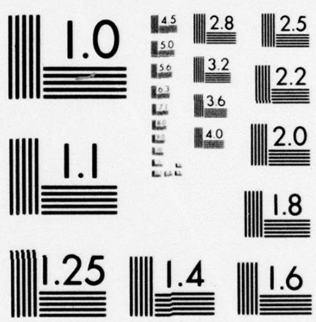
AD-A056 743 INSTITUTE FOR WATER RESOURCES (ARMY) FORT BELVOIR VA F/G 13/2
EMPIRICAL INVESTIGATION OF THE EXISTENCE AND MAGNITUDE OF A COM--ETC(U)
SEP 77 D A MOSER, C A BERRY

UNCLASSIFIED IWR-RR-77-R3 NL

1 OF 2
AD
A056743



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

LEVEL II

EMPIRICAL INVESTIGATION OF THE EXISTENCE AND MAGNITUDE OF A COMMERCIAL AND INDUSTRIAL AFFLUENCE FACTOR

A REPORT SUBMITTED TO:
U.S. ARMY ENGINEER INSTITUTE FOR WATER RESOURCES
KINGMAN BUILDING
FORT BELVOIR, VIRGINIA 22060

SEPTEMBER 1977

RESEARCH REPORT 77-R3

EMPIRICAL INVESTIGATION OF THE EXISTENCE AND MAGNITUDE OF A COMMERCIAL AND INDUSTRIAL AFFLUENCE FACTOR

A Report Submitted to:

U.S. Army Engineer Institute for Water Resources
Kingman Building
Fort Belvoir, Virginia 22060

by

David A. Moser
Charles A. Berry

of

U.S. Army Engineer Division, Ohio River
Cincinnati, Ohio 45201

SEPTEMBER 1977

IWR Research Report 77-R3

Copies may be purchased from:

National Technical Information Service
U.S. Department of Commerce
Springfield, Virginia 22151

IWR-RR

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(14) REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER IWR-RR- IWR Research Report 77-R3	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER (9)
4. TITLE (and Subtitle) (6) Empirical Investigation of the Existence and Magnitude of a Commercial and Industrial Affluence Factor		5. TYPE OF REPORT & PERIOD COVERED Final rept.
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) David A. Moser Charles A. Berry		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer Division, Ohio River Cincinnati, Ohio 45201		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (11)
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Engineer Institute for Water Resources Kingman Building Fort Belvoir, Virginia 22060		12. REPORT DATE Sep[redacted]r [redacted]77
		13. NUMBER OF PAGES 85
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (12) 103p.		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Benefit-Cost Analysis, Flood Control Benefits, Flood Damages, Damage Functions

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Corps of Engineers flood control studies have normally included an upward adjustment in flood damages to reflect the impact of increasing real income. Thus it is alleged that the increases in real income tend to result in increasing real value of property and contents in the flood plain. Current regulations restrict the application of an affluence factor to contents of residential property and provide limits to its use. →

DD FORM 1473, 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

405 728

B

This investigation explores two sources of data which potentially could be used to construct indicators of long-run changes in damageable value of commercial and industrial property and contents. This report finds that aggregate national data sources do not permit a consistent indicator of shifts in the real value of commercial and industrial property and contents. Further investigation of two areas for which the Corps had conducted several flood damage studies reached inconclusive results for two important reasons. First, the composition of commercial and industrial occupancy of flood plains rapidly shifted and second, repetitive flood damage surveys rarely resurveyed property previously surveyed, preferring to concentrate on development originating since the last survey. Thus the time series data was faulty for use in constructing indices.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

SUMMARY AND CONCLUSIONS

Purpose

The purpose of this study was to determine the empirical basis for the existence and magnitude of a commercial and industrial "affluence factor." The "affluence factor," as developed by the U.S. Army Corps of Engineers, was intended as a proxy for the unknown future growth rate in the real value of the capital stock and flood damages of activities located on flood plains. The use of this factor enabled the Corps to project the real value of expected future flood damages that would be prevented by proposed flood control projects. The value of the "affluence factor" used for particular areas was determined by assuming a one-to-one relationship between the growth in the real value of capital stock (and flood damages) and independent projections of economic growth parameters for the wider study area.

Overview of Methodology

The current research was designed to evaluate the validity of applying the "affluence factor" to existing flood plain commercial and industrial establishments. Using the factor on existing establishments implies that these firms increase the intensity of usage of their buildings over time. Therefore, this study concentrated on testing the "affluence factor" hypothesis by attempting to measure the increases in the real value of the capital equipment and inventories (i.e., capital contents) of commercial and industrial firms relative to the labor factor of production under the historical conditions of rising national income and changing technology.

One approach used in determining trends in capital utilization and the subsequent rise in real capital stock values was to determine, through the investigation of capital deepening, the change that establishments have undergone. The study was initiated with an examination of past trends in the real value of capital contents of commercial and industrial establishments independent of flooding hazard locations. The particular measures examined were intertemporal changes in the estimates of capital contents-labor ratios and capital contents per establishments averages. These values were calculated for each year between 1958 and 1971. It was expected that the rate and, possibly, direction of change in these values would vary from industry to industry; therefore, disaggregated industry data, deflated to 1969 prices, were used in the empirical investigation. Also, the effects of depreciation on the ratios calculated were determined by using estimates of the real value of both net and gross stocks of capital contents.

The average industry trends generated by the analysis of the national data, however, may not have been experienced by every establishment at all locations. To explore this likely possibility, the second stage of this study concentrated on the direct evidence of changes in the real value of the stock of capital contents and capital contents-labor ratios experienced by individual commercial and industrial establishments located on specific urban flood plains. Using Corps of Engineers flood damage survey data, gathered in the same geographical area, covering the same firms and collected in different years, direct evidence of a commercial and industrial "affluence factor" was, at least theoretically, attainable. The primary interest of this study was measuring changes in the real value of capital contents, assuming no changes in plant size. Therefore, the effect of new plants or plant additions had to be separated from capital expansion within existing plants. This was attempted by examining changes in the real value of capital contents to real value of building ratios. A rising capital contents to building ratio was considered evidence of more intensive building utilization. As with the national data, interindustry variations in growth trends were analyzed.

Once the growth trend experienced by firms located on flood plains had been determined, comparisons between the national and local experience were made. If similarities in growth trends were revealed in both analyses, a basis would exist for using the more complete national estimates of future capital growth to predict the expected future local conditions.

Findings and Conclusions

Deficiencies in capital equipment stock estimates prevented an empirical analysis of the commercial sector. The industrial sector, however, was explored using 73 manufacturing industries. The measured magnitude of the changes in the capital contents-labor ratios, over the 1958-1971 period, varied from industry to industry. In addition, the ratios for most of the industries did not increase (or decrease) continuously over the study period. The overall trends, however, did indicate that capital deepening had occurred in most of the manufacturing industries. This generalization characterized the capital contents-labor ratios whether the ratio numerator included net or gross stocks of capital contents. These findings did not necessarily imply that the effects of an "affluence factor" had been revealed. It is important to note that each national ratio calculated was an average for an entire industry. Each industry was composed of hundreds and thousands of individual establishments in many different locations in the United States. The findings suggested that the production processes used in each industry had changed to more intensive use of capital. The national data, however, does not necessarily reflect the experience in any particular firm at any specific location.

The investigation of the changes in the real value of capital contents of firms located on flood plains encountered even greater data scarcity than the national investigation. Data for this study came from Corps of Engineers flood damage surveys. The factor limiting data from several locations was that only one survey had ever been taken in most locations. This necessitated relying on a single flood plain, Mill Creek at Cincinnati, Ohio, for the basic data to test the affluence factor hypothesis.

Analysis of the data indicated that the real value of the total stock of capital contents and buildings of firms located on the Mill Creek flood plain had increased. These changes, however, were not shared evenly among all firms and sectors surveyed. Some establishments even experienced a decline in the real value of capital stock. The calculated capital contents-labor ratios indicated that there might be some trend increase. Since these observations were based on a small sample of firms and on measurements in only three years, the overall evidence for an affluence factor was, at best, inconclusive.

Comparisons between the national and local data were all but impossible to make. In terms of capital contents-labor ratios, the national experience was mirrored, to some extent, by some of the local industries. The local data deficiences, however, did not allow for a meaningful comparison between the local and national growth trends. The evaluation of the validity of applying national growth parameters to project economic growth in a particular area cannot be made without a more extensive local data base and test.

The overall evidence from this study indicated that the economic development of flood plain industries should not be considered as static. The level of participation of a geographically small area in the national growth process, however, cannot be conclusively demonstrated by this study.

Recommendations

The findings and conclusions of this study indicate the need for a more complete understanding of the interrelationships between national and local economies. If the desire is to predict the economic growth of an area, the predictive model should include both the area's regional and national economic linkages and the local area's economic peculiarities. One of the basic assumptions in using an "affluence factor" is that the activities located on flood plains will undergo the same changes as those predicted for the larger economic area, of which the flood plain is only a part. This study has not been able to conclusively demonstrate that this assumption is valid. Therefore, one recommendation from this study is that any future research into flood plain growth should include a more complete investigation of the flood plain economy and the interrelationship between the local, regional, and national economies. This should provide not only a better understanding of the growth processes of the area, but also a closer approximation of future economic growth that could be expected in a particular area.

One problem that will be encountered in future research into the economic growth processes of flood plains is the lack of continuous, comparable, easily usable data representing a flood plain economy. The use of direct interviews and secondary data, such as property tax records and industrial directories, is one possible alternative. The Corps of Engineers should also develop a flood damage survey form, a data collection procedure and a methodology for data use that is standardized Corps-wide. The data should be collected on a regular basis and compiled in a form that would facilitate easy comparisons between surveys and allow for analysis by automatic data processing techniques. A data base of this type would prove invaluable in understanding a complex urban flood plain economy affected by a proposed flood control project.

The recommended flood damage survey form should include:

1. The location of the establishments by coordinates on a reference grid of the study area.

2. The identification of the establishment by the appropriate SIC code.

3. The value and damage data separated into structures, equipment, and inventories.

4. The damage data in 1-ft. increments above the floor elevation.

5. The elevation of the basement and first floor.

6. Current sales and employment data.

7. Data on past levels of sales, employment, and capital stock.

The recommended flood damage survey procedures include:

1. The initial delineation of the flood plain areas to be surveyed should be made to eliminate inclusion of off-flood plain establishments.

2. All commercial and industrial establishments on the flood plain should be included in the survey.

3. A single measure for the value and damage data should be adopted Corpswide. Alternative measures are market value, broker value, net depreciated value, and replacement value.

The implementation of the revised survey form and data collection procedures should include an instruction manual as a reference for all Corps of Engineers interviewers. This manual should include a detailed analysis of the standardized survey methodology. In addition, it should contain the definitions of the data measures used in the survey and the importance of accurate and complete data collection.

COMMERCIAL AND INDUSTRIAL AFFLUENCE FACTOR

Background of the Problem

The U.S. Army Corps of Engineers has planned and constructed flood control projects on a large scale since the 1930's. In planning and evaluating projects, the Flood Control Act of 1936, [Public Law No. 738-74th Congress, H.R. 8455], provided that "the Federal Government should improve or participate in the improvement of navigable waters or their tributaries . . . for flood control purposes if the benefits to whomsoever they may accrue are in excess of the estimated costs . . . ." A project is considered feasible for construction recommendation if the present discounted value of the stream of expected future benefits from the project is greater than the present discounted value of the stream of expected future costs.

The benefits which can be attributed to a flood control project can be classified into any of three categories. These benefits, as defined in ER 1105-2-351, page 2-2, paragraphs 2-4a, b and c, are:

a. Inundation Reduction Benefits. An activity uses the flood plain exactly the same with and without a plan. The benefit is the increase in net income to the flood plain activity. (2-4a).

b. Intensification Benefits. A commercial, industrial, or agricultural activity on the flood plain modifies its operation because the reduction in potential flood damages makes it profitable to do so. The benefit is the increased net income to the activity and land owner comparing current and previous methods of operation. (2-4b).

c. Location Benefits. An activity uses the flood plain with a plan but not without, as a result of the reduction in potential flood damages. The benefit is the difference in net income to the new activity comparing the flood plain site to the alternative off-flood site which would be used without the plan less the difference in net income for the activity displaced by the new activity. (2-4c).

The projection of future benefits from the flood control project is limited to the first 50 years of project life. The most directly measurable benefit is from inundation reduction; however, in the evaluation procedure to determine this benefit it must be assumed that existing flood plain activities are static. The only change in activity allowed would be that caused by the implementation of the flood control plan. This restriction eliminates changes that would occur with and without the plan. Therefore, benefits from more intensive use of flood plain sites by existing activities, that occur even without the flood control plan, cannot be used in the calculation of expected future benefits.

If the activities existing on the flood plain can be expected to more intensively use their sites, even without the flood control plan, using the above method to calculate expected future benefits will result in an underestimation of the true benefits from the plan.

The focus of this research effort is to appraise the total benefits from more intensive site use. The problem is estimating the growth over time in the real value of the stock of property and contents of firms and activities currently located on the flood plain. This research is an attempt to measure only that real value growth which would take place with and without a flood control plan.

Prior to late 1973, the method for projection of the growth in these stocks was through the use of an affluence factor. Use of this factor necessitated assuming a linear relationship between the growth in the real value of capital stock and independent projections of economic growth parameters for the study area.

Three affluence factors were utilized in this process. Use of the residential affluence factor required assuming that the real value of residential structures and contents would grow at the same rate as the projected growth in the area's per capita real income. The commercial affluence factor was also related to the rate of growth in area per capita real income. Use of the industrial sector's affluence factor necessitated assuming that the real value of structures and contents in manufacturing establishments could be expected to grow at the same rate as the area's real growth in total manufacturing output.

The Affluence Factor Task Group

In late 1973 the Office of Management and Budget (OMB) returned to the Office of the Chief of Engineers a Corps of Engineers report on a proposed project for Cottonwood Streams, Idaho, indicating that the affluence factor could no longer be used in the estimation of potential future benefits from proposed projects. As a result, the Project Analysis Task Group was established in the Planning Division, Directorate of Civil Works, Office of the Chief of Engineers, in February 1974. The mission of this task group was to develop a procedure to evaluate the effects of the affluence factor on future flood control benefits. Essentially, they were to investigate the empirical basis for the existence and approximate magnitude of the affluence factor and to develop specific guidance for its use.

For the residential affluence factor, the task group investigation concentrated on three relationships:

a. The relationship between content value and structure value.

b. The relationship between changes in the real value of residential structures and changes in real incomes of home buyers.

c. The relationship between changes in the real value of residence contents and changes in real income.

The Task Group's research was concentrated on investigating trends in these three relationships by analyzing national and regional data. These were the study conclusions:

a. Based on insurance company estimates, the average value of household contents (food, clothing, furniture, and household equipment) usually represents approximately 20-25 percent of the value of the residential structure.

b. Examination of the real value of residential structures over time does not support the hypothesis that these structure values are increasing.

c. Real value of the net stock of household contents has been increasing at a more rapid rate nationally than per capita income. The OBERS* projected rate of per capita income growth for a region, in which a flood control plan is proposed, can be used to project content value and flood damages to contents of residence structures. The limit on projected values to contents was set at 75 percent of the value of the residential structure. This affluence factor can be applied to existing and future development units for residential property only.

The task group was unsuccessful in providing the basis for an affluence factor for commercial and industrial property. Instead, it was decided that this factor would be accounted for by determining the value of new development in commercial and industrial property.

Based on task group research, the use of the affluence factor in the evaluation of future inundation reduction benefits to residences was approved by the Office of Management and Budget (OMB). Chapter 5 of ER 1105-2-351, (13 June 1975). covered the procedures for applying the residential affluence factor. The factor can be applied only to existing and future residence categories located on urban or urbanizing stream reaches (5-2a). For existing development, the OBERS[1] regional growth rate for per capita income is the base value by which the real value of residential contents can be increased over time to account for the future effects of increased affluence. The affluence factor can be applied to projected future new residence units as they are added. The projected value of the real contents in residential structures is limited to a maximum of 75 percent of the structure value. In addition, the factor cannot be applied over any period longer than the first 50 years of the project (5-4f,1 and 2). In estimating future potential flood damages, it is assumed that there is a one-to-one relationship

---

[1]Office of Business Economics (now the Bureau of Economic Analysis) of the Department of Commerce and the Economic Research Service of the Department of Agriculture.

between future increases in household contents value and the value of future damage to the contents (5-4f,3). The residential affluence factor, based on changes in per capita real income, cannot be applied to commercial or industrial categories of flood plain activities because increases in the real value of commercial and industrial property can accrue only from expansion of existing units or by the construction of new units. Since both of these value changes involve new construction, they are to be evaluated as new development units.

The regulation reflects the task group's inability to provide the empirical justification for a commercial and industrial affluence factor. This stems from data deficiencies at both a regional and national level. A further complication results from the makeup of the commercial and industrial sector. Compared to the diversity in sizes and methods of operation characteristic in this sector, the residential sector is almost homogeneous. This homogeneity makes generalizations about the residential sector much more plausible than those about the commercial or industrial sector. The continued desire of the Corps to find out whether or not a commercial and industrial affluence factor exists resulted in this current research.

Outline of Work

In July 1975, the U.S. Army Institute for Water Resources contracted with the U.S. Army Engineer Division, Ohio River, Cincinnati, Ohio, under Contract No. VW8120326000000, to undertake the investigation of the existence of the commercial and industrial affluence factor. (See Appendix 8)

The goal of this project was to "develop guidance and empirical data to support the projection of changes in unit flood damage values for commercial and industrial property." The specific question to be answered was whether commercial and industrial firms, located on flood plains, have in the past made net additions to stocks of property so as to increase the real value of their buildings and contents. If this could be shown, the next step was to demonstrate a relationship between this growth and economic parameters which have been projected for the study areas. The final result of the project was to be the delineation of a methodology to be used in projecting future changes in the real capital stocks of commercial and industrial units and future potential flood damages to these stocks.

The outline of work included the following specific empirical investigations with the final product being an ER describing the procedure to implement a commercial and industrial affluence factor. The final task assumed that the existence of the factor could be supported by national and local data analysis. The research tasks included:

<u>TASK 1. The examination of national data to determine the influence of capital deepening on the damage potential of commercial and industrial property</u>. This task was designed to investigate the trends in sectoral capital-labor ratios and interpret any trends concerning the growth in capital stock and flood damage potential. Implications of the national trends on the local experience were to be inferred.

TASK 2. The examination of existing and historical flood damage surveys to determine changes in real damage value to commercial and industrial property. This task required investigation of trends in the value of capital stocks and flood damages to these stocks. Data were to be gathered from flood damage surveys. It was believed that these trends would offer direct evidence of the existence and magnitude of the commercial and industrial affluence factor. Also, examination of the flood damage surveys would provide an identification of types of establishment located on flood plains.

TASK 3. The comparison of national data and flood damage survey data through the use of correlation and other associations. This task necessitated investigation of regularities and differences between the national growth experience and the growth experience of commercial and industrial establishments on flood plains. This comparison would help identify any unique characteristics that could be attributed to an establishment's flood plain location.

EXAMINATION OF THE GROWTH IN THE REAL VALUE OF CAPITAL STOCK AT THE NATIONAL LEVEL

The investigation began by examining past trends in the value of the capital stock of commercial and industrial sectors independent of flooding hazard locations. In particular, the goal was to determine whether establishments in these sectors had experienced growth in the real value of their net stock of capital equipment and inventories. Increased capital-labor ratios were used as evidence of these changes.

These changes could be caused by several influences. One cause might be an increase in desired capacity output in response to rising aggregate demand. Other things being equal, this would necessitate a rise in the use of all the factors of production, including capital stock. A second influence might be capital using, labor saving, technological change. If an establishment takes advantage of the new technology, the capital-output and capital-labor ratios could be expected to rise. Even if existing establishments do not utilize technical change, one would expect that new establishments would take advantage of the "best practice" technology. Therefore, as new establishments are added to and old establishments leave the industry, one would expect capital-output and capital-labor ratios to rise over time. A third cause would be changes in the relative prices of capital and labor. If the price of capital falls, relative to the price of labor, one would expect the substitution of capital for labor both in the existing production processes (where possible) and through the adoption of capital using technologies. This would result in rising capital-output and capital-labor ratios.

One limitation of national data is that all capital-labor and capital-output ratios derived represent an average for a whole industry. This average includes many vintages of establishments and technologies. One would expect the average to move in the same direction as "best practice" technologies. Changing average values will result from old technology establishments leaving the industry, new technology establishments being constructed, and old technology establishments modernizing. Thus, the average is the mean for the entire industry and does not represent the conditions or trends of any individual establishment in any region.

Capital Deepening

One approach to determining trends in capital utilization and subsequent rise in capital stock values is to determine, through the investigation of capital deepening, the changes which establishments have undergone. Conceptually, capital deepening in commercial and industrial sectors occurs as the amount of capital stock per employee increases in real or constant dollars.

Growth in an industry's capital-labor ratio can occur under several possible situations:

a. The capital stock could grow faster than employment.

b. The capital stock could remain constant while employment declined.

c. The capital stock could decline but at a slower rate than employment.

Conceptually unique, the actual practice is that all of the above conditions could have occurred in an industry at the same time but in different establishments. However, as mentioned above, trend movements in the average capital-labor ratio in a particular industry would indicate changes in the "best practice" method of operation of individual plants. For existing firms to remain competitive with technological change occurring, they would either have to upgrade their productive facilities or eventually leave the industry. If this technological change necessitates more and better capital stock per employee, a firm could modernize in any one or combinations of the following ways:

a. A firm could build a completely new plant at a new site. It would be expected that new plants would embody the "best practice" quality and quantity of equipment. For capital deepening to occur in a firm, there must be more capital per unit of labor in the new plant than in the existing plant. If the capital-labor ratio of the new plant is greater than the current industry average, the entire industry average capital-labor ratio will rise.

b. A firm could expand an existing facility. Again, assuming no other changes in the industry, the expanded plant must have more capital per unit of labor than the industry average for the industry capital-labor ratio to grow.

c. A firm could replace wornout or obsolete equipment with "best practice" machinery and equipment. In this case, there is no expansion in plant size. The industry average capital-labor ratio would grow if the plant's new capital-labor ratio is greater than its old. It should be recognized that firms rarely replace all of the equipment and machinery at one time in an operating plant. Rather, modernization of existing plants is usually an incremental procedure.

d. A firm could simply add more and newer equipment to existing facilities. This results in more intensive use of the plant by filling in nonproductive space with capital and labor. For this to result in a rise in the industry capital-labor ratio, the incremental capital-labor ratio must be greater than the industry average.

These same situations could occur in industries which are experiencing stagnation or a net decline in their capital stocks. The industry capital-labor ratio could still be growing if the effect of the other economic forces noted above result in a tendency toward more capital per worker. Also, firms may leave an industry. If their capital-labor ratios are below the industry average, the average will rise when these firms cease operations or change product lines.

It is clear that capital-labor ratios can be interpreted ambiguously in terms of general implications for individual establishments regardless of their location.

Before sources and trends in national data are investigated, measures of capital and labor must be defined. Several alternative measures of the capital stock and formulations of capital stock and formulations of capital deepening can be used in the calculation of capital-labor ratios. Marginal ratios could be ascertained by collecting values of additions to the capital stock and employment in each industry. However, one would expect these ratios to exhibit considerable variability with negative as well as positive values. Because of these expected "jumps" in the data, average coefficients have been used in this study. There are still several ways of measuring capital and labor. An all-encompassing measure for the capital stock would be the total stock of structures, equipment and machinery, and inventories of finished products, goods-in-process, raw materials, and supplies. An alternative to this all-emcompassing measure is to calculate separate capital-labor ratios for each of these major components of the total capital stock. This is the most desirable method, as each component will likely change at different rates, exhibit different variability, and possibly move in different directions.

Once the stock is divided into its major components, the implications of using gross or net stock measures of structures and equipment must be explored. The gross stock measures the total amount capital equipment or structures in an industry which is available for production. One would expect a close relationship between gross stock and capacity output; however, the gross stock quantity will contain stocks of many vintages and productive capabilities. The net stock figure is simply the gross stock minus the accumulated depreciation. If it is assumed that the depreciation charges in each year approximate the loss of productive efficiency, one would expect the net quantity to correspond to the actual production by an industry. One would expect that old machinery would not be used extensively except when desired output approaches capacity output. Since the particular depreciation method chosen may drastically alter the derived capital-labor ratios, both net and gross capital stock measures were compiled and analyzed.

