that there was a stimulation in being around you that made them excited about their own work, and that they would go and do something a little bit more intensively or better.

Langelier: He's very generous. These boys are very generous. I've read a few letters they wrote when I retired. And I read the one Professor Hyde had written. I want you to read the letter Professor Hyde wrote--I mean to show you the quality of man that he is--I intended you to read that.

Chall: I'd like to put it into the manuscript.*

Langelier: Beautifully written letter, honestly. In some ways, I don't want to put it in. It's so complimentary, so flattering, but that was the thing that everybody wrote in their letters. Not that they thought that I was brilliant, or anything like that, but that I inspired them, you see.

They knew more math than I did, a lot of them, because they were just fresh out. I was a chemistry student; they were engineering students where you have a lot more math than you do in chemistry. In fact one reason I took chemistry was because I wasn't too good in math, and in engineering I would have to know a lot of math.

An electrical engineer knows more math than any chemist. So my students knew a lot more math than I did, and they knew that. I didn't hide it.

But they did give me credit, and especially Professor Hyde did give me credit, for having a lot of ideas and really inspiring the kids, because I never would take things for granted. In other words, "Let's find out." That was my attitude, and I did succeed, apparently, with even these very bright students like Caldwell, and Ludwig, and Vinton Bacon, or with any number of them--DeMartini was a good one.

Ruth, you tell her what Hyde said to you about my accomplishments. What did he say? [Laughter]

Mrs. Lang: He told me once that it was too bad that you had to spend your time teaching because you had more ideas in a week than he had in a month. [Laughter]

Langelier: Oh, no. That isn't what I wanted you to say. Ruth, I wanted you to say about the clothes--about wearing an apron in the laboratory.

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*I never saw the letter. M.C.

Mrs. Lang: He never wore an apron.

Langelier: Professor Hyde couldn't understand it. When I'd go in and work in the laboratory with students, using acids, and bases, and everything else, I never wore an apron!

Chall: How did you get away with that?

Langelier: With my best clothes on. Well, I don't know. That's what Hyde couldn't understand. He's told you that a half-a-dozen times, Ruth. He said, "I can't work ten minutes in the laboratory without burning a hole in my coat. But Bill, day after day, year after year, he never gets any acid on him."

Chall: You didn't, really?

Langelier: Nowadays, you know, everybody wears a white coat, but I never did. For some reason or other--I don't know why.

Mrs. Lang: He's good in the kitchen, too, Mrs. Chall!

Langelier: Yes. We used to wear coats of a kind of a tan material. Nowadays they all wear white coats, you know. I never wore anything like that. My students never did. I never asked my students to buy any. They didn't wear a protective garment.

In other words if you do your work right, you don't need that, really. It looks nice, and it's impressive. You see on the TV pictures of hospital work, and all that. It looks impressive, but actually you can work in a laboratory without burning your clothes, and I didn't. Ruth can tell you. Did I ever come home with burned holes in my clothes? I never have owned a laboratory coat. [Laughter]

Chall: Let me ask you something that Mr. DeMartini touched on that you didn't discuss, and that's the method that you used in teaching. He says that the classes were so small that all you had to do was just sit behind your desk, with the students in front of you.

Langelier: I told you why the classes were small, remember? We had too darn many prerequisites; they didn't have many free electives in sanitary engineering. We had fewer free electives than any other sub-department in civil engineering.

Chall: But he said that your method was to sit around a table with the five or six and just talk, and that was your lecture. And he felt they were very fortunate, because it was like holding a graduate seminar.

Langelier: Yes. Well that's about all that I could do. I would tell them stories like I'm talking to you now.

Chall: But you prepared your lectures in advance for them?

Langelier: I did. The first year, you know, your students are 'way ahead of you! [Laughter] And it was pretty tough; especially taking an architecture student like Bill Wurster and trying to teach him plumbing and heating and ventilating, when he's right out of the school of architecture.

Chall: Was there any problem, ever, during the time you were here, about the fact that you didn't have a Ph.D.?

Langelier: No. The new professors that were employed all had the Ph.D. or the equivalent doctorates. Of course I got a doctorate later. In 1957 my New Hampshire College--the University of New Hampshire--invited me back there and presented me with a doctor of engineering degree.

Chall: I had heard, that because you were a chemist among engineers, there was a feeling that you really didn't belong to the club, and this hindered promotions from time to time.

Langelier: That's right. I stayed a long time as an associate professor. I wasn't displeased at all, although I did feel that I was a black sheep, because every man in my department was a civil engineer, and they all went to meetings together. I didn't even belong to the American Society of Civil Engineers. Professor Hyde was a leading figure in that organization.

The students were very kind, and elected me to their honor fraternities, for instance, Tau Beta Pi and Chi Epsilon, the two engineering fraternities, and I became a member of those. But I never attended the meetings. Sidney Harding never missed a meeting of civil engineers in San Francisco; Professor Hyde and all these other fellows would all get together and go to their meetings, and I didn't go because I wasn't an engineer.

Langelier: I belong to the American Chemical Society. So I was a loner! And Professor Derleth didn't promote me. I think I remained as an associate professor from...oh, ten years, possibly.

Chall: I see. Were you hired as an associate professor?

Langelier: No, I was hired as an assistant professor, and was promoted after two years to associate professor, and I remained in that grade till the late thirties.

But I didn't feel badly about it, because I was very fortunate. I was being invited to do work for the old East Bay Water Company, and San Francisco Water Department, and the Marin Water District. Even the Metropolitan district called on me--southern California--and so I had a lot of interesting research work to do and I was perfectly satisfied.

Professor Hyde, of course, was very loyal to me, but the other engineers, said, "Oh, he's just a chemist." [Laughter] I didn't feel badly about the lack of promotion because, as I say, I did have more work than I could do. During those years is when I did the bulk of my research work. We'll have to discuss the research separately--I'll get out some of the papers and read them.

Chall: Dean Derleth was, I guess, chairman of the department, from about 1908 until 1942. Then after that, chairmen came and went within just a few years.

Langelier: Yes.

Chall: What was the policy in those years? Why was he the head of the department for so long?

Langelier: He came here of course and ruled with an iron hand. Dean Derleth was a real character. [Laughter] You know he designed this bridge?

Chall: The Bay Bridge?

Langelier: The Bay Bridge, the Carquinez Bridge--those were his interests: structural engineering. Well, he really was a consultant--I'll put it that way. As they did in the early days, they always imported engineers from the East to do everything that was to

Langelier: be done--they got eastern engineers. But he was very, very instrumental in conceiving the Carquinez Bridge and promoting it, and was consultant all the way through.

Interesting Sidelights About Some of the Research and Consultation

Founding the East Bay Municipal Utility District

Langelier: I remained a consultant of the old East Bay Water Company until they went out of business--until they sold to the East Bay Municipal Utility District. And there is an interesting tale. Professor Hyde at this time was no longer doing work for the East Bay Water Company, but he did in the early days. For instance, he forested these reservoirs around here. He planted eucalyptus trees and everything, so the mud didn't flow into the reservoirs around the hills here.

Chall: That was Professor Hyde who did that?

Langelier: Yes. In the very early days, long before I came here. He had done considerable consulting work with the old East Bay Water Company, he and a man by the name of DeBerard [Wilfred W.], who later became the editor of Engineering News-Record, in Chicago, and a very close friend of Professor Hyde. I remember they carried out experiments at Lake Chabot in connection with these supplies.

At the time I'm speaking of, Professor Hyde was engaged in other things--he'd built the Sacramento plant. What they needed mostly was an operating consultant, and that's why I was retained with them, until 1928, when they sold their plant to the East Bay Municipal Utility District, which was organized largely under the auspices of Louis Bartlett and others. In those days districts were being organized, both for water supply and the disposal of sewage, sewerage systems. Louis Bartlett was one of the leaders. Slightly socialistic, because it went into municipal ownership--from private ownership to municipal ownership.

Langelier: The district was organized, and they brought in an engineer, Arthur P. Davis. He was not a sanitary engineer, but a reclamation engineer. He was a very, very competent civil engineer, thoroughly skilled in impounding waters, building hydro-electric plants, delivering water through pipelines, and all that sort of thing--hydraulics--thoroughly competent. But he had had very little or no experience in purification of water, so it's only natural that he favored bringing water in from the mountains, from some high elevation. Water in its pristine purity delivered right to the consumer. "Mountain to Spigot," was the expression Louis Bartlett and others used in their talks around the Bay, and there was great excitement around the Bay.

