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JOURNAL OF THE

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REBUILDING AN OLD CITY

BY HON. JOHN F. COLLINS, Mayor of Boston

(Presented at a dinner meeting of the Boston Society of Civil Engineers, held in conjunction with A.S.C.E. convention on October 16, 1960.)

BOSTON is one of the great cities of America. None has made a finer contribution to the history, the culture, the way of life of this nation of ours. Yet too much of Boston's greatness lies in its past.

Today Boston has far more than its share of slums and blight. This decay is sapping the great strength and beauty, vitality and charm which it still possesses in such abundance.

Among Boston's greatest assets are its harbor and rivers, its hills and parks, but above all its people. Bostonians love their city. I believe they are ready to do their share toward making it a better place.

Once started on its way toward rebuilding, Boston will find all America cheering it on and ready to help.

There is, after all, a little bit of Boston in everyone who calls himself an American.

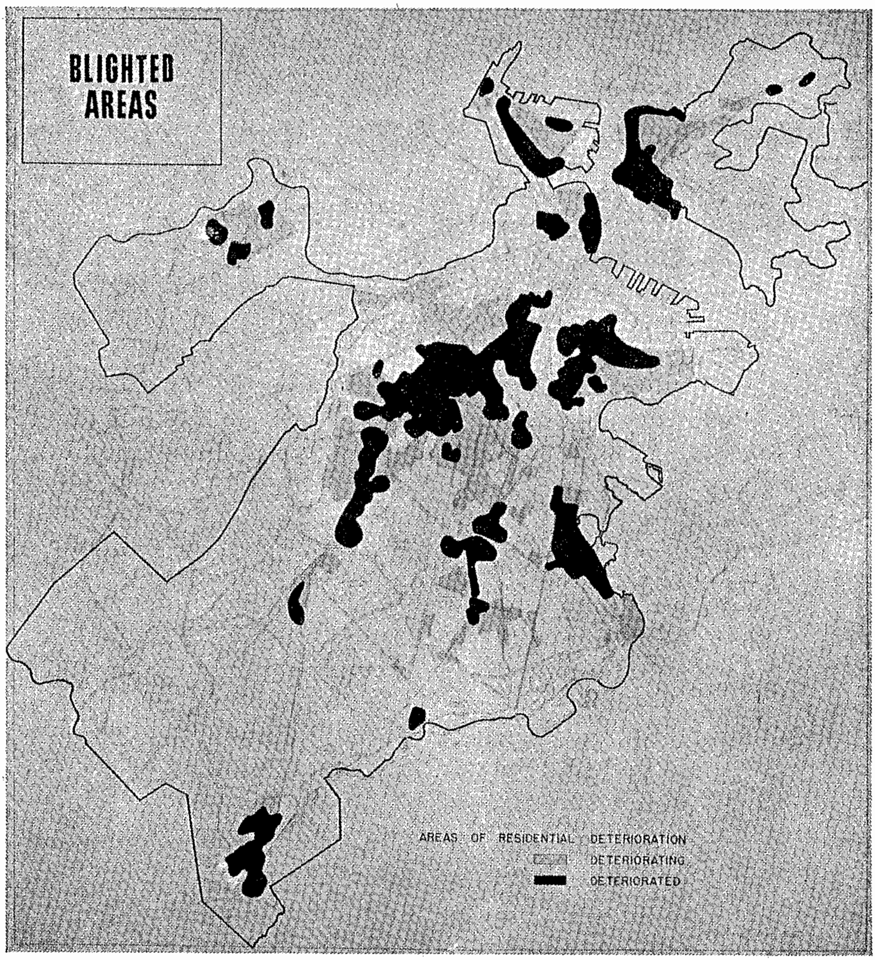
BOSTON HAS TOO MANY SLUMS, TOO MUCH BLIGHT

I have not tried to create or gather any new statistics on the extent of slums and blighted areas in Boston. In the first place, I found those already prepared impressive enough, and depressing enough too, I might add. In the second place, statistics have had only a limited success in moving cities to act on their problems of slum and blight. The blighted areas map is graphic evidence of how widespread and serious the problem is. The charts showing the rising tax rate, declining tax base and population are vivid demonstrations of the seriousness of the City's economic problems.

Boston has all kinds of slums and all kinds of blight. It has overcrowded slums and half empty slums. It has bad housing and badly rundown commercial areas. It needs lots of slum clearance but it offers great opportunities for rehabilitation.

For those who are not convinced or who need their recollection refreshed I suggest that they go and see for themselves. The best way is to walk around the City and have a firsthand look yourself.

Of the many walking tours a citizen might take I suggest two. They will give some idea of the extent of blight in Boston today.



Washington Street from Northampton street to Haymarket square —distance under 2.5 miles (MTA rapid transit stops at both ends).

This walking tour will take you along one of Boston's main arteries. Starting in Lower Roxbury you will quickly be in the South End, then you pass into the downtown shopping area and finally to the very decayed part of downtown which is to become the Government Center area. Detours into the side streets and back alleys will help to round out the picture.

On your way you will see lovely squares, a beautiful cathedral, the City's first redevelopment project, the big department stores, Old South Meeting House and Faneuil Hall.

You also will see some of the worst slums in the City plus enough shabby rundown commercial buildings to make you uncomfortable about the future of downtown.

Main Street in Charlestown from Sullivan square to City square—distance one mile (MTA rapid transit stops at both ends).

Here is hallowed ground. There is much that is handsome and worth preserving in Charlestown. It could be one of the most attractive and convenient neighborhoods in the City. Ask yourself how long it can survive the onslaught of the slums you will pass through on your way to City square.

If these walks discourage you try the Freedom Trail. The obstacles today are far less than those which were faced and conquered long ago.

The Big Decisions

Boston has some big decisions to make if it is going to undertake the major rebuilding program which is necessary if it is to face the future with confidence.

First, has Boston enough faith in itself and its future to make the try?

Boston has its share of prophets of gloom and doom who think the City is too far gone to be rebuilt. It has its share of sceptics who believe that Boston's habits in transacting the public business make a major effort impossible.

Second, is Boston willing to face the full extent of its slums and blight, to stop tinkering with patchwork solutions and support a big, bold, fast moving program?

Third, will Boston have enough patience to understand that cities are not remade in a day or a year, and have enough courage to accept the hardships and disruption that are inevitably a part of rebuilding?

Fourth, will Boston be willing to accept the leadership of its Mayor in this rebuilding effort?

I assume the answers are affirmative, and so make the recommendations which follow.

Recommendations

Recommendations are divided into several categories in the following order: Proposed development program, financing, staff organization and suggested guideposts.

Proposed Development Program

There is only one program now available or even on the horizon by which Boston can begin to cope with all its major areas of slum and blight.

This program is federally aided urban renewal. Broadly conceived and vigorously administered it can turn the corner. Boston can afford a large scale federally aided urban renewal program. There is no other comprehensive solution available and a patchwork solution is not good enough.

Rehabilitation is the key to the kind of urban renewal program Boston requires. Considerable clearance will still be needed but rehabilitation should be the major emphasis.

With judicial approval of the tax agreement features of the Prudential legislation for blighted areas a major obstacle to new investment in Boston has been removed.

At this stage two kinds of urban renewal action are possible. One, the filing of a survey and planning application for a specified area, leads directly to adoption and execution of an urban renewal plan. The other step is a request for funds to make a general neighborhood renewal plan. The purpose of this plan (known in the trade as a GNRP) is to identify subareas needing urban renewal treatment and to establish priorities for undertaking indicated projects.

This report recommends a comprehensive, action oriented urban renewal program combining survey and planning applications and general neighborhood renewal plans.

The material needed for making the necessary federal applications recommended below has been put together in draft form and can be put into final form very quickly once Authority and Council approval have been given for the filing of such applications.

The first group of recommendations deals with Downtown Boston, the second with the ring of neighborhoods closest to downtown.

Downtown Development Program for Boston Proper

Boston Proper is the name the planners give the peninsula which stretches back from the Harbor to Massachusetts avenue. It includes the Central Business District and areas adjacent to it.

This area is the most important part of Boston and the primary reason for the existence of the other neighborhoods of the City in their present form. Here are located one of the major financial centers of the United States, the largest retail shopping center in New England, and the regional centers for a whole host of government, professional and commercial activities.

Here also are some of the worst slum and blighted areas of Boston. So large, so menacing, in fact, that they are pushing most new private development steadily out Boylston street if not out of the City altogether. This is an area that is in deep trouble.

Yet potentially this is the most attractive and most interesting downtown in all America, bar none, not even fabled San Francisco.

Its ancient street pattern can be turned to far more of an asset than the more efficient but dull grid pattern common to most other American cities.

Its abundance of historic sites offers islands of strength around which rebuilding can confidently begin.

Its compactness, its walkability give it hope of putting the automobile in its proper place.

Here is Boston's greatest asset, its surest source of continued strength and greatness, if we can but renew the area before too many functions abandon it for the open country or for more efficient downtowns elsewhere.

For the purpose of analysis and recommendation this area is divided into three general neighborhood plan areas: Downtown, Downtown North and Back Bay.

Downtown North is the older and more historic Boston and the one which will receive action treatment first.

Downtown North—Historic Old Boston

Downtown North is that part of Boston Proper lying to the north and east of the Beacon Hill Historic District and to the east of School and State streets. It excludes the West End project now in execution.

A general neighborhood renewal plan is proposed for the entire area. It would be completed simultaneously with the completion of the Government Center redevelopment plan.

1. Government Center

Downtown Boston is the major governmental center of New England. It is not only municipal headquarters, it contains the State Capitol and most state offices and the most important regional and state offices of the federal government.

These functions are today widely scattered in overcrowded, obsolete buildings. They will be more efficient and more economical if they are gathered together.

The Boston City Planning Board, through consultants, prepared a bold, imaginative and sensitive plan for the creation of a Government Center in what is now the most rundown section of the central area.

This plan has in principle won the support of the federal and state governments as well as the City. It is proposed that the plan be carried out through a nonresidential federally aided redevelopment project.

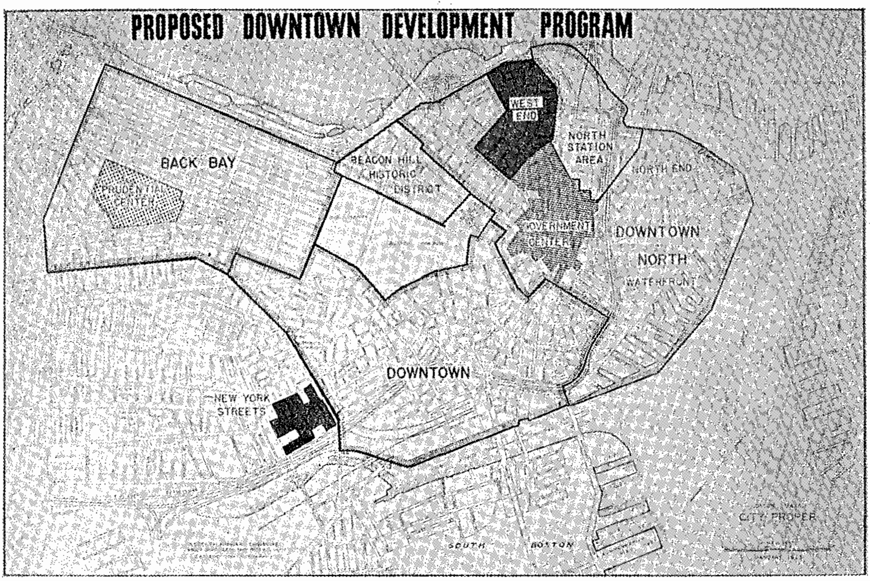
This project can be one of the most important in Boston's history. Without it the presently blighted area will grow and spill over into the remainder of the central area and seriously weaken it. Contrariwise, with the Government Center on its way a plan for the renewal of the central business district can have some real hope of success.

The Federal Urban Renewal Administration has just approved an application for federal survey and planning funds for the Government Center project.

The U. S. General Services Administrator has indicated a willingness to locate a large federal building in the project area provided he has satisfactory assurances that suitable buffer buildings will guarantee that the federal building will not be isolated. The City has given the necessary assurances concerning the City Hall. The General Court has given similar assurances regarding state participation. The assurances and other matters relative to federal participation must now be put in acceptable form.

The Government Center Project should have top priority in the city government. Though the basic planning work has been completed much more remains to be done to make the project a success. Government Centers have a tendency to be rather dull and uninspired. By keeping the spirit of the consultant's report Boston can avoid such a failure.

During the planning period careful study should be given to certain fringe areas which might well have been included in the survey and planning study area. For example, the area bounded generally by Congress street, Hanover street, the Central Artery and State street is an area of prime historic significance for the whole nation.



Some of the buildings such as Faneuil Hall and the Quincy Market are in daily use for their original purposes. This is living history at its best.

Some other parts of the historic area are street patterns and not much more. Scornful as the purists may be of Sturbridge or Williamsburg, they help make history come alive for young and old alike. A restoration of old Boston in this area would be quite appropriate despite the shadow of the Central Artery. This section could have been included in the Government Center as a rehabilitation section. The desirability of so including it should be thoroughly explored in the project planning period now beginning.

2. *North Station Area*

This area is bounded approximately by the North Station complex, the Central Artery and the Government Center and West End Projects.

A group of merchants and property owners in this area have sponsored and published a very competent study and report on their area making specific redevelopment and renewal recommendations. The report is now being analyzed by the planning staff. It could be regarded as a second priority project directly following the Government Center. The self-help approach taken here deserves in response priority attention and action from the City government.

3. *The North End*

The North End is one of the most lively neighborhoods of Boston. It has a flavor and a way of life which should be preserved, not destroyed. A clearance project for the North End would be an outrage. The City would never be the same.

Every effort should be made to rehabilitate and strengthen this unique neighborhood. The general neighborhood renewal plan will help achieve this goal.

Early in this planning process the City should begin working with a broadly based and representative North End neighborhood improvement committee.

4. *The Atlantic Avenue Waterfront Area*

This area used to be Boston's window on the world. From here clipper ships traveled the sea lanes of the world. Today the area is stagnant, unattractive and deteriorating. Most of the port functions have moved elsewhere in the harbor. The old wharves and warehouses have been left to adjust as best they can. And some of the adjustments are fascinating indeed. Who would ever believe that an ancient harborfront warehouse could be converted into apartments so attractive as to enjoy a long waiting list?

This waterfront area can and should again become Boston's window on the world. A seafaring city should be able to look upon the sea and the harbor as it goes about its daily rounds. The great port cities of the world, New York, San Francisco, Naples, Bombay, Colombo, Hong Kong, all enjoy the sights and sounds of their harbors, the sight and smell of the sea.

What is needed is an action program aimed at rebuilding and redeveloping this area.

The first and biggest job is to think through the kinds of development which will make the best use of this land. A second and equally important job is to determine how many of the existing uses can better be located elsewhere.

Once plans and programs are made for the redevelopment of the area it is likely that the urban renewal process will be called into play.

The Greater Boston Chamber of Commerce has long had an interest in a waterfront development program for the Atlantic Avenue area. Boston is fortunate in having a vigorous Chamber with a far deeper and more practical understanding of urban renewal than is usually the case.

The Chamber was among the first to propose redevelopment of the Waterfront Area. The Chamber might very well be willing to undertake and finance an urban renewal study of the area. In seeking such help from the Chamber the City should make clear that it will cooperate in every way including, of course, the work to be done in the preparation of the proposed general neighborhood plan for this area. The City should also freeze the disposition of City owned property in the area until a program can be established.

It would of course be essential for the Chamber to work with the various state agencies which have a present or potential interest in the area.

The interest and excitement generated by the Golden Gateway Redevelopment Project in San Francisco is an indication of the potential a waterfront rebuilding program can offer.

Downtown Boston

The area bounded approximately by the Common, the Public Garden, Arlington street, the railroad tracks, the Central Artery and State and School streets is recommended for a general neighborhood renewal plan.

This area contains the retail core, the financial and entertainment centers.

When people think of Boston or almost any other city, they are thinking of downtown. It is the downtown area particularly the shopping area which gives a city much of its flavor and character.

Boston's downtown can be uniquely attractive. The narrow old streets, the lovely Public Garden and Common, the many historic buildings combine to give downtown Boston a setting which any city anywhere in the world would be proud to have. Add to that a mass rapid transit system which is underground and you have something very special indeed.

Yet most Bostonians would agree that downtown leaves something to be desired. Everybody has ideas about what ought to be done. Everybody agrees that a big rebuilding program ought to be undertaken and soon. But then there are the taxes. Downtown Boston has its problems, and these problems seem to be getting worse instead of better.

What can be done?

The City Planning staff has completed what it calls a "General Plan for the Central Business District." The planners see great opportunities for downtown. To them this is the most exciting, most promising part of Boston.

The planners' General Plan has been approved by the Planning Board and the question, always the question with a Plan, is, what happens next.

Conceptually sound, imaginative, thorough the planners' plan is but it is not self-executing.

If Downtown Boston is to be rebuilt we need to put together an action program.

The first step is the preparation of a general neighborhood renewal plan. Out of this broader area plan will come specific action projects.

The Retail Trade Board has indicated its awareness of the serious problems affecting the retail core and its desire to cooperate with the City in achieving workable practical solutions.

The City should welcome this interest and cooperation and should encourage the Retail Trade Board and its membership to undertake extensive studies of their own.

It is entirely possible that a rehabilitation project for the retail core can be undertaken simultaneously with the preparation of the general neighborhood renewal plan for the downtown area. If the Retail Trade Board is ready to support it, this approach should be taken.

The growth of suburban shopping centers, the number of empty stores downtown, the tremendous importance of the retail core to the tax base all point toward the need for early action.

Large scale area clearance should be avoided. Emphasis should be on making the retail core more attractive and separating vehicular and pedestrian traffic as much as possible.

The Back Bay and Prudential Center

The remainder of Boston Proper, the Back Bay, is also recommended for a general neighborhood renewal plan. This is particularly urgent in view of approval of the Prudential Center legislation by the Supreme Judicial Court and the General Court.

The Prudential Center can be a great boon to the Back Bay area and to the City as a whole. However, without proper planning and zoning controls speculators could destroy the special quality of the existing Back Bay residential area.

This area is bounded by the Public Garden, the Charles River, Massachusetts avenue and the alley between Commonwealth avenue and Newbury street.

It is ideally located for residential use and is one of the handsomest urban districts in the United States. Its wide, tree-lined streets, its large and pleasant houses are worth preserving, perhaps even to the extent of having the area designated as an historic district. Though these houses are not as old as those on Beacon Hill, we will not see their like again.

The Beacon Hill houses have proved adaptable to modern single family use. The larger houses of the Back Bay are virtually obsolete for such use.

A debate is now under way on whether the height restrictions should be taken off and high rise apartments allowed to dominate the area. Serious concern has also been expressed about the rate at which institutions are acquiring property in this area.

The even scale, the harmony of these blocks is one of their chief attractions. Once lost, it can never be regained. While tall apartment buildings might be appropriate for the water side of Beacon street, they will not be helpful in retaining the character of the remainder of the Back Bay residential area.

A general neighborhood renewal plan for this area, the neighborhood of the Christian Science Church and the area between Huntington avenue and the tracks, can do much to insure that the impact of the Prudential Center on the Back Bay is all good.

THE REST OF BOSTON OUTSIDE BOSTON PROPER

Ninety per cent of Bostonians live outside Boston Proper. Slums and blight have found their way into many of these outside areas. Other areas are almost totally free of blight. A balanced, comprehensive urban renewal program cannot safely ignore the decay which menaces too many of Boston's residential neighborhoods. Some need urgent treatment now. Others will benefit by general neighborhood renewal planning. The healthier neighborhoods will benefit by having the most blighted neighborhoods renewed.

Set forth below are more detailed proposals concerning certain of these areas.