Two basic measures of labor can be used in calculating capital-labor ratios. One is average annual employment; the other is total man-hours per year for production workers. Using average annual employment results in capital-labor ratios which indicate the average dollar amount of capital available per employee. Using the total man-hours worked per year by production workers yields a capital-labor ratio with slightly different properties. The man-hour denominator allows this capital-labor ratio to capture the changes in the intensity of capital usage as well as simply the changes in the amount of capital per employee.

National Data: An Overview of Previous Research.

This section summarizes the research completed by other investigators into capital stock estimates and capital coefficients. Although the discussion is not all-inclusive, it does present the principle of problems and findings.

The most ambitious research into the capital stock of the United States was done in the late 1950's. The findings were published by the National Bureau of Economic Research in a series of volumes entitled Studies in Income and Wealth, (5, 6, 7, 12, 14, 19, 20). These volumes presented the conceptual problems of measuring capital stock, methods of estimation, and measurements of productivity and technical changes derived from the data developed. Although the research was wide-ranging, it proved to be somewhat deficient as a data source for examining the evidence of capital deepening. The problems with the data included:

a. All the estimates of capital stock value used were total fixed stock, combining both structures and equipment into one estimate.

b. The empirical investigations concentrated on the manufacturing sector. The amount of manufacturing sector disaggregation into component industries was very limited.

c. Much of the research was concentrated on coefficients showing cross sectional capital output, output labor, and capital-labor ratios. Efforts at measuring the capital stock over a series of years were quite limited.

d. There were no estimates of aggregate capital stock for the years after 1957.

The empirical capital-output ratios generated in the Studies in Income and Wealth series were a basic source of data for Anne P. Carter's book, Structural Change in the American Economy (4). Her work was concentrated on the changes in the total capital-capacity output ratios which occurred between 1939, 1947, and 1958. Carter also found that "most labor coefficients fell more than the corresponding capital coefficients and thus the capital-labor ratio increased in most sectors [between 1939 and 1958]." However, Carter's work was based on direct estimation of the capital-output ratios rather than on developing these ratios from underlying capital stock and capacity output estimates.

Another major research effort to determine the internal capital structure of manufacturing establishments was undertaken by the National Planning Association. In Capacity Expansion Planning Factors, by Waddell, Ritz, Norton, and Wood (26), the authors attempted to estimate factors which would approximate the relationship between the various inputs needed to construct a plant for most manufacturing industries. These factors were the proportion of the total cost of a plant which could be attributed to each of the material, equipment, and labor components necessary to build and equip that plant. They also attempted to measure the relationship between the total capital cost of a plant and its capacity output. These factors were estimated for manufacturing industries typically at the 4-digit SIC code level. The major problem with this study is that it was static. In predicting capital stock changes needed to produce a given change in capacity output, the analysis assumed:

a. No change in the capital-capacity output ratio for the industry over time.

b. No change in the factors over time.

These factors were developed, assuming no technical change, by specifying a fixed relationship between capital and output and also among the components of the capital stock in a particular industry. Also, the factor development required that capacity output expand only through balanced additions to the capital stock (i.e., complete new plants rather than additions). The lack of change provisions in the capacity expansion factors makes the application of the unadjusted 1957 estimates to more recent data a dubious proposition.

These major research efforts offer two important conclusions about the relationship between capital and output and capital and labor. First, for capacity output to increase capital, stock must increase. Second, the relationship between capital and output and capital and labor is not static as assumed by the National Planning Association researchers.

Capital Stock Data Sources

The above research provided no estimate of capital-labor ratios or value of capital stock for any year since 1958. Fortunately, interest in measuring the capital stock in the U.S. has revived. In January 1974, the Bureau of Economic Analysis in the Department of Commerce published Fixed Nonresidential Business Capital in the United States, 1925-73 (24). This volume is essentially a revised and updated compilation of capital stock estimates published periodically in the Survey of Current Business since December 1966. This series includes estimates of the stock of structures and the stock of equipment in 1958 dollars; in addition, the equipment stock is disaggregated by type. The estimates, however, are only disaggregated into three sectors: Farming, manufacturing, and nonfarming nonmanufacturing. This aggregation level nearly masks the structural changes in the various manufacturing industries.

Given the results of the above examination, obtaining more detailed capital stock estimates covering several years became crucial. One potential source was the capital stock series Capital Stock Estimates, 1947-1971, developed by the Mathematics and Computation Laboratory for the Office of Preparedness, General Services Administration. For computing these estimates, the manufacturing sector was disaggregated into 3-digit SIC code industries. The nonmanufacturing sectors were treated at a more aggregated level. The data developed contains both gross and net estimates of the stock of plant and equipment in current and constant dollars for the years 1947-71. These expensive data are available only on magnetic tape from the National Technical Information Service. The Office of Preparedness data were not obtained because two other capital stock data series were available.

The Bureau of Economic Analysis (BEA) was contacted to determine whether more detailed data were available than that previously published. John Musgrave at BEA said that no capital stock estimates at a more disaggregated level were available; however, he said that Daniel Creamer was working on converting the BEA data to a 3-digit SIC industries series. Dr. Creamer was contacted at the Conference Board in New York City and agreed to supply his capital stock data. The Creamer estimates for the period 1953-1965 included both structures and equipment by gross and net stocks in current and constant 1963 dollars. Warned by Dr. Creamer of the potential problems in using the separate equipment and plant data, the estimates were checked for consistency with the gross investment data obtained from the Annual Survey of Manufactures and the Census of Manufactures. It was found that the Creamer data was in compatible with the separate investment data on a year-by-year basis. This inconsistency cast serious doubt on the validity of using the data to examine year-to-year changes.

The only other discovered source of capital stock data was the Interindustry Forecasting Project Group at the University of Maryland, directed by Dr. Clopper Almon, Jr. Dr. Almon is a joint author of the book 1985: Interindustry Forecasts of the American Economy (1). The book reported an attempt to forecast important economic parameters and to investigate projected changes between 1971 and 1985. One of the critical features of the forecasting model was the necessity of estimating past changes in capital stock and capital output ratios. Once these data were derived, they were used to predict structural changes in a 90 sector model of the U.S. economy. Dr. Almon's group was contacted to determine the extent and availability of their capital stock data. Margaret B. Buckler, one of the joint authors of the book, provided the capital data for use in this study, providing the data was not published.

The Almon data included estimates of the equipment stock only, in gross and net terms, by input-output sector, in 1969 dollars for the years 1953 to 1971. Most of the sectors were 3-digit SIC code industries although some sectors contained more than one 3-digit industry. Checking the consistency of the Almon data revealed a close correspondence between the year-to-year changes in the stocks and the gross investment data. These data were the basic source of capital stock estimates used in this investigation into capital deepening.

Sources of Other Data and Adjustments

Several other data series had to be assembled before the calculation of the desired coefficients could begin. A comprehensive value measure of capital contents within structures was developed by adding inventory value to the capital equipment value data. The data for inventories of finished products, goods-in-process, raw materials, and supplies were obtained from the Annual Survey of Manufactures for the years 1959-1962, 1964-1966, and 1968-1971 and the Census of Manufactures for the years 1958, 1963, and 1967. These data were first assigned to the same industry category as the capital equipment data. They were then deflated using the industry wholesale price index, adjusted to a 1969 base, and published in the Survey of Current Business. The adjusted data were then added to the capital equipment data to approximate the total capital content value in each industry.

The employment data in each sector were available from several sources. The primary source for average annual employment data was Employment and Earnings: United States, 1909-1972. These data were augmented by data from the Annual Survey of Manfactures for various years. The man-hour data measures the total man-hours for production workers in each industrial sector in each year. The Annual Survey of Manufactures and Census of Manufactures were the basic sources for the man-hour data; Industry Profiles, 1958-1966 was used as a cross check to fill in any gaps. The most time-consuming procedure was arranging the data into the same industry classifications as Almon's capital equipment stock data.

Data on the number of establishments in each industry were available only from the Census of Manufactures. For the time of the study, there were only 3 years for which data were available detailing the number of establishments: 1958, 1963, and 1967.

Exploring output data sources required a definition of output. One approach was to define output as the value of shipments plus inventory changes. Both of these measures are available in the Annual Survey of Manufactures and Census of Manufactures. One serious limitation in using shipment data at the 2 or 3-digit SIC code level is the extensive amount of cross shipments within industries. This results in an overestimate of actual output using Census and Survey shipment data. The amount of error increases as the amount of specialization within the industry increases. An alternative measure of output is value added data, available in the Annual Survey of Manufactures and Census of Manufactures. A third measure of output can be developed using the Index of Industrial Production compiled by the Board of Governors of the Federal Reserve System. These physical output series are published monthly, seasonably adjusted, in the Federal Reserve Bulletin. However, these indexes are given for only the 2-digit SIC code industries except SIC 208, (Beverages) and SIC 371, (Motor Vehicles and Parts).

The data below cover only the 1958 to 1971 period. Years prior to 1957 were excluded because in that year a revised SIC Manual was issued. In this revision, extensive modifications were made in the manufacturing sector data and classification. Some of the industries in this sector can be traced through the revision; however, historical information prior to 1958 is unavailable for many industries because of the SIC revision.

It should be noted that no sources of capital stock data for the commercial sector could be identified other than at a highly aggregated level. In addition, inventory data for retail establishments is not available on an annual basis. Therefore, at the national level, empirical evidence of capital deepening is limited to manufacturing industries.

Trends From the Basic Data

A closer examination of the trends in the data which underlies the evidence of capital deepening was undertaken. A short summary of the general movements in each of the basic data sets is presented below:

a. Gross capital equipment stock (Appendix 2, Table 1-2, p. 52). All but two industries experienced a rise in the gross stock of capital equipment between 1958 and 1971. As expected, the changes in these data were relatively small. Most sectors experienced almost continuous rises in the value of capital equipment stocks. However, several industries an initial trend decline, then an increasing capital equipment stock value beginning in the mid 1960's; this resulted in a U-shaped change path over time. The two sectors displaying declines were:

24. Wooden Containers.
49. Plumbing and Heating Products.

While sector 49 showed a steady year-to-year decline, sector 24 had steady declines until 1964, a rise through 1967 and then declines through 1971. This resulted in an S-shaped path similar to that shown for Sector 56 in the figure below.

b. Net capital equipment stocks (Appendix 2, Table 2-2, p. 53). All but three of the sectors exhibited increases in net capital equipment stocks between 1958 and 1971. Again, there were distinct specific growth paths including relatively continuous, U-shaped and S-shaped trends. (See Figure 1, below.) In addition, there was generally greater variability in the net stock values than the gross stock values reflecting the effects of depreciation. The three sectors experiencing declines were:

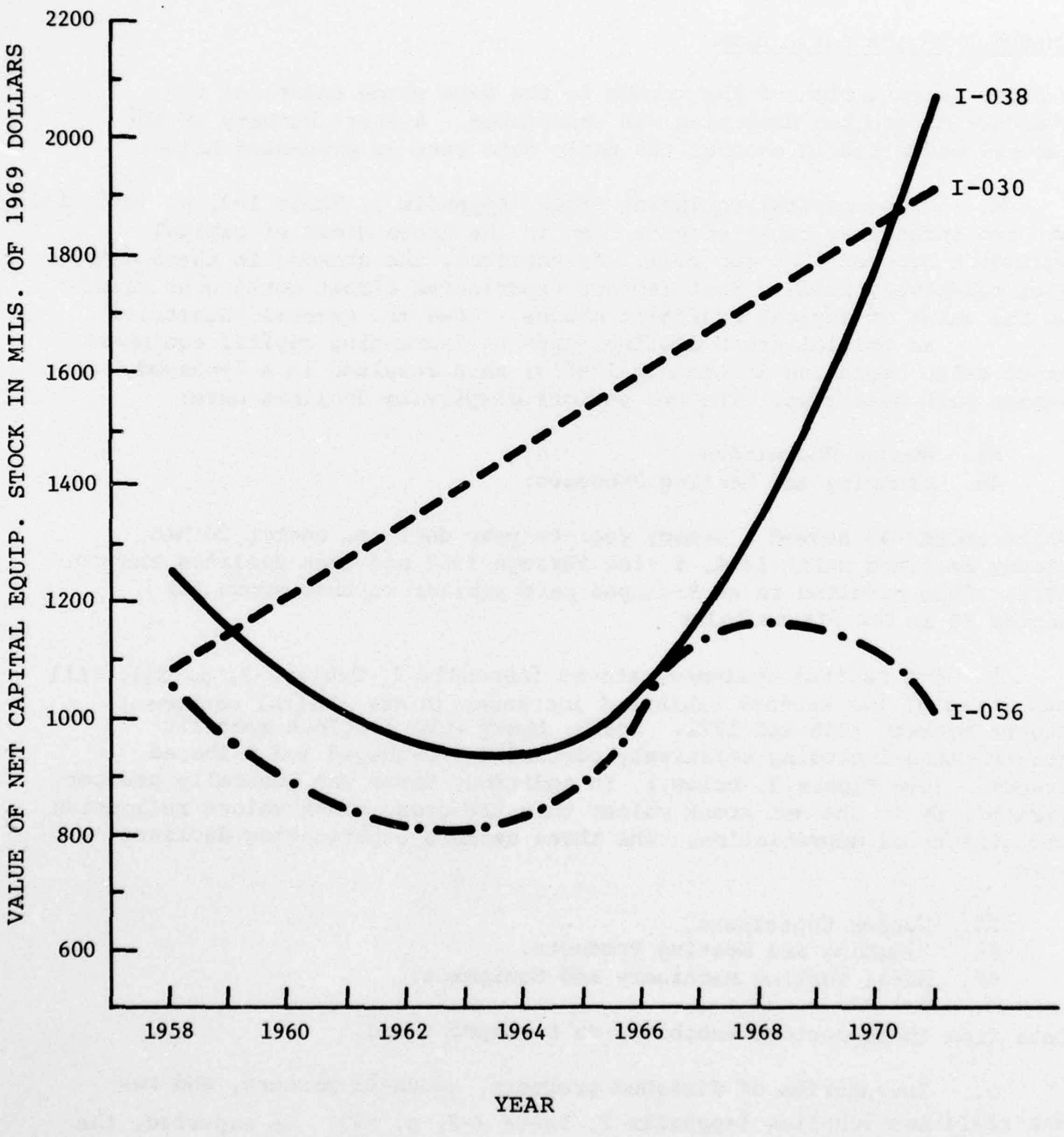
24. Wooden Containers.
49. Plumbing and Heating Products.
56. Metal Working Machinery and Equipment.

Data from these sectors exhibited an S-shaped trend.

c. Inventories of finished products, goods-in-process, and raw materials and supplies (Appendix 2, Table 3-2, p. 54). As expected, the inventory data had considerable year-to-year variability; however, all but five sectors displayed a generally rising trend. Some sectors did experience an initial downward movement resulting in a U-shaped change path. The five sectors exhibiting declines in inventories were:

FIGURE 1

EXAMPLES OF THREE BASIC TRENDS IN NET CAPITAL EQUIPMENT STOCK DATA



10. Bakery Products.
22. Logging and Lumber.
24. Wooden Containers.
42. Leather Tanning and Industrial Leather Products.
75. Engineering and Scientific Equipment.

Inventory decline in these sectors can be attributed to two possible causes: (Either the industry experienced a general decline, or the industries are very sensitive to national income changes.) If the latter is the cause, the choice of years for comparison is very important.

d. Net capital equipment stock plus inventories (Appendix 2, Table 4-2, p. 55). All but two sectors experienced increases between 1958 and 1971. There was the expected variability due to the effect of inventory changes; however, the same time paths, as earlier noted, were evident. The two sectors having declines in total net capital contents were:

24. Wooden Containers.
42. Leather Tanning and Industrial Leather Products.

e. Average annual employment (Appendix 2, Table 5-2, p. 56). Of the 73 manufacturing sectors, 53 experienced rising total employment over the 1958-1971 period. There was relatively little variance from the basic trends except during national cyclical downturns. Most of the 20 declining employment industries had a generally steady downward movement. However, several of these 20 did have bulges in employment during the mid 1960's. The 20 declining employment industries were:

6. Meat Products.
7. Dairy Products.
9. Grain Mill Products.
10. Bakery Products.
11. Sugar.
14. Miscellaneous Food Products.
15. Tobacco.
18. Miscellaneous Textiles.
22. Logging and Lumber.
24. Wooden Containers.
31. Industrial Chemicals.
32. Agricultural Chemicals.
38. Petroleum Refining.
42. Leather Tanning and Industrial Leather Products.
43. Shoes and Other Leather Products.
45. Stone and Clay Products.
46. Iron and Steel.
49. Plumbing and Heating Products.
71. Aircraft and Parts.
75. Engineering and Scientific Instruments.

It should be noted that many of the declining employment industries are concentrated in sectors engaged in the processing of extractive industry output.

f. Production workers' man-hours (Appendix 2, Table 6-2, p. 57). The trends noted in total employment are also evident in the man-hours by production workers measure of labor. One interesting difference is that only 17 industries experienced declines in man-hours. Rising man-hours under condition of falling total employment could have resulted from several factors including: (1) An increasing percentage of production workers as a proportion of total employment, and (2) employees working more hours in sectors having declines in employment. The 17 industries showing declines in total man-hours were:

7. Dairy Products.
10. Bakery Products.
14. Miscellaneous Food Products.
15. Tobacco.
16. Fabrics and Yarns.
18. Miscellaneous Textiles.
22. Logging and Lumber.
24. Wooden Containers.
31. Industrial Chemicals.
32. Agricultural Chemicals.
38. Petroleum Refining.
42. Leather Tanning and Industrial Leather Products.
43. Shoes and Other Leather Products.
45. Stone and Clay Products.
49. Plumbing and Heating Products.
71. Aircraft and Parts.
75. Engineering and Scientific Instruments.

Note that in sector 16 there was a decline in man-hours even though average annual employment increased. In addition, sectors 6, 9, 11, and 46 all had increases in man-hours but not increases in average annual employment.

g. Gross stock of capital equipment plus inventories (Appendix 2, Table 7-2, p. 58). All the industries except two experienced a rise in the gross capital content measure. A few industries displayed U-shaped value time paths, but most showed a generally rising stock of gross capital equipment plus inventories. The two sectors experiencing a decline were:

24. Wooden Containers.
42. Leather Tanning and Industrial Leather Products.

These same two industries had declines in the net capital content value measure.

THE EVIDENCE OF CAPITAL DEEPENING

Several sets of series of capital labor ratios were calculated. Each set of capital labor ratios contains 73 manufacturing industries and covers 14 years from 1958 to and including 1971. The capital deepening data sets are:

a. Dollars of net capital equipment stock plus inventories per employee.

b. Dollars of net capital equipment stock per employee.

c. Dollars of gross capital equipment stock per employee.

d. Dollars of gross capital equipment stock plus inventories per employee.

e. Dollars of net capital equipment stock per production workers' man-hours.

f. Dollars of inventories per production workers' man-hours.

An abbreviated listing of these coefficients is presented in Appendix 3.

The following generalizations can be made about each of these data sets:

a. Dollars of net capital equipment stock plus inventories per employee (Appendix 3, Table 1-3, p. 59). These net capital contents-labor ratios increased in every industry over the 1958-1971 period. However, there were three distinct paths of growth which can be identified:

(1) Fairly consistent growth with only one or two deviations from the basic trend (see industry 60).

(2) A U-shaped path with the capital labor ratio falling from 1958 to the mid 1960's, then rising so that the 1971 coefficient value is above the 1958 value (see industry 59).

(3) Many year-to-year deviations but with a generally rising trend, with some examples of a U-shaped path (see industry 14).

b. Dollars of net capital equipment stock per employee (Appendix 3, Table 2-3, p. 60). Not all industries exhibited increases in these ratios over the period. The industries that did not indicate increases have the same three characteristic paths as the set contents-labor ratio (set a above). The five industries that had decreases all displayed a U-shaped trend; however, the 1971 figures did not regain the 1958 ratio level. The sectors having decreases were:

17. Floor Covering.
49. Plumbing and Heating.
56. Metalworking Machinery and Equipment.
61. Service Industry Machinery
70. Motor Vehicles and Parts.

c. Dollars of gross capital equipment stock per employee (Appendix 3, Table 3-3, p. 61). The ratios in this data set have the same characteristics as sets (a) and (b) above. The only change is that a sixth industry showed a decrease during the period in addition to the five in (b) above:

73. Locomotives and Railroad and Street Cars.

d. Dollars of gross capital equipment stock plus inventories per employee (Appendix 3, Table 4-3, p. 62). Every industry in this data set displayed a rising gross capital contents-labor ratio. However, the variability noted in the previous ratios is inevident in these coefficients. Almost all of the industries exhibited a basically smooth rising trend in this measure of the capital-labor ratios sector.

e. Dollars of net capital equipment stock per production workers' man-hour (Appendix 3, Table 5-3, p. 63). This set of data exhibited the same general conditions as set (c) above, including the same sector experiencing decreases in this ratio. One significant difference in this set from others is that few of the sectors had the large amount of variability noted when the denominator of the capital-labor ratio was average annual employment.

f. Dollar value of inventories of finished products, goods-in-process, and raw materials and supplies per man-hour worked by production workers (Appendix 3, Table 6-3, p. 64). The data set exhibits the year-to-year variability expected from an inventory coefficient because inventories are the most volatile component of the capital stock. However, some generalizations can be made. All but two of the industries have final year coefficients greater than the initial year. Also, the general shapes of change paths over time noted in the other sets are evident although not as smooth. The two industries showing decreasing ratios were:

29. Newspapers.
79. Miscellaneous Manufactured Products.

Sector 29 had a general S-shaped path; sector 79 had the familiar U-shaped path.

Capital per Establishment

Based on the limited establishment data noted earlier, two measures of the capital stock in the average establishment were calculated: (a) Dollars of net capital equipment stock plus inventories per establishment; and (b) dollars of net capital equipment stock per establishment.

a. Dollars of net capital equipment stock plus inventories of finished products, goods-in-process, and raw materials and supplies per establishment (Appendix 4, Table 1-4, p. 65). These data are simply the average capital contents of manufacturing establishments. As noted early, data on the number of establishments is collected only for Census of Manufactures years. Therefore, there are only three data points for each industry. The number of establishments refers to the number of sites where there is a production facility categorized in a particular industry.

A few generalizations can be made about these averages, keeping in mind that they are based on observations for only 3 years. Most of the industries showed large increases in the average capital contents per establishment. Some sectors exhibited a steady trend increase between the 3 years; others had decreases between 1958 and 1963 but more than offsetting increases between 1963 and 1967. Four sectors had decreases in average contents per establishment between 1958 and 1967. All of these sectors experienced increases in average content value between 1963 and 1967; however, the increases were insufficient to offset decreases between 1958 and 1963. These four sectors were:

34. Plastics and Synthetics.
38. Petroleum Refining.
39. Tires and Tubes.
79. Miscellaneous Manufactured Products.

b. Dollars of net capital equipment stock per establishment (Appendix 4, Table 2-4, p. 66). The establishment average net capital equipment stock increased in most of the 73 industries between 1958 and 1967. However, many of these sectors had decreases between 1958 and 1963. Eleven sectors had decreases between 1958 and 1967. Of eleven sectors, only sector 73 experienced a decrease in average contents between 1963 and 1967. The sectors which exhibited declines in net capital equipment per establishment were:

17. Floor Covering.
33. Glue, Ink, and Fatty Acids.
34. Plastics and Synthetics.
38. Petroleum Refining.
49. Plumbing and Heating.
56. Metal Working Machinery and Equipment.
59. Miscellaneous Machinery, except Electrical
66. Radio, TV sets, and Phonograph Records.
69. Batteries, X-rays, and Engine Electrical Equipment.
70. Motor Vehicles and Parts.
73. Locomotives and Railroad and Street Cars.