Professor Hyde naturally had built plants, and they were building plants all over the country, filter plants, that could produce the equivalent of mountain water, from the Sacramento River water.

The East Bay Water Company, naturally, thought they had a better method, a much cheaper method of producing and delivering water of equally good quality using the floodwaters of the Sacramento River. Now, the Sacramento River nearby, say in the vicinity this side of Pittsburg, at certain seasons of the year--low-flow--the water has too much chloride in it--the back-flow from the ocean. It couldn't be used.

But every year there are flood waters, and it was Professor Hyde's idea to pump for about one hundred days during the heavy run-off season--to pump water into reservoirs in the Montezuma Hills, I think they're called, in Contra Costa county. I think, there were some reservoir sites available. And these flood waters could be pumped into these reservoirs and then brought to this area and filtered, as was being done in Sacramento. It would have been a much cheaper water supply; in other words, water nearby instead of water from a great distance.

Anyway, the district idea won out, and the East Bay Water Company lost out, and was sold to the new municipal utility district, and they brought in water from the Mokelumne. They went to the foothills, and brought the water in by gravity as far as Walnut Creek, and then they had to pump it to get it into the reservoirs locally. There's a pumping station over there in Walnut Creek. So the old East Bay Water Company with all of its engineers had to disband.

Chall: Do you recall any of the battles that went on between those contending for water from "mountain to spigot" and river water? I assume Professor Hyde was speaking on behalf of his idea, and Mr. Bartlett was speaking on the other side.

Langelier: They both spoke to put this thing over. Professor Hyde made speeches, and Arthur P. Davis and Bartlett made speeches favoring the "mountain to spigot." And they won out. I testified, and I think there was a court case of some kind. I remember appearing before some group somewhere. I've forgotten now the details, but I know that I appeared for the water company as a witness as to what would happen under certain conditions.

But the idea of "mountain to spigot" appealed to the people. Of course, they don't know. The people have to decide so many questions that they know very little about.

The Patent on Coagulation

Langelier: I didn't tell you about the patent I got. You know, working on that Sacramento plant, I knew that this was something new and that it would be adopted in other places, and I wanted to get some credit for having developed it; and so, instead of writing a paper--I did write a paper several years later describing the process--I applied for a patent. It was a patent on the use of hydrogen ions to lower the pH of water to effect better coagulation. The patent is dated 1920.

In 1920 the word pH had never appeared in any water or sewage publication. Later on Wolman [Abel] and Buswell [A.M.] separately questioned that it was my discovery, but I assume its authentic because I got the patent.

For fifteen years I never paid any attention to it at all. Then, in 1937, I started getting mail from New York. Someone wanted to buy my patent. And there was no printed letterhead--just written on ordinary paper, you know. And I paid no attention to it. I said, "Well, I'll just let this slide by." I didn't even answer it. I got a second letter, and a third letter, from New York--all wanting to know about this patent they wanted. So I still didn't say anything. Finally, one morning in my office, Langelier: a man came in and he introduced myself, and he said, "I'm So-and-So. I'm with the Link Belt Company. He says, "We're being sued. It is claimed that we're infringing a patent owned by the Dorr Company (Dorr Oliver), and they're bringing suit against us, claiming infringement of one of their patents. Our attorneys in Chicago tell us that we aren't infringing the Dorr patent, but we're infringing a patent owned by a man named Langelier in Berkeley. And so that's why I'm here." [Laughter]

And I said, "Well, I got that patent not with any view of commercializing it at all, but if you're being sued over a matter involving a patent which I own, if you'll make arrangements to let everybody use it--I'll be glad to release it." And so they made an appointment with me and I went to Chicago and met with three different companies. The Link Belt Company, the Jeffrey Company of Columbus, Ohio, and the Chain Belt Company of Milwaukee. Those three companies all manufactured equipment that was similar to what I had patented, you see--for water purification. And they were all interested, because they were all going to be sued by the Dorr Company. So they got together and they made a deal and they offered me a certain price for it, and I accepted it right there. The patent only had two years to run, but it relieved them.

Chall: I was interested in this patent. As I've gone around and talked to some of your former colleagues, they say, "I think Langelier took out a patent on something he did." And they're curious about this. So, now you have cleared up the mystery.

Langelier: Before I got that patent, I went to a professor--his name was Jones--in our law department. And he says, "Oh, yes. There's no reason why you shouldn't get a patent on this." And he recommended a patent attorney in the City to handle it. At that time the University had no patent policy; now they do. When I was doing this work on seawater distillation, we applied for two or three patents, but it was done under a different arrangement altogether. The University applied for the patents in that case.

But, you know [in the research leading to the patent], after I found out that an acid alum is better than a basic alum, which is contrary to everything that had been published prior to that, I found that the manufacturers were the ones that were boosting the basic alum, because they could ship it

Langelier: in cloth bags without it decomposing the burlap, you see? Otherwise, they would have to ship an acid alum in wooden barrels, which are far more expensive. [Laughter] I'm convinced that that was the reason that everybody specified basic alum--no one had ever tried it, but the manufacturers had got the owners of these plants to believe that it was better than the acid alum.

Research on Corrosion

Langelier: The most important paper, I would say, even more important than the work in flocculation, in my view, is the work that we did in the laboratory of methods of preventing corrosion of water pipes--corrosion and encrustion. The first publication in this field was dated 1936.* From then on several papers were written, not only by myself, but others became interested in the subject. Even in Germany they took my material and rewrote it for use in Germany. And you know Frank DeMartini wrote a paper.** If you'll read the introduction to his paper you'll see why he did it, and his conclusions.

There were several of these. A man by the name of Hoover, Charles P. Hoover--one of our better known chemists, the inventor of numerous water-softening processes, wrote a paper reviewing this subject. The title of his paper was "Practical Application of the Langelier Method."*** So, during those ten years, it was a very live topic.

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*Wilfred F. Langelier, "The Analytical Control of Anti-Corrosion Water Treatment," Journal of the American Water Works Association, (October, 1936) 28:1500-1521.

**F.E. DeMartini, "Corrosion and the Langelier Calcium Carbonate Saturation Index," Journal of the American Water Works Association (January, 1938) 30:85-111.

***Charles P. Hoover, Journal AWNA, (November, 1938) 30:1802-1807.

Chlorinating the San Francisco Water Supply

Langelier: In 1928 there was a typhoid epidemic--not a bad typhoid epidemic, but the city of San Francisco was sued by someone that had contracted typhoid fever, and claimed that they had gotten it from drinking city water. So I was called in to make an investigation of that--or at least to furnish material and to testify in the court case--which I did. And from that time on I kept getting work with the city of San Francisco, and continued to do that until after I retired from the University.

In the early years, I was instrumental in helping them with their chlorination problems. You see, at that time, the U.S. Public Health Service had a representative out here. Later that representative was Mr. DeMartini, but before DeMartini, it was a Mr. Harry Harmon, and he was instrumental in getting the city to chlorinate its water supply.

In those days, the only drinking water standard we had was the standard that had been set up by the Public Health Service, and it specified the purity of water that must be obtained if the water were to be served on trains entering interstate travel. That was our standard of water safety--one that had been promulgated by the U.S. Public Health Service, and it applied, of course, only to trains entering into interstate traffic, because within the confines of any one state, of course, the federal had no jurisdiction.

Even so, whenever a water analysis was reported on, we always said, "The water conforms with the standards of the U.S.P.H.S. relating to water supplied on trains." That was the only standard.

Harmon thought that San Francisco water should be chlorinated. It wasn't filtered at that time, but it was water obtained from reservoirs where the watershed was controlled. No trespassers are allowed on the watershed.

There had never been waterborne typhoid fever in San Francisco as far back as you could go, except possibly a few occasional epidemics here, and then it might have been transmitted by food, but not by water. There was no evidence that these waters from the local run-off areas ever were the cause of typhoid fever. And they were proud of that fact, and they

Langelier: were proud of the fact that the water wasn't filtered--it didn't need to be filtered. Just like when the East Bay Utility District was formed, it was, "mountain to spigot." In other words get safe water and you don't have to purify it.