CHARLESTOWN

Charlestown is the site of the Battle of Bunker Hill and the home of an estimated 21,000 people. The hills of Charlestown offer some of the best views in the City and the flats have some of the worst slums. The slums are moving up the slopes of the hills. For all its history and all its charm Charlestown has been treated as a stepping stone to downtown Boston from the North. The elevated and the Mystic Bridge do a pretty thorough job of blighting Charlestown all by themselves.

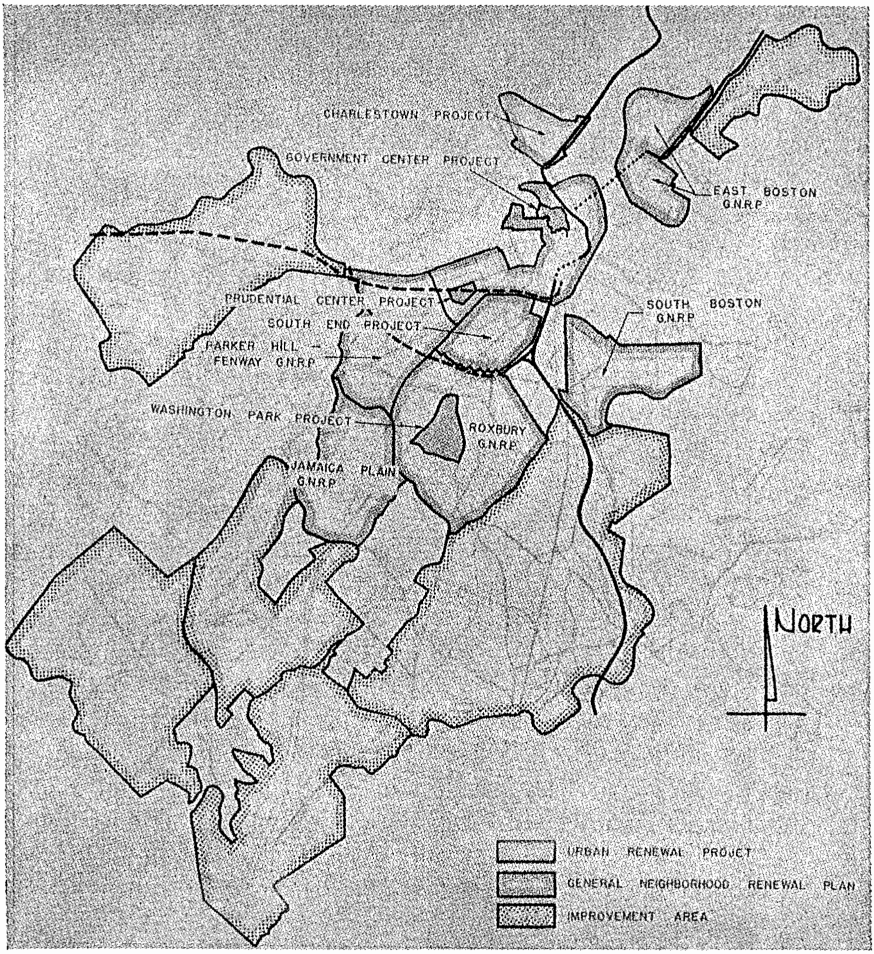
Despite these adverse influences and long standing neglect of the area by the City government, there is a large amount of good housing and more which can be saved if a rehabilitation program is begun promptly enough.

An urban renewal program can provide for rehabilitation of sound housing, clear the slums and spur the City to provide long needed schools and other community facilities.

A meeting has been held with a representative group of Charlestown residents to gain their views and to explain the urban renewal process to them.

Their response was encouraging. Charlestown should be formally designated as an urban renewal area and an application filed for survey and planning funds. Close contact with the neighborhood committee should be maintained throughout the planning period. Much more can and should be made of Charlestown's historic past. It can help Charlestown to renew itself.

The City's share of the cost of carrying out an urban renewal project can be met almost entirely by providing long scheduled community facilities such as the new Harvard-Warren School, scheduled for construction in the fall of 1961. This school is estimated to cost



almost $2,000,000. Since it will serve the Charlestown area it can be used to make available almost $4,000,000 in Federal funds without additional cost to the City. Other scheduled community facilities can make up nearly all the remaining City cost.

South End

The South End is an area of faded elegance where some 42,000 Bostonians live. It is bounded by the B. and A. tracks, the Central Artery and the Inner Belt. The outer South End is sometimes identified as part of Lower Roxbury. However, the Inner Belt will cause it to become part of the South End.

Once a residential area of great charm its day of fashion was brief and it has become seriously blighted. It now contains some of the worst housing in Boston, a good part of Skid Row and some very run-down commercial areas.

Opposed to this decay are some great strengths around which a renewed neighborhood can focus. They include the handsome and still sound blocks such as Union Park, the Squares, the great Cathedral, the area's institutions and many other churches.

Above all, however, is the indomitable spirit of the people who live in the South End and the great faith of their friends and supporters in the rest of the City.

The South End is too promising to ignore, too near the edge of disaster for remedial action to be delayed.

The South End needs a major renewal effort. It will call for substantial clearance to cut away the slums. Much of the clearance area should go into nonresidential uses. It will require resourceful rehabilitation on a very large scale. There are some very good reasons why rehabilitation can work in the South End.

The South End has lots of light and air, far more than Beacon Hill. The streets are wider, the backyards are ample.

The rehabilitation project of the Friends Neighborhood Guild in Philadelphia offers a stirring example of what can be done to restore and re-invigorate such an area. A wholesale application of the design ideas of the Friends project with the application of all the available tools of urban renewal could make the South End a pleasant surprise to one and all.

There are proposed schools, a fire station, a library and other community facilities which can defray most of the City's share of the cost of carrying out the project. It is unfortunate that the opportunity was neglected to use the $2 million Franklin-Rice School to obtain $4 million in federal aid without additional cost. That money could have given the school itself a much more adequate site, and made possible very substantial rehabilitation.

Every renewal project needs not only to be strong in itself but to tie on to something strong. A well conceived urban renewal plan can orient the South End toward the Copley Square-Prudential Center business and shopping area.

It is not much of a walk. Hundreds of commuters who work in that area prove it every day by parking their cars in the South End and walking to work.

Urban renewal of the South End should have a high priority. The South End is a well organized neighborhood and the City and the neighborhood should develop and maintain a close working relationship through the preparation and carrying out of the urban renewal plan.

The proposed Castle Square project area should be incorporated in the South End project and planning for its redevelopment should proceed on that basis. If whenever tenants and financing are assured for developments of the magnitude proposed, the project can be pulled out and moved ahead, if early acquisition legislation can be obtained.

Concentrations of blight are found outside the central area, Charlestown and the South End in several other districts, principally Roxbury-North Dorchester, Parker Hill-Fenway, South Boston, East Boston and Jamaica Plain.

For each of these areas the general neighborhood renewal plan approach is proposed.

For the outer areas less affected by blight a nonfederal improvement area program is proposed.

Roxbury-North Dorchester

The proposed area would be bounded by the Inner Belt, the New Haven tracks, Columbus avenue, Seaver street, Columbia road and Massachusetts avenue.

This area is deteriorating rapidly. A program must be prepared for the whole neighborhood before it is too late.

The area contains many attractive features, particularly the adjacent parks which give hope that the neighborhood can be restored.

Community organizations are active in the area. Their participation and support can help greatly in making the general neighborhood planning program a success.

The Redevelopment Authority has received approval for survey and planning activities for a renewal project in the Washington Park area of Roxbury. This can be an attractive project if it is part of an overall area program. A general neighborhood renewal plan will go a long way toward insuring the success of Boston's first effort at urban renewal.

Parker Hill-Fenway

This is Boston's prime institutional area. It is bounded by Parker Hill, the town of Brookline, the Charles River, Massachusetts avenue and the New Haven tracks.

The area has many natural assets and can be one of the most attractive in Boston. It has, however, its full share of blight. The likely expansion of the many major institutions in the area can have a blighting effect on the tax paying land which is left.

With integrated planning for the whole area a new tax base can be created as a result of the expected institutional growth.

Individually held property can be maintained and improved if there is definite knowledge of what the future of the area will be.

Under a 1959 amendment to the housing act the expenditures of educational institutions for property acquisition can be used toward making up the City's share of the cost of carrying out improvements in the area. Substantial credits will be available to Boston from this area.

If neighborhood groups and the institutions can work together this area can become one of the showplaces of Boston. If they go their separate ways, in the long run no one will benefit.

South Boston

South Boston has some of the best located and maintained residential areas in Boston. It also has some of the most important industrial plants and port facilities in the City. These two very different land uses are not on friendly terms. Rather there is a belt of slum and blight between them which is dangerous to both.

The slums and blight menace the sound residential areas of South Boston and are no asset to the industrial users either.

A general neighborhood renewal plan will identify various project areas and indicate desirable areas for rehabilitation and for clearance for industrial or residential reuse.

South Boston has too many advantages, its people have too much pride and hope for their neighborhood to let it be neglected any longer.

The General Neighborhood Renewal Plan approach should be submitted to the people of South Boston and if they give it their support, work should get under way at once.

East Boston

East Boston would be divided into two parts. The Orient Heights section to the east of the highway and railroad tracks is proposed as an improvement area. A program of general neighborhood renewal planning is proposed for the rest of the area. This program would identify and schedule areas for rehabilitation and areas for clearance for industrial, commercial or residential reuse. The geographical advantages of East Boston's location are so great that there would be little difficulty in developing cleared areas for new uses. With the worst of the blight removed, rehabilitation of the remaining area could proceed with confidence.

Neighborhood participation is essential to the success of such a program, particularly when it comes to the selection of priority project areas.

Jamaica Plain

The Jamaica Plain neighborhood is one of the less blighted older neighborhoods of the City. Yet blight is substantial enough to cause concern. A general neighborhood renewal planning study can help identify the strong and weak points of the area and suggest ways of strengthening the healthy portions and correcting the deficiencies that exist.

The approach again would emphasize rehabilitation and cooperative work with a representative neighborhood organization.

Opportunity Projects

It seems likely that as the program moves along there will be opportunities to carry out small-scale projects which can have major benefit to the City. The program should be flexible enough to permit this.

Financing the Program

The City of Boston can afford to undertake this program now and all at once. The more serious question is can it afford not to.

The proposals made here will cost the City an estimated $30,000,000 in capital funds. There is ample bond margin for this amount. It will require approximately $60,000,000 in new federal funds.

The federal share of the funds can be made available. The City's share of the cost can be financed through long-needed neighborhood improvement such as schools. The cost of these capital improvements can be met without exceeding the amount presently paid each year for already outstanding debt service. The decline in debt service charges over the years ahead gives the City this opportunity to finance a major rebuilding program without the already burdensome tax rate therefor.

Staff Organization for the Development Program

Rebuilding a city is no simple matter. A major development program requires a wide variety of activities all of which must be meshed together if the program is to move ahead. It is one thing to propose such a program. It is another to carry it out. A workable administrative arrangement is essential if this program is to succeed.

The special-provisions for Boston in the Prudential legislation go a long way toward providing Boston with the set-up it requires.

The policy-making function is divided among the Mayor, the City Council and the Redevelopment Authority. The function of the Council is legislative and is traditionally separate and apart. Administrative responsibility is divided between the Mayor and the semi-autonomous Redevelopment Authority. A good program can get lost quicker by divided responsibility than in any other way. The challenge here is to devise a method which will make it possible for the Mayor and the Authority to do their work on this big program as an effective team while preserving to themselves their respective prerogatives under the law.

There are many ways to provide for this unity of approach. Committees are often proposed and seldom work. The Mayor and the Authority could endeavor to work out problems which might arise at the "summit." This is a dubious time-consuming solution for a Mayor who is chief executive officer of the whole city government and for Authority members who each have private careers to follow.

The Mayor and the Authority could each set up a separate staff representative. This solution provides as many opportunities for conflict as for cooperation.

PROPOSED BOSTON DEVELOPMENT PROGRAM
ALLOCATION OF FEDERAL FUNDS

	GNRP Planning Cost	Survey and Planning Cost	Federal Capital Grant
I. NEW PROJECTS			
1. Roxbury GNRP	$188,000	see below	see below
2. Downtown North GNRP	277,000	see below	see below
3. Back Bay GNRP	277,000	—	—
4. Charlestown	—	$365,000	$9,828,000
5. South End	—	526,000	24,267,000
6. Parker Hill—Fenway GNRP	191,000	258,000	2,642,000
7. Downtown GNRP	277,000	1,000,000	10,000,000
8. South Boston GNRP	213,000	199,000	5,554,000
9. East Boston GNRP	200,000	226,000	3,690,000
10. Jamaica Plain GNRP	193,000	289,000	4,180,000
TOTALS	$1,816,000	$2,863,000	$60,161,000
II. PROJECTS PENDING AND APPROVED			
Washington Park	—	$295,000	$2,554,000
Government Center	—	320,000	9,352,000
III. PROJECTS IN EXECUTION			
New York Streets	—	$175,000	$3,200,000
West End	—	181,000	9,232,000

A simple and direct solution is for the Mayor and the Authority to agree on one man as the top administrator to be in charge of the development staff and program, subject to the dual control of the Mayor and the Authority. He should be removable at the pleasure of either the Mayor or the Authority and should explicitly waive any tenure rights he might acquire under state law. Thus whatever power he might have he could be removed from office at any time.

This report proposes the creation of the position of development administrator to fill that function. The development administrator would serve in the dual capacity of head of the Authority staff and head of a proposed office of development responsible to the Mayor.

In the Redevelopment Authority the Development Administrator would have the following functions:

Develop and carry out plans and program of the Authority subject to appropriate review by the Authority;

Direction of Authority staff;

Internal organization of Authority staff and functions;

Relations with federal and state agencies;

Recruitment of staff personnel;

Establishment of staff compensation subject to Authority approval;

Appointment of personnel, counsel and consultants subject to Authority approval;

Coordination with Mayor and City departments.

Under the reorganization the Authority staff would be divided into four divisions:

Planning, Project Development, Land, Operations.

The planning staff would consist of the planners transferred from the City Planning Board by the Prudential Center legislation. Additional renewal planners would be recruited. The operations staff would consist of the Authority staff as it existed at the time the Prudential Center bill was passed. New personnel would be recruited for the project development and land sections.

Functions of the divisions would be as follows:

1. PLANNING DIVISION

   a. General Planning Section

      (1) Comprehensive Planning
      (2) Capital Improvement; Programming
      (3) Community Planning
      (4) Referrals.

   b. Transportation Planning Section

      Preparation of a transportation planning program and coordination with other agencies involved.

   c. Renewal Planning Section

      Preparation of redevelopment, renewal and general neighborhood renewal plans, final project reports and other required documentation.

2. PROJECT DEVELOPMENT DIVISION

   a. Federal processing to the loan and grant stage
   b. Federal relations during project execution

c. Relocation of families
d. Relocation of businesses
e. Rehabilitation in renewal areas.

3. LAND DIVISION

a. Land acquisition including appraisals and negotiations except in West End and Whitney street
b. Land disposition except for West End and Whitney street
c. Negotiation of 121a contracts, including tax agreements.

4. OPERATIONS DIVISION

Complete responsibility independent of all other divisions for the substantial work remaining to be done in the West End and Whitney street projects and for the closing out of the New York Streets project.

In addition, the Operations Division will have the following responsibilities for new projects:

a. Title searches
b. Closings
c. Property management
d. Demolition
e. Project engineering
f. Site improvements
g. Controller—payroll and project accounting.

In addition to the work of the divisions the Development Administrator's office will contain a unit for administrative management, legal staff and special counsel.

The Operations Division would continue to occupy space at 73 Tremont street. The rest of the Authority's work would be carried on from City Hall Annex. Assuming refurbishing and refurnishing sufficient space is available for present needs and likely future expansion.

OFFICE OF DEVELOPMENT

The proposal here is that an Office of Development be created by ordinance. It would be headed by the Development Administrator by appointment of the Mayor.

The Office of Development would have responsibility for coordination with other city department heads and with a citizens advisory committee to be appointed by the Mayor. It would also have responsibility for coordination of code enforcement in improvement areas.

The Office of Development would have the following staff functions:

1. COMMUNITY RELATIONS. To be transferred from the Mayor's office.

2. CIVIC COORDINATOR. The civic community should be able to look to one person in the development office to get information on what is going on, to contribute suggestions and ideas and to maintain contacts. One function of the Civic Coordinator would be to step up plans and programs for the creation of a development fund.

Since this is a new function the Civic Foundation could be asked to finance it for a beginning period.

3. HOUSING EXPEDITER. Promotion of housing programs and policies is a highly specialized, much neglected and very important area. One of the Housing Expediter's functions would be to promote the establishment of a private housing development fund.

Since this, too, is a new function the Civic Foundation could be asked to finance it for a beginning period.

4. PUBLIC INFORMATION. The public is entitled to as much information as possible about the development program in the most useful form possible. An experienced full-time information officer can be very useful in meeting this need. So can a publication budget.

Whether or not this is a new function it would be appropriate for the Civic Foundation to finance it for a beginning period.

The Zoning Commission and the Board of Adjustment are now homeless and could be transferred to the Office of Development for housekeeping purposes.

The carrying out of an ambitious development program requires the help of many professionals with specialized talents and a high order of competence. The demand for such people far exceeds the supply. Boston can obtain such people if it offers sufficient compensation and establishes a workable administrative set-up.

GUIDEPOSTS

The success or failure of an ambitious urban renewal program will be determined in large part by the guideposts or ground rules which govern it. The best plans can come to naught without public confidence in the program and the way it is being carried out.

Here are some of the policies which will help insure public confidence:

1. Public Information

The citizens should be fully informed about the progress of the program in its various stages. The primary means of accomplishing this should be through the newspapers and the television and radio stations. Talks before interested groups can also be useful. The individual citizen should also be able to walk in off the street and get the answers to his questions.

Reporter and citizen alike, however, must understand that at some stages in a project there are many questions which have no answers except speculative ones. Here the best possible answer must be given with proper caution that the final answer is not known.

2. Neighborhood Participation

The residents of a neighborhood for which renewal is proposed should assume an active role in the replanning and renewal of their area. Neighborhood participation can best be secured through a renewal committee composed of representative citizens of the neighborhood.

A basic assumption of this program is that it will be carried out on a partnership basis between City Hall and the people of the neighborhoods through neighborhood renewal organizations.

3. Family Relocation

One major purpose of a renewal program is to relocate families from substandard dwellings into decent, safe and sanitary housing at prices or rentals they can afford to pay at convenient locations. This is not just a pious principle; it is the basic requirement of the law. It is of prime importance that such relocation of families as may be required be done with decency, humanity and a firm determination that the spirit as well as the letter of the relocation law be observed.

4. Business Relocation

Some dislocation of businesses is just as inevitable as that of families, and the hardship is at least as great.

Even though there is no legal requirement to do so, a business relocation office should be established and staffed to assist displaced businessmen in finding satisfactory new quarters.

5. Projects and Patronage

A large scale urban renewal program offers tremendous opportunities for patronage and the dispensing of favors. Job opportunities are opened up; contractual services are required. The purchase and then sale of large amounts of property offers many opportunities for doing favors.

However, neither the public nor the federal government can be expected to provide the support such a program requires unless they are confident that patronage and favoritism are out.

6. A City Beautiful

Renewal and rehabilitation do not guarantee beauty. It is entirely possible to rebuild Boston in an unattractive, unimaginative way which will make people wonder whether the new is in fact better than the old. This can be avoided with sufficient forethought and courage.

It is the function of distinguished architecture and imaginative civic design to see that beauty is the hallmark of the renewed city. Beauty once flourished in Boston. It must again. The Public Garden, the State House are marvellous examples of what can be accomplished.

"PUBLISH OR PERISH": THE SURVIVAL OF CIVIL ENGINEERING AS A LEARNED PROFESSION

BY GORDON M. FAIR,* Member

(Presented at a meeting of the Boston Society of Civil Engineers, held on November 16, 1960.)