Conclusions

From the above data, it is obvious that there were several trends occurring in the manufacturing industries. Working in combination, these movements have produced the capital-labor ratios which are the basic evidence for capital deepening. It is readily seen that growth in the capital stock is not necessary for capital deepening to occur. In addition, changes in the quality of capital and the production process can allow substitution of capital for labor.

The experience of the manufacturing sector indicates that there was certainly capital deepening during the study period; however, there may be a few exceptions depending on the measures of capital and labor uses. Second, the average amount of equipment in most industrial establishments has increased. Third, there are varying trend growth rates and time paths traced not only by the capital-labor ratios and average capital contents in manufacturing but also by the underlying data.

A more important conclusion from the available national data is the tenuous application of national trends to particular areas. At the national level, data are compiled indicating averages for entire industries made up of hundreds and thousands of individual establishments. The national data can indicate general changes and directions in which the total industry is moving. Analysis, however, at this extremely aggregated level can provide few insights into what has happened in individual establishments. Analysis of national data indicates there have been structural changes in the average input coefficients for the entire industry, but the distribution of those changes between old and new establishments cannot be determined. The analysis shows only average changes in an industry, not the changes in the component units of that industry. Insights into these changes can only be secured by investigating the changes at the individual plant level. Once these changes are known, inferences about how they fit into the entire industry experience can be made. To achieve this the research turned to the evidence of capital stock change at the local level.

EXAMINATION OF EXISTING FLOOD DAMAGE SURVEYS TO DETERMINE CHANGES IN COMMERCIAL AND INDUSTRIAL CAPITAL STOCK AND FLOOD DAMAGES

Background of the Problem

Analysis using national data indicated that capital deepening had occurred in all but a few manufacturing industries in the United States. The inferences that could be made from this evidence on individual establishments, on or off a flood plain, were tenuous. This inconclusive result brings to the fore examination of the direct evidence of the changes in the capital stock and damages to that stock which have occurred in individual firms on a specific flood plain.

As a background to this examination, first a model of the effect of a change in capital stock on flood damages and flood protection benefits is presented. The following is based on the presentation in Analysis of Theories and Methods for Estimating Benefits of Protecting Urban Flood Plains, written by Edward Greenberg, Charles J. Leven, and Alan Schlottman at the Institute for Urban and Regional Studies, Washington University [9]. Ignoring discounting, the benefits from flood protection can be calculated as

$$B = \Delta^1 PdK_o + (\psi - \Delta d^2 Pd)\Delta K$$

where

B = benefits from flood control

Δd^1 = reduction in flooding on the flood plain

Δd^2 = Increase in residual flooding on flood plain over flooding at alternative location

K_o = capital that would locate on the flood plain without protection

$K_o + \Delta K$ = capital that would locate on the flood plain with protection

ψ = unit differential locational advantage of locating on the flood plain of the additional capital that would locate there relative to alternative location of that capital

P_d = value of property loss from a unit of flooding

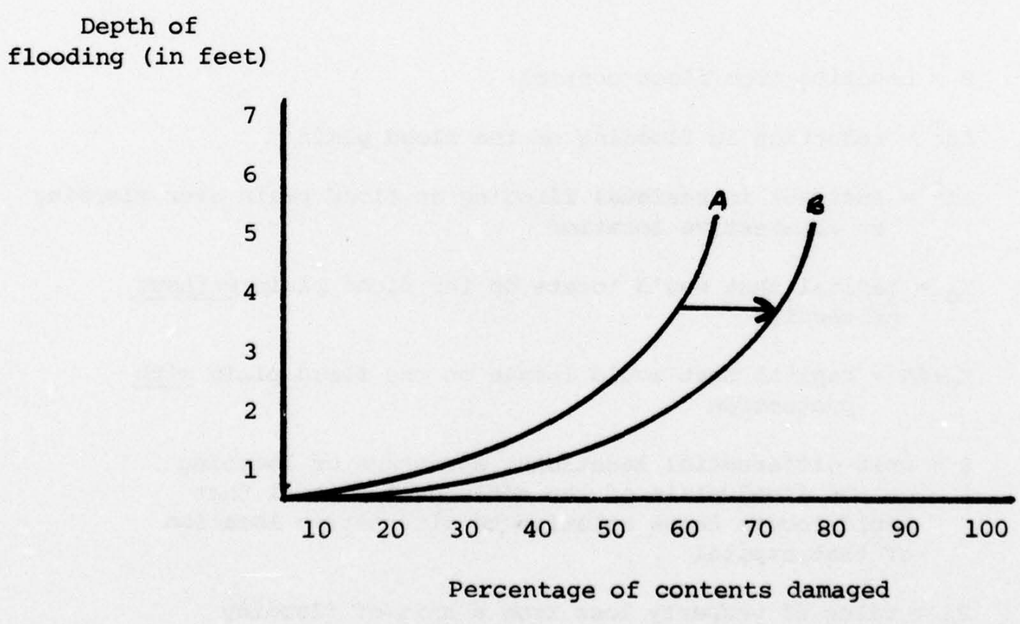
The Washington University researchers then proceeded by concentrating on the location factor (ψ) and on the change in capital (ΔK). In the presentation it was assumed that P_d and K_o were constant over the life of the flood control project. This implied an economically static flood plain and that the expected unit locational advantage of one unit more capital locating on the flood plain without protection is less than or equal to the expected unit flood damages. Therefore, the conceptualized model of flood protection benefits ignores the changes in K_o which would occur even without flood protection.

The purpose of the following section is to investigate the properties of P_d and K_o. In particular, it is necessary to determine whether P_d and K_o are, in fact, constant over time; and, if not, whether the direction and size of the changes in these values can be estimated. To achieve this goal, data for flood damages and capital stock values were investigated for commercial and industrial firms located on flood plains.

Methods to Determine Changes in Capital and Flood Damages

One way to determine changes in flood damage is by investigating shifts in the P_d function. This can be done by using depth-damage curves. These curves show the relationship between the depth of flooding and the percent of the total capital contents damaged in an establishment. An example of a depth-damage curve is given below. (See Figure 2.)

FIGURE 2
MODEL DEPTH/DAMAGE FUNCTION



A shift to the right, from A to B, in the depth-damage curve would indicate that the capital contents had become more susceptible to flood damage. This would mean that P_d had increased resulting in increased benefits from flood reduction. The expected benefits would increase even if there were no changes in the real value amount of capital stock.

The other change which may alter the expected benefits from flood control is a change in the capital stock. If activities located on flood plains increase the real amount of their capital, potential damages and expected benefits will also increase.

While the above procedure is conceptually clear, an immediate implementation difficulty is measurement of these changes in capital stock value. In particular, it is necessary to concentrate on changes in the capital content value of existing structures. Therefore, account must be taken of changes in the measured value of capital stock resulting from the construction of new buildings and plant additions. One approach is to use capital content value to building value ratios. Changes in the ratios will provide information as to whether there has been a movement toward more or less intensive use of structures.

In most cases, it is necessary to deal with average capital content value and average structure value measures of capital stock. Averages must be used because, probably the data available will not cover all of the same establishments over several years. Thus, an increase in the average could simply mean that many of the smaller firms had gone out of business or the new firms have capital content values larger than those represented by previous data.

One way of determining whether the average capital content value has been influenced by the above factors is by examining average building values and capital content value to building value ratios. Increasing average building value between observations indicates that the later data represents firms that are either larger than those previously observed or that many changes in structure have occurred. If at the same time the capital content value to building value ratio increased, the value of the capital contents has increased more than the structure value. Increases in these ratios, with increasing value of capital contents, would be partial evidence of the existence of an "affluence factor" for commercial and industrial sectors.

Sources of Flood Damage Data

Because of the need for consistently gathered and published flood plain data, it was hoped that the Federal Insurance Administration (FIA) would be a primary source of standardized flood damage data. The FIA data would be based on flood plain insurance applications and from damage claims processed as part of the National Flood Insurance Program. Arranging these data by industry and location, it was hoped that value trends on individual flood plains as well as locational differences could be explored. Mr. Sam Bruger, Staff Economist of FIA, was contacted to determine the extent and availability of the FIA data. It was found that some of the desired data were available but not in readily usable form. More important, the data had been collected only since the end of 1974. It was decided that the FIA data might be a valuable source of future information, but that id did not have the time dimension needed for this study.

The second and primary data source used was flood damage surveys. The U.S. Army Corps of Engineers has periodically surveyed flood prone areas to determine both actual and potential damages occurring from alternative depths of flooding. The Corps uses this information in calculating damages to be prevented by proposed flood control projects.

For a particular survey to be useful to this study, it must contain at least these four important pieces of information:

a. Value of structure for each establishment;

b. Value of capital contents for each establishment;

c. Damages to capital contents for flooding above the first floor;

d. The depth of flooding above the first floor.

In addition, this information had to be for commercial and industrial establishments whose line of business could readily be determined. It was also particularly important that surveys be obtained for the same area but taken in different years.

In searching for this flood plain damage information, many contacts were made, both inside and outside the Corps. The individuals contacted and the results achieved are presented in Appendix 5. One immediate problem was the lack of successive flood damage surveys for the same area. This eliminated several possible data sources. A second problem was that in some instances no value estimates were made; these surveys were not useful for this study. Few local data sources which at least potentially met the criteria were readily accessible. The surveys actually used were obtained at the Louisville District, U.S. Army Corps of Engineers, Louisville, Kentucky.

The Flood Damage Survey Data

The following flood damage surveys were examined for use in this research:

1959 Evansville, Indiana--Pigeon Creek
1961 Evansville, Indiana--Pigeon Creek
Louisville, Kentucky--Ohio River
Cincinnati, Ohio--Mill Creek

1965 Louisville, Kentucky--Ohio River
(southwest of 1961 survey area)
1966 Tell City, Indiana--Ohio River
Owensboro, Kentucky--Ohio River
1968 Cincinnati, Ohio--Mill Creek
1974 Cincinnati, Ohio--Mill Creek, Reach-1 only
(see maps below)

These particular surveys were chosen for several reasons. Each survey included value data for both building and capital contents for each firm surveyed. Each survey also included damage data for various depths of flooding over both the basement and first floor. Using surveys covering the same cities was an attempt to eliminate locational factors that might be different in different cities. However, the Tell City and Owensboro surveys were included for added observations in the time series, even though varying location factors did not allow for the valid comparison of these observations with those for other areas.

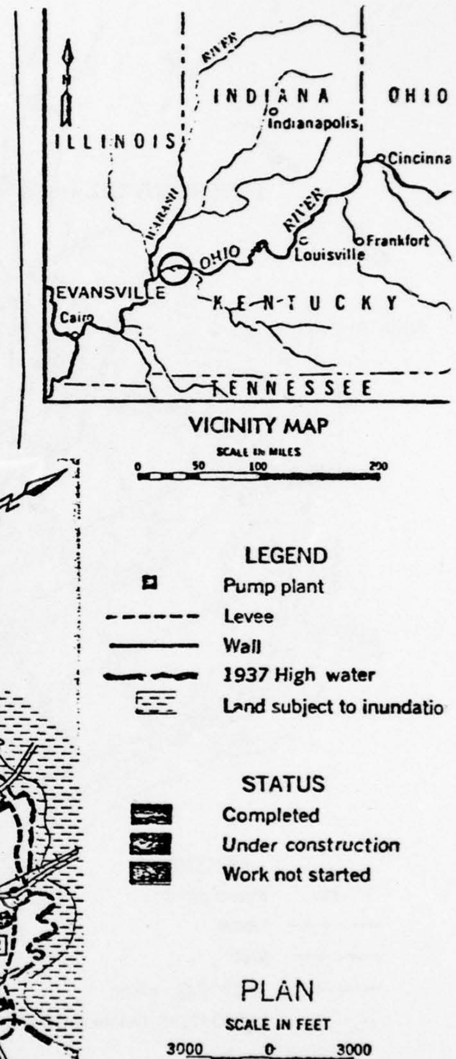
It is obvious that an intertemporal comparison between Evansville, Indiana; Louisville, Kentucky; and Cincinnati, Ohio has severe limitations. The two surveys in Evansville and Louisville do not encompass the same areas. Therefore, comparisons over time may have shown the effects of locational differences more than anything else. The 1961, 1968, and 1974 surveys for the Mill Creek in Cincinnati seemed to offer a better opportunity for a time series study. However, neither the 1968 nor the 1974 surveys were as extensive as the one taken in 1961. In addition, development on a major part of the Mill Creek flood plain was radically changed between 1961 and 1968. During this period, urban renewal resulted in the mass removal of buildings from Reach-1 of the flood plain. By 1968, most of the commercial establishments that had been surveyed in Reach-1 in 1961 were no longer there.

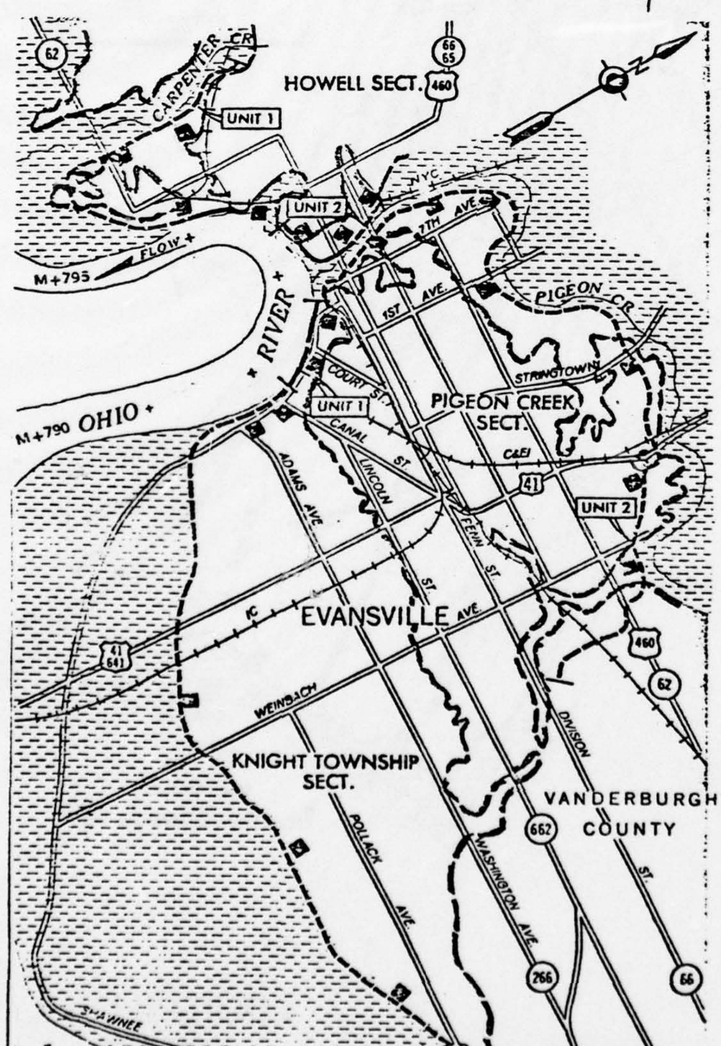
The effect of these differing survey areas and dramatic changes in conditions between surveys resulted in no area which had been surveyed more than once. Data analysis could indicate changes in the capital structure in commercial and industrial sectors that has not really taken place. Rather than just a change in value, the effects of a change in the population of firms might have occurred. Although there are many shortcomings, the information was used to make preliminary judgments on the impact of the location factors and the usefulness of this type of data for ascertaining the existence of a commercial and industrial affluence factor.

Methodology of Data Organization

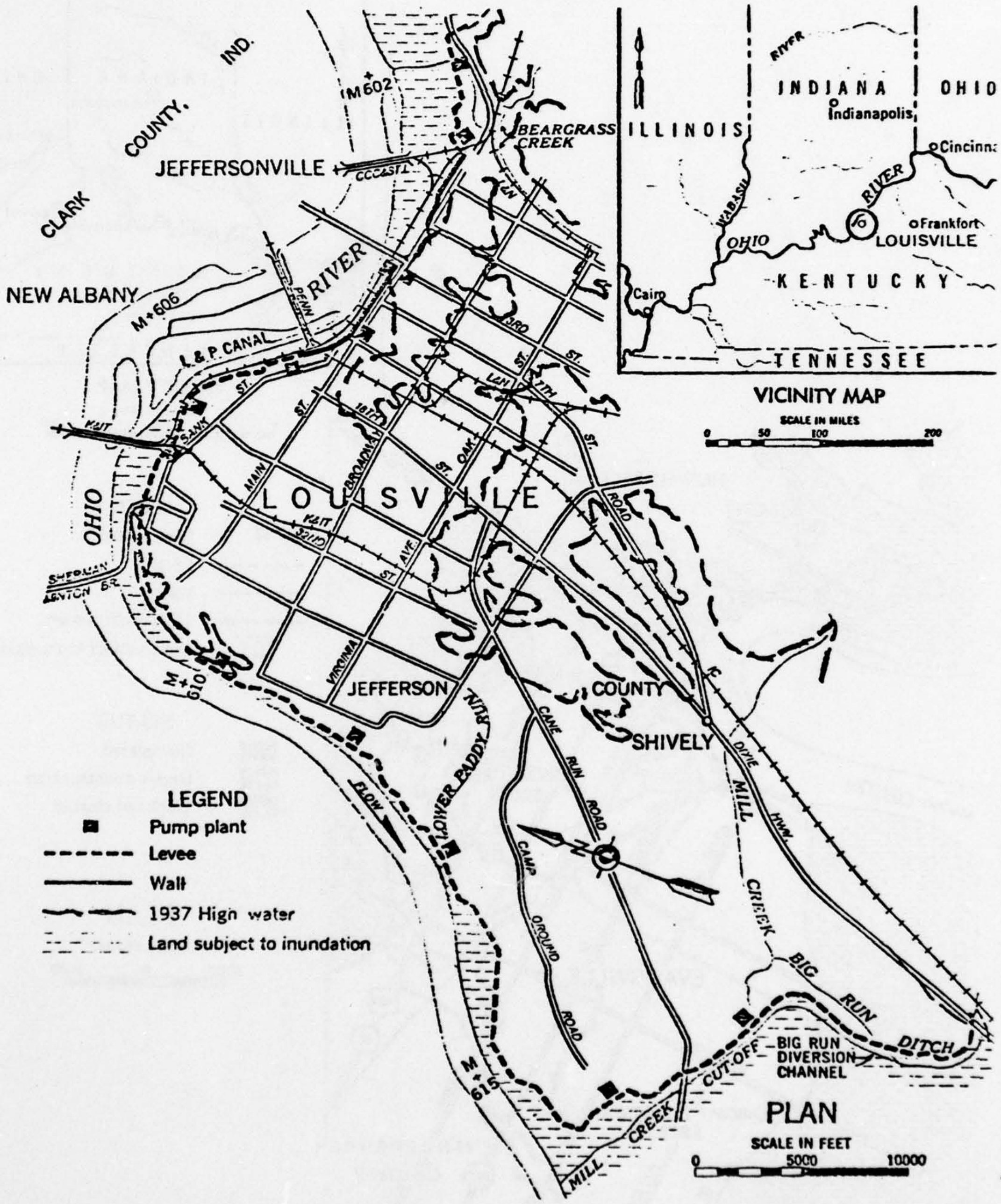
Each survey used two broad categories into which firms were classified: Commercial and industrial; however, there seemed to be no rigorous criteria used in assigning a firm to a category. For this study, only establishments found engaged in manufacturing, as defined in the 1967


INDIANA
OHIO
CINCINNATI, OHIO
OHIO RIVER
OHIO RIVER
LOUISVILLE, KY.
EVANSVILLE, IND.
TELL CITY, IND.
OHIO RIVER
OWENSBORO, KY.
KENTUCKY





EVANSVILLE
LEVEE
OHIO RIVER, IND.
LOUISVILLE, KY. DISTRICT
SCALES AS SHOWN
REVISED 30 JUNE 1974



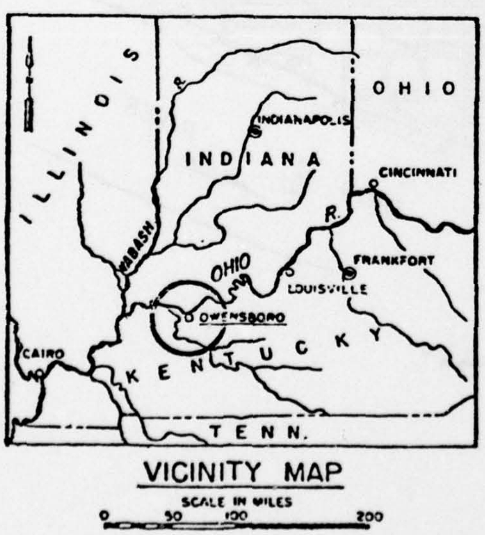
LOUISVILLE, KY.

OHIO RIVER

LOUISVILLE, KY. DISTRICT

SCALES AS SHOWN

REVISED 30 JUNE 1953



VICINITY MAP

SCALE IN MILES
0 50 100 200

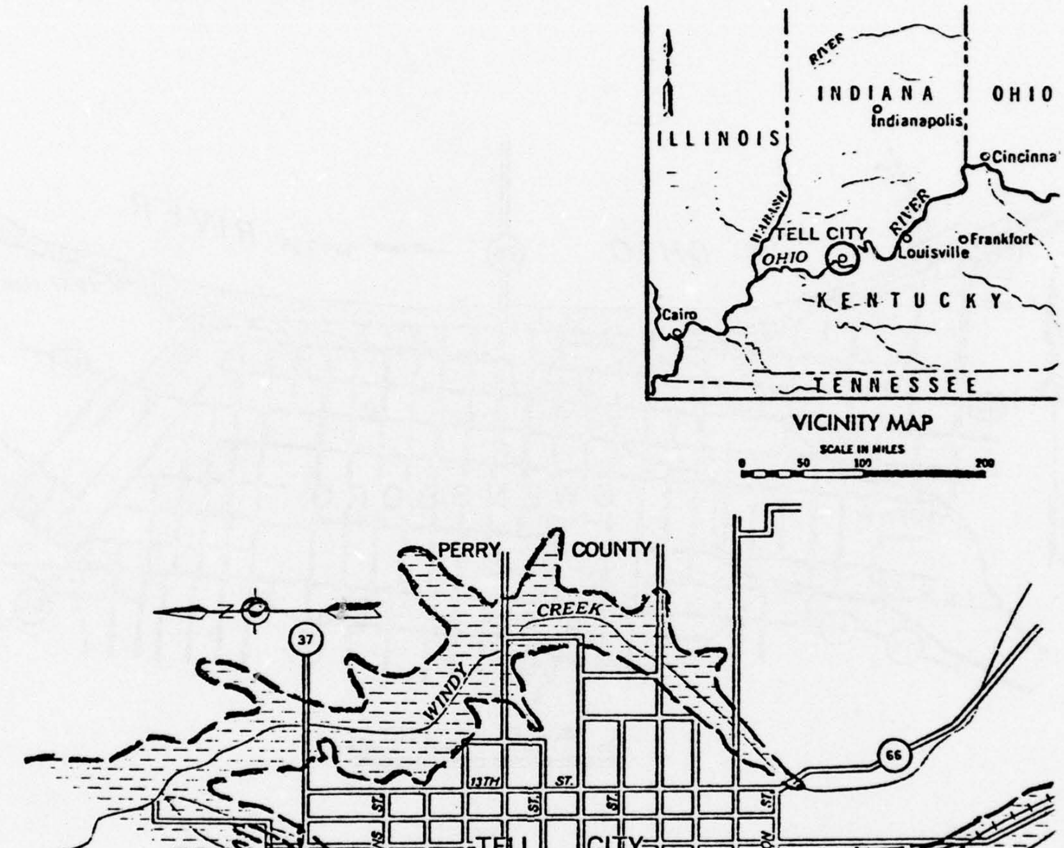
OWENSBORO, KY.

OHIO RIVER

SCALES AS SHOWN

LOUISVILLE DISTRICT, LOUISVILLE, KY.

MAP PREPARED: 30 JUNE 1953



LEGEND

- Pump plant
- X Gate opening
- ------ Levee
- —— Wall
- 1937 High water
- Land subject to inundation

TELL CITY, IND.