Harmon, I think, was instrumental in convincing the engineers in the San Francisco Water Department that that water should be chlorinated. And that was just at the time that I had started working on this epidemic.

Chall: Was it waterborne?

Langelier: Oh, no. It wasn't waterborne. And I remember that it was rather interesting proving that it wasn't. How could we prove that it wasn't the city water that was responsible?

The attorney for the plaintiff said that this case developed just at the time when the water department was repairing the water mains in front of their house, and they had shut off the water, and pollution could have gotten into the water under those conditions.

In testifying, I had to show that the water was under pressure, and if there was any leakage in the pipes the leakage would be outward, and not inward. Not only that, but any workman in that area would have to have been a typhoid carrier in order to infect the water. And the possibility of one or two persons working on a repair job actually being a carrier was only about one in several thousand, and so forth. I used everything that I could think of to show that it just couldn't be the water.

And then I remember, the opposing attorney says, "Why, don't you know that water has B. coli in it?" And I said, "Yes. Occasionally there are B. coli in the water, but B. coli does not cause typhoid fever!" And I went on to explain why B. coli is an index organism and not the specific organism that causes typhoid fever. I had a lot of fun testifying in that case, I remember. But anyway, from that time on I continued until just after I retired from the University. I made regular visits to their laboratory. I helped them install a laboratory down at Millbrae--I think the laboratory that they are using now, in one of their old pump buildings down there.

Langelier: I made inspections of their sources of supply and advised them on what they should do to meet certain conditions. I assisted them in laying out plants for chlorinating the water by methods that we'd worked out with the East Bay Water Company--use of the ton cylinder, for example.

Challenging the Price of Chlorine and Alum

Langelier: I can tell you rather an interesting story, I think, but it isn't technically important. When I came out here, the chemical companies just sold these chemicals to the water departments for all the traffic would bear. For instance, chlorine. They charged the price of chlorine manufactured at Niagara Falls, the freight out here, not only on the chemical, but the freight on the steel cylinder which held it, and then the return of that cylinder back to Niagara Falls. In other words, chlorine was very, very expensive.

I read in the paper one morning that the Interstate Commerce Commission had decided that a new type of railroad car, which is a flat-truck and which held a dozen one-ton cylinders of chlorine, was really a part of the car, do you see? Just like a tank car, but instead of one large tank there were a dozen cylinders, each holding a ton of the chemical. So it was a part of the car, and therefore the purchaser didn't pay for the car, he just paid for what was being transported.

When the Interstate Commerce Commission made this decision, I was at a convention down at Watsonville--a waterworks convention. And I spoke to the fellow that was manufacturing chlorine up here at Pittsburg, Great Western Chemical Company I think it was called, and they were charging us the Niagara Falls price out here. I said, "You sharpen your pencil now; we want some lower quotations on chlorine for the East Bay Water Company in view of this decision." Immediately, he says, "We'll go you better than that. We'll let you come up with a truck and truck it from Pittsburg. We'll sell you one cylinder at a time!" See, we wouldn't have to take a whole carload.

So, we started trucking. One of the first users of the one-ton cylinders was the East Bay Water Company. We devised a scheme for unloading these. We built our equipment for feeding

Langelier: this into the water. We arranged to have a platform the same level as the truck bed so all we would have to do was roll the full cylinder into a door on this side; and a door on the other side to roll out the empty cylinder onto the truck. And all of our San Francisco Water Department chlorine plants were made that way. [Laughter] And the price of chlorine dropped to less than half.

The same thing happened in connection with alum. When Professor Hyde designed the plant at Sacramento they were charging us all the traffic would bear--these chemicals were all made in the East at that time. So he designed a plant for making alum right on the spot. Large tanks in which you would simply mix bauxite, which looks like ground brick--reddish aluminum oxide--and strong sulfuric acid. When you mix the two together, they just boil up and produce a thick syrup of aluminum sulfate, and you don't need to crystallize it or anything. Just run that syrup into the water as a coagulant.

You save the crystallization process and the freight on all of this. The alum itself is more than half water, and you're paying freight on a chemical that's half water. And of course the freight charge on pure chemicals is higher than it is on crude chemicals. At any rate, it cut down the price of alum about one-half.

And I did pretty much the same thing with the East Bay Water Company, only instead of building a plant to make alum here--they had two or three plants where we were to use it--I went to Mr. Stauffer. The Stauffer Company is one of the large chemical manufacturers in the country today. But the old, original Mr. Stauffer--I went to see him one day back in the early twenties in San Francisco, and I said, "We've got a problem. We need some alum, but we don't want highly purified alum, we just want the crude material--just sulfuric acid and bauxite, not filtered. Give us a price on it." And he gave us a price that was about half what we'd been paying for it. In other words, he gave us a price that was so low, that we didn't need to build a plant to make it.

He was interested, because he thought there would be other uses for it. So he was glad to cooperate with us. And right here at their plant in Richmond they started making this crude alum for us, which the East Bay Water Company bought. I don't know--they may still be buying it from them. Of course now these things are all open to bid.

Langelier: But anyway, the price came down because we found ways of producing it ourselves.

Chall: What was the reaction from the eastern companies?

Langelier: Oh they don't care. It's just a drop in the bucket to them.

Chall: It wasn't enough of a problem to them?

Langelier: No. But one of Bartow's boys, a friend of mine--Mr. Birdsall--when he graduated from Illinois he went to work for one of these companies. He didn't like it very well. I remember meeting him one time, and he kind of chided me about it.

Chall: They must have known what you were up to.

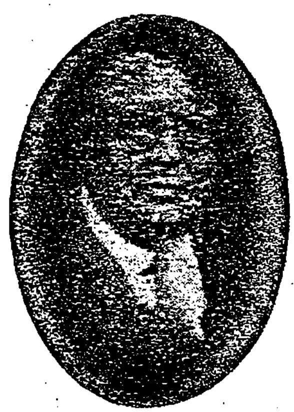
Langelier: Professor Hyde had a lot of fun with that bauxite plant, you know--building that plant--because it required a lead burner. The plant that had the acid had to be lined with lead, and when you have to solder lead there's a trick to it; they call it lead burning. And he got a man that worked with the Stauffer Chemical Company out at Richmond, to undertake that work up there in Sacramento. That plant is in use today, I'm sure, and it was very successful.

Citations and Awards

Chall: Mr. DeMartini told me that you had received an award in 1943. It was a publication award, formerly known as the Goodell Prize, for joint authorship with Harvey Ludwig of a paper on coagulation. This was cited, he said, as "the most notable contribution to the science or practice of water works development." Do you remember that?

Langelier: Oh, yes. I remember that, but I didn't mention it. And then there was another one later on on the same subject by the American Society of Civil Engineers. I got a medal for that; it's around here somewhere. Yes, that was a citation. But you don't want all those citations, do you? Because there are quite a few of them.

The George Warren Fuller Awards



The George Warren Fuller Awards are given each year, one for each Section, to members of the American Water Works Association for their distinguished service in the water supply field and in commemoration of the sound engineering skill . . . the brilliant diplomatic talent . . . and the constructive leadership of men in this Association which characterized the life of George Warren Fuller.

Fuller Awards

GEORGE HANSEL GODWIN — Alabama-Mississippi Section
"For his intelligent management of the water supply works of his city; and for his many services to his associates in the water works field."

DARIO TRAVAINI — Arizona Section
"Early organizer, perennial officer and committeeman of the Section; nationally influential sanitary engineer; devoted public servant of his own and many other communities; a courageous leader of men."

WILFRED FRANCIS LANGELIER — California Section
"In recognition of his spirit of research—which he has instilled into his students; and in further recognition of his many professional contributions to the art of water treatment—all in a spirit of uncommon humility and devotion to his chosen work."

IRA PERCY MACNAB — Canadian Section
"For effective leadership within the Section; for notable achievement in water works management in the Maritime Provinces; and as the prime mover in the organization of the first Branch in the Canadian Section."