"I hold every man a debtor to his profession; from which as men of course do seek to receive the countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereunto."—SIR FRANCIS BACON.

THE slogan "publish or perish" that introduces this address is often voiced in the academic community as a warning to young teachers who have not yet attained a permanency in their university. Implied is the threat that they must either give evidence of possessing the drive and ability to advance their field of learning through creative scholarship, or fail of promotion. It is in this sense of professional responsibility and competence that I have employed my catchwords.

From meetings of our profession, enquiries of committees, and publications of our societies, it seems that the civil engineer's lot is no longer a happy one; that his services are poorly compensated; that he feels insecure in his work, inadequately appreciated by his public, and dissatisfied with his education; that recruitment to his banner is lagging behind that of other branches of engineering and that those enlisting in his ranks are of inferior quality; that in a world of change he has failed to move forward; and that the present generation no longer sees intellectual challenge in bridging great rivers or arms of the sea, harnessing the floods, slaking the thirst of communities and industry, expediting physical communication, or having any part, for that matter, in creating the seven times seventy wonders of the modern world.

Exercised equally and perhaps more immediately—and certainly more vociferously—about the present status of our profession seem to be the teachers, deans, and presidents of our institutions of higher learning, and it is, indeed, impossible to separate a discussion of the profession from that of education for the profession. My address,

* Gordon McKay Professor of Sanitary Engineering and Abbott and James Lawrence Professor of Engineering, Harvard University.

therefore, falls naturally into two parts: (1) the status of civil engineering as a learned profession, and (2) the status of education for civil engineering. To these must be added, as a matter of compassion, some assurance of the probability of survival.

The Status of Civil Engineering as a Profession

Origins of our Profession. To measure the present condition of our profession, let us quickly turn back the pages of history to the origins of civil engineering and thence forward to the more recent past. Accordingly, I shall call on S. E. Finer, Professor of Political Institutions at the University College of North Staffordshire to have the first say (1). "The engineers," to quote from his study of Sir Edwin Chadwick, social reformer and leading spirit in the Sanitary Awakening of Great Britain in the mid-nineteenth century, "particularly the railway engineers, were the folk-heroes of mid-Victorian England. The railway—the most revolutionizing technical invention of the whole century—struck the imagination of the nation like nothing else. Composers wrote ballads like *The Railway Bell(e) and the Railway Guard, Excursion Train Gallops,* and *Railway Overtures. Tracts for the Times* were parodied in *Tracts for the Trains.* Newspapers broke into a rash of 'Murders on the line,' or 'Melancholy accidents.' . . . In that lusty infancy of civil engineering there were no specialisms: every man was expected to ply all branches of the mystery. The railway constructors drove tunnels, made cuttings, built locks, and drained marshes. They built undreamed-of bridges of steel, like the Britannia and the Saltash, and reared splendid and graceful viaducts, like those at Dutton and Llangolen, Monsal and Wharnecliffe.

"These engineers were a peculiar social phenomenon. Most of them were of the humblest origin . . . . Robert Rawlinson's father was a builder, Rendel and Hawkshaw were farmers' sons, Stephenson was the son of a collier. They rose to fame and influence by their native ability and their gusty energies. By consequence they were intensely individualistic even for an individualistic age. It was they who invented the term 'private enterprise.' They obstructed the Railway department of the Board of Trade, the Harbour Commissions of the Admiralty, and the Board of Health, protesting against the 'mischievous flourishing of the functionary weed,' and the 'difficulties thrown in the way of the rising generation of engineers by the governing classes of the country.' They would not, in their own words, be 'interfered with, restricted, and controlled.' . . . In their ruthless eruptive animal energy, the engineers showed a swashbuckling disdain for the social evils around them. 'Railways were meat and drink.' Nearly all of them were Tories and Protectionists in an era when Torying was just beginning to become synonymous with a tenderness to vested interests and with Herbert Spencer's version of *laisser-faire*. Indeed, Spencer's *Man versus the State*, written when he had just ceased to practise as an engineer, may be taken as the social philosophy of the whole profession—civil engineering and social buccaneering.

"The engineers were an 'order,' a freemasonry, whose centre and sounding-board was the Institute of Civil Engineers. By mid-century this had transcended its original purpose. It was no more a simple self-improvement society, but a social club, a clearing-house for information, a bureau for employment. It aspired even to be a Senate. But one cannot read its 'Minutes' without being struck by its self-complacency and its professional bigotry. The whole Institute had a chip on its shoulder. Its emblem should have been the thistle, and its motto *Noli me tangere*."

That is not a very encouraging beginning, but we may excuse it by assuming that Finer, within the context of this biography, may have given us a somewhat partisan account of our origins. Nevertheless, there are at least two observations that we should take to heart from the passages that I have cited and from Finer's later discussion of the battle between the civil engineers and the men agreeing with what was called the "dilettante engineering" of Sir Edwin's aids in the substitution of small-bore clay pipe sanitary sewers for brick combined sewers of large dimension.

The first observation supports a criticism often voiced against civil engineers in our day, as it was a hundred years ago, namely, that civil engineers have shown little leadership in and understanding of public affairs and, like their forbears, suicidally, have obstructed progress in the very field of which they are the masters. The social philosophy of encouraging public services as well as private goods and services has, indeed, come to the fore once again in our times. Economists and political scientists point in mounting measure to the imbalance between the two types of services, although not often in words as provocative as those of Kenneth Galbraith (2) in his "Affluent

Society." There, his evaluation of our present society is epitomized in his description of "The family which takes its mauve and cerise, air-conditioned, power-steered, and power-braked automobile for a tour through cities that are badly paved, made hideous by litter, blighted buildings, billboards, and posts for wires that should long since have been put underground. They pass into a countryside that has been rendered largely invisible by commercial art. They picnic on exquisitely packaged food from a portable icebox by a polluted stream and go on to spend the night at a park which is a menace to public health and morals. Just before dozing off on an air mattress, beneath a nylon tent, amid a stench of decaying refuse, they may reflect vaguely on the curious unevenness of their blessings. Is this indeed American genius?" Galbraith's conclusions, therefore, are that:

"The line which divides our area of wealth from our area of poverty is roughly that which divides privately produced and marketed goods and services from publicly rendered services" and "The disparity between our private and public goods and services is no matter for subjective judgments."

The second observation supports another criticism of civil engineers in the present, as it did when Sir Edwin Chadwick conducted his great crusade for clean water and good drainage, namely, a tendency to overvalue experience and to undervalue experimentation, as well as research and education. Here may I quote a paragraph or more from the presidential address of A. J. S. Pippard to the Institution of Civil Engineers (3). Shown, in addition, will be that the questions we are discussing are not unique to America.

"The most important function of practical training is the amplification of theory by experience and it is one of the most urgent and responsible professional duties of the established engineer to deal faithfully with the young men who will ultimately succeed him and who must rely on him for the widening of outlook which will make possible the full use of the scientific education they have received.

"The civil engineer can no longer afford to hold, or even pretend to hold, theoretical knowledge in contempt. Let us accept the position that the future of the profession depends upon sound practice based on a solid foundation of science and show this faith in the education and training of our young men; then we need have no misgivings about the security of their position in the world of tomorrow.

"Engineering being the application of natural laws in the service of man, it should be clear without laboured argument that the study of those laws, and appreciation of the consequences flowing from them, are matters of supreme importance and interest to the practitioner. One can go further and assert that in the absence of such study and appreciation, the profession of engineering must languish and ultimately die. True, even in such a disastrous event, there would remain the need for routine construction and maintenance, but the living spirit would vanish and the engineer would rightly cease to rank as a creator and would sink to the level of a hack.

"The real life-blood of the profession must therefore be research, but in saying this I do not want to be misunderstood. Research is not only, or even mainly, the prerogative of a few selected workers in universities and in official and private research establishments; the spirit and practice of research should inspire every member of the profession. The opportunities are greater today than ever before for the practitioner to add something to the general store of knowledge, and we shall be judged by our successors not only by the engineering works produced in our generation but by our contributions to that body of knowledge which will provide them with the means to exceed our achievements. I would emphasize this point for it must never be forgotten that research in engineering must be directed to the main function of the art, which is construction, and only to the extent to which it ultimately advances the practical ends of the engineer can it properly be considered to add to the science.

"This, however, is a broad generalization, and much that may appear to be excluded as legitimate engineering research by contemporary thought will surely in a few years, or maybe generations, prove of practical value in the hands of those who will follow us."

I cannot forgo introducing a puckish note at this point by quoting, as did Pippard, the contrasting opinion of the great 19th century engineer Smeaton: "In my intercourse with mankind," he said, "I have always found those who would thrust theory into practical matters to be, at bottom, men of no judgment and pure quacks."

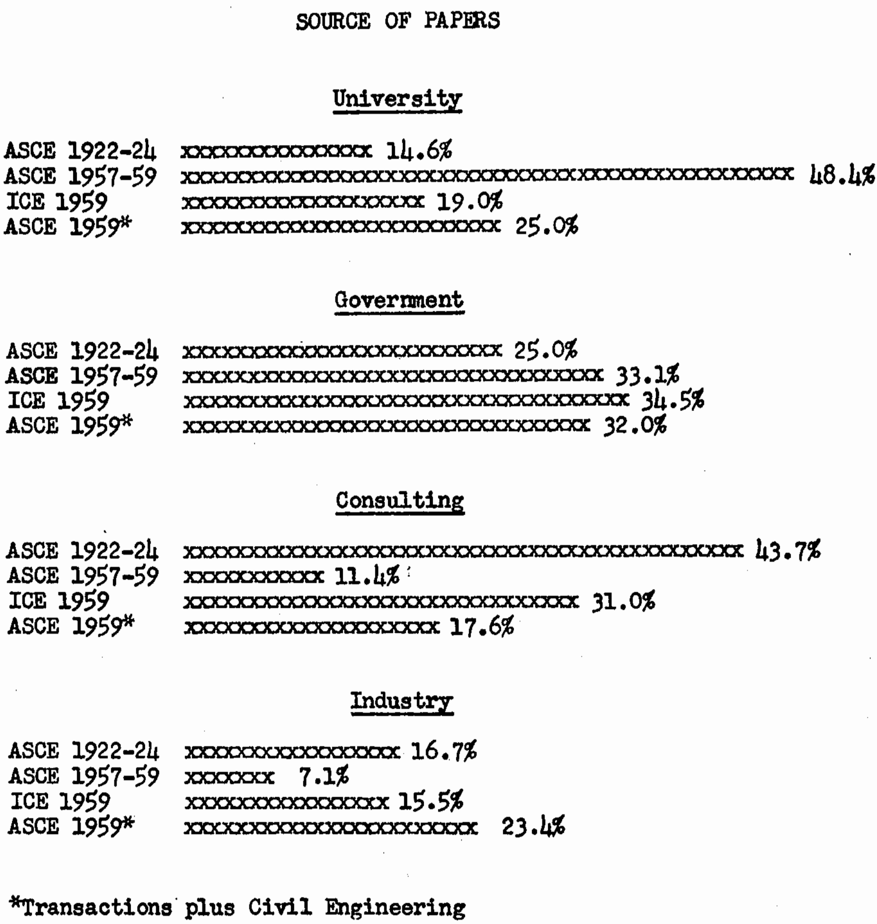
A brief and final quotation from Sutton Pippard's address will lead me to an analysis of our professional publications.

"It has been said that every man has at least one book in him. Whether this is true I do not know but every civil engineer should have at least one or two ideas which would be of value to his fellows, and I suggest that as a matter of professional duty such ideas, whenever possible, ought to be placed on record for the common good."

It has seemed to me for some time that our professional publications are not quite as representative of the profession as once they were. I have noted among other things (1) a progressive reduction in important communications by engineering consultants and industrial agencies; (2) a progressive increase in mathematical papers by teachers and university research groups; (3) a progressive decrease in the discussions of all types of papers; (4) a progressive abridgement of accounts of important new works; and (5) a progressive falling-off of analytical papers by all but university groups.

Some of these statements are supported by my analysis of the principal publications of the American civil engineering profession recorded in Figs. 1 and 2. There I have shown the four major sources and subjects of the papers published in the Transactions of the American Society of Civil Engineers for the triennia 1957-59 and 1922-24. To these I have added a source and subject analysis of the communications that appeared during 1959 in the Proceedings of the Institution of Civil Engineers of Great Britain and in the Transactions of the American Society of Civil Engineers *cum* Civil Engineering. My statistical sample, I grant you, is small, and evaluation of the publications by others might not reproduce my results exactly. Hence I leave the interpretation of these summaries to the reader along with an examination of the changes that are not analyzed in these figures. Of special interest to me has been the confirmation of the drop off in analytical papers in the U.S. shown by the combined percentage values for Transactions and Civil Engineering in Fig. 2.

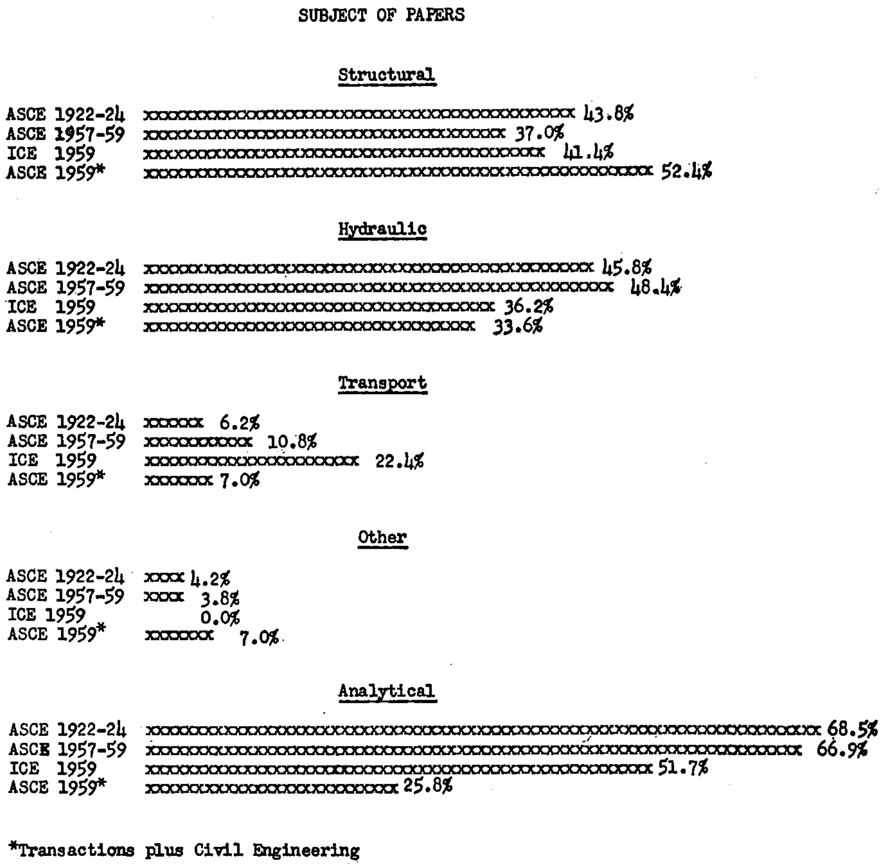
Towards Professional Responsibility. Among the learned professions, medicine is about as closely an applied science as is engineering and, most particularly, civil engineering. Although medicine has, notably during the year just past, experienced a decline in highly qualified applicants for medical education, I do not believe that the decline has been so sharp as that in civil engineering. In my opinion, therefore, we can still learn much from the organization of medicine for professional responsibility. This is shown in Table 1, taken from a study by D. H. Pletta (4). The organization of Law is added for good measure. In his discussion of this table, Pletta has stressed the time lag between the organizational activities of engineers and members of other professions. However, this aspect of professional coordination is not so deeply worrisome to me as is the failure of civil engineering to identify itself anywhere nearly as much with professional education as has medicine. I question even whether there ever has been in



Source Analysis of Transactions, A.S.C.E.; Proceedings, I.C.E.; and Transactions plus Civil Engineering, A.S.C.E. (Percentages)

FIGURE 1.

America a professional school for engineers in the same sense as a professional school for physicians. Accordingly, I have outlined in Fig. 3 the very considerable involvement of medical practice with medical schools. On the left of my composition is the contribution to



Subject Analysis of Transactions, A.S.C.E.; Proceedings, I.C.E.; and Transactions plus Civil Engineering, A.S.C.E. (Percentages)

FIGURE 2.

professional education by medical science and its self-perpetuation and growth through study and research; on the right is the bifurcate contribution of medical practice (1) by the attachment of medical practitioners to medical school staffs and (2) by the students "walking" the hospitals; at the bottom is the opportunity for medical graduates to choose, if they wish, a career in public administration through schools of public health. Not shown, because it is numerically unimportant, is the opportunity for hospital administration and other activities close to private management.

TABLE I.

A Study in Comparative Professional Organization

	Medicine	Law	Engineering
First Licensing Law	1760	1890	1907
First College Course	1765 (U.Pa.)	1799 (W.+M.)	1819 (Norwich)
2-4 Plan Adopted+	1918	1921	19??
Prof. Society Accreditation	1907	1921	1936
National Board of Examiners	1892	1931	1920
Founding of Professional Society	1847 (AMA)	1878 (ABA)	1934 (NSPE)
Licensed Individuals	239500	262300	260000
Practicing Individuals	207240	254700	500000*
Membership in Professional Society++	180700	97000	53000

+2 Yr. Pre-Professional followed by a 4 Yr. Professional Program.
++Membership restricted to legally qualified individuals.
* Estimated number eligible for licensing.
Statistical data presented above represent the best available information and cover the period 1959-60.

If engineering education were to be supported in similar measure by the engineering profession, the organization of its professional schools would have to take the form shown in Fig. 4. At first glance, the reader may conclude that we possess some such organization; but this is not so. As yet, the lines have not been drawn so sharply, the functions not defined so clearly. We have been content with "practising professors" instead of engaging "professorial practitioners." To be sure, we have introduced students to practice through cooperative education; but have we ever made the office, works, or department in which the cooperative student is placed, an arm of his education in the sense that the teaching hospital is an arm of the medical school? We have produced the cooperative student; but have we developed the cooperative practitioner? Did we ever see that it is essential to the full

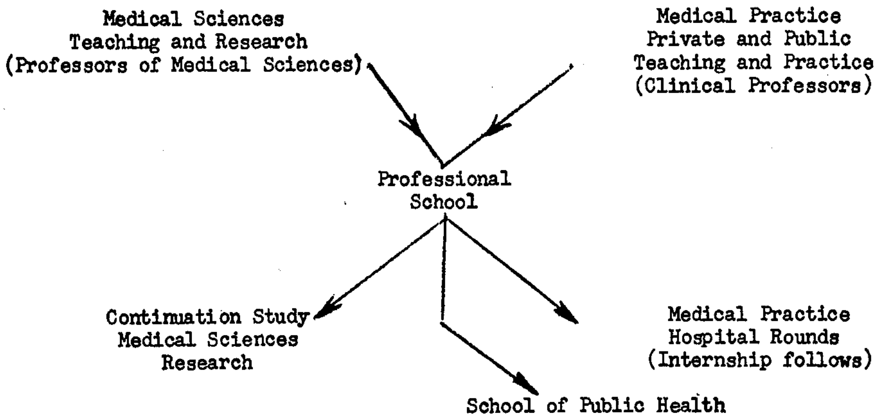


FIGURE 3.—INVOLVEMENT OF MEDICAL PRACTICE IN MEDICAL TEACHING.