OHIO RIVER

LOUISVILLE, KY. DISTRICT

SCALES AS SHOWN

Standard Industrial Classification Manual, were classified as industrial. The commercial category contains wholesale, retail, and all service firms. Each establishment detailed in the surveys was assigned its appropriate three-digit SIC code. For commercial firms, the assignment was based on the firm's name and other information about the line of business included on the actual survey forms. Industrial firms were assigned an SIC code by using the State Directory of Manufacturers for the appropriate state and year. Those firms which could not be assigned an SIC code with reasonable accuracy were not included. In most cases, the eliminated firms accounted for less than 5 percent of the total number of establishments surveyed.

After the SIC codes were assigned, data from each firm was arranged in groups by the SIC numbers. Table 1 summarizes the number of establishments identified in the commercial sector.

Table 1

Number of Commercial Sector Establishments in Each Survey

SIC CODE	Sector Name	Number of Establishments Evansville 1959	Evansville 1961	Louisville 1961	Louisville 1965	Cincinnati 1961	Cincinnati 1968	Cincinnati 1974
581	Eating & Drinking Est.	17	29	214	30	102	13	10
59X	Misc. Retail Stores	13	18	109	22	36	12	1
554	Auto Service Stations	16	20	49	45	57	6	4
541	Grocery Stores	11	25	62	11	75	5	0
50X	Wholesale Trade	37	10	80	1	40	17	14
753	Auto Repair Shops	5	14	29	11	41	4	5
	Total (6 Sectors)	99	116	543	120	351	57	34
	Total for Survey	145	215	1076	202	559	114	59

These six sectors accounted for at least 50 percent of the total number of commercial establishments identified in each of the flood damage surveys. The variation in the rankings of the sectors between surveys reflects the differing economic characteristics of the survey areas (and the changes which occurred between the Cincinnati surveys).

The industrial sector also contains a wide variety of types of manufacturing firms; however, there are fewer industrial firms than commercial firms. Because of the few observations for 3-digit industries, the firms were aggregated into a 2-digit classification. The number of observations in the most numerous industries is summarized in Table 2 below.

Table 2

Number of Industrial Establishments in Each Survey

SIC CODE	Sector Name	Number of Establishments: Evansville 1959	Evansville 1961	Louisville 1961	Louisville 1965	Cincinnati 1961	Cincinnati 1968	Cincinnati 1974
34X	Fabricated Metal Prod	6	0	33	0	38	11	12
35X	Machinery, Except Electrical	3	1	20	0	27	4	8
20X	Food & Kindred Prod	10	0	28	0	18	3	4
27X	Printing & Publishing	2	1	25	0	12	3	0
28X	Chemicals & Allied Prod	1	1	20	0	13	5	1
	Total (5 Industries)	22	3	126	0	108	26	25
	Total for Survey	36	13	186	0	154	47	45

It is obvious from Table 1 and Table 2 that sample size for a particular commercial or industrial sector is small. These limited data were examined for changes in the value of capital stock (both building and contents), and flood damages. If there is a correspondence between the local and national experience, the national trends may be used, with adjustments, to approximate the local changes. First it must be determined if there are any recognizable trends in the capital content value and flood damage value to firms located on flood plains; then, comparisons with national data may be made.

Changes in Real Damage Value to the Capital Contents Value of Commercial And Industrial Property

Based on the flood damage survey data, the methods outlined above were used to determine whether there had been changes in the real value of damage to and capital contents of commercial and industrial establishments. Since the capital contents and damage values were reported in current dollars, the data first had to be deflated to constant dollars. The building values were deflated using the Engineering News Record building cost index adjusted to 1969 as the base year.

The development of a capital content value price index was much more complicated. The content data includes both equipment and inventory components. Also, one would expect the equipment to be of several different ages representing the price levels at which each piece of equipment was purchased. In the manufacturing industries, the approximate value relationship between equipment and inventories had to be determined. Using the previously assembled national data, it was found that there was little change in the equipment-inventory value ratio over time. To approximate an equipment stock price index, the value of the total capital equipment stock in the manufacturing sector was estimated in current and 1969 dollars. From these two estimates, a capital equipment stock price index was calculated. Using the average equipment-inventory value ratio, the industrial wholesale price index and the capital equipment stock price index, a composite capital content price index was calculated. This single index was used to deflate the capital content value data for all industrial sectors.

Since most of the capital content value in the commercial sector is in inventory, the industrial wholesale price index was used as a commercial capital content value deflator. The indexes used are listed in Table 3 below.

Table 3
Price Level Indexes

	Industrial Wholesale Price Index 1969=100	Composite Capital Content Price Index 1969=100	ENR Building Cost Index 1969=100
1958	88.3	80.7	66.5
1959	89.9	82.6	69.4
1960	89.9	83.9	70.8
1961	89.4	85.0	71.9
1962	89.4	86.0	73.4
1963	89.3	87.1	75.2
1964	89.8	88.6	77.5
1965	90.9	90.4.	79.4
1966	92.9	92.7	82.3
1967	94.3	94.7	85.1
1968	96.7	97.2	91.3
1969	100.0	100.0	100.0
1970	103.8	104.6	105.8
1971	107.5	106.0	120.0
1972	111.2	111.8	132.7
1973	118.7	115.7	144.1
1974	145.0	132.2	152.4

Changes in Capital Contents and Damage Value: Commercial Category

The first method used to estimate changes in capital content and damage value was the development of depth-damage curves. One way of deriving these curves is to: (1) Determine the total capital content value in a particular sector; (2) at each depth of flooding above the floor, determine the total damages incurred; (3) for each depth divide the total value of the damages to the capital contents by the total content value; (4) plot these percentages against flood depth. This should result in a smooth curve relating the percent of capital contents damaged to the depth of flooding. But there is a tremendous amount of information lost by aggregating percent damages of many firms into a single value, and such a procedure disguises the base data variability.

Instead of this aggregate method, depth-damage curves were developed by plotting the percent of capital contents damaged at each depth for each firm. These plots were developed only for sectors which had a sufficient number of observations. Establishments sustaining damage in basements were excluded. Examples of these plots are included in Appendix 7, p. 74

The scattergrams developed for the commercial sector revealed the great variability among data points. This was most evident for the scatter plotted with data from the 1961 Mill Creek survey. Although the 1961 Louisville survey data also exhibits variability, the scatter in the data points was limited and was much closer to what had been anticipated. Individuals familiar with the surveys attribute most of the data problems to errors by the surveyor or by the firm's respondent. These problems make the validity of using the survey data for interara and intertemporal comparisons doubtful.

The scatter of the data precludes the attachment of a meaningful single depth-damage curve to each commercial sector. This means that changes, which have taken place in the damage susceptibility of commercial capital contents, cannot be adequately indicated by shifts in the depth-damages curves. Other methods of measuring whether these shifts have occurred can be used; however, lack of confidence in the survey data cast doubt on the results of such attempts.

The second method used was the calculation of average value of capital contents per establishment values in conjunction with capital content value to building value ratios. At the 3-digit SIC Code level many of the commercial sectors did not have a sufficient number of observations to make these values significant. In addition, some of the sectors for which a relatively large number of observations existed, such as trucking, warehousing and wholesaling, reflected the sectors regional economic importance to the particular urban area surveyed. Examination of the average capital content data adjusted to constant dollars reveals four other commercial sectors important in terms of the number of establishments and the trends in the average capital content values. Using the Mill Creek data it was found that all four of these sectors experienced increases in average capital content values. (See Table 4)

Table 4

Average Capital Contents Value (in thousands of 1969 dollars)

SIC Code	Sector Name	1961	1968	1974
553	Retail Auto Parts	$42.8	$67.8	$59.2
554	Auto Service Stations	8.5	12.7	10.7
581	Eating and Drinking Est	10.8	18.5	16.7
753	Auto Repair Shops	14.2	19.2	12.8

These averages indicate that the real value of capital contents in these commercial sectors increased between 1961 and 1968; however, all these sectors experienced a decline in capital content real value between 1968 and 1974.

The capital content value to building value ratios also exhibit a generally rising trend. (See Table 5 below)

Table 5

Content value/Building value

SIC Code	1961	1968	1974
553	.96	1.04	1.00
554	.37	.66	.52
581	.38	.52	.62
753	.50	.49	.61

These ratios indicate that the capital content value has increased faster than the building value. The values given in Table 4 and Table 5 appear to indicate the existence of an affluence factor in these commercial sectors. Unfortunately, the three samples in these sectors do not include the same firms or the same locations. The data for each year was supplied by different firms. Therefore, the changes noted above resulted from observing different establishments in different years; some firms were not resurveyed; some went out of business, and some new firms were established on the flood plain. The most important of these observed changes was the urban renewal effort on the Cincinnati, Mill Creek flood plain. Urban renewal resulted in most of the smaller, old structures being replaced by new, larger structures. This would account for the changes in observed data between 1961 and 1968. The decline in the real values between 1968 and 1974 indicates that most of the urban renewal on the flood plain had been completed. Thus, in all likelihood the effects of a location factor have been observed rather than the effects of an affluence factor.

Changes in Capital Content and Damage Value: Industrial Category

The most industrialized areas surveyed were Louisville in 1961 and the Mill Creek in Cincinnati in 1961, 1968, and 1974. Although industrial establishments account for a relatively small percentage of the total number of firms identified in each flood damage survey, industrial establishments are responsible for most of the total capital content value and total building value in each survey. Table 6 below shows the percentage of total capital content value and building value in industrial and commercial sectors in each survey attributable to manufacturing firms.

Table 6

Percentages of Capital Content Value and Building Value: Industrial Category

	Louisville	Cincinnati		
	1961	1961	1968	1974
Percent of total capital content value in industrial sector	87.9	74.0	87.8	86.3
Percent of total building value in industrial sector	68.3	66.5	93.4	89.0

The percentages in Table 6 indicate that the industrial sector is most important on these flood plains in terms of the total capital stock value and thus in terms of potential flood damages.

The Cincinnati, Mill Creek surveys proved to be the most useful sources of data for the investigation of changes in capital content value over time. The damage figures given in the surveys were not comparable over time because of differing flood depths assumed for each survey. Several firms surveyed more than once were traced through the series of surveys. These firms were not only resurveyed but were also in the same location. The same 15 industrial firms were surveyed in both 1961 and 1968; 16 of the same firms were surveyed in both 1961 and 1974; only 6 of the same firms were surveyed in all three surveys. Several calculations using these data were performed and are presented in Tables 7, 8, and 9.

Table 7

Summary of Data for the Same Six Firms Surveyed in 1961, 1968 and 1974

	1961	1968	1974
Number of Firms	6	6	6
Total Building Value (in thousands of 1969 dollars)	2698	7804	4774
Total Capital Content Value (in thousands of 1969 dollars)	4218	4218	3831
Total Employment	2323	2704	3912
Average Capital Content Value (in thousands of 1969 dollars)	703.0	703.0	638.5
Total Capital Content Value/Employment	1.82	1.56	0.98

Table 7 (Cont'd)

Summary of Data for the Same Six Firms Surveyed in 1961, 1968 and 1974

	1961	1968	1974
Total Capital Content Value/Total Building Value	1.56	0.54	0.80
Mean of Capital Content Value to Building Value Ratios from Each Firm (standard deviation)	1.94 (.67)	1.01 (.53)	1.88 (1.47)
Mean of Capital Content Value per Employee Ratios (standard deviation)	7.40 (6.24)	6.44 (6.17)	23.67 (48.65)

Table 8

Summary of Data for the Same 15 Firms Surveyed in 1961 and 1968

	1961	1968
Number of Firms	15	15
Total Building Value (in thousands of 1969 dollars)	32,784.4	88,395.0
Total Capital Content Value (in thousands of 1969 dollars)	38,605.9	39,125.7
Total Employment	6,384	5,513
Average Capital Content Value (in thousands of 1969 dollars)	2,573.7	2,608.4
Total Capital Content Value/Employment	6.05	7.10
Total Capital Content Value/Total Building Value	1.18	0.44
Mean of Capital Content Value to Building Value Ratios from Each Firm (standard deviation)	1.47 (.77)	1.12 (.96)
Mean of Capital Content Value per Employee Ratios (standard deviation)	9.91 (9.52)	14.70 (14.91)

Table 9

Summary of Data for the Same 16 Firms Surveyed in 1961 and 1974

	1961	1974
Number of Firms	16	16
Total Building Value (in thousands of 1969 dollars)	16,508	22,707
Total Capital Content Value (in thousands of 1969 dollars)	30,365	38,440
Total Employment	4,758	10,965
Average Capital Content Value (in thousands of 1969 dollars)	1,897.8	2,402.5
Total Capital Content Value/Employment	6.38	3.51
Total Capital Content Value/Total Building Value	1.84	1.69
Mean of Capital Content Value to Building Value Ratios from Each Firm (standard deviation)	1.77 (.98)	2.42 (1.77)
Mean of Capital Content Value per Employee Ratios (standard deviation)	8.47 (6.08)	13.21 (31.69)

Observations from the analysis of the data in each of these tables are presented in the following:

a. From Table 1: The real value of capital content in these six firms was constant between 1961 and 1968 but declined between 1968 and 1974. Moreover, the real value of building in these firms experienced a large increase between 1961 and 1968 but a decline between 1968 and 1974. At the same time there was a steady increase in total employment. Thus the capital contents per employee ratio declined over the 1961-1974 period. Therefore, these firms made additions to their plants, but the real value of capital content did not change significantly. The combination of rising employment, increased structures value, and declining capital content value indicates that either these firms' experience was unusual or that the value data is in error. The data for these firms also present no evidence for a positive affluence factor.

b. From Table 2: The real value of capital content, in the 15 firms covered, increased by a relatively small amount between 1961 and 1968. At the same time there was a large increase in building value while total employment declined. Therefore, the total capital content value to total building value ratio declined while the capital content value per employee rose. The small changes in real value of capital contents with a large increase in the real value of structures create an unusual picture of the changes which took place in these firms. The data also does not support the existence of an industrial affluence factor for these firms.

c. From Table 3: Both the total real value of capital content and total real value of structures for these 16 firms increased between 1961 and 1974. At the same time total employment increased. The result of these changes was that the total capital content to total building value ratios declined. However, the mean value of these ratios for the individual firms increased. This was caused by several firms experiencing significant increases in capital content value to building value ratio. This indicates that the evidence for the existence of an affluence factor in these firms is mixed. However, it is unwise to make any generalities about whether an industrial affluence factor exists based on a sample of only these 16 firms.

The evidence from these three tables is inconclusive at best, particularly when the small sample sizes are considered. It can be seen that value of capital content in these firms has increased. In addition, at least some of these firms constructed additions to plants between the flood damage survey periods. Therefore, there have been significant changes in the capital stock, both building and capital contents, of these firms which are located on flood plains. It is impossible to determine how much of the change can be attributed to an industrial affluence factor or even demonstrate conclusively, that the affluence factor for industrial property even exists.

A major problem with using these data from a relatively small area is that large firms tend to have a very significant impact on trends discerned from data for the area. Also, the limited comparability between the surveys makes any trends inferred from the data open to questionable. The survey data indicates that capital values in the industrial sector have undergone significant changes. Measurement of the magnitude of these changes from the limited data is all but impossible. In a geographically small area, the lumpiness of capital expansion by individual firms becomes evident. Comparisons between the data for the survey years available from these flood plains magnifies the discontinuity of the changes which take place in a particular area. A data base encompassing larger areas would help smooth out this lumpiness and provide a better base for the investigation of the changes in capital content value which have occurred over time.

COMPARISONS BETWEEN NATIONAL DATA AND FLOOD DAMAGE SURVEY DATA

The purpose of this section is to determine how well the national data can be used to approximate local conditions. In particular, the analysis was used to determine whether the economic parameters developed in the first section could be used as proxies for local experience.

Several problems, in using the flood damage survey data to estimate local economic trends, were noted in the previous section. Two of the most significant problems were the relatively few observations and the effects of discontinuities in capital stock expansion. These problems mask the overall trends in the economic development and capital structure of local firms and industries. If it can be shown, however, that there is a measurable and predictable relationship between the national and local experience, the more complete and more readily available national data can be used to predict the economic trends for an area.

Differences between the level of national and local economic parameters and the trends in these parameters must be expected. These differences reflect the peculiar economic character of an individual area including such things as industrial mix and historical growth patterns. Also, since Corps local data are for firms on flood plains, the data should also reflect the impact of flood risk on the investment decisions of these establishments.

Interrelationships Between a Subarea and the Nation

It was noted above that potential flood damage risk may have an impact on investment decisions of firms located on flood plains. In addition, the unique economic character of an area will also affect that area's response to rising aggregate demand in the nation as a whole. No area, particularly one which contains a significant amount of large manufacturing firms, is immune to the forces in the national economy. As a result, it might be expected that local industries participate, at least in part, in the processes of growth and change which can be identified at the national level. Therefore, even if the local and the national economic parameters are not the same size, it can be expected that the parameters will move in the same direction over time.

The Data

There were serious limitations in the amount and usefulness of local data. The possible comparisons between the local and the national data were limited to two statistics.

First, average capital content per establishment values were examined. Local average capital content value data bore little resemblance to the national data either in magnitude or change direction. In fact, the local average capital content values displayed little pattern other than abrupt shifts. These shifts were caused almost entirely by changing sample size and changing composition of the sample. (See Table 1-4, p. 65; Table 1-6, p. 70).

Second, capital content value per employee ratios offered a slightly better opportunity for comparison. Some observations about these data are:

a. Many sectors exhibited large movements both upward and downward in the capital-labor ratio.

b. The capital-labor ratio in the same sector was relatively static.

c. For many sectors, a capital-labor ratio for only one year was available.

d. Five sectors were identified as having a relatively continuous growth in their capital-labor ratios.

Note: See Appendix 6, Table 2-6.

The five sectors displaying continuous growth in the local capital contents-labor ratios were:

9. Grain Mill Products
50. Structural Metal Products
56. Metalworking Machinery and Equipment
58. General Industry Machinery
59. Miscellaneous Machinery Except Electrical

One serious problem with use of these data is that except for 1961, most sectors only had a sample of one firm as a data point in 1968 and 1974; two exceptions, with more than one firm in the sample, are sectors 50 and 56. A comparison between the local ratios for all five sectors and the national ratios is displayed in Table 10 below.

Table 10

Capital Contents Value per Employee
(in thousands of 1969 dollars)

	1961		1968		1974	
	Local	National	Local	National	Local	National*
9. Grain Mill Prod	23.92	10.56	26.84	14.66	50.06	15.98
50. Structural Metal Prod	4.52	5.88	7.16	7.31	9.63	8.22
56. Metalworking, Machinery and Equipment	9.59	7.13	9.80	8.51	22.00	9.41
58. General Industry Machinery	5.29	6.84	-	9.42	6.24	10.71
59. Miscellaneous Machinery, Except Electrical	8.95	3.01	14.58	3.80	132.4	4.43

*National data for 1971

Few generalizations can be made from the comparisons because of the small number of establishments these ratios represent. The general trend in capital-labor ratios at the national level is mirrored to some extent by the local data. Thus, the national data may be a useful proxy for the mostly unavailable local data; however, a much more extensive base of local data would have to be developed before the significance of the relationship comparison between national and local experience can be investigated.

DIRECTIONS FOR FURTHER TESTING OF THE AFFLUENCE FACTOR HYPOTHESIS

This investigation began with the hypothesis that commercial and industrial firms make net additions to equipment and inventory contents, in real terms, in response to growing aggegate demand and technical change. The experience of firms located on flood plains was the focus. To test the hypothesis, the evidence of capital growth and capital deepening at the national level was examined. Estimates of capital stock available indicated that the amount of capital equipment and inventory stocks, in real terms, had increased in most manufacturing industries over the 1958 to 1971 period. In addition, most industries also exhibited increasing capital-labor ratios which implied capital deepening.

Although the evidence for real growth in capital contents is fairly conclusive at the national level, few inferences could be made about the experience in a small geographic area, such as an urban flood plain. In pursuing the existence of capital contents growth at a local level, value data gathered through flood damage surveys conducted by the U.S. Army Corps of Engineers was examined. These surveys provided information about the industry mix of flood plain development. Analysis of the data demonstrated that economic development and land use on a flood plain cannot be considered static. Successive surveys of the Mill Creek (Cincinnati, Ohio) flood plain showed new firms locating, old firms leaving, new plants and plant additions being constructed, existing buildings changing uses and vacant land being occupied. These complex changes made it all but impossible to measure the real growth in the capital contents in existing buildings by using the flood damage survey data.

In this study an attempt has been made to predict future capital stock growth by examining historical experience. It has been found that the evidence, at least that available from flood damage surveys, is ambiguous and incomplete.

The results of using flood damage surveys in this study emphasizes the problems of using survey data for other than its intended purpose. The Corps of Engineers uses the survey data in aggregate form differentiating only between eight land uses: Residential, public, industrial, commercial, roads or streets, railroads, unimproved, and utilities. These totals are summed from data for individual sites, particularly residential, commercial, and industrial. There is little care taken, however, to ensure that the data are available for use at a more disaggregated level because the data were never intended to be used at a detailed sector level. Thus, the survey methodology now employed by the Corps precludes the potentially invaluable opportunity of a detailed exploration of capital and land use on flood plains.

Changes in Flood Damage Survey Forms

There are several changes which would make the data gathered during flood damage surveys more usable for future research. Some of these changes are improvements in the forms used for damage appraisals. The form itself should be altered to allow for ADP processing of the survey data. The data contained on the forms should concentrate on the individual sites on the flood plain. The use of each site can be identified by the appropriate SIC code. The value and damage data should be separated into structures, equipment, and inventory categories. The damage values should be delineated by 1-foot increments above the floor elevation for each building. The structures should be identified by coordinates on a reference grid of the survey area. The age of the structure and the date of occupancy of the current user should be included. From this information, value and damage data could be determined at varying levels of detail for alternative floods. This could be done simply by specifying the elevation of the flood at each location.

The suggested flood damage survey form will be beneficial only if its use follows some standardized methodology. In particular, this uniform procedure should specify the measure to be used for the value and damage data, (i.e., market value, book value, net depreciated value).

When resurveys of particular flood plains are begun, care should be taken to ensure that the latest survey covers the same geographic area as the previous survey, (to the extent that time and money permit). However, even if only a subarea of the prior survey is covered, the design of the suggested survey form will allow for easy comparison between the two surveys.

Interviews of Establishments Located on the Flood Plain

One additional approach to finding an affluence factor for commercial and industrial property is by directly interviewing existing firms located on flood plains. These interviews may provide the information needed to describe the historical pattern of real capital content growth which has occurred in these firms. In addition, whether these firms consider a flood risk factor in evaluating potential investment alternatives may be determined.

To evaluate the usefulness of an interview approach to determine the existence and size of a commercial and industrial affluence factor, officials of 10 manufacturing firms located on the Mill Creek (Cincinnati, Ohio) flood plain were interviewed. The firms chosen had been contacted at least twice during previous flood damage surveys. Although the companies interviewed do not constitute a statistical sample, the information gained should allow for the determination of whether continued commercial and industrial affluence factor research is warranted.

First, a telephone call was made to the plant manager of each company. During each call, the plant manager was informed of the purpose of the proposed interview and of the general areas to be covered. At the beginning of each interview, a letter of introduction and a brief statement outlining the research effort were presented to the company official.

A formal questionnaire was not used during the interviews; instead, general subject areas were covered with the person interviewed asked to respond with as much detailed information as possible. The subjects explored were:

1. The current value of real property at the plant site.

2. The changes in value and quantity of real property during the past 20 years.

3. The changes in real output during the past 20 years.

4. The adoption of new technology.

5. The changes in products produced.

6. The extent of flood hazard recognition.

7. The impact of flood risk on investment decisions.

8. The adaptation of the firm to the flood risk at their location.

Although not all of the officials interviewed could provide data to support their responses in the above areas, the interviews revealed several interesting characteristics which could influence future research. First, only two of the firms contacted recognized that they were in an area subject to flooding. Second, none of the firms considered potential flood damages as part of investment decisions. Any additions to productive facilities were based on economic considerations of lowering unit product costs and increasing output. Third, the adoption of new technology was most evident in firms experiencing rising product demand and labor costs. In older plants, technological advances were usually instituted by improvements of existing machinery and the addition of better material handling techniques. Both these measures reduced the amount of employment expansion that would have been necessary to meet a rising demand. In newer plants, the adoption of new technology was more often by the addition of modern machinery in vacant plant space. Fourth, most of the officials interviewed felt, that over time, they had increased the intensity of use of their buildings. In older plants, it was difficult to determine if there had been any real net additions to the stock of capital contents, especially when depreciation and obsolescence were considered. In newer plants, most firms had experienced real net additions to capital contents. These firms had more capital contents with no building additions because the companies had planned excess plant space when the production facility was constructed. Therefore, as demand rose, machinery and equipment were added to the vacant plant area. When the plant is completely occupied and producing near capacity, a building addition or a new plant location may be considered.