WILLIAM DENNIS COLLINS — Chesapeake Section
"In recognition of eminent service in the field of water chemistry; his pioneering leadership in the advancement of knowledge of the chemical characteristics of the water supplies of the United States; and for his active interest in the Association."

MANUEL J. PUENTE — Cuban Section
"For his exceptional engineering capacity; for his untiring efforts in bettering water works design in Cuba manifest in his participation in the plans for reconstruction of the Havana Water Works; and for his high ethical standards in resolving water works problems in Cuba."

THOMAS PAUL — Florida Section
"For diligent work in the improvement of maintenance and operation of water works plants; and his aggressive efforts on behalf of the Section."

JESSE JOHN WOLTMANN — Illinois Section
"A consulting engineer of excellent repute in the field of sanitation, who has given of his time, efforts, and energy for the improvement of the Section's activities by his willingness to serve on many committees and in various offices."

HOWARD WILLIAM NIEMEYER — Indiana Section
"For valuable service to the Indiana Section; his careful analysis and effective reporting of operating experience in the fields of distribution system operation and maintenance; and his improvements of customer services and metering with resultant improvement in water works practice."

EDWARD BARTOW — Iowa Section
"In recognition of a lifetime of inspiration to all who know him; for his leadership in education and research; and in tribute to his fine personality, and his great qualities as a citizen."

ROBERT HARLAN HESS — Kansas Section
"For his able leadership in Section affairs; for his contribution through water works schools and professional literature; and for his interest in water works research."

JACK ELLIS COOPER — Michigan Section
"For his outstanding leadership in the education and training of water treatment plant personnel through University Inservice Training; Selected Technical and Extension Courses of Instruction."

NATHAN THOMAS VEATCH — Missouri Section
"In recognition of the services he has rendered to the water supply industry, to the individuals working in the water works field, and to the public—all beyond the call of his many responsible, professional duties."

KARL RAYMOND KENNISON — New England Section
"In recognition of his outstanding skill in the field of water works design and construction; and to honor his high and fearless standards of professional integrity."

C. B. TYGERT — New Jersey Section
"For his outstanding service to the New Jersey Section, as a loyal member, a tireless worker and a most capable secretary."

LINN HARRISON ENSLOW — New York Section
"For his meritorious work in the development of water chlorination; the spreading of knowledge upon the design, construction, and operations of water works; and his industrious and valuable participation in the activities of the Association."

ROBERT STANLEY PHILLIPS — North Carolina Section
"For his untiring efforts for the betterment of the North Carolina Section as its Secretary-Treasurer, and editor of its JOURNAL; for his outstanding leadership in connection with Operators Schools; and for his willingness to share his knowledge with others."

LUTHER THOMAS FAWCETT — Ohio Section
"For his loyal interest, outstanding cooperation, and inspiring leadership in Section affairs; and for his many services to the Section."

WINSTON HEADLY BERKELEY — Pacific Northwest Section
"For distinguished service in the field of water purification, especially the fluoridation of water supplies. A man who lives in the spirit of his work, always devoted to the advancement of the water works field."

CARLETON EMERSON DAVIS — Pennsylvania Section
"In recognition of a distinguished career of more than a half century in the planning, construction and operation of public water supplies notably in the Panama Canal area and in the great metropolitan areas of New York City and Philadelphia; and for his long and continuing service to the Association."

ROBERT BRITTAIN SIMMS — Southeastern Section
"For his leadership in the organization of the Southeastern Section; for his thirty years of distinguished service to the City of Spartanburg in providing through foresighted planning and efficient management, a safe and adequate water supply for all purposes."

JOHN HENRY O'NEILL — Southwest Section
"In recognition of thirty-six years of distinguished service as a State Sanitary Engineer, contributing to the advancement of water works practice as an organizer of educational programs for water works personnel; and as founder of the Louisiana Conference on Water Supply and Sewerage."

PERCY HAROLD McGAUHEY — Virginia Section
"For his promotion of engineering skills; for his past inspiration to young engineers; and for his distinguished career and active interest in the Virginia Section for which he has given freely of his energy and time."

PAUL DUDLEY SIMMONS — West Virginia Section
"In recognition of his outstanding work in the field of water purification; for fine service to his community and for leadership in water works organization in the state."

OSWALD JOHN MUEGGE — Wisconsin Section
"For his continuous and unfailing interest in and support of the activities of the Wisconsin Section, especially in relation to the Waterworks Operators School; and for his active efforts in improving the status of the Professional Engineer."

The following Sections have made no awards

Kentucky-Tennessee Section — Montana Section
Minnesota Section — Nebraska Section
Rocky Mountain Section

Chall: If you can, someday, make up a list, I'd like to have it.*

Langelier: I really think the paper that is the most interesting is this fiftieth anniversary issue of the American Water Works Association. It explains so well the early history of sanitary engineering in the United States.**

It shows, for example, pictures of the chairmen of the Water Purification Division through these fifty years. Now there's Edward Bartow, and here I am. Professor Hyde was chairman in '39 and '40. And there are others here. As a matter of fact, on this last page here, are three of my students that made it in recent years: Derby [R.L., 1922], Medbury [H.C., 1936], and Sanchis [J.M., 1929]. I say my students, but I should say Hyde's students and my students--both.

Reminiscing

Charles Gilman Hyde

Chall: What I thought I'd like you to do today would be to reminisce a bit about your former colleagues in the engineering department. I'd like to know about those annual field trips with Professor Hyde to visit the sewage treatment plants.

The few students and colleagues of his I've met get starry-eyed when they talk about Professor Hyde and his circle of students who were so close to him. So, I must depend on you for some stories of those early years.

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*List not given to me. M.C.

**"A Souvenir of the Golden Anniversary of the Water Purification Division." Journal of American Water Works Association, Vol. 55, No. 7, July, 1963. In it, the article by Gordon M. Fair, "Fifty Years of Progress in Water Purification," pages 7-18, specifically cite the contribution of Wilfred Langelier.

Langelier: I don't know that I can add very much to what I've already said, except that I didn't go on many of these trips. It came right at the end of the semester, and there were a lot of things to do, and I wasn't...Well, I just didn't go on many of them. [Laughter]

Chall: Sewage treatment plants didn't excite you? [Laughter]

Langelier: They dealt with things I think more particularly of as engineering. It was more like an engineer's trip, and I was more interested in certain branches of research that I was carrying on--chemical research. And these boys were engineering students, and mostly they talked about engineering problems.

The plants were not very far advanced at that time, and as I told you the field trip began early in the morning--six o'clock--and it lasted until it got dark at night. They visited, usually, that last plant using the headlights of the automobile to get an idea of what the plant was like. [Laughter] They went as far south as Fresno. I remember at least some of the years they went they would take a trip down the valley as far as Fresno, visit a number of places around there. Other times they would go up north, to the Sacramento Valley, and visit plants up around Oroville. Other times we went up in the vineyard country, Santa Rosa and beyond.

Chall: And it was just at the desire of Professor Hyde, where you would go?

Langelier: Yes! He would just sit down and plan a few trips. A few days before they started on this trip he planned a route that he would like to take, without knowing what they were going to find at all, you know. They would just go into a little town and say, "Let's see what there is here." They'd look up a mayor, if there was a mayor, or a policeman, or somebody, and find out what kind of a water supply they had and what kind of a sewerage system, and where the sewage was discharged--all that sort of thing. And we saw a good many septic tanks, and rather crude--what we would today call very crude--disposal systems.

But I think the students enjoyed it. At least they remember it--those trips! [Laughter]

Chall: They certainly do. Mr. DeMartini gave me a couple of pictures of one trip, the trip that he took as a senior with some of his colleagues and Professor Hyde.

Langelier: Oh, yes. Always somebody with a camera, you know, that would take these pictures. I can't remember too many happenings, other than the actual visits themselves. I mean I don't know of any incidents that I can think of off hand.

Chall: When Professor Hyde would finally find some of these installations out in the country that he hadn't seen before, would he then check them over and discuss the good and bad points with his students?

Langelier: Oh, yes. He was always very enthusiastic, whatever he found. He would criticize, in some cases, and other times he would compliment the designer of the installation, and point out whether the results were as good as they should be, or whether they were overloading the diluting stream. He would discuss everything pertinent to the installation as he saw it.

Chall: Well, he was the expert at the time.