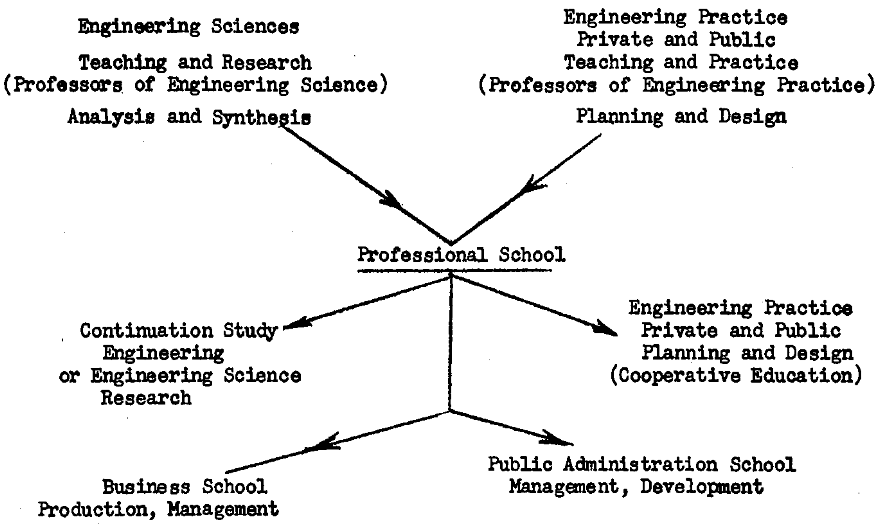


FIGURE 4.—REQUIRED INVOLVEMENT OF ENGINEERING PRACTICE IN ENGINEERING TEACHING FOR MEDICAL EQUIVALENCE.

success of this venture to enlist the supervisor of the student as a member of the faculty of our professional schools in the varying ranks of the academy in the way this has been done in medical schools?

Obviously, the creation of an engineering school in the image of a medical school is not all beer and skittles. The Harvard Medical

School, for example, has a student body of about 500,* a teaching staff in the medical sciences close to 200,† and in clinical work of nearly 1,150‡ within 16 hospitals. The involvement of medical practice with the medical school is indeed fantastic, and has mounted ever higher from year to year in spite of a stationary student population. Thus the total number of teachers of faculty rank is now over 450, with a supporting group of about 900. I, for one, would like to see at least one equivalent U.S. school of civil engineering. In my opinion, it would be swamped with superior applicants.

Looking abroad, it seems to me that both United Kingdom and Continental European civil engineers, in spite of shortcomings and worries of their own, have been more responsive to the educational needs of their profession than have American engineers. In Britain, the Institution of Civil Engineers is an examining body, and the Chartered Civil Engineer a teacher as well as a practitioner. On the Continent, some of the best engineers in government and industry (there is almost no private practice) are anxious and proud to be teachers in the important professional schools of their country, and there exists in Germany, at least, a two-year rotating internship for graduates who wish to enter the civil service at the municipal, state, or federal level.

THE STATUS OF EDUCATION FOR CIVIL ENGINEERING

Origins of our Education. Speaking to the National Convention of Tau Beta Pi in 1950, I introduced the following note about the origins of education in the U.S.A. (5).

"In the early years of this country, Thomas Jefferson advocated two educational measures for the ultimate benefit and safety of the republic: first, mass education at the elementary level and, second, selective education of the most brilliant minds for leadership in the professions and in the affairs of state. Both of these educational efforts were to be supported from public funds. In accordance with the French system of higher education, which was greatly admired by the small group of American intellectuals to which men such as Franklin and Jefferson belonged, admission to higher education was to be open, irrespective of wealth and social standing, to all those who could qualify

* Not including almost 600 postgraduates in short-term specialties.
† Of whom 130 are full-time appointees, research and teaching fellows not being counted at all.
‡ Of whom more than 400 are full-time appointees, research and teaching fellows again not being counted at all.

for it in competitive examinations or *concours*, as they are called in France.

"In the middle years of this country, by contrast, there was introduced, in the era that had felt the levelling influence of Andrew Jackson, a new concept: that of raising the average standards of education for all young people. A democratic people that thad just conquered a vast continent responded quickly to the Jacksonian ideal. In the days of Emerson and transcendentalism, all things seemed possible, and the country was joyfully ready to hitch its wagon to the star of Jacksonian equality.

"In the fast-expanding American community, which often received as many as a million adventurous immigrants in a year, the problem of free public education was tackled with superb energy and zest. In a period covering the biblical life span of man, the enrollment in secondary schools multiplied about thirty times as fast as the population, and the enrollment in colleges about ten times as fast. Among the men who were responsible for this great undertaking were the prophets of universal education Horace Mann and Henry Barnard, who had taken their cue from the great Swiss emancipator of school children, Johann Heinrich Pestalozzi. Among the measures that advanced higher education was the Morrill Land Grant Act of 1862 which created the great state universities of this country. This act has been rightfully referred to by President James B. Conant of Harvard University as the one great contribution to political thinking in America after 1776.

"Viewed on the basis of numbers, a truly magnificent job was done. Yet, today, doubts are being raised on many sides about the adequacy of the Jacksonian principle. We are told by the more critical that we have turned out a first-rate group of second-rate capacity. Even the less critical are in general agreement that the Jacksonian principle has failed to give us the leadership that we need if we are to remain a great people. A high average standard of education is not enough. It must be supplemented and supported at the highest level by greater opportunity for the most gifted minds and an adequate response to this opportunity by the possessors of these minds. Only then will the democracy develop and enjoy to the full its greatest asset: the total capacity of its people. We have come to understand, in the words of the Harvard Report on General Education in a Free Society, that democracy is based upon 'the interworking of two complementary forces, the Jeffersonian and the Jacksonian, the one valuing opportunity as the nurse of excellence, the other as the guard of equity.' In line with the criticism of the Jacksonian principle, furthermore, the Harvard report goes on to say that 'much of our future will be written in answer to the question whether Jeffersonianism and Jacksonianism are in fact complementary or whether they struggle against each other.' "

As yet, the doubt raised in the Harvard report has not been resolved. Nevertheless, there is today a great and growing awareness of the compelling necessity of "greater opportunity for the most gifted minds" at all levels of education. That consciousness of our need for more and better education should be greater among the practicing members of the profession than among the teaching members is, however, sad. For we read in the Report of the Task Committee on Professional Education of the A.S.C.E. that only 22 per cent of the heads of civil engineering departments in our engineering schools thought that undergraduate study in their departments should be extended to five years, whereas 66 per cent of the members of A.S.C.E. opted for this increase (6). Unfortunately, this complacency in high places appears to be continuing to this very day. To quote the words of the Task Committee: "With notably few exceptions the general program for engineering education has been limited to four years. During the period of tremendous expansion in the field of higher education, and in the face of the growth in the art and science of all professions, it is significant that the schools of engineering have generally retained the four-year curriculum, while the medical, architectural and legal professions have extended their educational programs."

Shown in Table 2 are the present time requirements in our country

TABLE II.

Present Requirements for Professional Education, U.S.A.

	Minimum years or equivalent						
	Medicine	Law	Business		Engineering		Planning
Preprofessional college education	3-4	4	4		1		3-4
Professional education	4	3	2		3		2
Post-professional training	1	-	-		-		-
Degree	M.D.	L.L.B.	M.B.A.		S.B.		Master
Post-graduate study	-	2+	2+	1	2	3	2
Degree	-	S.J.D.	D.B.A.	S.M.	E.M.	Ph.D. or D.Eng.	Ph.D.

for professional education in medicine, law, business, engineering, and planning (city and regional planning being implied). A further study in which the focus is on the two fields of applied science (medicine and engineering) by themselves is presented in Table 3. Once again, the

TABLE III.

A Study in Comparative Professional Education in Medicine and Engineering

	Minimum years			Engineering
	Medicine	Medical Sciences	Engineering	Sciences
Preprofessional college education	3-4	4	2-4	4
Degree	- AB	AB	SB	SB
Professional education	4	1	3-2	1
Professional Degree	M.D.	M.A.	M.Eng.	S.M.
		3	5-4	3
		Ph.D.	D.Eng.	Ph.D.
Years to Doctorate	7-8	8	7-8	7

reader should note the differentiation between education in the medical and engineering sciences from education in medicine and engineering. As time moves on, we may expect that some educational institutions will confine their instruction and research to the engineering or medical sciences respectively, whereas others will continue to provide integrated programs of scientific and professional education.

Towards Educational Responsibility. That we may not view engineering in an educational vacuum, the place of the technologies in a university is shown in Figs. 5 and 6, Fig. 5 being the equatorial belt of the sphere in Fig. 6. It goes without saying that engineering is one of the suggested technologies. Harold Cassidy, Yale chemist, who has elaborated this symbolic structure of the university describes his globe as follows: (7)

"In all disciplines of the university which have intellectual content there are practiced three kinds of activities: analysis, synthesis, and reduction to practice. *Analysis* is the activity of gathering data, describing things as they are, collecting and recording instances, making lists, and so on. Now an intelligent person cannot go very far in this kind of activity before he begins to see patterns in his data, likenesses in his descriptions, similarities among the separate instances. As this occurs, the essentially analytical activity goes over into a synthetic one. *Synthesis* is the activity of finding connections between the data made available by the analytical activity, making hypotheses and theories, and developing laws. In short, synthetic activity is a generalizing activity. It involves abstraction, for the general statement is at a higher level of abstraction than the many single instances in which it is based. But the hypothesis, theory or law must be reduced to practice. *Reduction to practice* is the activity through which a return is made from the general principle to the single instance. It may be carried out to see if a predicted fit is obtained. It is then the experiment designed to test a theory. It may be the examination of a document to see whether it meets some critical test. It is also the creative activity by which the work of art or science is produced.

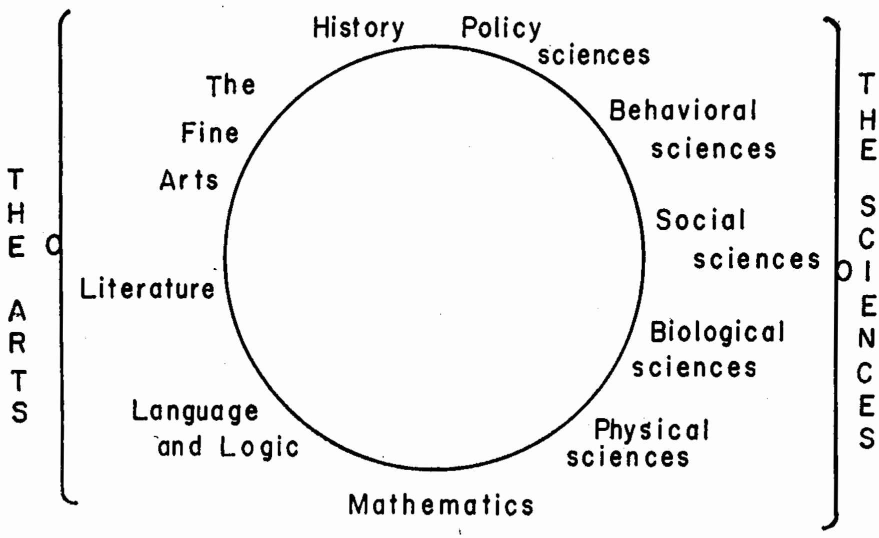


FIGURE 5.—DEFINITION OF THE ARTS (THE HUMANITIES) AND THE SCIENCES. *After H. G. Cassidy.*

"The technologies we define as disciplines wherein reduction to practice is emphasized. But we must insist that, like any other university discipline with intellectual content, the technologies comprise analysis and synthesis, and as a part of the university they comprise the heuristic activity . . . (of) the analysis and generalization at higher levels, of the technology. If pure reduction to practice were involved, we would not have a technology, but a craft. In this definition we do not derogate the craft, but distinguish it clearly from the technology.

"Every discipline in the Arts and Sciences has its conjugate technology. In the sciences these are often called engineering; in the arts they have special names. And it is a characteristic of the technology that it often calls upon many disciplines, which it then fruitfully com-

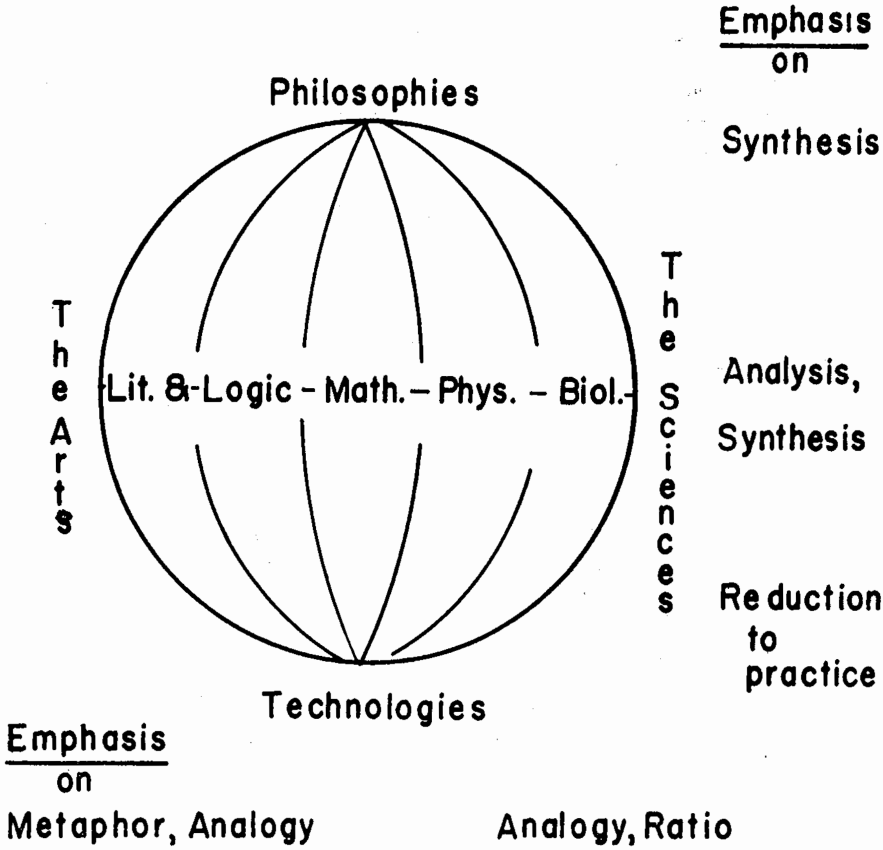


FIGURE 6.—CONCEPTUAL ANALYSIS OF THE STRUCTURE OF THE UNIVERSITY. THE EQUATORIAL BAND OF DISCIPLINES, SHOWN IN PART, IS TAKEN FROM FIGURE 5 AND EXTENDS AROUND THE SPHERE. *After H. G. Cassidy.*

bines. Thus medicine is the technology of a whole constellation of disciplines, ranging from physics and chemistry to literature and drama. Most kinds of engineering include mathematics, physics, and a number of other sciences. Law is the technology of jurisprudence, and calls upon anthropology, psychology, and much more. The technological disciplines of literature and the fine arts—the 'commercial' disciplines—as also drama, call upon many kinds of knowledge and experience."

In their response to the so-called crisis in civil engineering, some of our teachers have concluded that only analysis and synthesis deserve to be included in the engineering curriculum, that there should be no "reduction to practice" and, therefore, I presume, no development of "technologies." Eliminated from engineering curricula, among other material, would be all instruction in engineering design. To be sure, the profession could use a philosopher or two, and engineering scientists should examine this area of uncertainty, but I am convinced that all engineers need the intellectual stimulus and discipline of design. However, instruction in design need not be the routine and unimaginative grind that some of us remember. Since engineering, in my judgment, finds fulfillment in design, I hold that engineering students should not be denied the satisfaction of their creative instincts, sharpening of their imagination, and contact with the imponderables that intrude in all engineering situations. Also, design should be guided by great and active designers. It is these men who should be the professors of engineering practice.

A discussion of program structure and course content I leave to the committees of E.C.P.D.* and A.S.E.E.† It does not lie within the frame of reference of our discussion. Obviously, however, there should be rich sequences of mathematics, physics, chemistry and other sciences—both pure and applied—and equally demanding sequences in structural mechanics and structures; soil mechanics and foundations; fluid mechanics and hydrology and hydraulics. At the professional level, these should be capped by instruction in structural engineering, foundation engineering, and hydraulics (including sanitary) engineering, as well as planning, systems analysis, and other integrating offerings that will provide the public services and goods for both underdeveloped and highly-developed countries. Familiarity with statistical processes, computer techniques, and econometrics as well as comparative government is as essential to the modern engineer as are the languages of mathematics and graphics that he made his own many years ago.

There are other good reasons why I shall not detail course pro-

* Engineers' Council for Professional Development.
† American Society for Engineering Education.

grams. One is contained in Professor George F. Swain's suggestion that when a physician makes a mistake, he buries it; when a lawyer does, he appeals the case; and when an engineer does, he excuses himself by saying that this material was not covered in the course he took in school. A second reason is expressed, more charitably, by Dean Gildersleeve of Barnard College when she says: "That Great American superstition that the only way you can learn anything is having a course in it, has, of course, been a dreadful blight and handicap in our American education." Her statement, incidentally, is reinforced by the judgment of President Lowell of Harvard that "all true education is self-education."

Neither shall I speak of the cultural and socio-economic courses "that every engineer should have." Professor Lewis Jerome Johnson reacted to course prescription that *nolens volens* was to convert its taker into an educated man by saying that "Culture absorbed for culture's sake is self-defeating." Yet I do want to add the opinion of Sir Walter Scott (substituting for the word lawyer used by him the word engineer): "An engineer without history or literature is a mechanic, a mere working mason; if he possesses some knowledge of these, he may venture to call himself an architect." Within my own experience, indeed, I have never met a truly outstanding engineer who had not made of himself a cultured human being, no matter what his origins and his education.

Towards Research Responsibility. From what has been said so far, it should be clear that the responsibility of our profession for advancing the frontiers of knowledge is shared jointly by the world of learning and the world of practice. The underlying reasons are especially cogent in an era when what was once a trickle of scientific discovery has swelled into a mighty flood and the pressures for industrial and community growth are forcing a shortening of the time lead between discovery and use. So great has become the impact of an advancing science upon engineering in our time that the interpretation of new developments in science to the using community of government or industry has become a key responsibility of the engineer. This is the meaning of "reduction to practice" and the creation of "new technologies." This is the strongest bulwark of engineering against becoming merely "a craft."

The accelerating pace of technology is depicted in Fig. 7 by Ladis

Kovach after Karl McEachron (8). As suggested there, the basic laws of motor and generator behavior were enunciated by Michael Faraday in 1830, but half a century went by before Thomas A. Edison, in order to build a power station for supplying energy to his newly invented electric light, reduced Faraday's analysis and synthesis to practice.

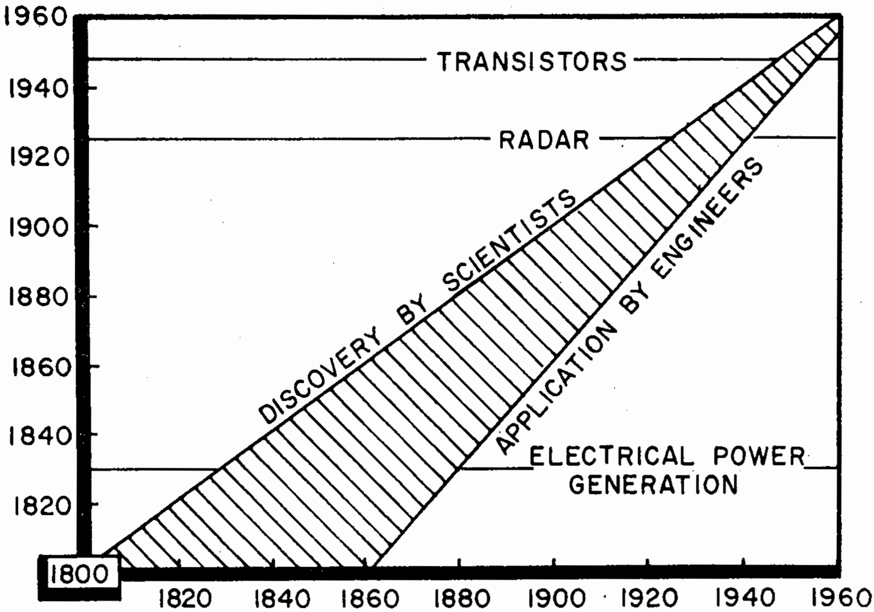


FIGURE 7.—THE CLOSING GAP BETWEEN SCIENTIFIC DISCOVERY AND ENGINEERING APPLICATION. *After K. B. McEachron.*

Radar was discovered in the 1920's. Fifteen years later it was put to use under the pressures of threatening war. Transistors were developed by the Bell Laboratories in 1947. Lead time was here reduced to just a few years. Artificial diamonds, finally, became a commercial product within two years after they had been synthesized by the General Electric Company.