In summary, the results of the interviews indicate that the manufacturing firms contacted do not generally recognize the flood hazard potential at their locations. Therefore, it is possible that the growth processes of manufacturers with plants located on flood plains may not be significantly different from manufacturers at off-flood plain locations. The implication for an industrial affluence factor is that manufacturers located on flood plains do experience internal capital stock changes even without new construction. There are limits, however, to real capital contents growth. This growth can be expected to be limited by the constraints of existing building size and maximum economically efficient building utilization.

Finally, in existing plants the most significant growth in flood damageable capital contents can be expected when the plant has currently unused floor area. The prediction of this growth should be based on an understanding of the linkages between the industries located on the flood plain and the regional and national economies.

Combining Land Use Models With Growth Models

A second approach to the problem of predicting the growth of capital contents in firms on flood plains is through the development of a general equilibrium urban land use model. Several land use models have been formulated for the U.S. Army Corps of Engineers to evaluate the effects of flood control on flood plain land use.[1]

The particular emphasis of these approaches was on the measurement of intensification and location benefits to the household sector resulting from the reduction of flood risk. For the most part, these efforts did not satisfactorily treat land use changes and increases in potential flood damages which would occur even without a flood control plan. In addition, they either ignored industrial activities or assumed that the location of these activities on the flood plain was exogenously determined.

The problem with these land use models, especially for predictive purposes, is they do not directly incorporate the dynamic element of growth. Although the effect of exogenous population growth on land use is included, none of the models consider the linkages between the local economy and the regional and national economies. These interrelationships may not be particularly important to intraurban residential location and land use; however, ignoring the linkages makes it almost impossible to predict the extent to which the local industrial sector has participated in national growth.

---

[1] See:

a. INTASA. A Computer Simulation Model for Flood Plain Development Part I: Land Use Planning and Benefit Evaluation. IWR Report 72-1, Feb. 1972.

b. ____________. Part II: Model Description and Applications. IWR Report 73-1, Nov. 1972.

c. Weisz, Reuben Nathan and John C. Day. A Methodology for Planning Land Use and Engineering Alternatives for Floodplain Management. Unpublished report submitted to U.S. Army Engineer Institute for Water Resources, Alexandria, Virginia, Dec. 1972.

d. Institute for Urban and Regional Studies, Washington University. Analysis of Theories and Methods for Estimating Benefits of Protecting Urban Floodplains. IWR Report 74-14, Nov. 1974.

An urban land use model for industrial development should include two levels of analysis. The first level would include the linkages between the local and national economies. This is, in essence, an exploration of the effect of national growth on local industries. The second level would develop an urban land use model. Included in this model would be the relationship between location and flood risk and land values and flood risk. Combining the two levels, local land use changes resulting from changes in the national economy could be predicted.

One measure of the effect of economic growth on land use might be changes in land values. Often the price of land represents the capitalization, at expected interest rates, of the expected net returns to the user. The user of a site for any given production process can maximize the net returns on the resources at his command, (i.e., labor and capital), by proper adjustment of the intensity of land use; with higher rents, more intensive land use is appropriate. There is, however, a definite ceiling for rent payable. At the ceiling level of rent, it is just possible for the producer to remain in business on the site, assuming adoption of the most appropriate intensity of land use. Therefore, rising site values should have two effects on land use: (1) The site should be used more intensively, where intensity is measured by the input of capital and labor per unit of land; (2) the site will change to a different, more intensive use when the rent exceeds the "ceiling" rent payable by the current user.

Secondary Data Sources For Possible Testing of Models

Testing a model predicting changes in land use requires information on an individual site basis. Several sources of information, collected by location, are available for many metropolitan areas. Three of these sources are:

a. City directories that are usually updated each year. These directories list the occupant, activity, and product for each address in the city.

b. State manufacturing directories that list most manufacturers in the state, the address of each firm, its product and the number of employees. These directories are updated periodically, usually every one or two years.

c. County real estate tax records that list the following for each lot: Owner, street address, zoning classification, (residential, commercial or industrial), size, value, and any improvements. Although these records are not updated every year, comparison of values over many years are possible.

The potential usefulness of these records of economic growth and land use change was explored for the Mill Creek, Cincinnati, Ohio, flood plain. This preliminary study was limited to portions of three streets known to be located within the 100-year flood plain.

The investigation was arranged in four steps. First, the streets and approximate street numbers to be explored were determined from Corps of Engineers' flood plain maps and Cincinnati street maps. Second, based on this information, the Cincinnati City Directory for each year, from 1958 through 1975, was used to track the changes in occupants and land use at each address over the period. Third, real estate tax records and plat maps were examined for the years 1969 and 1974 to determine changes in the value of land per square foot and value of improvements at each lot. Finally, the Ohio Directory of Manufacturers for each year published from 1958 to 1975 was used to determine changes in the employment of the manufacturing firms identified by the city directories.

Several advantages and problems of using these sources of information for future research were identified by this preliminary investigation. The street directories can be used to track the occupancy and use of flood plain sites. The changes in the economic character of particular neighborhoods can also be identified. The directories, however, do not provide direct evidence of the intensity of land use. The manufacturers directory can be used to determine changes in employment of individual firms located on the flood plain. One serious problem is that the total employment given for each firm often includes the employment at branch plants, not just at the flood plain site. The real estate tax records could be the most valuable source of data on flood plain sites. Problems encountered with the Hamilton County valuations, however, make valid comparisons in value impossible at this time. Lots and improvements are not reappraised every year; instead, official changes in valuation have been made every 10 years according to state law. The only exceptions to this rule was that revaluations were made when improvements were undertaken.

The appraised value of real property for tax purposes must, by state law, be equal to the property's fair market value. In the past, however, this was not usually the case. Instead, the appraised value was usually some fraction of the true market value. In addition, the relationship between appraised value and market value was not constant across all locations. Therefore, land and improvement values obtained from real estate tax records prior to 1975, for Hamilton County, Ohio, are in all likelihood inaccurate and inconsistent. The State of Ohio has recently enacted legislation requiring real estate appraisal for tax purposes at least every six years. Hamilton County, in implementing this law, has adopted a computerized appraisal system which will allow yearly reappraisals. The appraisal method relies on actual market transactions over a 3-year period to determine land value. This computerized approach is being adopted in many states. The land values generated by this system should be accurate and consistent and will provide valuable information in the future. At this time, however, only 1975 appraised values from this system are available.

Conclusions

In summary, changes in the flood damage survey procedure would make the information gathered by these surveys both more accessible and more flexible so that the damages from many different hypothetical floods can be estimated. This information would be a valuable data source for future investigations into capital stock and land use changes. Direct interviews with flood plain occupants previously surveyed will provide an accuracy check of the existing data and insights into the effect of flood risk on investment in flood prone sites. A comprehensive land use model linking the local industrial sector with the national economy is one alternative for a comprehensive approach to urban flood plain land use and growth. There are serious problems, however, in obtaining valid data to test such a model.

APPENDIX CONTENTS

APPENDIX CONTENTS (CONT'D)

APPENDIX CONTENTS (CONT'D)

APPENDIX 1

Relation Between SIC Code and Input-Output Sector Code

Input-Output Industry Number	SIC Number	Sector Name
6	201	Meat Products
7	202	Dairy Products
8	203	Canned & Frozen Foods
9	204	Grain Mill Products
10	205	Bakery Products
11	206	Sugar
12	207	Candy
13	208	Beverages
14	209	Misc. Food Products
15	21X	Tobacco
16	22X-227-229-225	Fabrics & Yarns
17	227	Floor Coverings
18	229	Miscellaneous Textiles
19	225	Knit Fabric & Apparel
20	23X-239	Apparel
21	239	Household Textiles & Upholstery
22	241,242	Logging & Lumber
23	243,249	Plywood, Millwork, Structures, etc.
24	244	Wooden Containers
25	25X	Household & Office Furniture
26		
27	26X-265	Paper & Products except Containers
28	265	Paper Containers
29	271	Newspapers
30	27X,271	Printing & Publishing, except Newspapers
31	281	Industrial Chemicals
32	287	Agricultural Chemicals
33	286,289	Glue, Ink & Fatty acids
34	282	Plastics & Synthetics
35	283	Drugs
36	284	Cleaning & Toilet Items
37	285	Paints & Allied Products
38	29X	Petroleum Refining
39	301	Tires & Tubes
40	302,303,306	Rubber Products, except Tires
41	307	Plastic Products
42	311,312	Leather Tanning & Industrial Leather Products
43	31X,311,312	Shoes & other Leather Products
44	321,322,323	Glass & Glass Products
45	32X,321,322,323	Stone & Clay Products
46	331,332,339	Iron & Steel
47	33X,331,332,339	Nonferrous Metals
48	341,3491	Metal Containers
49	343	Plumbing & Heating Products
50	344	Structural Metal Products

APPENDIX 1 (cont'd)

Input-Output Industry Number	SIC Number	Sector Name
51	345,346	Stampings
52	342,347,348,349X,3491	Hardware Plating, Wire Plating & Valves
53	351	Engines & Turbines
54	352	Farm Machinery
55	353	Construction, Mining, Material Handling Machinery
56	354	Metalworking Machinery & Equipment
57	355	Special Industrial Machinery
58	356	General Industrial Machinery
59	359	Miscellaneous Machinery, except Electrical
60	357	Office & Computing Machinery
61	358	Service Industry Machinery
62	361	Electric Measuring, Transformers & Switches
63	362	Electric Apparatus & Motors
64	363	Household Appliances
65	364	Electric Lighting & Wiring Equipment
66	365	Radio, TV Sets & Phonograph Records
67	366	Communication Equipment
68	367	Electronic Components
69	369	Batteries, X-rays & Engine Electric Equipment
70	371	Motor Vehicles & Parts
71	372	Aircraft & Parts
72	373	Ship & Boats
73	374	Locomotives & Railroads & Street Cars
74	375,379	Cycles, Trailers & Parts
75	381	Engineering & Scientific Instruments
76	382	Mechanical Measuring Devices & Thermostats
77	384	Surgical & Medical Instruments
78	383,385,386,387	Optical & Photographic Supply
79	39X	Miscellaneous Manufactured Products

APPENDIX 2

Table 1-2

Gross Capital Equipment Stock
(in millions of 1969 dollars)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	972	1,167	1,464	43	249	251	294
7	1,493	1,771	1,765	44	1,091	1,376	1,938
8	1,112	1,416	1,881	45	4,119	4,674	5,185
9	1,097	1,323	1,600	46	11,106	13,060	17,233
10	1,441	1,529	1,603	47	3,157	3,620	5,346
11	338	513	641	48	625	738	969
12	366	427	565	49	368	303	295
13	2,070	2,360	3,019	50	1,007	1,126	1,458
14	1,055	1,208	1,493	51	1,346	1,437	2,007
15	328	401	402	52	1,359	1,760	2,365
16	2,665	3,055	3,748	53	489	561	991
17	304	289	364	54	560	595	739
18	280	358	520	55	834	981	1,450
19	591	608	859	56	1,766	1,746	2,105
20	899	949	1,083	57	715	790	993
21	174	212	363	58	1,116	1,299	1,696
22	1,598	1,791	2,058	59	414	466	650
23	465	679	1,068	60	563	883	1,497
24	69	63	65	61	456	482	705
25	670	723	950	62	590	607	776
26				63	713	791	1,099
27	6,152	7,388	9,622	64	811	802	950
28	1,030	1,255	1,625	65	506	618	856
29	962	1,082	1,418	66	102	176	316
30	2,108	2,662	3,461	67	757	1,056	1,685
31	5,852	7,351	9,593	68	611	964	1,602
32	324	523	779	69	396	405	588
33	690	640	808	70	5,951	6,759	7,578
34	2,780	3,674	5,006	71	1,133	1,429	2,486
35	660	718	1,036	72	206	250	377
36	365	499	716	73	211	219	272
37	286	292	402	74	53	80	156
38	2,142	1,965	3,315	75	59	81	100
39	948	1,170	1,644	76	215	296	371
40	757	858	1,062	77	155	202	288
41	733	1,292	2,274	78	524	678	1,148
42	103	97	109	79	833	936	1,111

APPENDIX 2 (cont'd)

Table 2-2

Net Capital Equipment Stock
(in millions of 1969 dollars)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	542	658	828	43	127	130	155
7	880	967	892	44	644	793	1,127
8	620	813	1,079	45	2,325	2,539	2,720
9	632	746	893	46	6,529	7,465	9,801
10	775	803	815	47	1,805	2,025	3,130
11	200	316	358	48	340	407	545
12	192	236	322	49	163	141	147
13	1,092	1,285	1,718	50	559	606	809
14	565	647	815	51	677	773	1,132
15	178	217	199	52	742	1,010	1,316
16	1,352	1,677	2,016	53	264	308	613
17	152	140	207	54	281	317	397
18	151	205	305	55	482	554	832
19	270	319	485	56	904	901	1,104
20	449	499	558	57	361	425	540
21	89	121	222	58	611	727	932
22	874	968	1,073	59	211	251	333
23	256	409	620	60	334	537	933
24	33	32	32	61	229	271	406
25	336	386	517	62	313	309	431
26				63	374	431	620
27	3,509	4,189	5,402	64	388	415	516
28	571	694	889	65	275	350	483
29	504	577	773	66	55	109	172
30	1,224	1,452	1,902	67	421	605	932
31	3,165	4,166	5,252	68	348	561	865
32	192	301	422	69	195	208	341
33	344	305	441	70	3,171	3,775	3,955
34	1,467	2,150	2,756	71	605	769	1,302
35	354	378	603	72	122	138	223
36	188	282	421	73	101	110	152
37	141	152	234	74	31	49	102
38	1,078	951	1,979	75	35	44	54
39	528	648	944	76	127	171	203
40	400	466	582	77	89	114	168
41	451	837	1,424	78	290	389	690
42	50	48	56	79	434	493	593

APPENDIX 2 (cont'd)

Table 3-2

Inventories
(in millions of 1969 dollars)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	629.3	701.8	738.4	43	440.8	449.0	579.3
7	478.8	428.2	519.7	44	297.1	493.2	629.7
8	1,709.3	1,990.5	2,512.5	45	1,294.3	1,333.1	1,535.0
9	658.0	758.5	812.0	46	4,434.0	4,835.0	5,714.6
10	215.5	213.9	215.9	47	2,013.5	2,387.9	3,291.3
11	320.1	399.8	463.8	48	362.6	531.7	708.4
12	314.8	379.5	461.3	49	326.8	383.9	439.9
13	1,171.1	1,457.5	1,810.1	50	1,364.7	1,809.1	2,149.6
14	909.6	1,077.1	1,182.2	51	647.5	890.9	1,239.5
15	1,752.2	2,618.5	2,120.0	52	1,226.7	1,723.4	2,298.8
16	1,594.5	1,781.2	1,739.0	53	481.1	664.2	1,137.4
17	192.4	292.0	451.5	54	610.7	880.4	1,059.1
18	255.4	324.8	319.9	55	1,275.4	1,770.3	2,454.3
19	455.4	654.8	878.3	56	926.3	1,356.3	1,657.9
20	1,516.9	2,275.0	2,636.6	57	831.1	1,089.7	1,394.6
21	304.8	377.1	551.3	58	903.3	1,391.6	1,838.3
22	857.8	757.8	854.0	59	272.7	303.3	479.0
23	554.9	645.2	864.6	60	701.6	1,315.5	2,155.0
24	83.8	70.5	60.6	61	557.8	828.7	1,305.1
25	795.2	1,021.9	1,411.5	62	570.4	696.4	1,003.1
26				63	600.1	807.8	1,019.2
27	1,102.2	1,445.8	1,856.6	64	671.6	889.0	1,090.7
28	500.3	674.1	787.9	65	431.1	579.6	815.2
29	137.6	121.8	177.0	66	332.1	545.8	710.9
30	1,273.0	1,470.3	1,956.5	67	1,120.0	2,060.4	2,909.8
31	1,266.1	1,624.1	2,069.9	68	625.7	904.1	1,571.6
32	312.7	449.3	468.1	69	259.6	346.1	556.5
33	298.9	344.8	448.7	70	2,456.1	3,850.9	4,070.4
34	598.7	773.6	1,116.4	71	3,572.3	4,060.6	8,863.8
35	511.1	646.9	1,005.0	72	519.4	728.4	777.8
36	444.8	586.5	905.9	73	276.6	398.6	415.5
37	326.9	412.9	503.6	74	108.5	166.0	405.1
38	1,901.3	1,984.9	2,207.2	75	325.1	134.7	267.3
39	470.5	515.8	661.3	76	363.3	495.3	577.9
40	390.2	512.3	588.9	77	171.3	235.0	421.4
41	303.0	495.6	826.5	78	471.0	713.5	1,029.9
42	182.3	167.3	122.9	79	1,788.2	1,319.6	1,791.0

APPENDIX 2 (cont'd)

Table 4-2

Net Capital Equipment Stock Plus Inventories
(in millions of 1969 dollars)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	1,171.3	1,359.8	1,566.4	43	567.8	629.0	734.3
7	1,358.8	1,395.2	1,411.7	44	941.1	1,286.2	1,756.7
8	2,329.3	2,803.5	3,591.5	45	3,691.3	3,872.1	4,255.0
9	1,290.0	1,504.5	1,705.0	46	10,963.0	12,300.0	15,515.6
10	990.5	1,016.9	1,030.9	47	3,818.5	4,412.9	6,421.3
11	520.1	715.8	821.8	48	702.9	938.7	1,253.4
12	506.8	615.5	783.3	49	489.8	524.9	586.9
13	2,263.1	2,742.5	3,528.1	50	1,923.7	2,415.1	2,958.6
14	1,474.6	1,724.1	1,997.2	51	1,324.5	1,663.9	2,371.5
15	1,930.2	2,835.5	2,319.0	52	1,968.7	2,733.4	3,614.8
16	2,946.5	3,458.2	3,755.0	53	745.1	972.2	1,750.4
17	344.4	432.0	658.5	54	891.7	1,197.4	1,456.1
18	406.4	529.8	624.9	55	1,757.4	2,324.3	3,286.3
19	725.4	973.8	1,363.3	56	1,830.3	2,257.3	2,761.9
20	1,965.9	2,774.0	3,194.6	57	1,192.1	1,514.7	1,934.6
21	393.8	498.1	773.3	58	1,514.3	2,118.6	2,770.3
22	1,731.8	1,725.8	1,927.0	59	483.7	554.3	812.0
23	810.9	1,054.2	1,484.6	60	1,035.6	1,852.5	3,088.0
24	116.8	102.5	92.7	61	786.8	1,099.7	1,711.1
25	1,131.2	1,407.9	1,938.5	62	883.4	1,005.4	1,434.1
26				63	974.1	1,238.8	1,639.2
27	4,609.2	5,634.8	7,258.6	64	1,059.6	1,304.0	1,606.7
28	1,071.3	1,368.1	1,676.9	65	706.1	929.6	1,298.2
29	641.6	698.8	950.0	66	387.1	654.8	882.9
30	2,497.0	2,922.3	3,858.5	67	1,541.0	2,665.4	3,841.8
31	4,431.1	5,790.1	7,321.9	68	973.7	1,465.1	2,436.6
32	504.7	750.3	890.1	69	454.6	554.1	897.5
33	642.9	649.8	889.7	70	5,627.1	7,625.9	8,025.4
34	2,065.7	2,923.6	3,872.4	71	4,177.3	4,829.6	10,165.8
35	865.1	1,024.9	1,608.0	72	641.4	866.4	1,000.8
36	632.8	868.5	1,326.9	73	377.6	508.6	577.5
37	467.9	564.9	737.6	74	139.5	215.0	507.1
38	2,979.3	2,935.9	4,186.2	75	360.1	178.7	321.3
39	998.5	1,163.8	1,605.3	76	490.3	666.3	780.9
40	790.2	978.3	1,170.9	77	260.3	349.0	589.4
41	754.0	1,332.6	2,250.5	78	761.0	1,102.5	1,719.9
42	232.3	215.3	178.9	79	2,222.2	1,812.6	2,384.0

APPENDIX 2 (cont'd)

Table 5-2

Average Annual Employment
(in thousands of employees)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	322.6	317.3	311.5	43	316.3	316.2	269.6
7	315.8	286.3	203.7	44	156.7	169.7	170.1
8	245.7	260.6	263.0	45	447.3	457.7	421.2
9	130.7	125.6	113.0	46	907.6	938.4	890.6
10	300.9	286.4	245.4	47	323.6	357.2	370.6
11	36.3	36.3	30.7	48	63.4	65.9	81.2
12	77.5	76.5	84.0	49	77.5	78.7	68.3
13	217.0	220.9	227.9	50	339.7	375.5	382.8
14	143.6	142.1	139.8	51	282.6	319.1	321.0
15	94.0	86.6	71.4	52	321.3	429.1	480.2
16	511.9	481.4	548.3	53	86.3	90.1	116.9
17	37.6	40.9	54.6	54	112.3	135.2	123.3
18	70.2	71.9	66.4	55	221.3	255.3	281.1
19	215.4	228.9	255.2	56	260.7	304.5	310.7
20	1,093.3	1,192.4	1,158.5	57	167.9	192.1	199.9
21	139.9	161.2	182.9	58	226.9	259.0	277.8
22	378.5	339.8	279.4	59	157.6	187.5	189.6
23	206.5	235.9	238.6	60	146.5	189.5	229.1
24	41.8	34.4	23.7	61	99.8	112.7	162.1
25	383.0	429.1	436.9	62	163.6	170.5	173.4
26				63	180.7	191.9	197.4
27	424.5	439.6	433.3	64	155.4	166.6	174.0
28	176.6	200.4	225.7	65	137.5	172.3	171.8
29	325.2	345.6	349.1	66	106.9	135.1	108.4
30	586.1	635.4	728.1	67	382.3	416.8	532.0
31	284.3	289.7	255.5	68	233.5	304.9	359.9
32	45.9	53.2	40.5	69	107.4	100.1	114.9
33	80.4	80.0	89.5	70	724.1	843.4	716.2
34	154.6	194.5	186.1	71	627.9	625.2	648.2
35	108.7	118.1	131.3	72	141.2	158.8	164.3
36	91.2	105.0	106.7	73	43.2	55.7	53.7
37	63.2	66.0	71.3	74	32.5	54.9	106.3
38	211.9	182.0	143.8	75	67.0	31.0	50.5
39	104.8	101.8	103.4	76	93.1	98.4	103.5
40	152.8	172.4	160.8	77	47.5	57.2	77.6
41	121.4	197.4	281.6	78	138.0	161.4	172.6
42	47.1	34.7	26.2	79	387.5	413.0	429.3

APPENDIX 2 (cont'd)