Langelier: Yes. 'Twas in the early days of automobiling, you know, and the boys always enjoyed getting out. There weren't many cars around in those days.

Chall: Yes, quite an adventure. What about in 1944, when he retired? Was he still taking the boys out as late as that?

Langelier: I don't know whether he continued that up until the time of retirement or not. My feeling is that he did, but I'm not too certain. In the later years, I didn't go. I went in some of the earlier years.

Chall: Mr. Stead [Frank, 1930] and Mr. Ongerth [Henry, 1935] and Mr. DeMartini--all students of Professor Hyde said that they became a part of the Hyde family circle by the time they were seniors, and felt quite gratified to be able to do so.

Langelier: Yes. I remember that Professor Hyde, at his first meeting with the students after they had registered and enrolled, would have a dinner party at his home. Every year, every fall, he entertained all the new students along with the old students. They played the usual social games, and it gave them a good chance to get acquainted. So our sanitary engineers were always a well-knit group because they had so much laboratory work together. That's where students get acquainted with each other, oftentimes--in laboratory courses. And of course our sanitary engineering

Langelier: boys were just loaded with laboratory work [laughter], which they were all required to take. And in that way they got well acquainted with each other. And I've noticed they remain friends.

Yesterday afternoon, Vic Sauer visited me here. He goes 'way back, you see [1935]. He's the engineer for Contra Costa County, but he had come to the Claremont Hotel to attend some meeting of engineers in problem solving--problems having to do with industry, I think, on the lower river. At any rate, it was a meeting in the Claremont, and he was nearby, so he just stopped in for a half an hour to talk.

We were talking about these board engineers [State Department of Public Health], and I asked him about some of the younger men that I had lost track of, and we couldn't think of. First [in the Bureau of Sanitary Engineering] it was Chester Gillespie, the chief engineer, and then he was succeeded by Ed Reinke, and then it was Herb Foster, and then Ongerth.

Chall: Right. I think that's the chain.

Langelier: I couldn't think of Foster's name, and he couldn't, and a half hour after he left here he called me on the phone. He said, "That was Herb Foster, Jr." He was the son of Herb Foster, Sr., who was a student of Professor Hyde's before I came here. He continued to work in the University, looking after water supplies, private water supply properties that the University owned.

Chall: Yes. In this chart I have here, Herb Foster graduated with the class of 1907, and his son in 1931.*

Langelier: I remember it was before we moved. I remember him as a student--I can visualize the scenes, you know. And I remember having seen him once in Professor Hyde's office in the old building. I told you, didn't I, that my office had a coal stove in the corner to keep it warm. There was no steam. Steam was put in right after I came, in 1916. Prior to that the building wasn't even heated. It was heated with a stove in each room.

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*Professor Hyde's Boys, U.C., 1905-1944.

Langelier: Professor Hyde had a rain gauge on my window sill. He was very anxious to get a complete record of rainfall, and I was to look after the machine, and I didn't do a very good job. Sometimes the clock would run down. [Laughter] I didn't do a very good job because I wasn't so much interested in that, and I didn't quite see the significance of it, because the East Bay Water Company had a half a dozen of these things all over their watershed getting data like that. But this was a recording machine, a rainfall machine. And it never rained, you know, [laughter] except during the winter months. But the machine was run every day, the year around.

Chall: What was his interest in it?

Langelier: Professor Hyde? He had an interest in "pertinent data." When he came here, as I say, there were many things that weren't available to him, that should have been--back in Massachusetts they would have been available, but they weren't here.

For instance, I went on a trip one time with one of the state health officers. Every town we went to, he would talk to school children, and he would say, "We're not registered in this state. This state is not a registration state, and it should have been." Now, Massachusetts was one of the first states to record morbidity statistics, birth-death rates, and everything. It was very difficult to control epidemics if there were no data of population, and that sort of thing. And data were very scanty back in the twenties. It would be interesting to know when the state of California became a registered state.

Chall: But he was telling the children so that they would be aware of it as they grew up?

Langelier: Yes. He wanted them to take an interest in that sort of thing. I cannot think of that health officer's name, but he was a very popular person, well known all over the state, and he couldn't go by a school building without going in and asking the teacher. He would talk to the students, the pupils. [Laughter]

I think they call it the "registration area." The United States registration area, I believe. And at that time California was not included.

Langelier: He thought that epidemics and that sort of thing could be controlled much better if doctors were forced to register all births and deaths and cases of infectious disease which they attended.

Chall: All this kind of data was important to Professor Hyde too?

Langelier: Those things interested him. Like getting good records of rainfall and particularly rates of rainfall. You see, it's the rates at which the rain falls that determines the diameters of sewers that are needed in a given city.

Oh, hardly a week passed but what he had some friend visiting out here from the East, and he would always organize a luncheon, either at the Faculty Club or at some other restaurant. He was very generous, very active, in that way. He was a great mixer. He had large numbers of friends and always wanted to entertain at his home or at restaurants for luncheon.

Anybody who would come, say, from the Public Health Service in Washington. "Well, So-and-So is in town!" he'd say. He'd call up everybody, or his secretary would, and we'd all go over to the Faculty Club and sit around until about two o'clock after lunch. And that happened over and over again and largely because, as you say, of his outgoing nature and his interest in people, and interest in his profession, in his field of sanitary engineering. He was a remarkable person that way.

Chall: He would question these people then about what they were doing?

Langelier: Not so much that. He was always very well posted; he was interested in that--but socially, he was oriented socially. He would introduce his students to these people where he thought it might help the student.

Chall: I'm sure it may have paid off.

Langelier: Oh, yes. He was always looking out for the interest of the student, way beyond the classroom. He would invite them to meet delegates to conventions here, and that sort of thing.

I was just reading the introduction to this book I have here on Stream Sanitation. It was written by Earle Phelps. He is a water technologist whose training is similar to mine, Langelier: and whose interests were similar to mine, and I was reading in the introduction to his book that he was testifying in court and someone asked him, "How come you know so much about so many different things?"

Chall: You mentioned Earle Phelps I think last week, too. Where was he?

Langelier: He's one of the Massachusetts Tech--MIT--men, but more of a chemist than an engineer, I would say, although he did engineering work. That group of men that were at MIT, they were the ones that trained a number of students that went out all over the country; just as Professor Hyde came here, Langdon Pearse, for example, worked in Chicago. And he was the chief engineer for the Chicago Sanitary District, of which Bacon is the chief engineer--one of our students. But Langdon Pearse, I think, was the first top-flight man in that position, and it was a very important position.

Chall: Who were some of the others in that MIT period?

Langelier: There was a woman who did the sort of work that I did here. She wrote, I think, the first book on water analysis, and they used to teach water analysis. Of course, by the time I took over the work we weren't satisfied just to do water analysis; we did all sorts of research, experiments and that sort of thing: water chemistry. Much more involved than it was in those days. But she did write the first book that I ever saw. Ellen Richards was her name.

And there was a group of professors there--Professor Hyde would know them all. And they trained students and some of the students went into the Massachusetts State Department of Health, which also was one of the pioneers in the field of sanitary engineering. Hyde will know all about that. They did a remarkable job in training people and sending them all over the country. And that has continued. Of course, we have some all over the country now and all over the world!

The thing that pleases me most is the fact that you are going to see Professor Hyde.

Chall: We still don't have that appointment; we're trying.

Langelier: I'll tell you now that he can answer all the questions that you want answered. And no one else can.*

Chester Gillespie and Edward Reinke

Langelier: In summertime I used to like to take long trips with Mr. Gillespie of the sanitary bureau and Ed Reinke, when they would go over the state visiting plants. I often went with them, sometimes a week or longer on a trip.

Chall: I see. They were concerned with water quality and standards?

Langelier: Yes. In those days they also had charge of the sewage disposal systems, and an interest in them. I remember going down to Los Angeles and seeing the long outfall sewers there and the treatment facilities for the disposal of Los Angeles sewage, and its relation to the beaches nearby, which were condemned.

Chall: Yes. They had permit powers, and they could condemn.

Langelier: That's right. They did, in those days; they condemned. So I visited more plants with those boys than I did on these annual trips with Professor Hyde and the students, really. I had a better opportunity to discuss these plants and really see them in depth, you know--to really study them.