It would hardly be possible to exaggerate the importance of this aspect of engineering research. Nevertheless, a more liberal consideration of the engineer's responsibility must lead to the conclusion that the engineer could build his interpretive function into a Maginot Line of the mind. This he should avoid at all costs. By accepting responsibility for analysis and synthesis as well as for the development of technologies, he will leave his imagination free to reach the frontiers of science as well as those of technology. We should realize in this connection that technology has become part of the armamentarium of the pure scientist and that there is no reason why pure science should not be introduced more effectively and in greater measure, also, into the weapons system of the engineer.

Let me point out in passing Kovach's conclusion that, in contrast to physical science, the lead time of mathematical theories, as shown in Fig. 8, still remains to be foreshortened. Included in Fig. 8 by

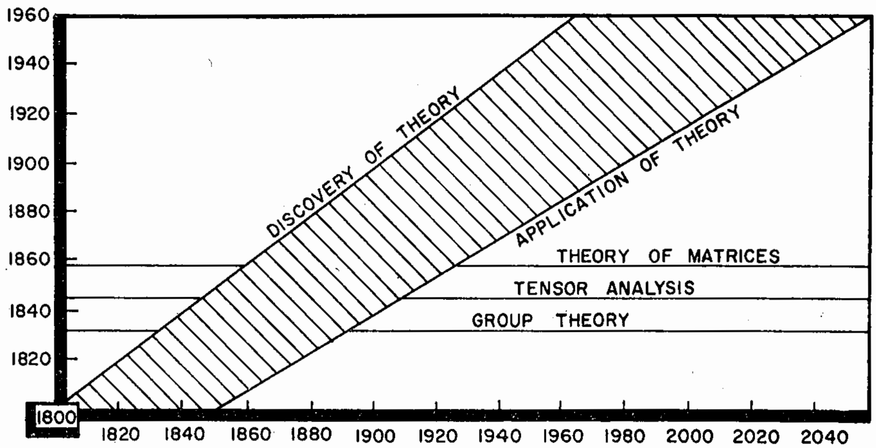


FIGURE 8.—THE WIDENING GAP BETWEEN MATHEMATICAL THEORY AND ITS APPLICATION. *After L. D. Kovach.*

Kovach is the time spread between the development of group theory by Evaniste Galois in 1832 and its application to crystallography simultaneously and independently by Fedorov, Schoenflies, and Barlow in 1890; Grossman's tensor analysis of 1844 which had to wait until 1905 when it was introduced into the Einstein theory of special relativity; and Cayley's theory of matrices of 1858 which finally found use in Heisenberg's quantum mechanics in 1925. This, too, is an area for more intensive exploration by engineers.

Addressing himself to civil engineering research and funds for it, Lee DuBridge, President of California Institute of Technology, has given sound advice as follows: (9)

"It can be stated with some certainty that funds for research will not come in ample amounts unless people are available to do the research and unless they are qualified and anxious to do it and have ideas about what they want to do.

"This suggests that possibly the next research funds you can lay your hands on should go toward the establishment of a couple of hundred predoctoral and postdoctoral fellowships in the leading civil engineering departments in the universities and engineering schools of the country. That would cost between a quarter and a half million dollars a year after the program was well under way. It would be a tremendously profitable investment. That is precisely the way physics research got its start in this country in the days after World War I, with the establishment of the National Research Council fellowships, financed by the Rockefeller Foundation. Civil engineering research is far more advanced now than physics was in 1920, of course. But there are more competitors for the services of young people, too. And bright young potential research people are not choosing civil engineering in large enough numbers. Here is a good place to start putting on the heat."

The Outlook for Survival

Since, in the engineering world, analysis and synthesis must be followed by reduction to practice, I should, at this point, foretell under what circumstances civil engineering may be expected to survive as a learned discipline. The essential parts of my answer have, however, already been stated in the preceding arguments of this paper. By way of summary, therefore, I have prepared Fig. 9 which, I shall suggest, is a model of the organic unity of civil engineering education and practice. Structurally, this model is symbolized by the human hand. The five fingers point to the five common functions of civil engineers: (1) *teaching and research,* like the thumb apposable to the four fingers —because learning and discovery must touch upon every decision of the profession; (2) consulting practice in *engineering science,* the youngest and as yet not fully acknowledged new dimension of the profession, pointing (as the index finger) to an ever-deepening concern of mathematically and scientifically talented members of our profession with the solution of present and future analytical problems in civil engineering; (3) *independent consulting practice,* the oldest and (like the middle finger) most central responsibility of the profession to be exercised with wisdom founded on experience, judicial restraint nurtured by independence, and broad knowledge stored up through many years of continuing study and response to our calling; (4) *public engineering practice* encircling (as suggested by the ring finger) the public services that measure the social capital of a given country and that demand efficient management and imaginative development; and (5) *supporting private enterprise* in its many forms (and by no means small, although symbolized by the little finger) through which the plans and conceptions of the profession are translated into physical realities.

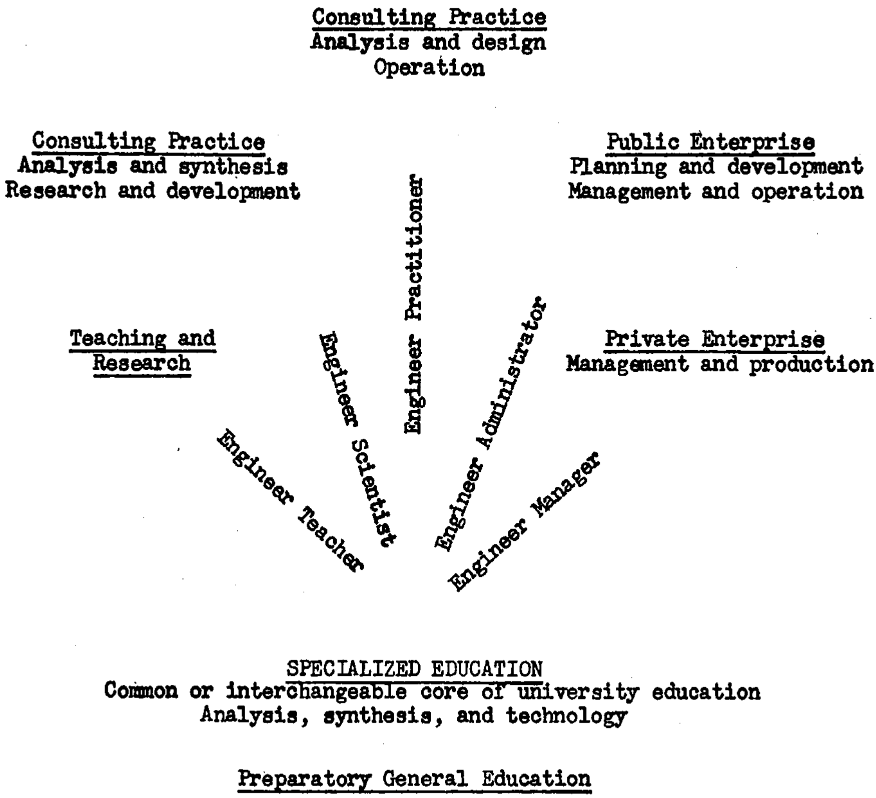


FIGURE 9.—THE ORGANIC UNITY OF CIVIL ENGINEERING AND PRACTICE.

The substance within the palm of the hand is the needed specialized learning, superposed on the common or interchangeable core of university education. Both practical and theoretical considerations lead to the conclusion that this specialized learning and research, too, must issue from the profession as much as from the universities; that the practicing professor must eventually be displaced by the professorial practitioner; and that the cooperative student or, for that matter, the beginner in practice must receive the benefit of supervised, progressive education under a master committed to the advancement of his profession and attached to a professional school as a matter of duty and satisfaction.

Supporting the hand from below in flexible wrist is the preparatory general education within the secondary schools. If it remains inadequate, higher education will continue to carry an unwanted and unnecessary burden of elementary instruction. Of this the universities of older lands have long been relieved.

There are within the life of every profession moments of decision in which the future must be weighed against the past and a new purpose wrought for its practitioners. This is the reason for our present crisis. The fact that it is considered a crisis, I am convinced, offers the best assurance of the survival of civil engineering as a learned profession.

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PEAK DISCHARGE RELATED TO HYDROLOGIC CHARACTERISTICS IN NEW ENGLAND

By Manuel A. Benson*

(Presented at a meeting of the Hydraulics Section, B.S.C.E., held on November 2, 1960.)

Introduction

The investigation described here was made as part of a continuing study to determine the causes of variation in flood peaks from place to place and to improve methods of defining flood-frequency relations on a generalized basis. The chances of success were considered better if the study were started in some large region within which the climatic variations and variations in runoff were not extreme. This pointed to a humid region. Other requirements were that the region have fairly long flood records and be fully mapped. New England seemed to meet the requirements better than any other area.

Previous Flood Studies in New England

New England is a densely populated, highly industrialized area. Many industries use water for power and for other purposes in the manufacturing process. Because industries and residences are located close to streams and, in fact, encroach at many places on the flood plains, major floods exact a large toll in lives and property damage. For this reason people in New England have shown an intense interest in the field of flood analysis. Many engineers in New England pioneered in the development of hydrograph analysis and flood formulas.

The Boston Society of Civil Engineers, through its Committee on Floods, published two famous reports in its Journal—those of September 1930 and January 1942. In the 1930 report, recommendations were made for computing design floods at individual sites based on previous flood experience at each site. The conclusion was reached that ". . . the flood situation at any point on any stream presents a problem of its own. No general formula can be of universal application. It is only by special study of all the data, and the conditions for the

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point under consideration, and comparison with floods on similar streams that the best results can be obtained."

The 1942 report elaborated on the methods of using unit hydrographs to improve the prediction of floods. The committee also investigated the frequency curves obtained by applying various theoretical probability distributions to the data. It concluded that results varied widely between the various methods and that none of them were a reliable basis for prediction beyond the period of record.

Kinnison and Colby (1945) made a study of the relation of flood peaks to drainage basin characteristics in Massachusetts. The results were reported on in the 1946 Journal of the Boston Society of Civil Engineers. In many respects the general methods used were similar to those of the present study. Separate formulas were derived for minor, major, and rare flood peaks. A comparison of the methods and results of their study and the present study is presented later in this report.

The New England-New York Interagency Committee (1955) tabulated flood-frequency data for 196 stream-gaging stations in New England. For each station, the mean and the standard deviation of the logarithms of annual flood peaks were computed. The skew coefficients were computed for 20 of the principal long-record stations. The results were not generalized so as directly to furnish flood-frequency information for ungaged sites. The recommendation was, "Where necessary, flood-frequency curves for ungaged areas may be derived by interpolation of data, or selection of a nearby station for correlation."

Bigwood and Thomas (1955) and Bigwood (1957) developed a floodflow formula for Connecticut. The index-flood method presently used by the U.S. Geological Survey was used to develop flood-frequency relations of general application within Connecticut. A comparison of the methods and results of their study and the present study is presented later in this report.

Methods of Analyzing Floods

Technical literature on the subject of flood frequency has been concerned mainly with the distribution of floods at a single site. This has been a controversial subject, although it is not the most important part of the general problem of determining flood-frequency relations. Defining the frequency curves at individual sites, by whatever means, is only the first part of the job; generalization has not been accomplished until the flood peak data are related to hydrologic factors.

It is necessary to start, however, by defining the flood-frequency distribution or curve at each individual site where flood data are available. There are many theories and many ways of doing this. The methods may be divided primarily into mathematical and graphical. In the investigation described here, it was decided to use graphical methods of producing frequency curves at individual stations. The chief reason for this was that basic hydrologic relationships as yet unknown were being investigated; it was desirable that the results not be affected by any possible bias introduced by assuming a theoretical distribution. It is not yet possible to demonstrate *a priori* that floods must conform to some one type of distribution. It is also difficult to justify any distribution on empirical grounds, because although it is easy to show a fit between theory and data in the region of the mean, it is hard to do so at the extremes, and this is the region of interest for floods. Graphical methods may vary slightly with the man doing the work, but the results of careful work do not have a built-in bias.

One method currently in use for regionalizing flood frequency is to use an index flood, usually the mean annual peak discharge. All other floods at a station are then expressed as a ratio to the mean annual flood. The dimensionless ratios are then combined for all stations within a homogeneous area, to obtain a generalized basic flood-frequency relation in terms of ratio to the mean annual flood. This method places some restriction on the results because it does not allow for the possibility that the ratio of a given flood, say the 10-year flood, to the mean may not be constant at all stations, but may vary with physical or climatic conditions prevailing over each basin. In order to avoid any restrictions on the relations that might be developed, it was considered best to make independent analyses at many different flood levels.

Summary of Procedures

The available stream-gaging records in New England were examined and those that were too short, too close to another station, or affected excessively by regulation were eliminated. There still remained 164 stations to use in the analysis. One of the first parts of the study was an investigation of historical flood data in New England, which extended the knowledge of flood events back between 200 and 300 years.

Maximum annual momentary peak discharges were listed for each station, and were then arranged in order of magnitude. Probabilities for each peak were computed as m/(n + 1), where *m* is the rank starting with one as the highest and *n* is the number of years of record. Where the historical study indicated long effective recurrence intervals for some of the recent major floods, the longer periods of time, rather than the recent periods of record, were used to compute their probabilities.

The peaks at each station were plotted on log-probability graph paper, and graphical frequency curves were drawn. Each curve was drawn only as high as defined by the data at the station. From the 164 station frequency curves, peak discharges were determined, within the range of each curve, at the probabilities corresponding to recurrence intervals of 1.2, 2.33, 5, 10, 25, 50, 100, 200, and 300 years. Table I shows the amount of data at each of the 9 levels.

TABLE I—NUMBER OF STATIONS DEFINING T-YEAR FLOODS

Recurrence Interval, T, in years	Number of Stations
1.2	164
2.33	164
5	164
10	164
25	154
50	116
100	100
200	68
300	22

At each of these levels, the peak discharges, as dependent variables, were correlated by multiple-correlation techniques with many hydrologic variables. These variables were chosen first by considering what factors might be expected to have an important effect on peak discharge, then by finding means of expressing them either directly or indirectly by some suitable index. Table II shows the variables investigated.

Some of the variables listed in Table II have been described and evaluated for many New England drainage basins by Langbein (1947). Other variables, such as indices for the main-channel slope, curvature

TABLE II—INDEPENDENT VARIABLES ANALYZED

1. Drainage-area size
2. Slope
   - Main-channel:
     - Langbein factor
     - Bigwood-Thomas factor
     - Potter factor
     - Logarithmic
     - 85-10% point elevations
   - Tributary channel
   - Average land slope
   - Profile curvature
3. Storage area
   - Lakes, ponds, and swamps
   - Lakes and ponds
4. Stream density
5. Altitude
   - Mean
   - Mean above gage
   - Altitude distribution index
6. Shape and drainage pattern
   - L, 1/W, L/W, Σal, $(\Sigma al)/A$, $L \cdot \text{Log } A$,
   - Shape classification (1 to 6)
7. Index of available moisture
   - Mean annual precipitation
   - Mean annual runoff
   - Mean March to May precipitation
   - Mean annual runoff/precipitation ratio
   - Mean March to May runoff/precipitation ratio
   - Maximum 24-hour precipitation
   - Rainfall intensity-frequency
8. Temperature
   - Mean January temperature
   - Mean January degrees below freezing
9. Orographic factor

of the main-channel profile, and the altitude distribution, were devised in the course of this study.

In the first part of the investigation, graphical multiple-correlation techniques were used. Study showed that linear relationships existed between peak discharges and all hydrologic factors when the logarithms of all the data were used. Various indices of each of the factors expected to influence flood peaks were tested for their efficiency in accounting for the variations in peaks. Drainage-area size, considered and later demonstrated to be of prime importance, was introduced first. Some measure of the main-channel slope was found to be next in importance to drainage area. Several methods for expressing main-channel slope were tested and finally a simple yet efficient index (Benson, 1959) was devised. This is the slope (in feet per mile) between two points along the main channel, one of which is 85 percent, the other 10 percent, of the total main-channel length above the gaging point.

Following main-channel slope, S, the percentage of surface area in lakes and ponds, (increased by 0.5 percent for linearization), St, was found to be a significant variable.

A fourth independent variable found significant was I, the rainfall intensity-frequency magnitude (in inches) for a 24-hour duration and a recurrence interval equal to that of the peak discharge. These data were obtained by use of U.S. Weather Bureau Technical Paper No. 29, Rainfall intensity-frequency regime, Part 4—Northeastern United States, 1959.

Graphical multiple correlation becomes insensitive after 3 or 4 variables. At this point multiple-correlation equations were computed mathematically at all 9 of the flood levels, and values of the flood peaks were computed, by means of the equations, for all stations. The ratios of the actual to the computed peaks were averaged at each station, and those ratios, representing error or departures, were then plotted on a map of New England (Fig. 1).

The multiple correlation developed to this point would not be considered satisfactory unless, as a minimum requirement, the errors were found to be randomly distributed. In Figure 1 the contours have been drawn to average the departures. They demonstrate a definite geographic pattern. Note that the ratios are high in the north (above 1) and change gradually to low values (below 1) in the south. An area along the Connecticut River shows a break in the regular pattern. The general north-to-south variation is consistent with the expected effect of one factor not yet included in the correlation—the effect of snowmelt and frozen ground in augmenting peak flows. The general pattern of departures is almost duplicated in the map of mean January temperature shown in Figure 2.