Table 6-2

Employment
(in millions of man-hours worked by production workers)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	497.4	474.5	514.9	43	514.7	498.8	436.1
7	276.3	238.6	193.0	44	256.4	269.8	289.4
8	397.9	409.0	423.1	45	704.6	697.1	661.2
9	178.1	164.4	167.6	46	1,338.8	1,545.7	1,417.5
10	369.3	332.3	302.0	47	503.6	551.5	591.5
11	58.2	54.5	52.9	48	110.2	121.5	146.6
12	123.9	127.5	132.3	49	104.1	107.2	96.5
13	236.7	219.8	236.2	50	494.2	532.5	564.3
14	197.5	193.6	194.2	51	375.3	424.8	529.3
15	141.7	125.7	118.5	52	614.7	694.9	743.6
16	1,061.8	1,072.8	1,012.3	53	113.2	137.3	161.3
17	59.4	74.8	91.8	54	141.7	188.5	175.3
18	114.6	121.9	109.2	55	295.5	362.2	382.1
19	367.8	398.0	415.3	56	404.0	504.2	469.9
20	1,692.6	1,874.7	1,825.8	57	255.5	293.6	270.8
21	228.3	262.4	293.6	58	308.0	389.0	380.8
22	613.0	552.1	484.1	59	201.1	251.5	311.6
23	339.4	394.7	400.5	60	180.9	206.5	246.3
24	67.4	58.6	40.5	61	141.9	181.3	226.2
25	615.3	698.1	715.0	62	208.0	204.3	237.4
26				63	238.2	276.7	278.1
27	663.5	683.5	720.9	64	226.4	255.7	270.2
28	311.3	344.7	354.9	65	212.7	233.8	258.6
29	299.6	306.1	308.9	66	121.7	187.6	159.5
30	782.5	835.2	953.2	67	368.5	521.5	565.3
31	326.9	328.1	334.2	68	393.5	489.4	472.8
32	60.9	59.6	52.6	69	136.1	141.8	175.7
33	89.6	91.7	118.6	70	1,186.2	1,499.9	1,148.8
34	186.1	235.9	262.7	71	853.2	781.7	729.2
35	110.9	113.8	144.9	72	224.1	269.1	262.0
36	99.6	113.1	128.6	73	62.2	92.5	79.6
37	66.7	72.6	78.9	74	56.4	92.6	173.6
38	244.6	203.0	204.9	75	105.6	42.9	61.9
39	140.2	141.5	149.0	76	115.0	136.8	123.4
40	233.2	267.8	239.6	77	62.7	75.6	106.0
41	216.2	330.9	460.6	78	159.3	200.7	210.8
42	66.8	60.2	43.5	79	587.7	659.5	643.3

APPENDIX 2 (cont'd)

Table 7-2

Gross Capital Equipment Stock plus Inventories
(in millions of 1969 dollars)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	1,601.3	1,868.8	2,202.4	43	680.8	750.0	873.3
7	1,971.8	2,199.2	2,284.7	44	1,388.1	1,868.2	2,567.7
8	2,821.3	3,406.5	4,393.5	45	5,413.3	6,007.1	6,720.0
9	1,755.0	2,081.5	2,412.0	46	15,540.0	17,895.0	22,947.6
10	1,656.5	1,742.9	1,818.9	47	5,170.5	6,007.9	8,637.3
11	658.1	912.8	1,104.8	48	987.6	1,269.7	1,677.4
12	680.8	806.5	1,026.3	49	694.8	686.9	734.9
13	3,241.1	3,817.5	4,839.1	50	2,371.7	2,935.1	3,607.6
14	1,964.6	2,285.1	2,675.2	51	1,993.5	2,327.9	3,246.5
15	2,080.2	3,019.5	2,522.0	52	2,585.7	3,483.4	4,663.8
16	4,259.5	4,836.2	5,487.0	53	970.1	1,225.2	2,128.4
17	496.4	581.0	815.5	54	1,170.7	1,475.4	1,798.1
18	535.4	682.8	839.9	55	2,109.4	2,751.3	3,904.3
19	1,046.4	1,262.8	1,737.3	56	2,692.3	3,102.3	3,762.9
20	2,415.9	3,224.0	3,719.6	57	1,546.1	1,879.7	2,387.6
21	478.8	589.1	914.3	58	2,019.3	2,690.6	3,534.3
22	2,455.8	2,548.8	2,912.0	59	686.7	769.3	1,129.0
23	1,019.9	1,324.2	1,932.6	60	1,264.6	2,198.5	3,652.0
24	152.8	133.5	125.6	61	1,013.8	1,310.7	2,010.7
25	1,465.2	1,744.9	2,361.5	62	1,160.4	1,303.4	1,779.1
26				63	1,313.1	1,598.8	2,118.2
27	7,254.2	8,833.8	11,478.6	64	1,482.6	1,691.0	2,040.7
28	1,530.3	1,929.1	2,412.9	65	937.1	1,197.6	1,671.2
29	1,099.6	1,203.8	1,595.0	66	434.1	721.8	1,026.9
30	3,381.0	4,132.3	5,417.5	67	1,877.0	3,116.4	4,594.8
31	7,118.1	8,975.1	11,662.9	68	1,236.7	1,868.1	3,173.6
32	636.7	972.3	1,247.1	69	655.6	751.1	1,144.5
33	988.9	984.8	1,256.7	70	8,407.1	10,609.9	11,648.4
34	3,378.7	4,447.6	6,122.4	71	4,705.3	5,489.6	11,349.8
35	1,171.1	1,364.9	2,041.0	72	725.4	978.4	1,154.8
36	809.8	1,085.5	1,621.9	73	487.6	608.6	697.5
37	612.9	704.9	905.6	74	161.5	246.0	561.1
38	4,043.3	3,949.9	5,522.2	75	384.1	215.4	367.3
39	1,418.5	1,685.8	2,305.3	76	578.3	791.3	948.9
40	1,147.2	1,370.3	1,650.9	77	326.3	437.0	708.4
41	1,036.0	1,787.6	3,100.5	78	995.0	1,391.5	2,177.9
42	285.3	264.3	231.9	79	2,621.2	2,255.6	2,902.0

APPENDIX 3

Table 1-3

Net Stock of Capital Equipment plus Inventories per Employee
(in thousands of 1969 dollars per employee)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	3.63	4.29	5.03	43	1.80	1.99	2.72
7	4.30	4.87	6.88	44	6.01	7.58	10.33
8	9.48	10.76	13.66	45	8.09	8.46	10.10
9	9.87	11.98	15.09	46	12.08	13.11	17.42
10	3.29	3.55	4.20	47	11.80	12.35	17.33
11	14.33	19.72	26.77	48	11.09	14.24	15.44
12	6.54	8.05	9.33	49	6.32	6.67	8.59
13	10.43	12.42	15.48	50	5.66	6.43	7.73
14	10.27	12.13	14.29	51	4.69	5.21	7.39
15	20.53	32.74	32.48	52	6.13	6.37	7.53
16	5.76	7.18	6.85	53	8.63	10.79	14.97
17	9.16	10.56	12.06	54	7.94	8.86	11.81
18	5.79	7.37	9.41	55	7.94	9.10	11.69
19	3.37	4.25	5.34	56	7.02	7.41	8.89
20	1.80	2.33	2.76	57	7.10	7.88	9.68
21	2.81	3.09	4.23	58	6.67	8.18	9.97
22	4.58	5.08	6.90	59	3.07	2.96	4.28
23	3.93	4.47	6.22	60	7.07	9.78	13.48
24	2.79	2.98	3.91	61	7.88	9.76	10.56
25	2.95	3.28	4.44	62	5.40	5.90	8.27
26				63	5.39	6.46	8.30
27	10.86	12.82	16.75	64	6.82	7.83	9.23
28	6.07	6.83	7.43	65	5.14	5.40	7.56
29	1.97	2.02	2.72	66	3.62	4.85	8.14
30	4.26	4.60	5.30	67	4.03	6.39	7.22
31	15.59	19.99	28.66	68	4.17	4.81	6.77
32	11.00	14.10	21.98	69	4.23	5.54	7.81
33	8.00	8.12	9.94	70	7.77	9.04	11.21
34	13.36	15.03	20.81	71	6.65	7.72	15.68
35	7.96	8.68	12.25	72	4.54	5.46	6.09
36	6.94	8.27	12.44	73	8.74	9.13	10.75
37	7.40	8.56	10.35	74	4.29	3.92	4.77
38	14.06	16.13	29.11	75	5.37	5.76	6.36
39	9.53	11.43	15.53	76	5.27	6.77	7.52
40	5.17	5.67	7.28	77	5.48	6.10	7.60
41	6.21	5.75	7.99	78	5.51	6.83	9.96
42	4.93	6.20	6.83	79	5.77	4.39	5.55

APPENDIX 3 (cont'd)

Table 2-3

Net Stock of Capital Equipment per Employee
(in thousands of 1969 dollars per employee)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	1.68	2.07	2.66	43	0.40	0.41	0.57
7	2.79	3.38	4.38	44	4.11	4.67	6.63
8	2.52	3.12	4.10	45	5.20	5.55	6.46
9	4.84	5.94	7.90	46	7.19	7.95	11.00
10	2.58	2.80	3.32	47	5.58	5.67	8.45
11	5.51	8.72	11.66	48	5.36	6.18	6.71
12	2.48	3.08	3.03	49	2.10	1.79	2.15
13	5.03	5.82	7.54	50	1.65	1.61	2.11
14	3.93	4.55	5.83	51	2.40	2.42	3.53
15	1.89	2.51	2.79	52	2.31	2.35	2.74
16	2.64	3.48	3.68	53	3.06	3.42	5.24
17	4.04	3.42	3.79	54	2.50	2.34	3.22
18	2.15	2.85	4.59	55	2.18	2.17	2.96
19	1.25	1.39	1.90	56	3.47	2.96	3.55
20	0.41	0.42	0.48	57	2.15	2.21	2.70
21	0.64	0.75	1.21	58	2.69	2.81	3.35
22	2.31	2.85	3.84	59	1.34	1.34	1.76
23	1.24	1.73	2.60	60	2.28	2.83	4.07
24	0.79	0.93	1.35	61	2.29	2.40	2.50
25	0.88	0.90	1.21	62	1.91	1.81	2.49
26				63	2.07	2.25	3.14
27	8.26	9.53	12.47	64	2.50	2.49	2.97
28	3.23	3.46	3.94	65	2.00	2.03	2.81
29	1.55	1.67	2.21	66	0.51	0.81	1.59
30	2.09	2.29	2.61	67	1.10	1.45	1.75
31	11.13	14.38	20.56	68	1.49	1.84	2.40
32	4.18	5.66	10.42	69	1.82	2.08	2.97
33	4.28	3.81	4.93	70	4.38	4.78	5.52
34	9.49	11.05	14.81	71	0.96	1.23	2.01
35	3.26	3.20	4.59	72	0.86	0.87	1.36
36	2.06	2.69	3.95	73	2.34	1.97	2.83
37	2.23	2.30	3.28	74	0.95	0.89	0.96
38	11.82	9.06	18.55	75	0.52	1.42	1.07
39	5.04	6.37	9.13	76	1.36	1.74	1.96
40	2.62	2.70	3.62	77	1.87	1.99	2.16
41	3.71	4.24	5.06	78	2.10	2.41	4.00
42	1.06	1.38	2.14	79	1.12	1.19	1.38

APPENDIX 3 (cont'd)

Table 3-3

Gross Stock of Capital Equipment per Employee
(in thousands of 1969 dollars per employee)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	3.01	3.68	4.70	43	0.76	0.79	1.09
7	4.73	6.19	8.66	44	6.96	8.11	11.39
8	4.53	5.43	7.15	45	9.21	10.21	12.31
9	8.39	10.53	14.16	46	12.24	13.92	19.35
10	4.79	5.34	6.53	47	9.76	10.13	14.43
11	9.31	14.13	20.88	48	9.86	11.20	11.93
12	4.72	5.58	6.73	49	4.75	3.85	4.32
13	9.54	10.68	13.29	50	2.96	3.00	3.81
14	7.35	8.50	10.68	51	4.76	4.50	6.25
15	3.49	4.63	5.63	52	4.23	4.10	4.92
16	5.21	6.35	6.84	53	5.67	6.23	8.48
17	8.09	7.07	6.67	54	4.99	4.40	5.99
18	3.99	4.98	7.83	55	3.77	3.84	5.16
19	2.74	2.66	3.37	56	6.77	5.73	6.78
20	0.82	0.80	0.93	57	4.26	4.11	4.97
21	1.24	1.32	1.98	58	4.92	5.02	6.11
22	4.22	5.27	7.37	59	2.63	2.49	3.43
23	2.25	2.88	4.48	60	3.84	4.66	6.53
24	1.65	1.83	2.74	61	4.57	4.28	4.35
25	1.75	1.68	2.17	62	3.61	3.56	4.48
26				63	3.95	4.12	5.57
27	14.49	16.81	22.21	64	5.22	4.81	5.46
28	5.83	6.26	7.20	65	3.68	3.59	4.98
29	2.96	3.13	4.06	66	0.95	1.30	2.92
30	3.60	4.19	4.75	67	1.98	2.53	3.17
31	20.58	25.37	37.55	68	2.62	3.16	4.45
32	7.06	9.83	19.23	69	3.69	4.05	5.12
33	8.58	8.00	9.03	70	8.22	8.01	10.58
34	17.98	18.89	26.90	71	1.80	2.29	3.89
35	6.07	6.08	7.89	72	1.46	1.57	2.29
36	4.00	4.75	6.71	73	4.88	3.77	5.07
37	4.53	4.42	5.64	74	1.63	1.46	1.47
38	10.11	10.80	23.05	75	0.88	2.61	1.98
39	9.05	11.49	15.90	76	2.31	3.01	3.57
40	4.95	4.98	6.60	77	3.26	3.53	3.71
41	6.04	6.55	8.08	78	3.80	4.20	6.65
42	2.19	2.80	4.16	79	2.15	2.27	2.59

APPENDIX 3 (cont'd)

Table 4-3

Gross Stock of Capital Equipment plus Inventories per Employee
(in thousands of 1969 dollars per employee)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	4.96	5.89	7.07	43	2.15	2.37	3.24
7	6.24	7.68	11.22	44	8.86	11.01	15.10
8	11.48	13.07	16.71	45	12.10	13.12	15.95
9	13.43	16.57	21.35	46	17.12	19.07	25.77
10	5.51	6.09	7.41	47	15.98	16.82	23.31
11	18.13	25.15	35.99	48	15.58	19.27	20.66
12	8.78	10.54	12.22	49	8.97	8.73	10.76
13	14.94	17.28	21.23	50	6.98	7.82	9.42
14	13.68	16.08	19.14	51	7.05	7.30	10.11
15	22.13	34.87	35.32	52	8.05	8.12	9.71
16	8.32	10.05	10.01	53	11.24	13.60	18.21
17	13.20	14.21	14.94	54	10.42	10.91	14.58
18	7.63	9.50	12.65	55	9.53	10.78	13.89
19	4.86	5.52	6.81	56	10.33	10.19	12.11
20	2.21	2.70	3.21	57	9.21	9.79	11.94
21	3.42	3.65	5.00	58	8.90	10.39	12.72
22	6.49	7.50	10.42	59	4.36	4.10	5.95
23	4.94	5.61	8.10	60	8.63	11.60	15.94
24	3.66	3.88	5.30	61	10.16	11.63	12.40
25	3.83	4.07	5.41	62	7.09	7.64	10.26
26				63	7.27	8.33	10.73
27	17.09	20.10	26.49	64	9.54	10.15	11.73
28	8.67	9.63	10.69	65	6.82	6.95	9.73
29	3.38	3.48	4.57	66	4.06	5.34	9.47
30	5.77	6.50	7.44	67	4.91	7.48	8.64
31	25.04	30.98	45.65	68	5.30	6.13	8.82
32	13.87	18.28	30.79	69	6.10	7.50	9.96
33	12.30	12.31	14.04	70	11.61	12.58	16.26
34	21.85	22.87	32.90	71	7.49	8.78	17.51
35	10.77	11.56	15.54	72	5.14	6.16	7.03
36	8.88	10.34	15.20	73	11.29	10.93	12.99
37	9.70	10.68	12.70	74	4.97	4.48	5.28
38	19.08	21.70	38.40	75	5.73	6.95	7.27
39	13.54	16.56	22.29	76	6.21	8.04	9.14
40	7.51	7.95	10.27	77	6.87	7.64	9.14
41	8.53	9.06	11.01	78	7.21	8.62	12.61
42	6.06	7.62	8.85	79	6.76	5.46	6.76

APPENDIX 3 (cont'd)

Table 5-3

Net Stock of Capital Equipment per Production Worker Man-hour
(in dollars per man-hour)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	1.09	1.39	1.61	43	0.25	0.26	0.35
7	3.18	4.05	4.62	44	2.51	2.94	3.89
8	1.56	1.99	2.55	45	3.30	3.64	4.11
9	3.55	4.54	5.33	46	4.88	4.83	6.91
10	2.10	2.42	2.70	47	3.58	3.67	5.29
11	3.44	5.80	6.77	48	3.08	3.35	3.72
12	1.55	1.85	2.43	49	1.57	1.31	1.52
13	4.61	5.85	7.27	50	1.13	1.14	1.43
14	2.86	3.34	4.20	51	1.80	1.82	2.14
15	1.26	1.73	1.68	52	1.21	1.45	1.77
16	1.27	1.56	1.99	53	2.33	2.24	3.80
17	2.56	1.87	2.26	54	1.98	1.68	2.27
18	1.32	1.68	2.79	55	1.63	1.53	2.18
19	0.73	0.80	1.17	56	2.24	1.79	2.35
20	0.27	0.27	0.31	57	1.41	1.45	1.99
21	0.39	0.46	0.76	58	1.98	1.87	2.45
22	1.43	1.75	2.22	59	1.05	1.00	1.07
23	0.75	1.04	1.55	60	1.85	2.60	3.79
24	0.49	0.55	0.79	61	1.61	1.49	1.79
25	0.55	0.55	0.74	62	1.53	1.51	1.84
26				63	1.57	1.56	2.23
27	5.29	6.13	7.49	64	1.71	1.62	1.91
28	1.83	2.01	2.50	65	1.29	1.50	1.87
29	1.68	1.88	2.50	66	0.45	0.58	1.08
30	1.56	1.74	2.00	67	1.14	1.16	1.65
31	9.68	12.70	15.71	68	0.88	1.15	1.83
32	3.15	5.13	8.02	69	1.43	1.47	1.94
33	3.84	3.33	3.72	70	2.67	2.52	3.44
34	7.88	9.11	10.47	71	0.71	0.98	1.79
35	3.19	3.32	4.16	72	0.54	0.51	0.85
36	1.89	2.49	3.27	73	1.62	1.19	1.91
37	2.11	2.09	2.97	74	0.55	0.53	0.59
38	4.41	4.68	9.66	75	0.33	1.03	0.87
39	3.77	4.58	6.34	76	1.10	1.25	1.64
40	1.71	1.74	2.43	77	1.42	1.51	1.58
41	2.09	2.53	3.09	78	1.82	1.94	3.27
42	0.75	0.80	1.29	79	0.53	0.75	0.92

APPENDIX 3 (cont'd)

Table 6-3

Inventories per Production Worker Man-hour
(in dollars per man-hour)

Input-Output Industry No.	1960	1965	1970	Input-Output Industry No.	1960	1965	1970
6	1.26	1.48	1.43	43	0.86	1.00	1.33
7	1.73	1.79	2.69	44	1.16	1.83	2.18
8	4.30	4.87	5.94	45	1.84	1.91	2.32
9	3.69	4.61	4.84	46	3.31	3.13	4.03
10	0.58	0.64	0.71	47	4.00	4.33	5.56
11	5.50	7.34	8.77	48	3.29	4.38	4.83
12	2.54	2.98	3.49	49	3.14	3.58	4.56
13	4.95	6.63	7.66	50	2.76	3.40	3.81
14	4.61	5.56	6.09	51	1.72	2.10	2.34
15	12.37	20.83	17.89	52	2.00	2.48	3.09
16	1.50	1.66	1.72	53	4.25	4.84	7.05
17	3.24	3.90	4.92	54	4.31	4.67	6.04
18	2.23	2.66	2.93	55	4.32	4.89	6.42
19	1.24	1.64	2.11	56	2.29	2.69	3.53
20	0.90	1.21	1.44	57	3.25	3.71	5.15
21	1.33	1.44	1.88	58	2.93	3.58	4.83
22	1.40	1.37	1.76	59	1.36	1.21	1.54
23	1.64	1.63	2.16	60	3.88	6.37	8.75
24	1.24	1.20	1.50	61	3.93	4.57	5.77
25	1.29	1.46	1.97	62	2.74	3.41	4.22
26				63	2.52	2.52	3.66
27	1.66	2.11	2.57	64	2.97	3.48	9.04
28	1.61	1.96	2.22	65	2.03	2.48	3.15
29	0.46	0.40	0.57	66	2.73	2.91	4.46
30	1.63	1.76	2.05	67	3.04	3.95	5.15
31	3.87	4.95	6.19	68	1.59	1.85	3.32
32	5.13	7.54	8.90	69	1.91	2.44	3.17
33	3.34	3.76	3.78	70	2.09	2.57	3.54
34	3.22	3.28	4.25	71	4.19	5.19	12.16
35	4.61	5.68	6.94	72	2.32	2.71	2.97
36	4.47	5.19	7.04	73	4.45	4.31	5.34
37	4.90	5.69	6.38	74	1.92	1.79	2.33
38	7.77	9.78	10.77	75	3.08	3.14	4.32
39	3.36	3.64	4.44	76	3.16	3.62	4.68
40	1.67	1.91	2.46	77	2.73	3.11	3.97
41	1.40	1.50	1.79	78	2.96	3.55	4.89
42	2.73	2.78	2.82	79	3.04	2.00	2.78

APPENDIX 4

Table 1-4

Average Net Capital Equipment Stock plus Inventories per Establishment
(in thousands of 1969 dollars)

Input-Output Industry No.	1958	1963	1967	Input-Output Industry No.	1958	1963	1967
6	217.4	236.7	309.3	43	140.9	168.2	220.0
7	125.3	175.4	235.2	44	721.7	882.2	1,231.9
8	604.8	710.0	922.0	45	245.2	251.6	288.5
9	354.6	421.3	510.5	46	3,326.4	3,362.5	4,139.0
10	156.5	184.4	243.5	47	1,147.5	1,227.0	1,670.9
11	3,153.5	4,331.7	4,236.8	48	2,160.2	1,874.0	2,226.1
12	351.7	481.1	569.6	49	496.4	491.3	644.4
13	414.4	517.1	706.1	50	212.1	201.5	258.7
14	250.0	350.4	417.6	51	278.4	269.0	410.8
15	3,704.4	7,344.7	8,296.4	52	200.1	221.6	294.0
16	828.8	1,256.1	1,360.0	53	5,789.3	4,715.2	6,446.7
17	1,175.5	1,076.2	1,196.6	54	591.8	650.8	881.8
18	343.2	420.5	519.2	55	811.1	822.6	1,223.0
19	251.1	296.1	411.3	56	236.3	219.7	293.3
20	97.2	119.1	155.7	57	350.7	391.1	557.3
21	54.6	60.9	82.9	58	434.7	458.3	673.2
22	55.5	62.7	63.3	59	47.7	39.2	47.9
23	105.6	113.3	152.2	60	2,610.4	2,680.4	3,723.9
24	93.9	98.4	122.3	61	579.9	603.2	879.0
25	110.9	120.8	165.7	62	756.5	789.6	1,048.9
26				63	889.9	827.9	1,160.0
27	1,535.2	1,546.3	2,074.0	64	1,599.1	1,657.0	2,372.8
28	476.7	505.4	585.3	65	353.9	392.9	583.1
29	80.4	80.6	109.5	66	990.5	1,018.1	1,500.8
30	84.2	90.5	116.9	67	2,022.9	1,939.2	2,555.3
31	2,562.2	2,538.8	3,296.2	68	915.7	514.7	883.8
32	331.0	494.4	799.5	69	508.3	595.5	602.0
33	304.6	265.2	320.5	70	2,481.9	2,157.7	2,910.5
34	4,980.6	4,056.5	4,643.7	71	3,085.1	3,522.4	7,075.0
35	619.7	750.2	1,104.8	72	334.1	304.2	565.5
36	216.7	296.4	416.8	73	3,304.3	3,847.1	4,416.0
37	278.3	289.7	368.9	74	173.9	174.4	203.5
38	1,937.8	1,632.3	1,828.9	75	536.0	304.2	413.3
39	7,350.4	6,759.4	7,048.4	76	550.0	718.7	953.9
40	686.1	718.6	843.8	77	202.1	241.6	310.2
41	197.4	240.3	359.0	78	574.6	713.3	993.1
42	345.7	348.2	354.0	79	153.6	116.9	146.7

APPENDIX 4 (cont'd)

Table 2-4

Average Net Capital Equipment Stock per Establishment
(in thousands of 1969 dollars)

Input-Output Industry No.	1958	1963	1967	Input-Output Industry No.	1958	1963	1967
6	94.4	110.4	149.0	43	32.5	36.6	45.5
7	82.4	120.2	151.3	44	474.3	541.3	801.8
8	161.1	180.6	272.1	45	166.9	164.7	189.1
9	164.2	193.8	253.3	46	1,974.1	1,961.6	2,556.7
10	120.1	144.4	192.0	47	589.3	545.5	794.1
11	1,166.7	1,579.3	1,956.0	48	919.3	872.3	1,026.8
12	130.2	166.3	231.5	49	193.1	141.0	176.6
13	195.0	235.2	340.7	50	57.1	54.9	69.1
14	102.7	121.4	162.1	51	147.3	125.9	184.5
15	333.3	505.1	650.5	52	77.4	81.3	112.0
16	390.2	504.6	700.9	53	2,014.3	1,624.2	2,203.3
17	560.3	418.3	363.6	54	194.0	172.8	229.9
18	124.1	160.3	220.8	55	209.5	205.0	312.8
19	98.7	97.3	143.1	56	131.0	94.7	117.6
20	21.1	21.3	27.9	57	116.6	112.8	154.6
21	13.6	13.3	20.3	58	179.5	164.6	235.1
22	26.8	31.9	36.4	59	22.2	17.5	22.0
23	31.2	38.2	62.0	60	881.5	869.9	1,080.8
24	30.5	29.4	38.7	61	195.1	153.9	210.4
25	34.5	32.4	46.0	62	297.5	270.9	298.0
26				63	370.4	296.6	417.9
27	1,120.7	1,128.6	1,559.4	64	652.8	511.4	704.9
28	259.6	254.6	313.1	65	146.8	150.7	227.0
29	62.3	65.1	88.2	66	140.2	145.6	273.8
30	40.9	45.4	56.7	67	604.6	410.0	549.9
31	1,888.1	1,808.4	2,438.5	68	161.8	191.6	324.7
32	129.5	204.6	364.6	69	245.1	218.5	226.6
33	177.8	131.8	155.9	70	1,528.7	1,093.7	1,512.1
34	3,764.1	2,883.9	3,448.8	71	411.1	524.5	1,013.4
35	252.4	279.7	408.3	72	56.3	62.8	82.5
36	64.8	100.0	129.2	73	1,282.6	882.4	1,073.2
37	92.5	76.6	102.9	74	36.1	37.1	41.4
38	757.5	525.3	577.7	75	45.9	74.1	70.9
39	3,926.8	3,774.2	3,983.5	76	149.3	187.3	241.5
40	361.7	343.0	421.8	77	67.3	81.4	92.1
41	114.5	147.0	224.4	78	234.9	270.7	345.2
42	76.2	75.7	94.0	79	30.6	31.5	37.6

APPENDIX 5

Flood Plain Data Sources Explored

1. William Hoehl, Flood Control Branch, Tennessee Valley Authority, Knoxville, Tennessee.

The TVA has made many flood damage surveys and we hoped that they would be a valuable data source. However, a personal inspection of the information available indicated that the TVA would not be an adequate source of flood plain data because:

a. Many of their surveys are old, dating from the thirties and forties.

b. Much of the area covered by the TVA is rural and there are few commercial or industrial areas.

c. None of the TVA surveys received contained any data on the value of structures or contents.