Chall: What did Mr. Gillespie and Mr. Reinke do when they were on these trips? What was their purpose?

Langelier: They usually would prepare written reports on each of these installations, and also advise with the authorities as to whether they were meeting their responsibilities or any things that needed to be done. Oftentimes they were asked to visit these cities with a view to inspection and giving advice on what should be done. Might be a problem in water chlorination, or it might be a matter of disposal of sewage.

Chall: If they went down to a big plant then would they be dealing with their own water chemists, or those employed by the city or district?

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*The interview could not be arranged prior to Mr. Hyde's death in September, 1971.

Langelier: Well, oftentimes we went to big plants to learn something ourselves. A plant like the Los Angeles plant, for example, had its own staff of engineers, and in cases like that we would go more to prepare a report--at least the board engineers would prepare a written report.

I think Mr. Gillespie probably spent almost half his time, and likewise the engineers under him spent, I would say, from a quarter to a half of their time in the field, and the rest of the time in the offices here preparing reports and writing reports.

Chall: While you were with him, were you getting ideas, or giving advice?

Langelier: Oh, I went more for a trip. I went more as an accommodation. They had the cars, and I would pay my own expenses, of course, but I enjoyed and learned a good deal about the state that way in the early years. I traversed the whole state, from top to bottom, with those engineers. Practically all of the engineers working in that bureau had been students under Professor Hyde.

Chall: That's right, including Mr. Gillespie, of course. And then, at that time your offices were very close, and you shared laboratory facilities.

Langelier: Well, that's it. You make it very short and just take out all of that that appears like bragging, if you will. Please. [Laughter]

Transcriber: Helen Kratins
Final Typist: Keiko Sugimoto

APPENDIX

Mrs Chall (4/30 @ 10 30 A.M.)

-1-

[Notes of Frank DeMartini on
Wilfred Langelier]

AWWA honors:-

1962 Honorary member - Special recognition for knowledge and accomplishments in water supply field.

1943 Publication Award (formerly known as Goodell Prize.) for jt. authorship with Harvey Ludwig of paper on Coagulation, as representing (1943) the most notable contribution to the science or practice of water works development

As a teacher - trained san. engr. students in laboratory examination of water & other water supply courses. Large %age of Bur. of S. Engr. Staff were his students during Langelier's years at Cal (1915 - 1950's ± ?)

Some of his students were:

E.A. Reinke, H.B. Foster, Henry Ongerth } All served as Chiefs of Bur. San. Engring.

Frank Stead, Director Div. Env. H. Calif. St. Bd. Health

Bill Seegar - Genl. Man. & Chief Engr. Marin Munc. Water Dis

Joe De Costa - Ch. Engr. East Bay Munic Util. Dist.
Roy Dodson - Asst. Magr. - San Diego Water Dept.
Chris Medberry - Asst. Genl Magr. & Ch. Engr. S.F. Water Dept.
Harvey Ludwig - Formerly Prof. S.E. (Cal), & President of Engineering Sciences.
Vinton Bacon - Genl Magr. - Chicago Sanitary District.

Close association with Gillespie, Hyde, Reinke - Stimulated all as to need for & value of research in w.s. field. & had a practical viewpoint, directing research efforts to practical problem solving.

Research Contributions: (Principals)

"The Analytical Control of Anti-Corrosion Water Treatment."

"Coagulation" Paper with Ludwig (1943)

"Motorized Apparatus for Rapid Determination of Ca + Mg. in Water."

Developed first application of coagulation mixing Basins with paddles for Sacto. Calif. water treatment plants.
(?) Also believe he stimulated Sacto to developing their own manufacture of $Al_2(SO_4)_3$ from Bauxite & H_2SO_4.

Served for many years as water purification Consultant to various large water systems.

1 - Sacto - Calif. - Advised on filtration problems + control of tastes & odors.

2 - East Bay Water Co. - One of primary contributions backing of Joe deCosta re filtration of Mokelumne water.

3 - Marin Munic. Water District - Consulted on disinfection water quality - & proposed unique coagulation system utilizing Tunnel from Alpine Res. which proved quite successful & economical.

San Francisco Water Dept - Advised on quality problems generally -

Examples -- Advised on timing of $CuSO_4$ tr. of reservoirs for alge control.

Treatment of Hetch Hetchy water for corrosion control.

Chlorine treatment of Hetch Hetchy water for control of slime growths in Coast Range Tunnels.

PROFESSOR HYDE'S "BOYS"
U.C. 1905 to 1944

Presented to him as a token of remembrance
by "the boys" at his Retirement Party, Hotel Claremont, Berkeley, California
July Eighth, Nineteen Hundred and Forty-Four

Class of 1905
Thomas E. Ambrose
Ezra O. Burgess
Thomas V. Cannell
Clarence E. Day
Howard Marshall
Harold Petterson

Class of 1906
John W. H. Barnes
John C. Black
Wm. L. Borthwick
Walter E. Burns
Earl L. Cope
Henry D. Dewell
Austin W. Earl
Wm. W. Gilmore
Harry M. Goodman
John P. Hickey
Lawrence R. Kessing
T. D. Kilkenny
Clarence H. Kromer
Leon H. Nishkian
George A. Posey
Bernhard Silberberg
Harry E. Squire
E. B. Stillwell
Henry W. Taylor
Howard C. Whitman

Class of 1907
Charles W. Backe
Herbert B. Foster
Guy O. Fraser
Louis A. Frei
Chester G. Gillespie
Harold F. Gray
Joseph W. (Joe) Gross
Sinclair O. Harper
Louis T. F. Hickey
Henry B. (Bert) Kitchen
Morris H. Levy
Sol D. Levy
Kingsbury E. Parker
Frank S. Robinson
Emanuel Scheyer
Rueben J. Wood

Class of 1908
Henry H. Burton, Jr.
Albert W. Miller

Class of 1909
Sylvain S. Abrams
Ned D. Baker
Lee O. Murphy
Glenn V. Rhodes
Harold G. Weeks

Class of 1910
Paul Bailey
Leo Glick
Earl H. Markwart

Class of 1911
Clyde C. Kennedy

Class of 1912
Elbert M. Chandler
James R. (Ralph) Shields

Class of 1913
Tom A. Bither
Harry W. Bolin

Class of 1914
Joseph (Joe) Doman
Edgar C. Fitzgerald
Edmund D. (Ed) Margrave

Class of 1915
Albert W. Paine
Adolph C. A. Sandner

Class of 1916
John N. Adams
William H. Hooker

Class of 1917
Bert A. Bone
Harry N. Jenks
Andrew M. Jensen
Edward A. (Ed) Reinke
Victor R. Sandner

Class of 1918
Gottlieb T. (Ted) Luippold

Class of 1919
George E. (Earl) Troxell

Class of 1920
Archer R. (Archie) Norcross

Class of 1921
Benjamin (Ben) Benas
Antonino LoPrest

Class of 1922
Ray L. Derby

Class of 1923
George W. Reed

Class of 1924
Carl Benson
Joseph D. (Joe) DeCosta
Emerson Dolliver
Andrew (Andy) Gram
Frederick G. (Fred) Nelson

Class of 1925
Adam C. (Carl) Beyer
Chester C. (Chet) Fisk
John L. Mason
Wm. J. (Bill) O'Connell, Jr.
Lawrence G. Sovulewski
Dario Travaini

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Oscar C. Blumberg

Class of 1927
Frank E. DeMartini
Thomas E. (Tom) Galvin
Emil O. Hokanson

Class of 1928
Raymond R. (Ray) Ribal

Class of 1929
Harry Hayes
Oswald H. Milmore
Joseph M. (Joe) Sanchis
Lester M. (Les) Snyder

Class of 1930
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Judson A. (Jud) Harmon
Edward A. (Ed) Heiss
Parker Kwan
William (Bill) McCoy, Jr.
Robert J. T. (Bob) Smith
Franklin M. (Frank) Stead

Class of 1931
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Curtis H. Cleaver
Thomas O. (Tom) Crow
Herbert B. (Herb) Foster, Jr.
Paul A. Loeffler
Iwao M. Moriyama

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Leonard (Len) Schiff
Otto J. Wittman