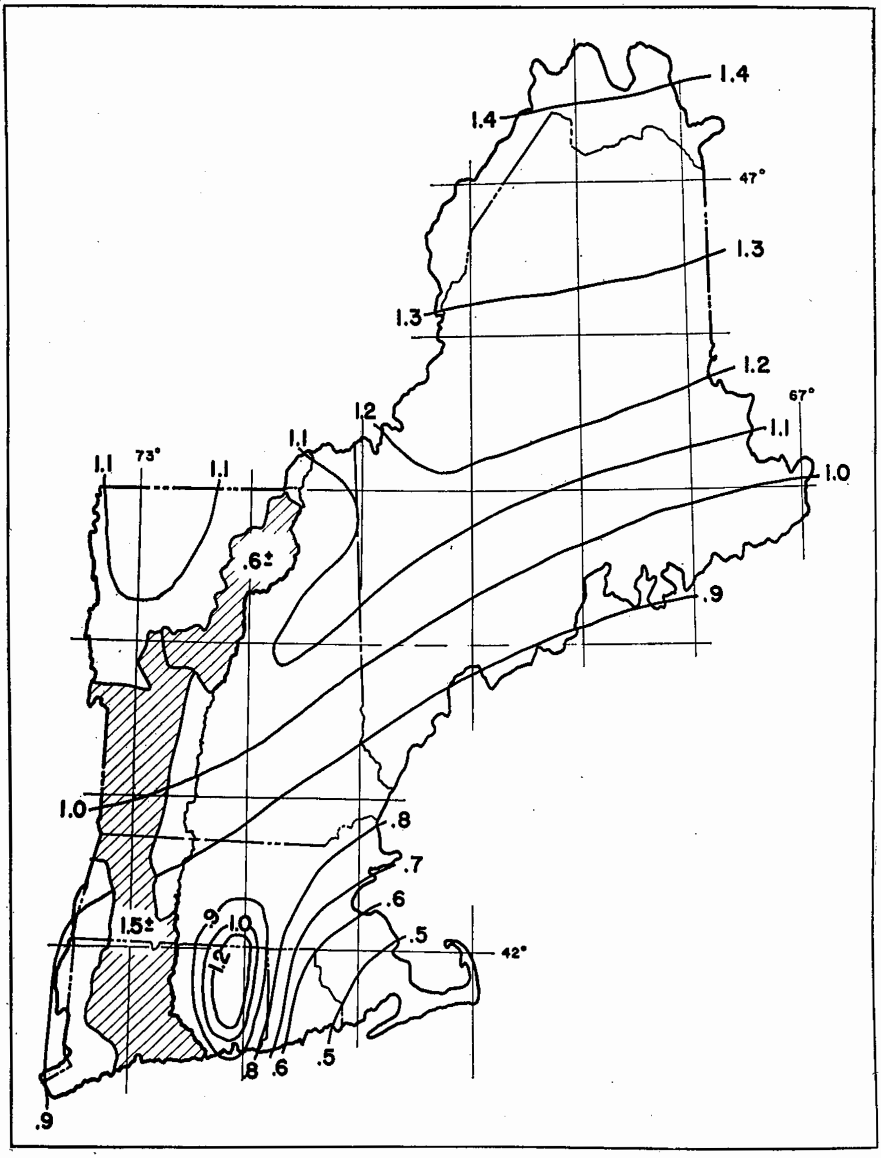

Figure 1.—Map of New England, Showing Residual Error of Discharges Computed by Using A, S, St, and I; Contoured Values Represent the Ratio of Actual to Computed Discharges.

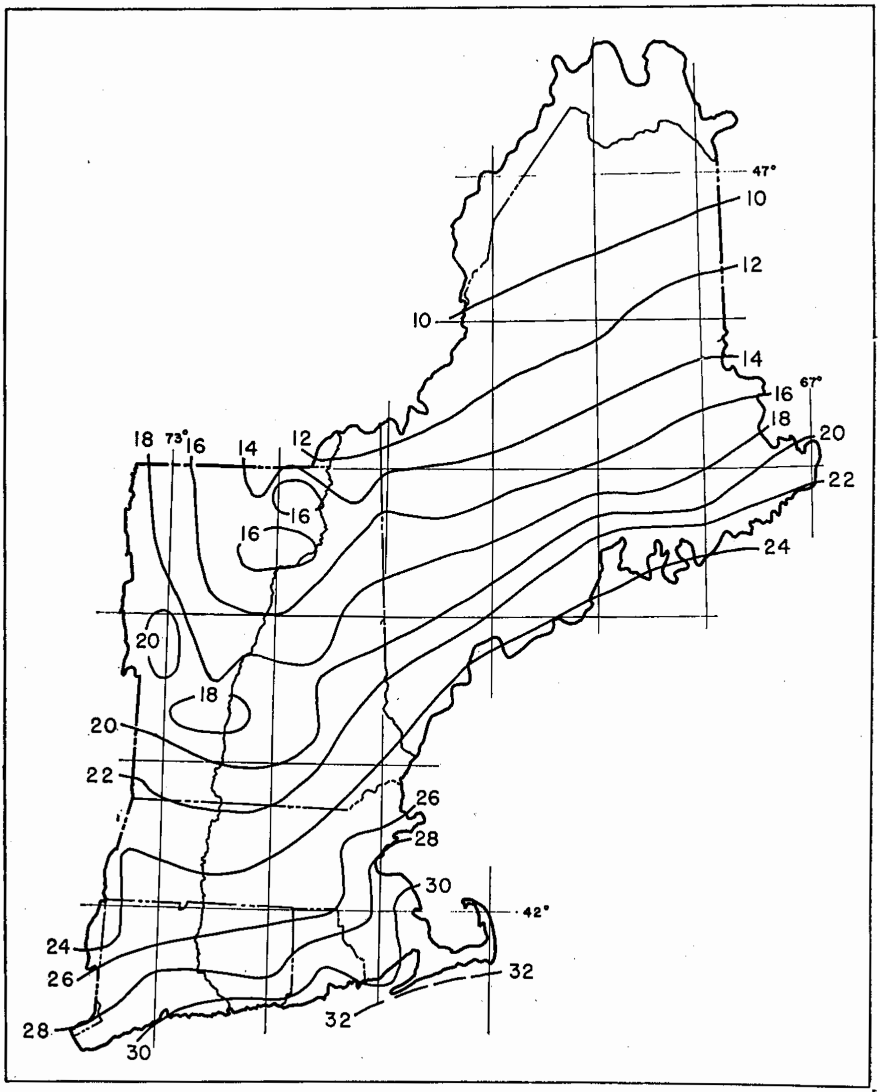

FIGURE 2.—MAP OF NEW ENGLAND, SHOWING JANUARY TEMPERATURE IN DEGREES FAHRENHEIT.

Most annual flood peaks in New England occur in the three-month period from March through May. The ratio of total runoff over total precipitation in the March-to-May period is shown by contours in Figure 3. The north-to-south variation is depicted here also. North of the line labelled 1.0, the runoff is higher than the precipitation during these three months, because of the melting of snow previously accumulated.

Data on the normal water content of accumulated snow at the time of the spring breakup are lacking, but either January temperature or the 3-month runoff-precipitation ratio may be used as an index of snowmelt. Average January temperature was chosen, and was converted to average degrees below freezing, t (with a minimum value of 1.0). After adding this variable to our regression equations, flood peaks were recomputed and another set of residual errors obtained that were again mapped as shown in Figure 4.

Maine is omitted from this map, and the remainder expanded. The introduction of temperature eliminates the north-to-south variation and gives a random scatter of errors everywhere except along the Connecticut River. Examination of the pattern now defined by the residual errors shows a definite relation to orography. Storm winds come mainly from the east or southeast. The area of depression contours in the north is a basin flanked on the east by the White Mountain chain, the highest in New England. West of the northern part of the White Mountains, there is a definite rain shadow, perhaps better termed a "peak-discharge shadow." South of about the 43° 45′ latitude, the White Mountains become low; the Green Mountains, which form the western ridge of the Connecticut Valley, are the highest in the east-west direction and become the controlling feature. The residual errors of the individual gaging stations show an increase up the slopes on the east side of the Green Mountains. The upper slopes of the Green Mountains intercept heavier precipitation, which is reflected in the peak discharges from the streams that head in the upper slopes, namely the White, Ottauquechee, Black, and West Rivers. As we progress southward to western Massachusetts and to Connecticut, which receive the highest storm rains in New England (see Fig. 5), the mountains have become hills. The first rise in elevation met by the winds from the east causes an increase in peak discharges; proceeding west into the Connecticut valley, there is a decrease, then a rise on the other side. Figure

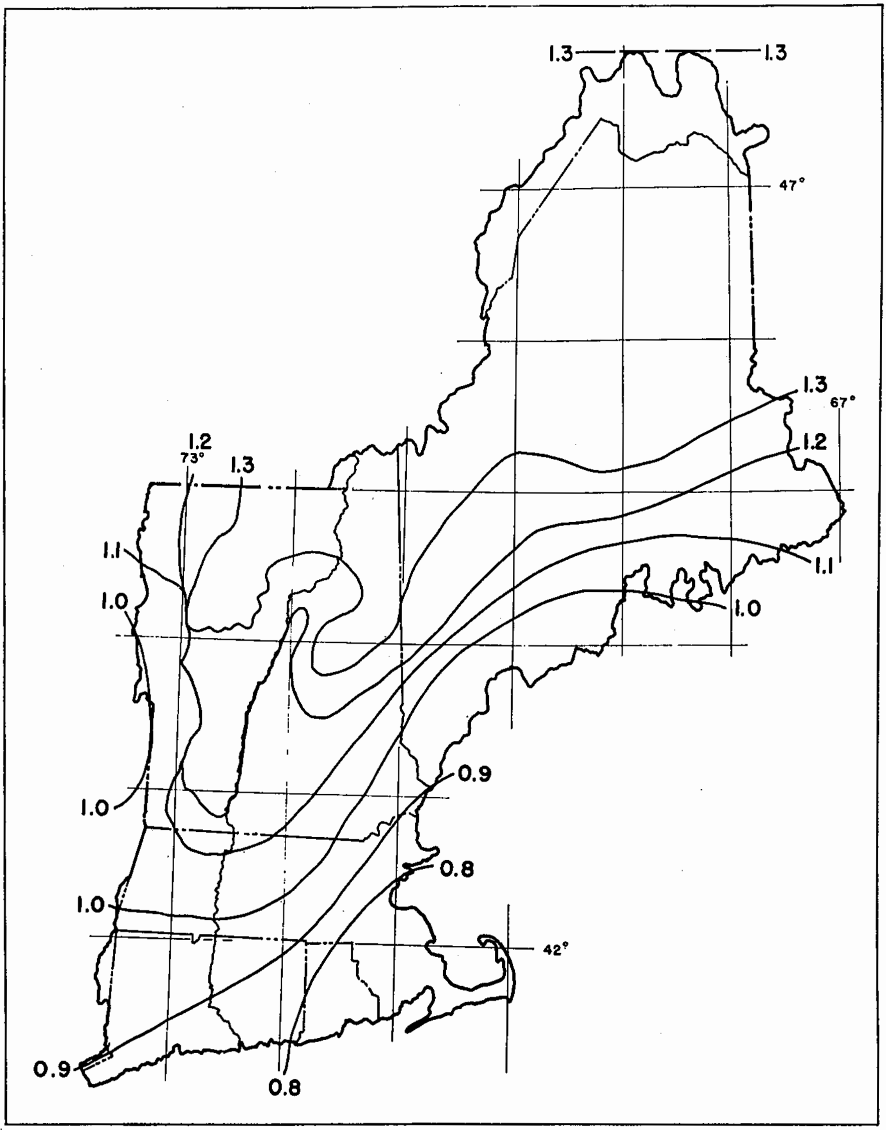

FIGURE 3.—MAP OF NEW ENGLAND, SHOWING THE RATIO OF RUN-OFF TO PRECIPITATION FOR THE 3 MONTH PERIOD, MARCH THROUGH MAY.

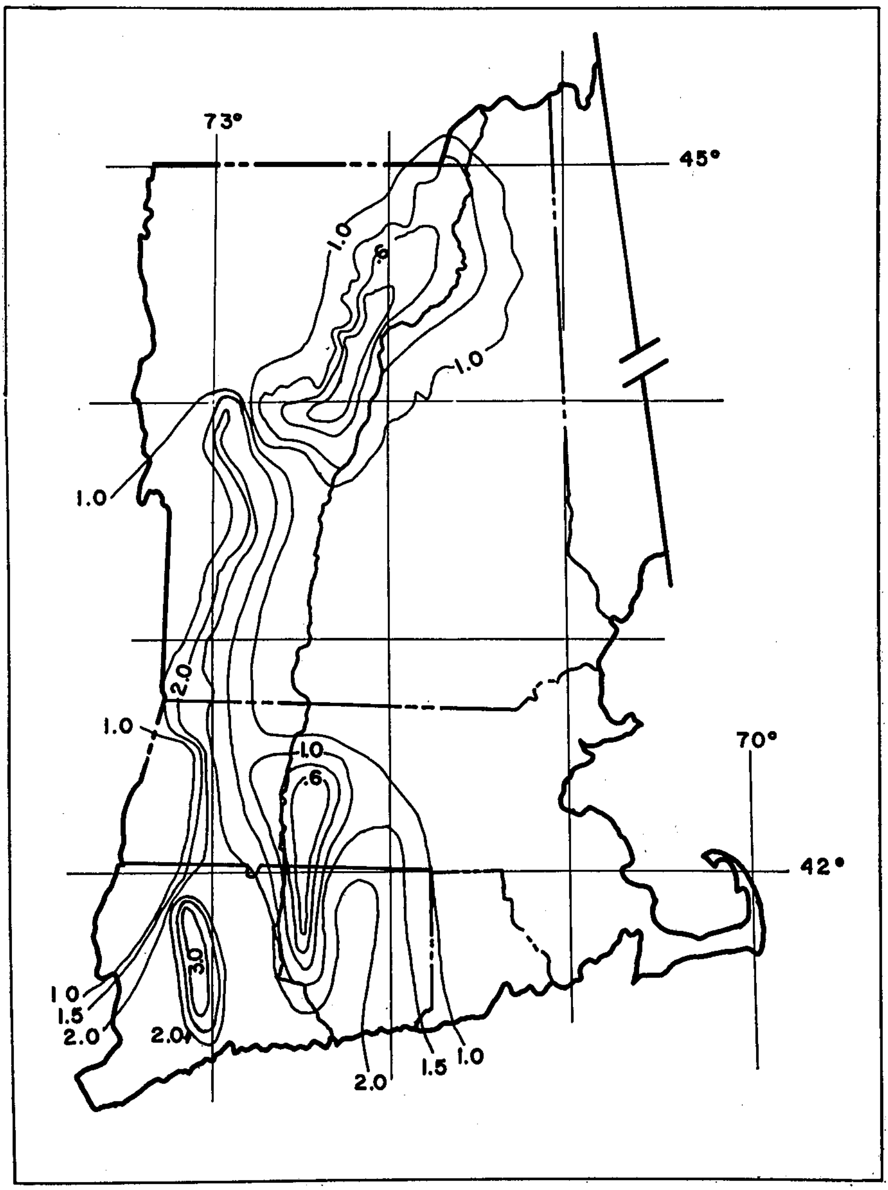

Figure 4.—Map of New England, Except Maine, Showing Residual Error of Discharges Computed by Using A, S, St, I, and t; Contoured Values Represent the Ratio of Actual to Computed Discharge.

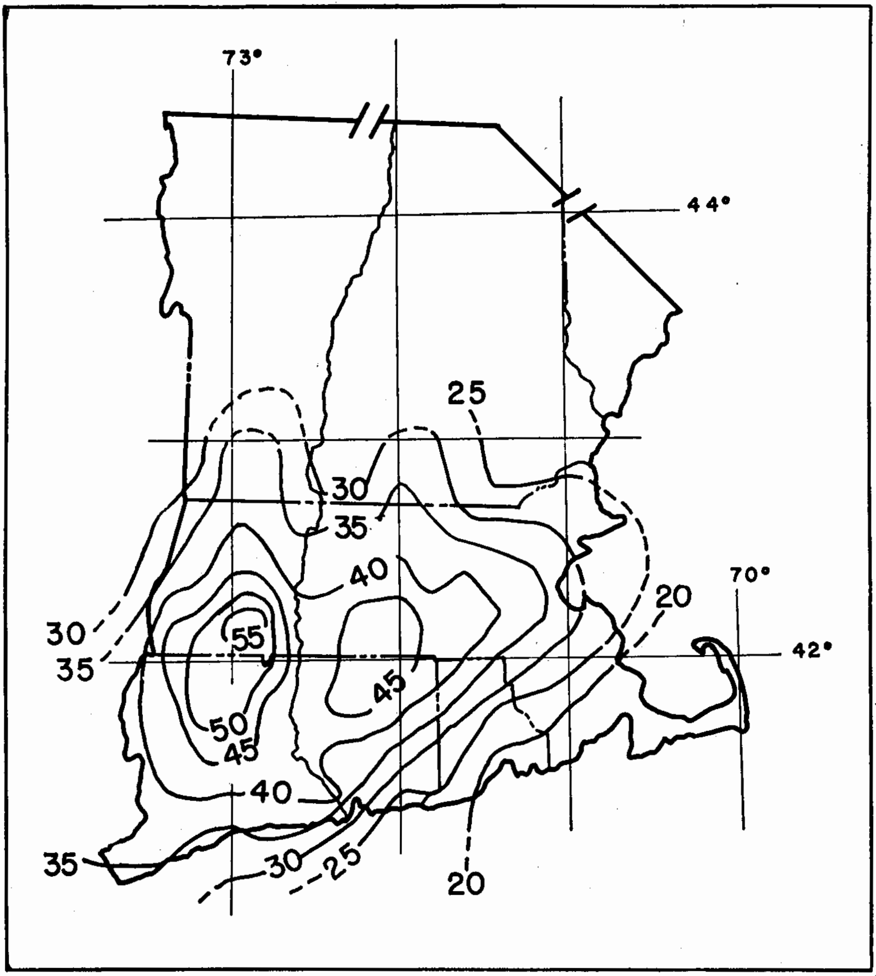

FIGURE 5.—MAP OF SOUTHERN NEW ENGLAND, SHOWING COMBINED PRECIPITATION IN INCHES IN 6 MAJOR STORMS—NOVEMBER 1927, MARCH 1936, JULY 1938, SEPTEMBER 1938, DECEMBER 1948, AND AUGUST 1955.

6 shows what happens along the 42° 15′ line; the top line is the ground elevation and the lower line is the pattern of residuals.

The pattern portrayed in Figure 4 represents variations in peaks that are unaccounted for by the precipitation and temperature variables already used. Perhaps the precipitation or temperature maps are

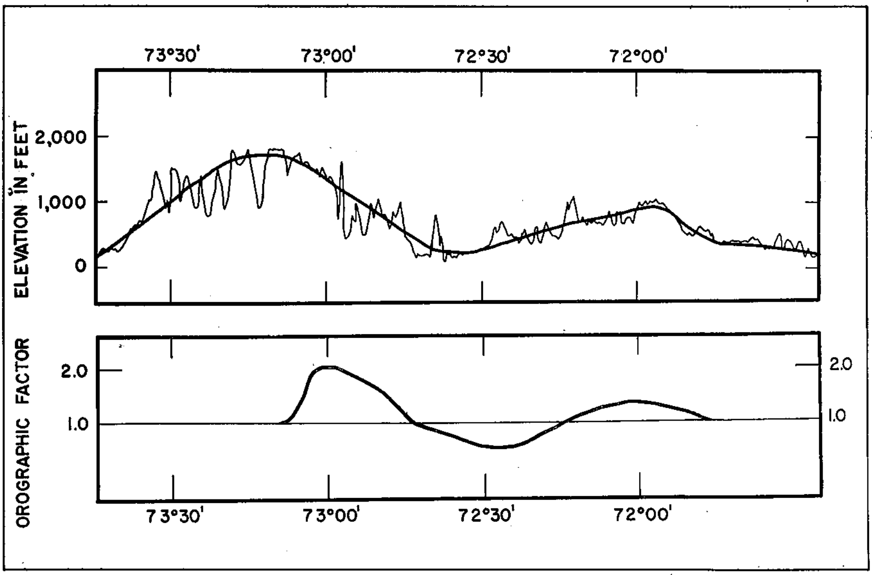

FIGURE. 6.—CROSS SECTION AND OROGRAPHIC FACTOR THROUGH LATITUDE 42° 15'.

based on too little data in the mountain areas or perhaps the orographic effect on peaks is too complex to be expressed by one or two simple climatic indices. One practical expedient for expressing the effect of orography would be to use, as an orographic factor, values based on the contours of Figure 4, which are consistently defined by the residuals of flood discharge at each station. The discharges are from entire basins, therefore they represent the integrated effect of whatever conditions are responsible for the pattern. When an orographic factor, O, based on the mapped contours, is introduced into the regression equations, the final residuals are then found to be randomly scattered over all of New England.

It would have been possible to use other variables of those investigated instead of the ones finally used. For example, average land slope, stream density, or others might have been used instead of main-channel slope. Each of these is highly correlated with the others. However, the main-channel slope proved to be the most efficient of these, i.e., it accounted for a larger part of the variation in peak discharges. After main-channel slope was introduced as a variable the other like variables no longer added anything significant to the correlation.