2. Larry Backs and Jerry Landes, U.S. Army Corps of Engineers, Kansas City District.

Jerry Landes has done some work on a commercial and industrial affluence factor based on the Turkey Creek flood plain of the Kansas City SMSA. Although they were interested in the project and intimated that they might have some useful flood damage survey data, Landes and Backs were not able to provide the desired information.

3. Bill Trishman, U.S. Army Corps of Engineers, Baltimore District.

Bill Trishman indicated that he did have flood damage surveys from Milton, Pennsylvania for two years: 1963 and 1974. However, he said that these surveys contained no data on the value of structures or contents.

4. Bill Eldridge, U.S. Army Corps of Engineers, Galveston District.

Eldridge told us that the Galveston District had prepared average capital stock and damage data for many categories of commercial establishments. The average value estimates were separated into structures, equipment, and inventories; the averages were also stratified into three size groups. The damage estimates were the percent of the value of structures, inventories, and equipment damaged at 1-foot flood increments. Although this data is comparatively extensive, there is no way of determining how many different areas and years were used to arrive at the averages. In addition, the averages apply to only a single year and are implied to be static over time.

APPENDIX 5 (cont'd)

5. Frank Moulis, U.S. Army Corps of Engineers, Pittsburgh District.

Moulis indicated that the Pittsburgh District had a large amount of information which would be available for our use. However, he was not able to identify a flood plain which had been surveyed more than once.

6. Al Elberfeld, U.S. Army Corps of Engineers, Huntington District.

Elberfeld was somewhat skeptical about the chances of the success of the affluence factor research. In addition, he was not able to identify an urbanized area in his district which had been surveyed more than once.

7. Bill Drake, U.S. Army Corps of Engineers, Missouri River Division, Omaha, Nebraska.

Drake was very interested in the research effort. Although he was not able to direct us to data sources in his area, he was enlightening on the problems of the flood damage surveys. He noted that many of the data problems we were encountering stemmed, in part, from the flood damage survey forms. In addition, he pointed out that the lack of Corpswide guidelines for preparing the flood damage surveys contributed to the problems of data comparability between districts and between surveys.

8. Susan Bailey, U.S. Army Corps of Engineers, Portland District.

Bailey worked on the task group which developed guidance for the residential affluence factor. However, she was not able to direct our research to data sources investigated by the task group which we had not yet explored. She was also unable to provide the desired survey data from her district.

9. Fred Bennett and Charles Curran, U.S. Army Corps of Engineers, Louisville District.

At the beginning of our research, the Louisville District had been suggested as a good source of flood damage survey data. Bennett and Curran originally identified four specific flood plains for which two or more surveys had been taken. These areas were Pigeon Creek, Evansville, Indiana; Mill Creek, Cincinnati, Ohio; Ohio River, Louisville, Kentucky; Buck Creek, Springfield, Ohio. Of these four, at least two surveys from Evansville, Cincinnati, and Louisville were used in this study. We were unable to find the Buck Creek surveys.

APPENDIX 5 (cont'd)

10. Kenneth McMannus, Soil Conservation Service, Fort Worth, Texas.

Sam Bruger at FIA suggested that we contact Tom Hodges in Fort Worth concerning a commercial flood damage study. McMannus forwarded a copy of the report, "Floodwater Damage Estimates Residential and Commercial Property." This study contained the same type of value estimates as those developed by the Galveston District; it also had the same problems noted above.

11. Neil S. Grigg, Department of Civil Engineering, Colorado State University, Ft. Collins, Colorado.

Dr. Grigg was contacted on the recommendation of Sam Bruger. Grigg is a co-author of Urban Drainage and Flood Control Projects; Economic, Legal and Financial Aspects. It was hoped that he would be able to direct our research to additional data sources. Although Grigg did provide us with his publication, it was of little use for this study.

12. Ed Schiffers, Department of the Army, Office of the Chief of Engineers.
George Antle, U.S. Army Engineer Institute for Water Resources.

Both Mr. Schiffers and Mr. Antle were able to provide the background to the affluence factor problem. In addition, both suggested further contacts for data and previous research.

<u>APPENDIX 6</u>

Table 1-6

Average Contents per Establishment
(in thousands of 1969 dollars)

Input-Output Industry No.	1961 Louisville	1961 Cincinnati	1968 Cincinnati	1974 Cincinnati
6		179.2		4,572.6
7	85.9	117.6		
8				
9	2,245.1	2,941.2	6,172.8	851.0
10	281.1	135.9	308.6	
11				
12	39.4			
13	26,247.8	35.3		151.3
14	1,702.6	1,823.5	617.3	
15	12,111.4			
16	523.5			
17				
18				
19				
20				
21	326.3	135.3		18.90
22			617.3	
23	186.9	687.0		
24	4,640.0	235.3		
25	171.9	312.9		794.2
26				
27		964.7	4,764.6	2,950.1
28	1,500.0	582.4	3,960.9	491.7
29	795.4	23.5		
30	1,279.1	125.9	435.5	
31	1,129.4	494.1	318.9	
32	370.6	1,176.5		
33		4,443.2	5,159.4	
34	676.5	200.0		
35	44.1			
36	42.8	1,197.0	1,337.4	3,403.9
37	953.3	70.6		
38	771.8			
39				
40		182.4		
41		1,088.2	3,600.8	
42				
43	75.5	1,400.0		18.9
44	24.6			
45	737.0	88.2	2,203.4	117.2
46	137.0	300.3	1,543.2	177.8
47	6,358.8	265.9	66.9	307.6

APPENDIX 6 (cont'd)

Table 1-6 (cont'd)

Average Contents per Establishment
(in thousands of 1969 dollars)

Input-Output Industry No.	1961 Louisville	1961 Cincinnati	1968 Cincinnati	1974 Cincinnati
48	3,734.4		13,374.5	5,748.9
49	4,590.6	1,220.6	357.2	189.1
50	1,406.3	174.1	523.9	1,550.7
51	1,558.7	655.2		
52	52.9	1,884.0	565.2	3,582.1
53				
54		235.3		
55	514.9	676.4	2,057.6	1,550.7
56	132.9	598.0	720.2	2,288.2
57	758.4	699.6	514.4	302.6
58	41.8	416.6		249.6
59	1,504.7	59.1	87.4	794.3
60	218.8			
61	797.0	495.9		
62		382.4	205.8	151.3
63				
64				
65	221.8		1,841.5	4,538.6
66				484.1
67	26.5			
68			8,230.5	
69				
70			771.6	60.5
71		865.9		
72			1,388.9	
73				
74				
75				
76	264.7		20.6	
77	21.4		1,337.4	
78				
79	267.4	1,172.0	990.0	

APPENDIX 6 (cont'd)

Table 2-6

Capital Contents per Employee
(in thousands of 1969 dollars per employee)

Input-Output Industry No.	1961 Louisville	1961 Cincinnati	1968 Cincinnati	1974 Cincinnati
6		8.95		1.76
7	16.08	6.54		
8				
9	17.59	23.92	26.84	50.06
10	2.49	11.32	10.64	
11				
12	4.38			
13	106.20	1.60		0.33
14	35.54	4.48	15.43	
15	9.83			
16	10.79			
17				
18				
19				
20	2.44			
21	4.18	10.79		2.36
22			41.15	
23	5.77	7.34		
24	20.91	9.80		
25	2.34	5.89		5.48
26				
27		8.73	27.65	113.46
28	9.26	5.24	304.68	8.34
29	1.18	23.53		
30	8.99	8.19	11.26	
31	16.13	15.44	13.01	
32	8.72	16.12		
33		24.72	14.39	
34	33.82	9.53		
35	2.20			
36	2.32	7.34	102.88	6.13
37	15.32	3.53		
38	6.95			
39				
40		14.02		
41		1.15	2.82	
42				
43	6.29	5.27		1.57
44	4.80			
45	5.45	7.51	10.59	3.61
46	4.04	5.12	5.49	3.56
47	9.74	4.94	0.47	3.34

APPENDIX 6 (cont'd)

Table 2-6 (cont'd)

Capital Contents per Employee
(in thousands of 1969 dollars per employee)

Input-Output Industry No.	1961 Louisville	1961 Cincinnati	1968 Cincinnati	1974 Cincinnati
48			5.73	11.50
49	5.75	7.42	14.29	3.15
50	29.74	4.52	7.16	9.63
51	14.60	4.19		
52	9.25	9.46	5.02	4.91
53				
54		0.78		
55	7.80	6.64	7.71	3.56
56	16.61	9.59	9.80	22.00
57	6.22	10.52	5.78	10.08
58	5.01	5.29		6.24
59	11.53	8.95	14.58	132.4
60	7.42			
61	5.72	7.34		
62		1.91	0.82	0.52
63				
64				
65	3.69		7.76	1.31
66				107.58
67	2.94			
68			5.87	
69				
70			8.38	4.03
71				
72				
73				
74				
75				
76	4.65		4.12	
77	8.56		19.10	
78				
79	6.59	3.13	34.16	