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George Hall
John C. (Carl) Jennings
Thomas F. (Tom) McGowan
Charles L. Reasoner
Primo A. Villarruz

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Casimir C. (Cas) Blonski
Blair I. Burnson
Earl W. Dakan
Byron E. Doll
Sidney F. (Sid) Dommes, Jr.
Claude M. Helm
Frank J. Juchter
Alfred M. (Al) Keuhmsted
Richard R. Kennedy
John W. Straser

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Ignacio P. Chavez
Joseph L. (Joe) Grahek
Homer W. Jorgensen
Jack H. Kimball
John C. Luthin
James A. (Jim) Millen
Alfredo C. Ocampo
Paul A. Oliver
Henry J. Ongerth
Roy E. Ramseier
W. M. (Mel) Riegelhuth
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W. R. (Bill) Seeger
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R. L. (Bill) Stanley
Marvin G. Sturgeon

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Theodore R. (Ted) Gregory
R. M. (Bob) Heidenreich
Anselmo J. (John) Macchi
Hiram C. (Chris) Medbery
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Earl C. Myers, Jr.
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Sam A. Weed
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J. B. (Jim) Hommon
Kaarlo W. Nasi
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Yale Rosenfeld
Bernard Schiller
D. W. (Don) Sloss

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Millard E. Buckman
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Stanley H. Cowell
Randolph H. Dewante
Alfred J. Geandrot
Pierce B. McIntosh
John A. (Jack) Maga
Charles P. Martin
John T. H. (Jack) Morris
Charles D. Y. Ostrom, Jr.
Gleason L. Renoud
Edwin R. (Ralph) Stowell
W. W. (Bill) Tinniswood

Class of 1939
Julian L. Bardoff
Frank V. Chiarolla
Roy E. Dodson, Jr.
Walfred A. Flod
Michael H. (Mike) Keyak
Thomas A. (Tom) Long
Harvey F. Ludwig
Jack W. Pratt
Morgan E. Stewart

Class of 1940
Robert C. (Bob) Adolphe
Vinton W. Bacon
Peter W. Burk
R. R. (Bob) Campbell
Harvey M. Cole, Jr.
James E. (Jim) Dunlap
Howard R. Gesley
Milton S. Hilbert
Robert P. Lonergan
Clyde N. Moore
Byron L. Nishkian
Norman T. Riffe
Arthur F. Royce
Irving M. Terzich
R. G. (Bob) Williams

Class of 1941
John W. (Jack) Bell
Fred H. Dierker
Howard S. Hitchcock
Gordon H. Klippel
William C. (Bill) Langley
Robert P. (Bob) Lowe
Russell G. Ludwig
William R. (Bill) Tolton

Class of 1942
George Adrian
Ichiro Fukutome
Bert Jameyson
Albin W. Johnson
John N. (Jack) Kerr
Arthur E. (Art) Lappinen
Karl J. Maier
Edward H. (Ed) Morjig
Edward I. (Ed) Murphy
Henry T. Omachi
Weldon L. Richards
Paul J. Toien

Class of 1943
James B. (Jim) Dupuis
Raymond M. (Ray) Hertel
Charles S. (Charlie) Howe
John B. (Jack) Howe
Robert C. (Bob) Levy
Leonard (Len) Melberg
Danilo (Danny) Prodanovich
Robert W. (Bob) Purdie
Ralph Stone

Class of 1944
Robert M. Glick
Stanley Goldhaber
Thomas R. Ostrom
Louis Robins

TABLE OF CONTENTS

Introduction

The papers herein presented represent the most significant published research contributions of Professor Wilfred F. Langelier. Included in the collection are a few which he authored jointly with some of his most distinguished graduate students, or with other professionals associated with him on the projects reported. Two papers by distinguished contemporaries of Professor Langelier are included because they evaluate and document the practical and the scientific validity of his best-known work.

In order that the reader who did not have the good fortune to work with Professor Langelier, to study under his guidance, may read these papers with a better perspective, it might be useful to summarize the pathways which led him from New England to California as well as the problems of the era which challenged him to pioneer in a whole new field of water quality technology.

Professor Langelier was educated in the field of chemistry, first at his home state college which is now the University of New Hampshire, and later at the University of Illinois. His inducement to leave New Hampshire after completing his undergraduate degree in 1909 was the offer of a position in the Illinois State Water Survey. The offer included the opportunity to divide his time equally between graduate study and routine work in the Survey laboratories; an especially convenient arrangement because the Survey was then housed in the University's chemistry department. The Survey was a unique institution directed and nurtured by Professor Edward Bartow. Under his farsighted guidance it pioneered in a program of sanitation chemistry and engineering which in most states has now become an important and necessary division of the State Health Department.

After receiving an M. S. degree in 1911, Langelier decided to stay on in the Survey to engage almost entirely in field work. This involved the preparation of descriptive reports of existing water supply and sewerage systems, investigation of typhoid fever outbreaks, installation of emergency 'hypo' plants for disinfecting water, investigation of occurrences of stream pollution, excessive clogging of water service pipes, and a host of other problems associated with the safety and the technology of providing high quality water to the public. On several occasions leaves of absence from the Survey were grated Langelier in order that he might make month-long official performance tests of newly built water purification plants, both within and outside the State of Illinois.

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* Prepared by P. H. McGauhey, Professor Emeritus of Sanitary and Public Health Engineering, and Director Emeritus of the Sanitary Engineering Research Laboratory; University of California, Berkeley.

Langelier looks back at his experiences in Illinois as having been most rewarding. He recalls that he came along at a time when the young profession of sanitary engineering was participating actively in a remarkable period of accomplishment and development. One after another the basic processes of water purification and the sanitary disposal of sewage which are most in favor today were under development. These processes included the well-automated, high-rate filtration of muddy river waters through coarse sand, water softening by base exchange, and water disinfection with chlorine. Also known and under development were the primary and secondary biological processes most efficient in the treatment of sewage.

Concurrently, within this discovery period in water technology there were important related advances in the physical chemistry of dilute aqueous solutions and colloidal dispersions. At the University, Professor Washburn was a leader in this field; Langelier recalls that shortly after his arrival at Illinois, Dr. Bartow invited Professor Washburn to address a group of water works men on possible applications of this new chemistry to the field of natural waters. Washburn enthusiastically discussed the dissociation of water itself, into hydrogen and hydroxyl ions. He intimated that water analyses in the near future would include an important new term, namely, Hydrogen Ion Concentration, represented by the symbol pH. Several years were to pass before an accurate determination of pH in natural waters could be made. However, time has proved that his prophecy was a gross understatement of fact. Within about two decades, it became the simplest and most frequently used test in water technology. Its importance is that it determines the distribution of carbonic acid and its salts; constituents present in all natural waters. Examples of its use will be found herein in the papers dealing with the stabilization of treated waters.

When in 1916 Langelier received an offer to teach water chemistry technology at the University in Berkeley he quickly accepted. Although at first he had misgivings that a Department of Civil Engineering could afford the luxury of an outside discipline, he joined the faculty of the Department as a chemist. There he remained to complete a tenure of forty years. Thus he became the first chemist to make his career from what at first seemed an unusual home for a chemist and, as years went by, to give the University of California a unique advantage in the field of education through this arrangement.

At the outset of his teaching career, it became apparent to Langelier that the processes of water and sewage treatment had evolved as extensions to water distribution and sewerage systems and had been accomplished largely by Engineers with minimum benefit of chemical theory. Water chemistry had been almost synonymous with water analysis. A water chemist was presumed to be an analyst. The existing reference literature was scant and mostly descriptive of completed or proposed projects. Accordingly, in classroom and laboratory Professor Langelier found it desirable to direct his attention mainly to the established unit operations of chemical engineering — coagulation, sedimentation, filtration, aeration, disinfection, etc. The papers in this collection reflect some of his earlier and more recent interests.

Although Langelier is probably best known within the profession of sanitary engineering for his formulation of the Saturation Index and work on the stabilization of treated waters, his own professed greater interest was in the study of flocculation phenomena, especially as related to the clarification of muddy waters treated with alum preliminary to high-rate filtration through coarse sand. His interest in this subject arose while in Illinois, when on several occasions he had observed the malfunctioning of filtration plants to have been caused by the penetration of coagulant chemical into the water mains. He had correctly diagnosed flocculation as the most essential feature to the filtration process.