No basin shape factor could be found that had any significant relation to flood peaks, despite the fact that reasoning shows that shape must have an effect. Apparently, the basin shape has to a large extent been accounted for once drainage area and slope have been included. This is because slope is computed on basis of the length of the main channel—for a given size of drainage area a variation in main-channel length indicates a variation in shape.

Results

The multiple-correlation equations which have been developed are of the following form:

$$Q_T = aA^b\ S^c\ St^d\ I^e\ t^f\ O^g$$

There are six independent variables. The first three—area, main-channel slope, and surface storage—are topographic variables. The next two, precipitation intensity and temperature, are climatic variables. The last is an orographic factor, a combination of topography and climate.

Drainage area is the most important variable. The standard deviations of the original peak discharges range between 130 and 190 percent (average of plus and minus deviations) of the mean values at each level. The use of drainage area leads to standard errors ranging only from 50 to 70 percent. Slope is highly important and it accounts for a 10 to 20 percent reduction in the standard error over that using area alone. Storage further improves the standard error between 2 and 5 percent. Rainfall intensity is not statistically significant below about 10 years; above 10 years the improvement in standard error ranges up to 3 percent. Temperature improves the standard error between 1 and 4 percent. The orographic factor improves the standard error between 5 and 20 percent. Although intensity and temperature each improve the overall standard error less than 5 percent, they are factors that vary regionally rather than randomly and the improvement in standard error does not tell the whole story. For example, the mapped residual error before temperature was introduced (Fig. 1) showed errors ranging from plus 40 percent in northern New England to minus 50 percent in southern New England. These regional errors were removed by temperature although the average improvement is only 1 to 4 percent.

Figure 7 shows how the exponents in the general equation vary as T, the recurrence interval, changes from 1.2 to 300 years. The *a* coefficient shows an abrupt change between 10 and 25 years because the variable I, rainfall intensity, has not been used below 25 years. The other coefficients all show consistent and smooth variations with recurrence intervals. The variations in coefficients *b, c, e, f,* and *g* have been tested and found statistically significant. The variations in the coefficient, *d,* for surface storage, were not found significant although *d* appears to vary uniformly with recurrence interval. For this reason a constant value, —0.3, has been used throughout in the final set of equations.

Table. III is a summary of simplified regression coefficients *b* through *g* selected from the curves of figure 6 and rounded to the nearest one-tenth in value. This simplification is accomplished with no appreciable loss of accuracy in the final equations. The *a* coefficients as shown are recomputed values which, on theoretical grounds, balance the simplified values of the other coefficients.

TABLE III—SUMMARY OF SIMPLIFIED REGRESSION COEFFICIENTS

$$Q_T = aA^b\, S^c\, St^d\, I^e\, t^f\, O^g$$

Recurrence Interval, T, in years	Regression Coefficients							Standard error in percent
	a	b	c	d	e	f	g	
1.2	2.14	1.0	.3	—.3	0	.4	.8	24.9
2.33	2.60	1.0	.4	—.3	0	.4	.8	23.2
5	3.54	1.0	.4	—.3	0	.4	1.0	26.6
10	4.52	1.0	.4	—.3	0	.4	1.1	28.4
25	2.08	1.0	.5	—.3	.5	.4	1.1	29.3
50	2.26	.9	.4	—.3	.9	.5	1.1	27.2
100	1.38	.9	.4	—.3	1.1	.6	1.2	32.6
200	1.01	.9	.3	—.3	1.2	.8	1.5	33.0
300	.681	.9	.3	—.3	1.3	.9	1.6	37.2

The final column of Table III shows the standard errors of estimate at each flood level. These are considered acceptable limits considering the nature of the problem.

COMPARISON WITH OTHER STUDIES

There have been two previous studies of generalized flood-frequency relations in New England made by the Geological Survey. Both

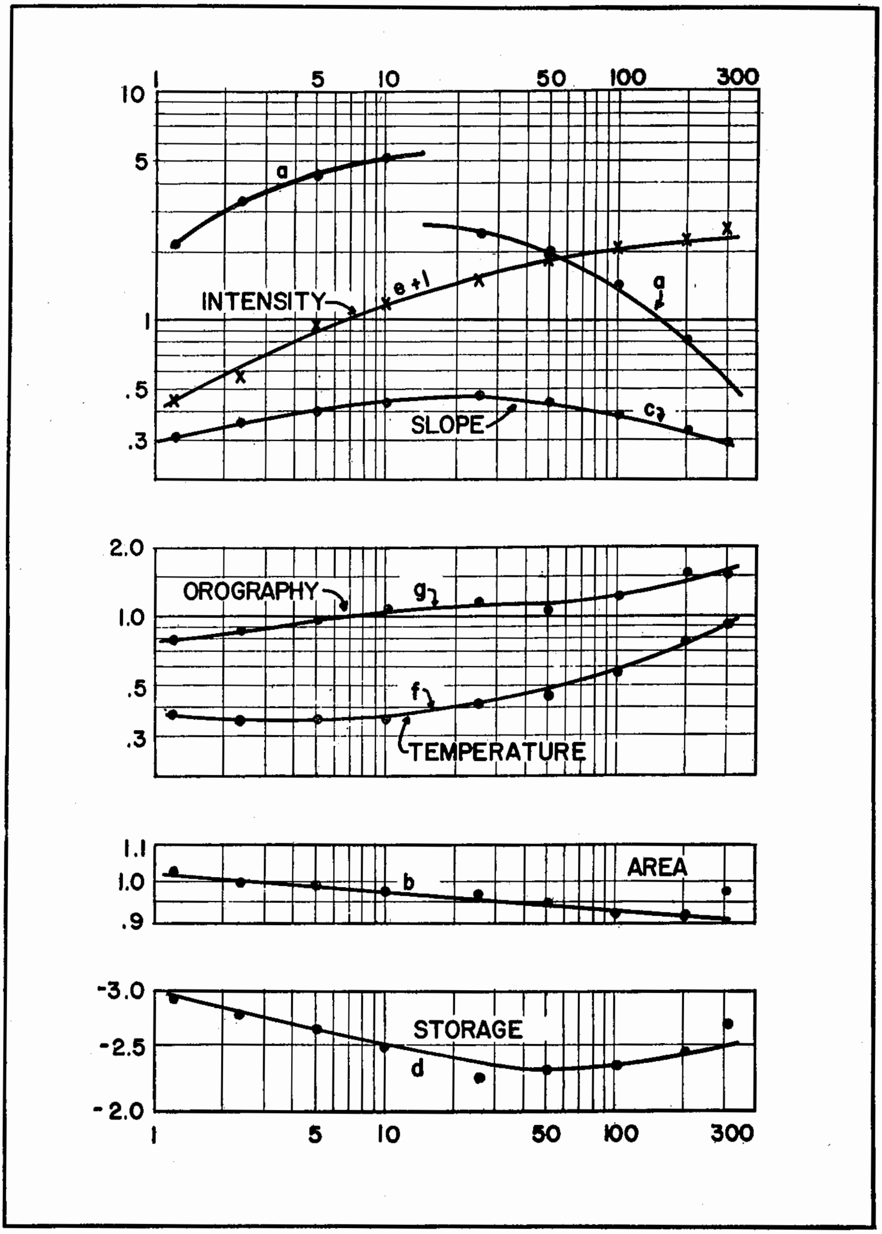

FIGURE 7.—VARIATION OF REGRESSION COEFFICIENTS WITH RECURRENCE INTERVAL.

of these studies have been extremely useful to State and Federal agencies and to engineering consultants for purposes of planning, regulation, and hydraulic design. Each is appraised in relation to the findings of this study.

Kinnison-Colby Study

The first of these studies was made by Kinnison and Colby (1945), and provides flood-frequency formulas applicable in Massachusetts. These formulas are for minor (15-year), major (100-year), rare (1,000-year), and maximum flood peaks. This was the first comprehensive study of the generalized relation of peak floods, on a frequency basis, with physiographic characteristics.

Flood peaks were developed mainly from unit hydrographs. The peaks were then studied in relation to many basin characteristics. The variables appearing in the final equations are for 1) drainage area (M), 2) surface area of lakes, ponds and reservoirs (a), 3) median altitude of the basin above the outlet (s), and 4) the effective length (L) of travel of water to the outlet. The combination of the last two, s and L, is closely allied with the main-channel slope that was used in the present study. It can be seen, therefore, that the Kinnison-Colby formulas contain essentially the first three terms of the present formula. Within Massachusetts, there is not much variation in either winter temperature or rainfall characteristics. For this reason neither temperature nor rainfall would be likely to appear in a formula based only on Massachusetts data.

The author of the present study has had the advantage of using longer periods of streamflow record, the comprehensive historical-flood study made in 1957, and analysis of data from a much larger area. The present study is based on peak discharge data obtained directly, as compared with such data obtained indirectly from unit hydrographs and rainfall records, as in the older study. In the present study, no attempt has been made to define the 1000-year and maximum possible peak discharges, as was done by Kinnison and Colby.

It is readily possible to make comparisons at the 100-year level of results by both the Kinnison-Colby formula and the present study for 26 stations of the 48 used in the Kinnison-Colby study. The 100-year discharges are computed as though these were ungaged sites. Results are measured against the 100-year values taken from the individual station frequency curves. The standard errors are, respectively, 44.4 and 34.7 percent. This means that by the Kinnison-Colby formula, approximately one-third of the computed 100-year peaks were in error by more than 44.4 percent; by the present formula, one-third of the computed values were in error by more than 34.7 percent.

Comparisons were made at the 15-year level by picking 15-year values from the curves which average the points computed by the new method for each station. For 15-year peaks, the standard error by the Kinnison-Colby formula is 33.9 percent, and by the new methods is 28.2 percent.

Bigwood-Thomas Study

Bigwood and Thomas (1955) and Bigwood (1957) developed regional flood-frequency relations applicable to Connecticut. The 1957 paper revised the relations by including data on the August 1955 hurricane flood. Their studies make use of the index-flood method.

The mean annual flood is related to basin characteristics by their "Connecticut flood-flow formula." All other floods are then related to the mean annual flood by means of a regional base-frequency curve. The formula for mean annual flood uses as variables 1) drainage area (a), 2) channel slope (S), which is the average of main-channel and tributary slopes, and a basin coefficient (C_B). The coefficient has a value of 0.85 for "normal characteristics," 0.55 if there is an "abnormal" amount of channel storage, and may be varied from 1.0 to 3.0 for areas ranging from "semisuburban" to "urban residential."

The drainage area used in the Connecticut formula is obtained by deducting "the portions of the drainage area not contributing to flood volumes." This is to a large extent dependent on judgment and may be questionable, because there is likely to be some contribution to the peak flow even from areas largely controlled. The basin coefficient, C_B, is largely a matter of judgment, which must be relied on to determine the "normal" or "abnormal" condition of channel storage and the degree of urbanization. Actually, there is extremely little data at the present time on which to establish the effect of urbanization on flood peaks.

The present study has the advantage of the use of more data based on a wider area of study. In addition, it avoids the use of coefficients with a wide range, with values to be determined by judgment. Bigwood and Thomas used historical data to establish recurrence intervals for the major floods. These recurrence intervals were then applied over large areas. In the present study, use was made of the detailed historical study made in 1957, not previously available. Historical data were used at each station to define the upper ends of the individual frequency curves.

Direct comparisons of results by both the Bigwood-Thomas (1957) method and the present study were possible for 37 of the 44 stations used by them. The discharges were computed as though these were ungaged sites. Results were measured against the values taken from the individual station frequency curves. A summary of these results are shown in the following table. Standard errors in percent are shown for each of the nine recurrence intervals.

These results mean, in general, that approximately one-third of the computed values were in error by an amount exceeding the percent indicated by the standard error.

STANDARD ERRORS OF DISCHARGES FROM CONNECTICUT FLOOD FORMULA AND FROM NEW FORMULAS, FOR 37 CONNECTICUT STATIONS

Recurrence interval	Number of stations	Standard errors in percent	
		Connecticut formula	New formulas
1.2	37	18.4	29.0
2.33	37	13.3	27.0
5	37	24.0	27.5
10	37	33.0	24.7
25	37	43.6	25.1
50	36	52.0	19.7
100	35	57.8	23.8
200	32	67.0	33.4
300	15	55.2	33.2

RANGE OF USE

The multiple-correlation equations apply only in New England within the limits of the data used to develop the relations. The results apply only to essentially unregulated conditions—roughly to basins with less than 4.5 million cubic feet of usable storage per square mile. Although data for drainage areas between 1.64 and 9,700 square miles were used in the analysis, the small number of stations below 10 square miles leave the results uncertain in that range. Because the flood experience is of necessity based on a given period of record, results must be considered as applicable to the events during that period. They can be used for prediction only if it is assumed that the general level of flood activity will be the same in the future period under consideration as in the past. It is believed that, irrespective of the general level of floods represented, the relative effect of the separate hydrologic factors for the New England region is fairly well defined by this study.

The approach used here might prove profitable in any humid region. Modifications in the variables used may be made as found necessary because of local conditions or because of the type of data available. Further study is being made in the arid and semiarid southwestern United States.

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STARTING NEW SEWAGE TREATMENT PLANTS

By Ariel A. Thomas,* Member

(Presented at a meeting of the Sanitary Section, B.S.C.E., held on October 19, 1960.)

Successful operation depends on effective operation. Starting sewage treatment plants may be rephrased—building and supporting an effective operating staff.

By the time a sewage treatment plant is ready to be placed in operation, very little can be done to change structures and equipment, such as pumps, tanks, instruments, digesters, and filters. The plant has been engineered, designed and constructed. The designers have done their utmost to produce the best and most flexible plant. Major changes are usually unnecessary and almost always impractical. However, regardless of the design, when a sewage treatment plant is ready for operation, the operating staff is the only variable. Operating success depends on the operating staff—the operators, the maintenance men and their supervision.

Starting may be divided into three stages:

1. The first stage begins with the preliminary report and continues through design and construction. It involves obtaining and holding the support of the municipal officials and the citizens for the sewage treatment plant and its effective operation.
2. The second stage "Initial Operation" starts about a month before actual start-up and continues for hours or weeks after sewage actually enters the plant. Training the operating staff is the chief function of this stage although holding the support of the municipal officials is still very important.
3. The third stage consists of "Refining Operation." While this continues for as long as the plant operates, we will for present discussion limit it to approximately a year after operations begin.

Without official and public support, the best sewage treatment

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plant and the most promising operating staff will be tangled in a morass which will soon produce unsatisfactory operation.

This support should have been building up as the preliminary reports were written and submitted and as the plant was being designed and constructed. In order for the sewage treatment plant to be designed and constructed, the municipal officials and voters must have been convinced of its importance. Care must be taken not to oversell the benefits to be produced by this treatment plant in the preliminary report and design stage. With operation about ready to begin, the engineer should be able to confirm the benefits which were promised in the preliminary report and by the designers. At this stage, it would be unfortunate to have to eliminate benefits which were used to sell bonds and obtain initial support for the project.

Starting a sewage treatment plant coincides with another very important event. The public officials and the taxpayers will see what their money and support has produced.

Every one is interested in publicity for the sewage treatment plant as operations start. The public officials should and usually want to arrange the publicity. They must be guided in three general areas.

1. Type of treatment, amount of purification of the sewage and benefits to the receiving waters.
2. When normal purification of the sewage and improvements of the polluted waters will occur.
3. The reasons for the time required to obtain normal purification and to improve the polluted waters and problems which may occur before normal purification is established. The potential problems are not usually publicized but must be known to the municipal officials.

Obviously, the treatment plant was designed to eliminate pollution. The responsible municipal official must know each step in the treatment process and what each will accomplish. He must have this information in a form which will be readily understood by newspaper reporters and the taxpayers. "Primary treatment will remove 40 tons per day of impurities from the sewage" means much more than "Primary treatment will reduce suspended solids 50 percent." He must be guided in comparisons which demonstrate the effectiveness of sewage treatment in the plant. In a primary treatment plant, for instance, comparison of raw sewage and final effluent is not effective. A view of the sludge being removed from the primary tank or discharged from a vacuum filter is more effective. In a complete treatment plant, a comparison of the raw sewage and a clear final effluent is effective once the clear final effluent is being produced. Publicity in advance of starting operations should emphasize the sludge removed in one case and could emphasize the final effluent in the other. Publicity which emphasized the purity of a primary effluent could backfire and cast doubts on the effectiveness of a perfectly satisfactory effluent.

The municipal officials should also have some estimate of the time required after operations start to produce the normal plant effluent and of the time required to visibly change stream conditions. In both cases, it is best to overestimate the time required. "Everyone is happy to be associated with excellent operators, a well designed plant, and outstanding municipal leadership which resulted in good operation being established sooner than could have been anticipated."

Reduction of pollution is not an adequate description of the effect of the sewage treatment plant on the stream. Elimination of odors, improved or new fishing, elimination of oil, greases and floating sewage material are much better descriptions. "Opening beaches which had been closed by pollution" is a much more effective statement than "reducing the coliform bacteria" although both can mean the same in a given instance. If the sewage treatment plant does not produce any visible physical improvement in the receiving waters within a few miles of the plant effluent, it is best to emphasize the treatment in the plant.

It should be emphasized to the municipal officials that the sewage treatment plant is the only visible (to the voters and newspapers) evidence of a large sum of money for a sewerage system. Neat landscaped appearance is inexpensive to provide and maintain and makes the plant something for the voter to be proud of and to support.

The municipal officials should also know that the first few months of operation may be hectic. They should know that it takes time to produce an effective biological growth. They should be advised of the things which might go wrong so that they will not be surprised. Thus they can handle public relations problems which may crop up in the first few months of operation.

An adequate staff and operating budget must be worked out with the municipal officials within the framework of the municipal salary ranges and organization. Items which must be included in the budget are salary for operation and maintenance staff, operating supplies, maintenance supplies, power, water, chlorine, chemicals, vehicles, employee benefits such as social security, hospitalization, and pensions, and insurance.

Vacations are a problem because they reduce the staff in the summer time when treatment is most critical and when outdoor maintenance can best be done. If each of a 48-man staff takes two weeks vacation in a 12-week period, one sixth or 8 men will be on vacation all the time. These men must be replaced when they are on vacation. Summer help is usually a less expensive answer than overtime by regular employees. If possible, the staff and budget should be worked out with the assistance and approval of the superintendent who will supervise the operation and maintenance staff. This procedure will minimize later changes which are sometimes required to fit the staff and budget into the pattern favored by the superintendent. Included in the first year budget should be a 5 to 10 percent contingency for extra personnel and for equipment and minor changes in the first few months.

This first section is aimed at putting the municipal officials in a position where they cannot be second guessed or place themselves or be placed in an untenable position. Happy, confident municipal officials will usually support the start of operations and will continue this support. Although we have called this the first stage of starting a sewage treatment plant, it is obvious that holding the support of the municipal officials and voters must continue as long as the sewage treatment plant operates.

The second stage of starting a sewage treatment plant begins with the recruiting of the staff. In large plants, the top staff should be on the job as soon as mechanical equipment and pipe begins to go in. This is also desirable in the smaller plants. In any case, the entire staff should be on hand at least a month before operations are expected to start.

The staff is given lectures on the treatment plant in general; what it will accomplish, how the receiving waters will be improved, their own specific jobs, and the organization of the various parts of the staff.

Make each staff member—operator, laborer, maintenance man or truck driver—a good will ambassador for the treatment plant. Each man who works at the treatment plant is an expert to his neighbors. Give him the information to be the expert. He will be happier and do a better job. He will generate much favorable publicity.

During this period, the staff learns by examination where pipes go, what valves to use, how to start pumps and all the other details of their job. One plant gave their operators problems such as getting sludge from here to there; what will you do if the dry well starts flooding; how will you relieve the overflowing primary plant. The problems were solved by tagging valves to be opened or closed and tagging pumps to be started, etc.

Maintenance men and instrument men could be sent to school during this period. Equipment manufacturers have set up schools which are usually tuition free.