Several papers in the present collection are mainly concerned with the mechanism of flocculation. They were originally published between the years 1921 and 1952. The first of these papers, a news story prepared at the request of a friendly editor of an engineering new weekly, was published in 1921. It was included in this series because of its value in having disclosed several innovations which have greatly influenced the design and operation of water filtration plants.

One of the most important of these innovations relates to an apparatus and a flocculation test procedure which was soon to be widely used and to become known as the Jar Test. Several models of the apparatus had been made. The one illustrated comprised four-in-line 200-mℓ clear glass tumblers, each provided with a variable low speed motor-driven agitator. This apparatus had been assembled to observe visually the conditions essential for optimum flocculation and clarification.

The first trials of the equipment were strikingly successful. Using synthetically prepared waters it was discovered that optimum flocculation required a minimum of about ten minutes of continued stirring, and that the required alum dosage increased with both the turbidity and alkalinity of the sample. From these observations it was possible to calculate that flocculation in these samples was occuring at an approximately constant hydrogen ion concentration close to true neutrality.

Langelier's associates observing these early jar tests were amazed at the simplicity and reproducibility of results and wondered how the discovery of this simple test procedure could have been delayed so many years.

Professor Hyde, noting the desirability of prolonged mixing or agitation and surmizing that mechanical mixing in separate compartments would prove superior to the usual mixing in a baffled channel, immediately began making arrangements to erect a pilot plant at Sacramento, for which city he was completing plans for a large filtration plant.

The Sacramento plant mentioned in the first of the articles which follow was placed in operation in 1924. It is believed to be the first plant of its type to provide prolonged and controlled mechanical agitation as a substitute for a short period flash or gravity mixing in a baffled compartment. This feature of plant design soon became standard practice.

There were still many unexplained factors surrounding the flocculation theory, but a systematic and in-depth study in the Berkeley laboratories was delayed until the fall of 1941, when two high-scholarship students, Harvey and Russell Ludwig, selected this topic for thesis study leading to M. S. degrees. One of the problems to be investigated was the distinction between the terms coagulation and flocculation. In the 1921 paper, Langelier had used the terms interchangeably, but since colloid chemical theory took no cognizance of prolonged agitation, it was argued by Langelier that flocculation is a two-step operation in which coagulation is only the first step. How well the students succeeded in finding answers to this and other questions was ably reported in the 1949 and 1952 papers. Publication of these two papers was unavoidably delayed until 1949 and 1952. We at Berkeley consider these two papers as required readings for all sanitary engineering majors.

An interesting application of alum clarification without filtration is described in a paper entitled "Shallow Sedimentation Basins." This was a "temporary" measure proposed by Professor Langelier to solve a serious problem involving objectionable turbidity of water from a mountain side impounding reservoir in Marin County, California. The project involved the utilization of the existing raw water pipe line and tunnel to double respectively as mixing and sedimentation basins. That the solution of the problem was successful can be judged by the fact that the "temporary" measure is still in use forty-five years later and incidentally is successfully competing with two modern filtration plants servicing other nearby reservoirs of similar character.

The first of the Langelier papers relating to the Saturation Index and the stabilization of treated waters appeared in 1936 under the title of "The Analytical Control of Anti-Corrosion Water Treatment." This paper and several to follow — the first papers to deal with ionic equilibria to natural and chemically treated waters — has been well received both here and abroad. Briefly, the Saturation Index is widely used by chemists to determine the potential of a given water either to corrode or incrust the interior of water piping. The former is objectionable primarily because the corroded metal can impart an objectionable red turbidity to the water; and the latter because, if excessive, it can reduce the carrying capacity of the piping. More specifically, the Saturation Index (S. I.) is the algebraic difference between the actual or measured pH of a sample of water and its equilibrium or saturation pH, designated pH_s. The value of pH_s is obtained from an equation ingeniously derived in terms of calcium and total alkalinity, and can be read from a suitable constructed Stability Diagram. A positive S. I., pH greater than pH_s, indicates a degree of supersaturation with calcium carbonate and a tendency to lay down a protective coating of the salt. A negative S. I. indicates the water will have a tendency to dissolve a protective carbonate coating and corrode the metal. Use of the Index in practice has generally indicated the desirability of slightly positive value at the entrance to the distribution system. The Saturation Index replaces a laboratory test procedure which is time-consuming and probably less accurate.

Reference has been made to Professor Langelier's early recognition and belief that a promising future awaited the profession of sanitary engineering. Time has now confirmed this judgment but for many years college enrollments in this major remained small and were disappointing. The first increase in student enrollments occurred during the late forties when civil engineering colleges began seriously to promote graduate instruction and research. Interest continued to grow until finally some ten years later with the advent of environmentalism and its worldwide popular demand for cleaner air, water, and land its future position was assured.

In the early seventies as these paragraphs are being written, a considerable number of scientists, engineers, and economists are challenging the position of environmentalists, many of whom have little knowledge of the serious economic problems involved in environmental control. We shall need a well-informed citizenry and there will be a continuing demand for well-trained specialists in all branches of environmentalism, but universities should be on guard to prevent an oversupply as has occurred lately in other fields.

Obituaries

Wilfred F. Langelier

[illegible] funeral [illegible] have been [illegible] for Wi[illegible] Langelier, emeritus [illegible] of sanitary engineering at the Univer[illegible]sity of California a[illegible] and the pioneering inve[illegible] of a water corrosion index widely used by plumbers.

Mr. Langelier, who was [illegible] died Sunday at his Berkeley home after a long illness.

Born in Nashua, N.H., Mr. Langelier attended the University of New Hampshire, graduating with a degree in chemical engineering in 1909. He received a master's degree in chemical engineering from the University of Illinois in 1911.

Joining the faculty of the University of California as an assistant professor of sanitary engineering in 1916, Mr. Langelier remained associated with the university throughout his life. He was among the first scientists in the country to teach sanitary engineering and was known for his seminal work in the field of environmental and water quality engineering.

In the 1930s and '40s, Mr. Langelier served as a consultant to local water companies and during that time developed the Langelier Index, used to determine how corrosive water might be to pipes and plumbing. The index is still used as an aid in water delivery and plumbing services.

A charter member of the American Chemical Society and the American Waterworks Association, Mr. Langelier retired from active teaching in 1954.

Mr. Langelier is survived by his wife, Ruth, of Berkeley.

San Francisco Chronicle
September 16, 1981

Wilfred F. Langelier

Wilfred F. Lange[illegible]or emeritus at the [illegible] of California at Be[illegible]d expert on sanitary engineering, died Sunday at [illegible] of [illegible]

A native of New Hamps[illegible] Langelier graduated from [illegible] University of New Hampsh[illegible] 1909, then obtained [illegible] degree at the Univers[illegible] nois to start a long [illegible] engineer, teacher, researcher and consultant in the field of water sanitation.

He worked for the Illinois water survey and then became associated with Professor Charles Gilman Hyde of Berkeley. The two of them were credited with establishing the University of California as one of the world's leaders in education and research in water technology.

Langelier was renowned for his many scholarly treatises and for the Langelier Index, a system now widely used in corrosion control.

After retiring from the university, he entered the consulting field.

He leaves his wife of 65 years, Ruth Davison Langelier. Services were private.

Oakland Tribune
September 16, 1981

INDEX -- Wilfred F. Langelier

Malca Chall

Graduated from Reed College in 1942 with a B.A. degree, and from the State University of Iowa in 1943 with an M.A. degree in Political Science.

Wage Rate Analyst with the Twelfth Regional War Labor Board, 1943-1945, specializing in agriculture and services. Research and writing in the New York public relations firm of Edward L. Bernays, 1946-1947, and research and statistics for the Oakland Area Community Chest and Council of Social Agencies 1948-1951.

Active in community affairs as a director and past president of the League of Women Voters of the Hayward Area specializing in state and local government; on county-wide committees in the field of mental health; on election campaign committees for school tax and bond measures, and candidates for school board and state legislature.

Employed in 1967 by the Regional Oral History Office interviewing in fields of agriculture and water resources, Jewish Community history, and women leaders in civic affairs and politics.