The sewage treatment plant must appoint a supervisor of maintenance at least a month before operations start. The manufacturers' representatives must give their maintenance advice and instruction to this supervisor or to his designated assistant and to no one else with the possible exception of the Consulting Engineer's representative. If they give advice to other staff members, the advice may not get to the responsible maintenance supervisor and may be wasted. Manufacturers will give most effective service to a well-organized staff and will save time in giving the better service.

After the equipment manufacturer's representatives have talked to the supervisor of maintenance, they should lecture to the staff on the maintenance and operation of their equipment. These equipment manufacturer's representatives should return again in the first month after operation actually begins to check operation and especially to check maintenance. They should be scheduled so that they come to the plant on separate days. If several arrive on the same day, their time may be wasted and the staff does not get the full benefit of their visit.

The Resident Engineer has collected equipment and operating instructions and should turn them over to the chief of the operating staff as soon as he is employed.

An operations manual must be prepared showing the capacity and use of equipment and facilities. The size of tanks, the rate of collector travel, the head-discharge-efficiency-power curves for pumps, the operating pressures for hydraulic systems, and the size of comminutors or bar racks should be compiled so that the data is readily available. Schematic piping and flow diagrams for sewage, sludge, chlorine, water, and other materials must be prepared. These should show all possible interconnections as well as normal routes of flow. This information should be basic and not affected by changes in operating procedures.

In addition, a detailed initial standard operating procedure must be established. It should be posted at operating stations and followed by all operators. This is absolutely necessary since shift operation requires that four men occupy each position. If they all follow established procedures, undesirable ones can be weeded out rapidly. If they each operate independently, good and bad procedures may be so mixed up that they cannot be identified. However, every man should be encouraged to be on the watch for better operating and maintenance procedures and any showing promise should be tried. It is to be expected that much of the initial standard operating procedure will be changed by experience.

Shop drawings have been accumulated by the Resident Engineer and should be turned over to the sewage treatment plant superintendent as soon as he can receive them. We make a practice of collecting two or three copies of each. We suggest that one be kept in the official file, one in the maintenance supervisor's office and one or more in a separate file in the maintenance supervision office for field use.

The laboratory staff must be oriented in plant operation and in their laboratory work. Their services and the information which they will provide will be indispensable as soon as operations start. The staff will need most of the month to unpack, sort and prepare equipment and supplies, and to make solutions.

The operating report forms must be designed and be ready before operations start. They must meet state requirements for minimum information and also record data which will make control of operations easier. They must also accumulate data on which plant expansions and changes for better or more economical operations can be based. In addition, forms should be designed for recording the operating data in the plant which will be incorporated into the operations report or be used to control treatment.

During this period, decisions are made to treat all or part of the sewage initially or to start all or part of the units at once. Sometimes, as in the case of a replacement for an old plant, all of the sewage is immediately available for treatment. Even so some can be by-passed or treated as it was before the new plant was available. Authorities whose income is from revenue usually like to receive all the sewage as soon as possible so that participants can be charged and the project becomes self-supporting at the earliest possible moment. My personal preference is to take all the sewage as soon as possible. I see no objection if the plant is adequately designed with duplicate equipment. On the other hand, some problems will develop faster and can be dealt with sooner and in the period when problems are expected if all the sewage is received at once and all units are started as sewage or sludge reaches them.

As the day for receiving the first sewage approaches, each operator and his supervisor tests pumps, valves and all other equipment to see that they are in operating condition. Examinations are made to be certain that tanks and pipes are free of debris and motors have the correct rotation and will start. The more carefully this job is done, the fewer problems will be experienced when the plant operation starts. All this has to be done under careful supervision and with due concern for the Contractors still on the job. Procedures should be established for volumetric checks of flow meters as tanks are filled.

It must be emphasized to the operations staff that the success of the operation depends on them. Their job is to operate the equipment, to clean pumps when required, to open valves, to close valves, to clean up, to dirty the place again while cleaning a pump, and to clean up the floor again. Probably some of the automatic control equipment will not operate satisfactorily at first. Without water or sewage, it could not be tested. The staff must understand that the first few days of operation are the most hectic, partly because of untested equipment, and partly because they are inexperienced.

Unusual items will be received at the sewage treatment plant or found in treatment plant equipment as a result of construction. At the time when the operating staff is new and least able to cope with bolts in pumps, clay in primary sludge, and rocks on bar screens, these things will appear. I would not be surprised to find any item in a pipe or tank if it could be fitted into it. Fortunately there is an excitement of the first flow of sewage into the plant which helps to carry the staff through the first few days.

Greasing, oiling, and maintenance must be put on schedule immediately. The Contractor greases and oils before he releases the equipment. The next greasing and oiling must be done by the sewage treatment plant staff. Some greasing will have to be done on the first day of operation. The most effective system is to have a complete list of all equipment and motors, together with the manufacturer's recommendation for greases and oils. Generally this should be reviewed by the company which will supply these items. The required lists of greases and oils can usually be markedly reduced. The major oil companies are glad to provide this service. Maintenance men must have their grease guns at "Ready" when sewage enters the treatment plant.

Spare parts should be purchased, stored and catalogued before the plant starts. There will never be a time when spare parts will be needed more urgently than at start up.

Electrical equipment such as motor overload heaters tend to malfunction in this period due to improper sizing for the conditions. Perhaps the power distribution center is in a warm room and the overload heaters shut off the motor at too low a current.

In this period too, equipment which is being used for the first time invariably produces problems if it is ever going to. Manufacturers will usually assist promptly.

This initial operating stage ends when sufficient equipment can be kept in operation to treat all the sewage all the time with a reasonable effort. With normal duplication of treatment units, this usually occurs in a week or less.

The third stage "Refining Operations" continues forever. A good operation staff is never satisfied with existing conditions. Opportunities are always available to improve operations or to save money in operations or in maintenance.

Early in this stage, the prime objective is to keep the treatment plant operating. Therefore, the maintenance staff first attack mechanical instrumentation, control, and electrical problems which could prevent operation of equipment. The engineer and the equipment manufacturer are generally involved since the guarantee period has not expired.

In general, even if defective, equipment which can be repaired easily and inexpensively by the sewage treatment plant maintenance staff should be repaired by it. Disputes over defective equipment which can be repaired for a few dollars cost many many times the amount in staff time. In addition the staff gets valuable experience when the equipment manufacturer is still readily available.

Defective equipment with large costs for repair must be repaired by the Contractor. Experience has taught me to call the Contractor and equipment manufacturer and at the same time advise the Contractor in writing that the equipment is defective and in accordance with the contract will be repaired by the municipality at his cost if repairs have not been started in the prescribed days.

Problems with equipment which may stop operations are usually cleared up rapidly. When they are, a schedule of testing all equipment, mechanical and electrical, should be started. All pumps should be tested. Pump motor amperage should be determined. Control systems should be checked completely. If an alarm should ring at high level, shut off the pumps and see if it does.

If pumps should start and stop on a schedule, find out if they do. If several pumps are designed to start in series as the wet well rises, place them on automatic control and let the wet well rise. If it will not rise high enough to start all the pumps, manually stop some of the pumps which started at low level. Make volumetric checks on meters. Be certain that solenoids are operating. Try all valves and gates. Try all possible operations no matter how unlikely that they may be used routinely. As these things are being checked initially, set up schedules for checking some of the equipment routinely. For instance an important mechanized by-pass gate should be checked monthly to be certain it will work when needed in an emergency. Automatic standby power which should start during a power failure should be checked monthly by cutting off power.

As these things are being done by the operators and maintenance people, look for improvements. Where could lights be added? Should this valve handle be extended? Should this variable speed motor be speeded up? Should this pump be operated on only one shift. How much chlorine should be added? In short many minor changes will markedly improve operation or minimize maintenance.

This third stage is the most important for the least expensive and most effective operation. It depends on the operation staff.

To all municipal officials and to all voters, to all engineers—proclaim that the sewage treatment plant is only as good as the operation staff.

Of General Interest

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETING

Boston Society of Civil Engineers

NOVEMBER 16, 1960.—A regular meeting of the Boston Society of Civil Engineers was held this evening at the United Community Services Building, 14 Somerset Street, Boston, Mass., and was called to order by President Arthur T. Ippen, at 7:00 P.M.

President Ippen stated that the minutes of the previous meeting held October 10, 1960 would be published in a forthcoming issue of the Journal and that the reading of those minutes would be waived unless there was objection.

President Ippen announced the death of the following members:—

Robert W. Anderson, who was elected a member December 17, 1947, and who died October 4, 1960.

Edward I. Gardiner, who was elected a member April 20, 1927, and who died in April, 1960.

Walter C. Voss, who was elected a member February 15, 1928, and who died November 2, 1960.

The Secretary announced the name of applicants for membership in the Society and that the following had been elected to membership October 17, 1960:—

Grade of Member—Lawrence C. Allen, John C. Chapman, Saul A. Nuccitelli, Robert S. Palmer, Richard L. Savage, Donald Tsiang.

Grade of Junior—Frank H. Barnhill, Jr., Richard T. Farquharson, Benjamin Fehan, Joseph C. Hohmann, Jr.

President Ippen introduced the guest speaker of the evening, Gordon M. Fair, Abbot and James Lawrence Professor of Engineering and Gordon McKay Professor of Sanitary Engineering, Harvard University, who gave a most interesting illustrated talk on "Publish or Perish—The Survival of Civil Engineering as a learned Discipline.

The meeting was preceded by a dinner and thirty-two members and guests attended the dinner. Seventy members and guests attended the meeting.

The meeting adjourned at 8:30 P.M.

CHARLES O. BAIRD, JR., *Secretary*

DECEMBER 14, 1960.—A Joint Meeting of the Boston Society of Civil Engineers with the Structural Section, BSCE was held this evening at the United Community Services Building, 14 Somerset Street, Boston, Mass., and was called to order by Vice President James F. Brittain, at 7:00 P.M.

Vice President Brittain announced that the Minutes of the previous meeting held November 16, 1960 would be published in a forthcoming issue of the Journal and that the reading of those minutes would be waived unless there was objection.

The Secretary announced the names of applicants for membership in the Society and that the following had been elected to membership December 14, 1960:—

Grade of Member—Peter A. Kahn, Charles A. Pickering, Jr., Evan A. Wilder.

Grade of Junior—Anthony Antoniello, John J. Cochrane, Richard L. de Neufville, Richard B. Lynds.

Vice President Brittain stated that this was a Joint Meeting with the Structural Section and called upon Paul S. Crandall, Chairman of that Section to conduct any necessary business.

Vice President Brittain introduced speaker of the evening, Prof. Roland S. Greeley, Assoc. Prof. of City Planning, M.I.T., who gave an interesting talk on "A City Planner Looks at the Urban Explosion". Discussion followed the talk.

Fourteen members and guests attended the meeting.

The meeting adjourned at 8:30 P.M.

CHARLES O. BAIRD, JR., *Secretary*

STRUCTURAL SECTION

NOVEMBER 9, 1960.—The meeting was called to order at 7 P.M. Myle J. Holley, Jr. presided in place of Paul S. Crandall who was recovering from an illness.

Albert G. H. Dietz professor of structural engineering at M.I.T., spoke on the structural metals section of the Boston Building Code which is now in process of revision. Professor Dietz stated that the full committee of this code revision has held some sixty meetings since the original committee was organized in 1955 and that the draft of its work was published in the July 1960 Journal of the Boston Society of Civil Engineers. He called for discussion from the floor on the various code items, noting that Compression Members, Combined Stress, Plate Girders and Gross and Net Section were revised somewhat more than other parts of the Code.

There was discussion from the floor about some of the new types of steel which are now available and the possible desirability of including them in the revised Code. Further discussion pointed out the need for "type" identification marks on structural steel, a practice which has already been started on concrete reinforcing bars.

Professor Dietz called attention to the enlarged section on compression members, commenting that much of the material was based on findings of the Column Research Council. In discussion, William LeMessurer told of a building failure in Toronto, the cause of which was confirmed in a relatively short time through application of the principles of the new information in the section on compression members. In further discussion, someone else suggested that serious consideration might well be given to seeking early adoption of revised codes.

The meeting adjourned following a standing round of applause for Professor Dietz and the Code Committee. The present Code Committee on Structural Metals consists of J. M. Biggs, O. G. Julian, H. S. Gillis, W. J. LeMessurer, W. F. Pike, J. Wolozin and A. G. H. Dietz, Chairman. D. Mathoff of the office of the Building Commissioner has acted as secretary.

Forty-five members and guests were present.

E. N. SMITH, *Clerk*

DECEMBER 14, 1960.—President Arthur T. Ippen opened the meeting and, following membership announcements, turned the meeting over to the chairman of the structural section, Paul S. Crandall. Mr. Crandall introduced the speaker, Roland S. Greeley, associate professor of city planning at M.I.T., whose subject was "A City Planner Looks at the Urban Explosion".

The speaker projected several images of metropolitan Boston as it might appear in the year 2000. He said that by the year 2000, very likely over one half the city will have been rebuilt and the population will have grown by one third. All of the growth could occur within the area of Route 128, he said. This could happen if there were re-centralization with the core city planned, as in downtown Manhattan. Another way growth could spread, would be as it has in the past decade, on a "spread-out" basis, until it reaches the proposed highway 495 which is to run approximately past Lowell, Littleton, and Marlboro. A third alternative is the concentrated centers type of growth: a center radiating from downtown Boston together with a belt radiating from Route 128. The speaker noted that the fourth and probably most desirable way, would be for expansion to take place in concentric circles in outlying satelite cities, as for example, Brockton, Lowell, or Lawrence. The optimum population of these proposed cities is between one and two hundred thousand, he said.

Professor Greeley discussed means of fostering improved quality and efficiency in urban growth, stressing the need for communities to get together; particularly, the need for the formation of a Metropolitan Boston planning group. Boston is now the largest city in the country without a metropolitan planning agency, he said. Following a question and answer period the meeting adjourned at 8:45 P.M.

E. N. Smith, *Clerk*

SURVEYING AND MAPPING SECTION

October 26, 1960.—The regular October meeting of the Surveying and Mapping Section was called to order by Harry R. Feldman, at 7:20 P.M. The chairman, Mr. Feldman announced that he was preceding with plans for the January meeting and would welcome any suggestions from the members with respect to programs for the April and May meetings. The May meeting will be a joint meeting with the Parent Society. Since there was no further business to be discussed on this occasion, the chairman introduced the speaker of the evening, Mr. Loring P. Jordon, Jr., a partner in the lw firm of Rachemann, Sawyer & Brewster, who spoke on the subject of "Water Front Property Lines". The informal talk was accompanied by a distribution of some very interesting written material on the subject which was prepared especially for this meeting by Mr. Jordan. A lengthy discussion period followed the presentation and the meeting was adjourned at 8:35 P.M.

The meeting was attended by fifteen members and guests.

Roy L. Wooldridge, *Clerk*

HYDRAULICS SECTION

May 4, 1960.—The meeting was called to order by John B. McAleer, Chairman of the Section at 7:10 P.M. The minutes of the previous meeting were read and approved. The meeting was held in the Hydrodynamics Laboratory of MIT. The Chairman then called upon Dr. Arthur T. Ippen, President of the BSCE to make comments on a proposal that the Hydraulics Section sponsor a special lecture series for the membership. Dr. Ippen cited the recent lectures on reinforced concrete design held at Northeastern University which had to be given in two sessions because of over 500 inquiries. He noted that the last lecture series sponsored by this section was in 1950. It was suggested that the executive committee should give further attention to this matter.

Professor James W. Daily, Past Chairman of the Hydraulics Section reported briefly on a questionaire on the need for a lecture series which was distributed at several meetings of the Section during 1958-59. Only 15 replies were received, however, all were in favor of some form of special lectures.

The Chairman then introduced the speaker of the evening, Dr. James W. Daily, Professor of Hydraulics, MIT, whose paper was entitled, "Dilute Fiber Suspensions in Shear Flows".

Professor Daily discussed the interest of the pulp and paper industry in the effect of fibers suspended in water on the flow characteristics in conduits. The fibers form non-Newtonian solutions whose behavior differs markedly from that of pure liquids. A research program at the Hydrodynamics Laboratory has undertaken to study pressure drop, velocity distributions, and turbulence distributions in circular pipes.

One interesting result is that for a wide range of turbulent flows the resistance of fiber suspensions is less than that for pure water at the same flow rates.

In the discussion, similar problems arising in bottom fluff layers in harbors and estuaries were mentioned.

The formal meeting adjourned at 8:25 P.M. to permit an inspection and demonstration of the various research projects in the Hydrodynamics Laboratory which lasted for approximately one hour.

The attendance at the meeting was 26.

DONALD R. F. HARLEMAN, *Clerk*

NOVEMBER 2, 1960.—The meeting was opened in the Society rooms at 7:15 P.M. by Professor L. Neale acting in the absence of the Chairman, John B. McAleer. The minutes of the previous meeting were read and approved. Professor Neale then introduced Mr. Manuel A. Benson, Hydraulic Engineer, U.S. Geological Survey, Washington, D.C., whose paper was entitled "Flood Frequency Analyses".

Mr. Benson discussed the relation of peak discharges of streams to hydrologic (topographic and climatic) basin characteristics. He stressed the need for information on the variation of flood peak experience from place to place. The New England region was chosen for this study by the U.S.G.S. The BSCE reports on peak discharges of 1936 and 1942 were reviewed as well as other published analysis of peak floods.

Stations with a minimum record of ten years (164 in all) were used; of the total group 22 stations had recurrence intervals of 300 years.

Mr. Benson concluded his talk with a graphical analysis of the effect of the following variables on peak discharges.

1. Drainage area
2. Channel shape
3. Storage area—lakes and ponds
4. Rainfall—intensity and frequency
5. Temperature—January degrees below freezing
6. Orographic factors

An exponential formula has been derived on the basis of the above variables giving the peak discharge as a function of recurrence interval for New England.

A lively discussion period followed the paper and the meeting was adjourned at 9:00 p.m. The attendance was 35.

DONALD R. F. HARLEMAN, *Clerk*

ADDITIONS

Members

Lawrence C. Allen, 57 Tappan Street, Melrose 76, Mass.

Robert E. Cameron, 118 Coronation Dr., Dedham, Mass.

John C. Chapman, 383 Main Street, Hingham, Mass.

Robert J. Hanson, 319 Lowell Street, Wakefield, Mass.

Agnes A. L. H. McLaughlin, 9 Winnisimett Ave., Wakefield, Mass.

Ernest R. Leffel, 29 Shirley Road, Needham, Mass.

Robert S. Palmer, Bunker Lane Farm, Durham, N.H.

Charles A. Pickering, 51 Francis Ave., W. Bridgewater, Mass.

Richard L. Savage, 157 Mt. Vernon St., Arlington, Mass.

Peter A. Kahn, 188 Derby St., Newton 65, Mass.

Donald Tsiang, 109 Russell Road, W. Newton 65, Mass.

Evan A. Wilder, 37 Normandy Road, Lexington 73, Mass.

Juniors

Anthony Antonelli, 12 Ryan Place, Swampscott, Mass.

Alexander A. Bove, Jr., 25 Broadway, Quincy, Mass.

Frank H. Barnhill, Jr., 45 Florence Ave., Arlington 73, Mass.

James F. Duffy, 273 Squantum St., No. Quincy, Mass.

Benjamine J. Fehan, 14 Lafield St., Dorchester 22, Mass.

Richard T. Farquharson, 44 Caughey St., Waltham 54, Mass.

Joseph C. Hohmann, Jr., 38 Cass St., W. Roxbury 32, Mass.

Richard de Neufville, 428 Memorial Dr., Cambridge, Mass.

Deaths

Robert W. Anderson, Oct. 4, 1960

Armand W. Benoit, May 15, 1960

Edward I. Gardiner, April, 1960

Benjamin W. Guppy, July 10, 1960

Kenneth M. Kelley, Sept. 22, 1960

Walter C. Voss, Nov. 2, 1960

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