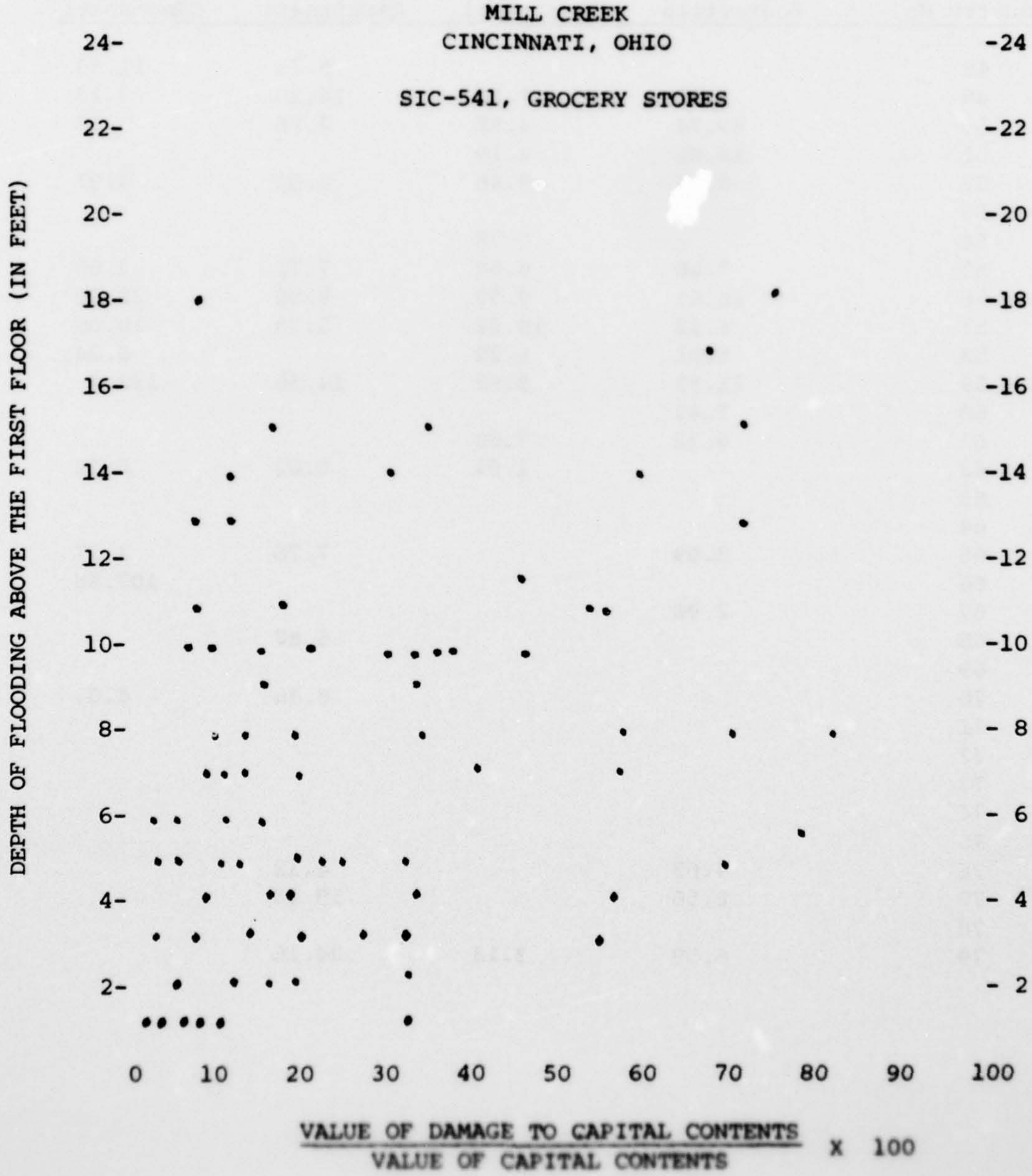
APPENDIX 7

Figure 1-7

DEPTH/DAMAGE SCATTERGRAMS

1961
MILL CREEK
CINCINNATI, OHIO

SIC-541, GROCERY STORES



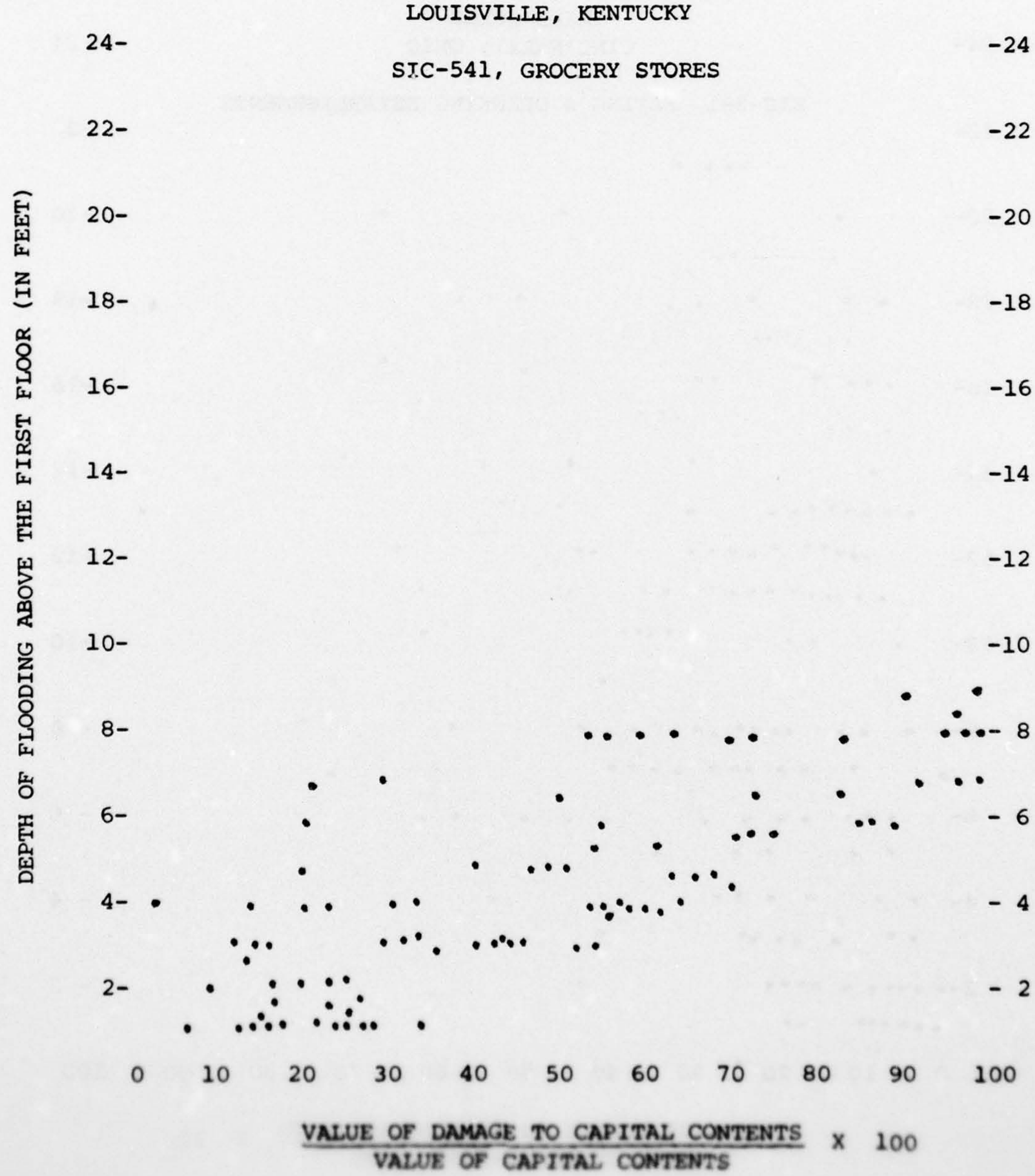
APPENDIX 7

Figure 2-7

DEPTH/DAMAGE SCATTERGRAMS

1961
LOUISVILLE, KENTUCKY

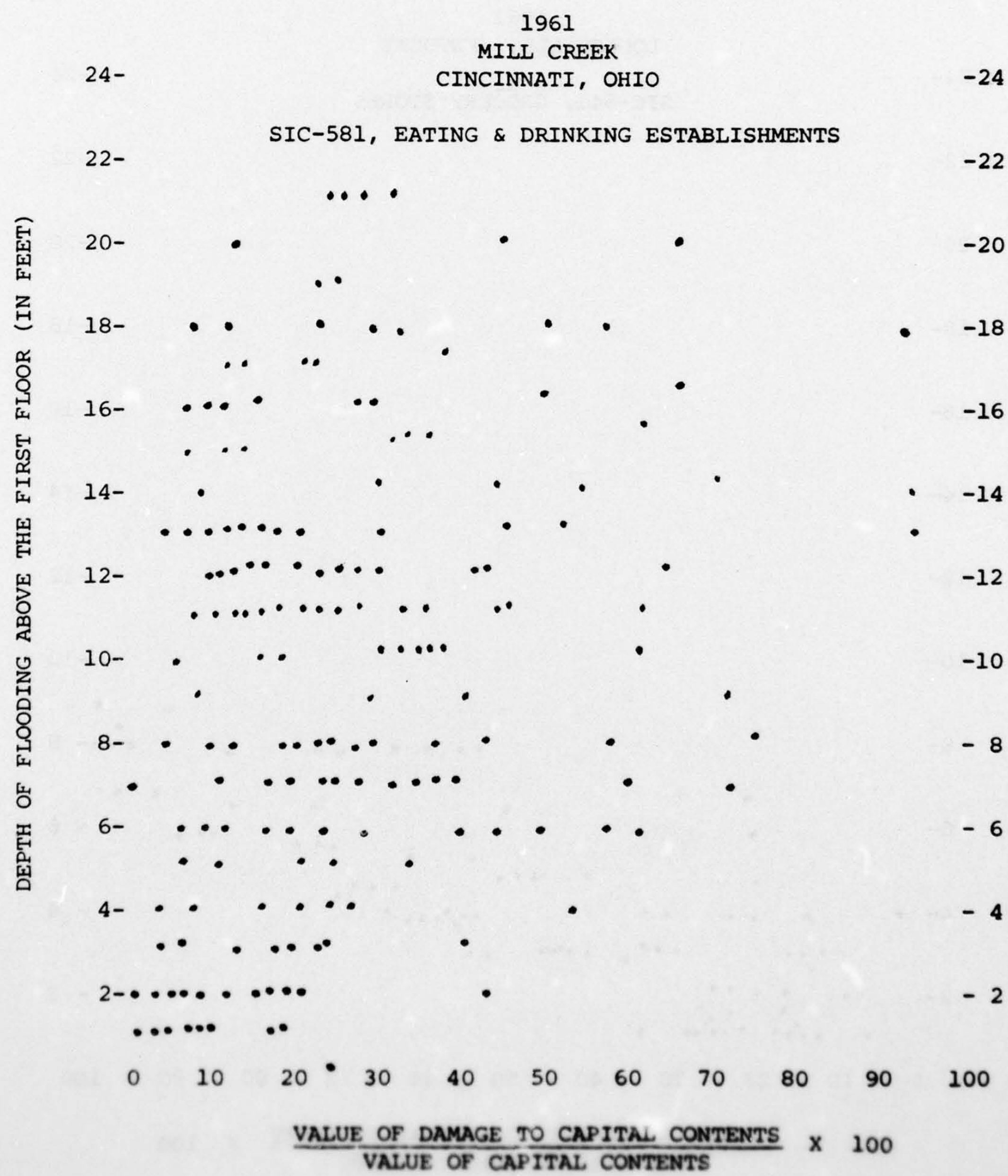
SIC-541, GROCERY STORES



APPENDIX 7

Figure 3-7

DEPTH/DAMAGE SCATTERGRAMS



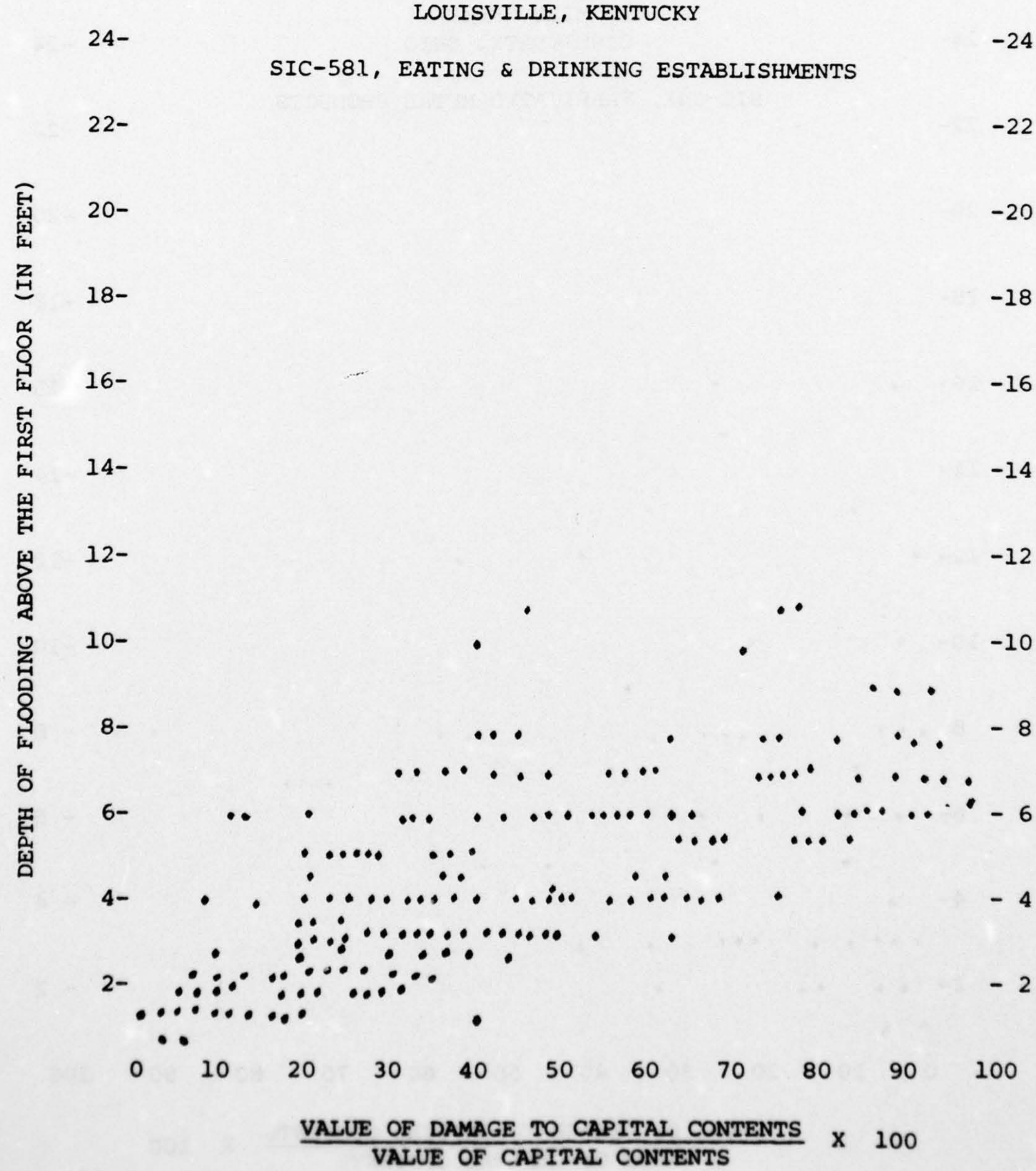
APPENDIX 7

Figure 4-7

DEPTH/DAMAGE SCATTERGRAMS

1961
LOUISVILLE, KENTUCKY

SIC-581, EATING & DRINKING ESTABLISHMENTS

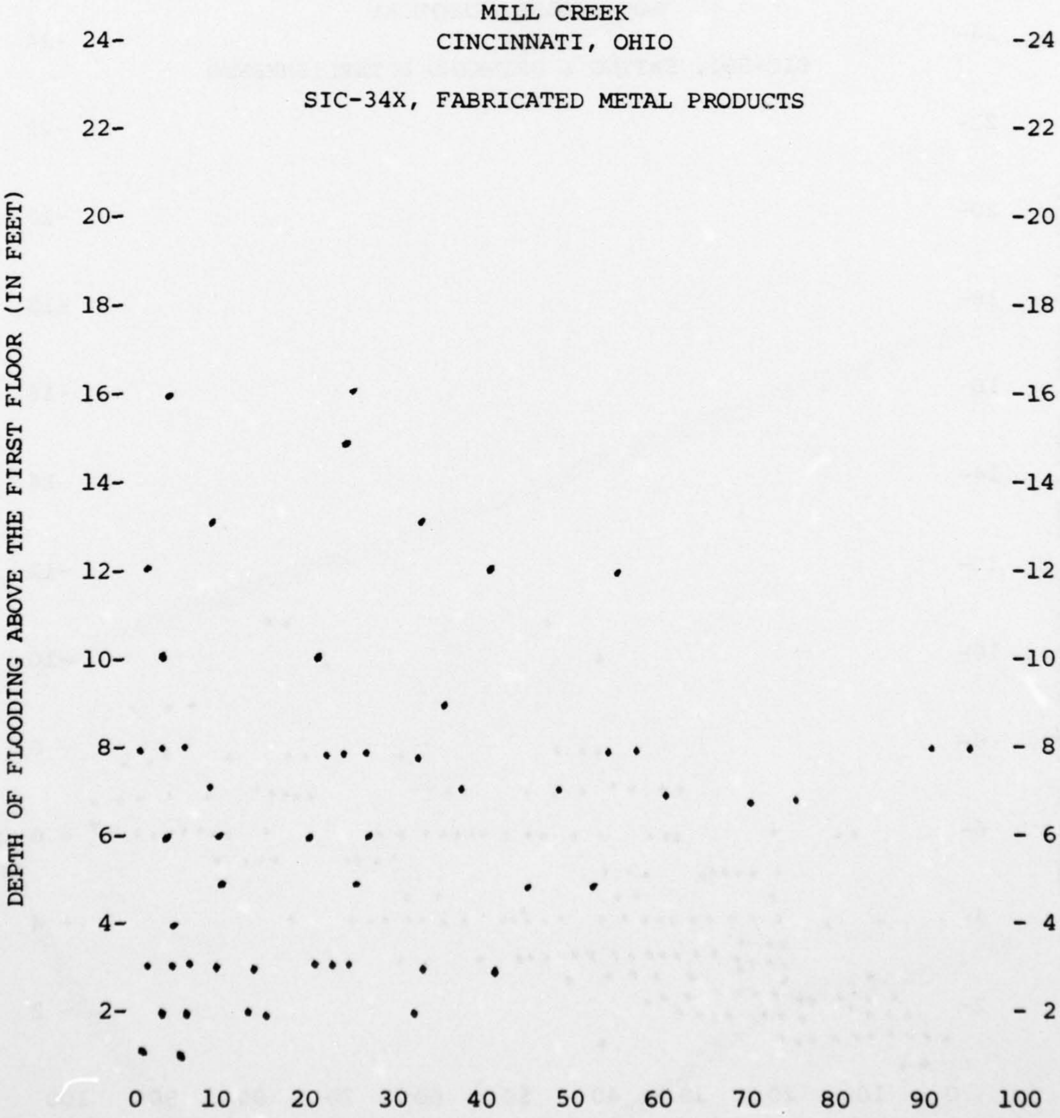


APPENDIX 7

Figure 5-7

DEPTH/DAMAGE SCATTERGRAMS

1961
MILL CREEK
CINCINNATI, OHIO
SIC-34X, FABRICATED METAL PRODUCTS



$\frac{\text{VALUE OF DAMAGE TO CAPITAL CONTENTS}}{\text{VALUE OF CAPITAL CONTENTS}}$ X 100

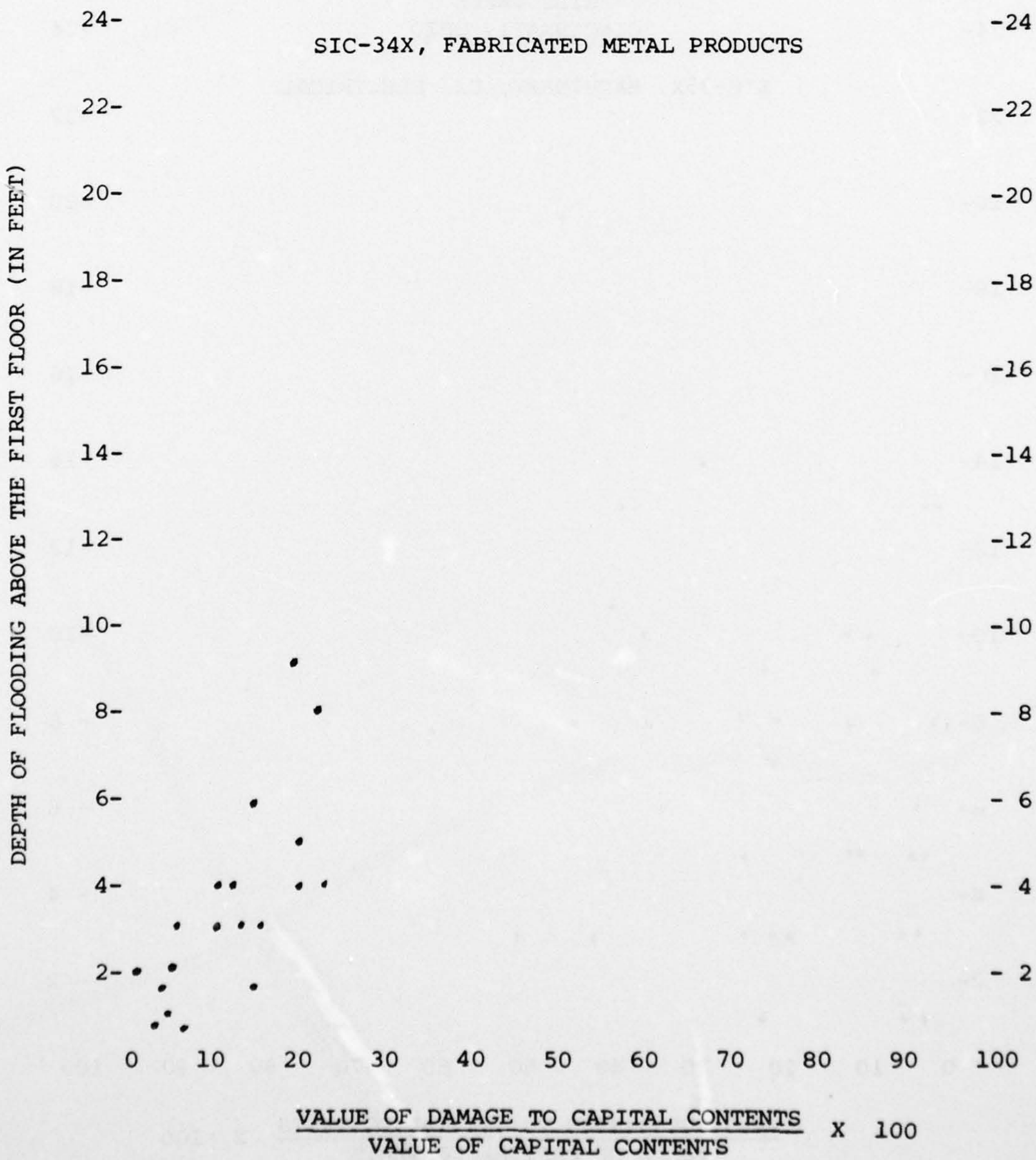
APPENDIX 7

Figure 6-7

DEPTH/DAMAGE SCATTERGRAMS

1961
LOUISVILLE, KENTUCKY

SIC-34X, FABRICATED METAL PRODUCTS



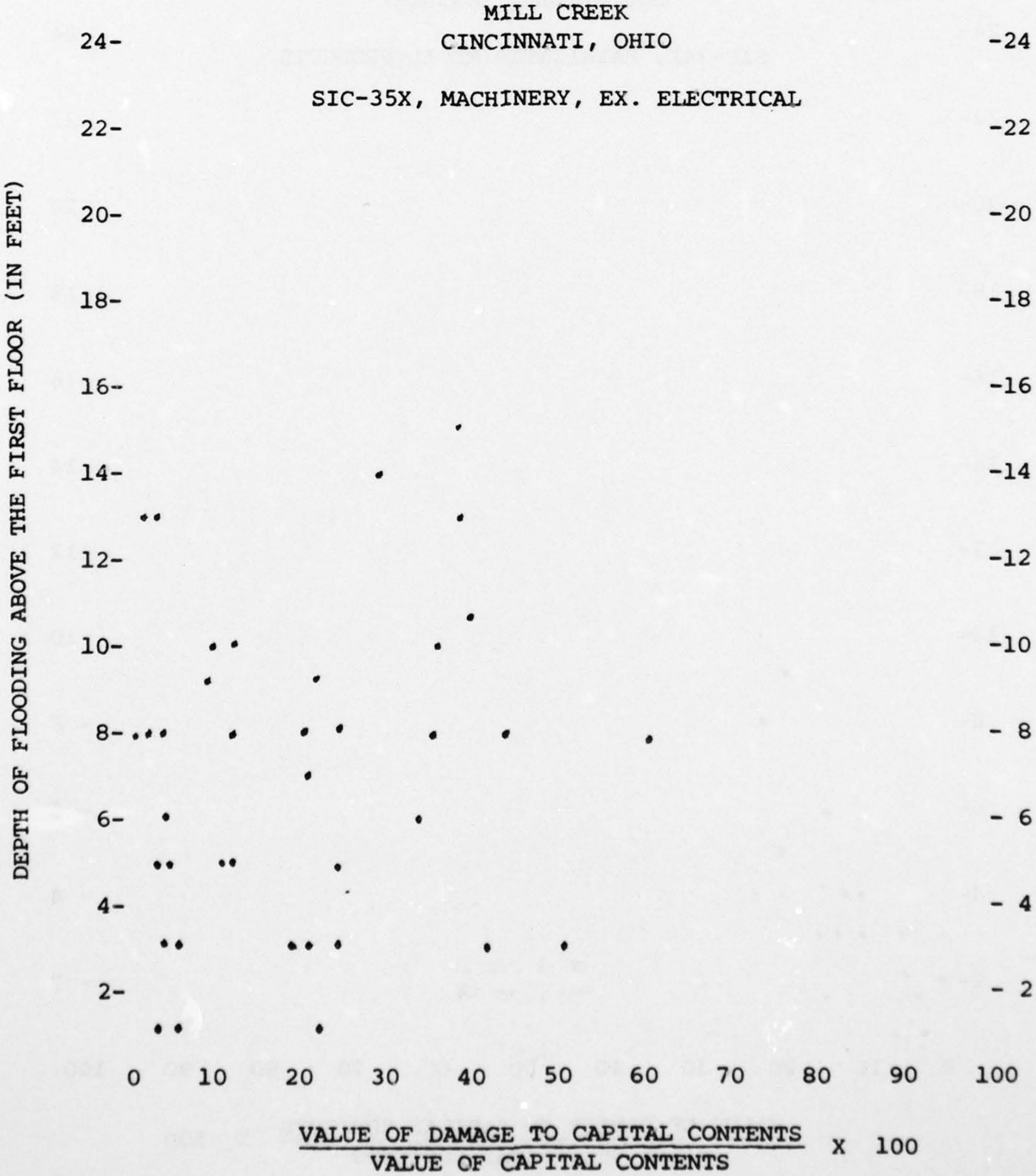
APPENDIX 7

Figure 7-7

DEPTH/DAMAGE SCATTERGRAMS

1961
MILL CREEK
CINCINNATI, OHIO

SIC-35X, MACHINERY, EX. ELECTRICAL



AD-A056 743 INSTITUTE FOR WATER RESOURCES (ARMY) FORT BELVOIR VA F/G 13/2

EMPIRICAL INVESTIGATION OF THE EXISTENCE AND MAGNITUDE OF A COM--ETC(U)

SEP 77 D A MOSER, C A BERRY

UNCLASSIFIED IWR-RR-77-R3 NL

2 OF 2

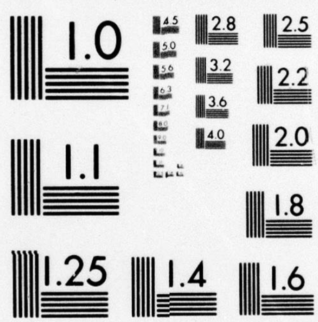
AD
A056743

END

DATE FILMED

9 -78

DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

APPENDIX 7

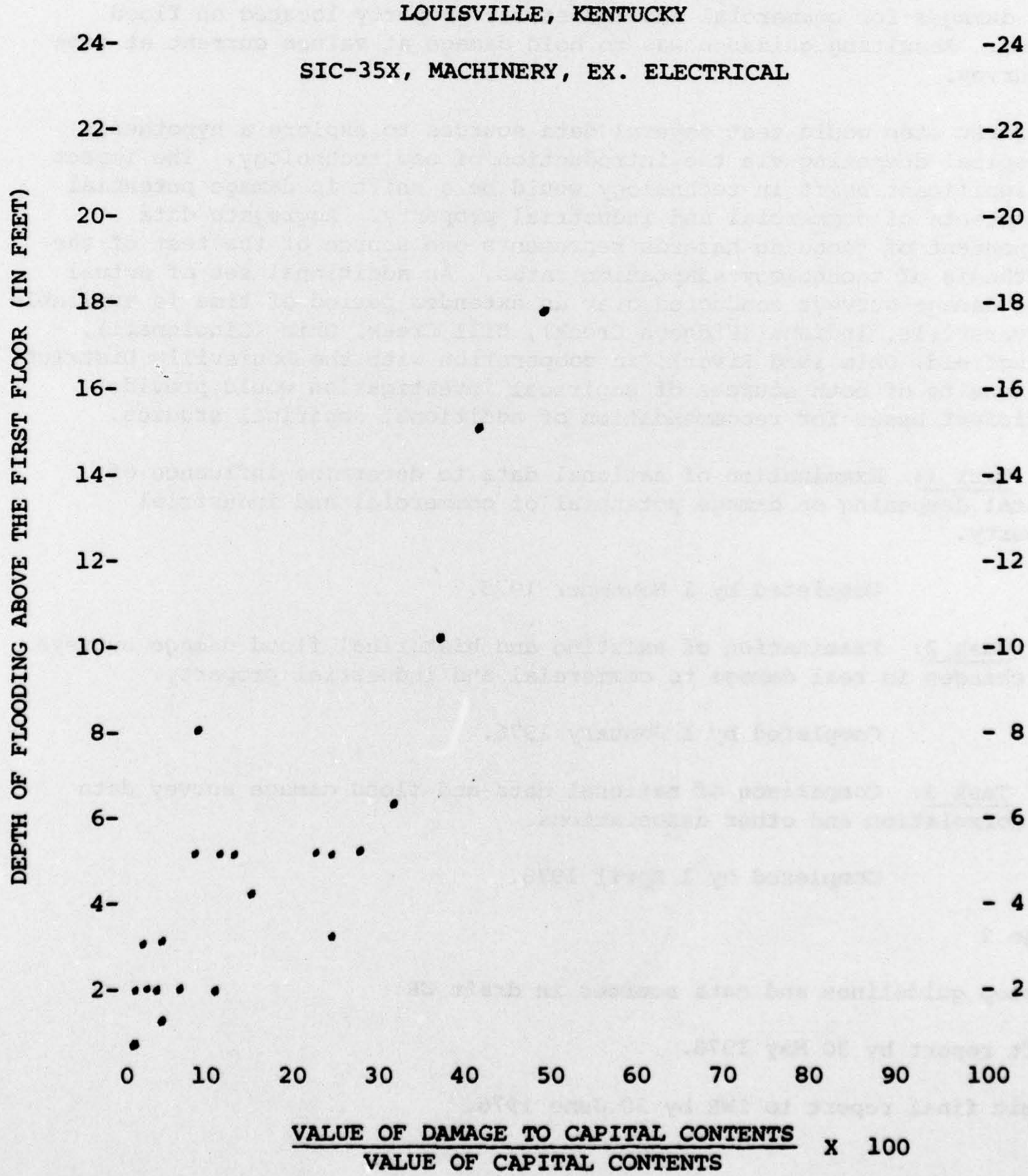
Figure 8-7

DEPTH/DAMAGE SCATTERGRAMS

1961

LOUISVILLE, KENTUCKY

SIC-35X, MACHINERY, EX. ELECTRICAL



APPENDIX 8

DEVELOP GUIDANCE AND EMPIRICAL DATA TO SUPPORT THE PROJECTION OF CHANGES IN UNIT DAMAGE VALUES FOR COMMERCIAL AND INDUSTRIAL PROPERTY

The task group which developed guidance for affluence factor analysis was unable to define a rigorous empirical verification for shifts in unit damages for commercial and industrial property located on flood plains. Resulting guidance was to hold damage at values current at time of survey.

The first step would test several data sources to explore a hypothesis of capital deepening via the introduction of new technology. The impact of significant shift in technology would be a shift in damage potential of contents of commercial and industrial property. Aggregate data independent of flooding hazards represents one source of the test of the hypothesis of technology adaptation rates. An additional set of actual flood damage surveys conducted over an extended period of time is available at Evansville, Indiana (Pidgeon Creek), Mill Creek, Ohio (Cincinnati), Springfield, Ohio (Mad River), in cooperation with the Louisville District. The results of both sources of empirical investigation would provide sufficient basis for recommendation of additional empirical studies.

Task 1: Examination of national data to determine influence of capital deepening on damage potential of commercial and industrial property.

Completed by 1 November 1975.

Task 2: Examination of existing and historical flood damage surveys per changes in real damage to commercial and industrial property.

Completed by 1 January 1976.

Task 3: Comparison of national data and flood damage survey data per correlation and other associations.

Completed by 1 April 1976.

Stage 2

Develop guidelines and data sources in draft ER.

Draft report by 30 May 1976.

Submit final report to IWR by 30 June 1976.

- - - - - - - - - - -

APPENDIX 8 (cont'd)

COST ESTIMATE

Direct Labor

Temporary GS-9 -- 11 months	$12,000
Consultant--30 days @ $138.00	4,140
ORD Coordinator--30 days @ $100	3,000

Indirect Costs

Burdens @ 8% (x 15,000)	1,200
Division Overhead @ .40	6,000

Travel

45 days per diem @ $33.00	1,485
Auto--3,300 miles @ .15	500
Trip to Washington (3 persons) 9 days Per Diem	297
Air	294
Computer	1,000
	$29,916

To be transferred to ORD by 2544.

- - - - - - - - - - - -

INTRA-ARMY ORDER FOR REIMBURSABLE SERVICES

For use of this form, see AR 37-108 and AR 37-110; the proponent agency is Office of the Comptroller of the Army.

1. RECEIVING OFFICE CONTROL NUMBER	VW8120326000000
	☐ FUNDED ☐ AUTOMATIC
2. ORDER a. NUMBER	IWR 76-4
b. DATE	17 July 1975
3. CHANGE ORDER a. NUMBER	
b. DATE	

4. ORDERED BY (Command, Installation or Activity, and address) (Include ZIP Code)

Institute for Water Resources
Kingman Building
Fort Belvoir, Virginia 22060

5. TO BE PERFORMED BY (Command, Installation or Activity, and address) (Include ZIP Code)

U. S. Army Engineer Division, Ohio River
P.O. Box 1159
Cincinnati, Ohio 45201

6. DESCRIPTION OF SERVICES TO BE PERFORMED

Develop guidance and empirical data to support the projection of changes in unit damage values for commercial and industrial property as described in inclosed memorandum. CWIS 31439 - Flood Control and Management Methodology.

Final report not to be submitted later than 30 June 1976.

At the end of each quarter SF 1080 will be submitted to this office. It should indicate partial or final payment and should reference this order.

7a. NAME AND TITLE OF ORDERING OFFICER	b. SIGNATURE	c. DATE
C. O. ESHELMAN, COL, CE Director, Institute for Water Resources	C O Eshelman	17 July 1975

ORIGINATING FINANCE AND ACCOUNTING OFFICE APPROVAL

8a. ACCOUNTING CLASSIFICATION	b. AMOUNT
96X3121 General Investigations Code 901-350, OCE 8800-5250-00	$30,000.

c. CHANGE

INCREASE AMOUNT ____________ DECREASE AMOUNT ____________ REVISED AMOUNT ____________

9. Services to be performed pursuant to this order are properly chargeable to the appropriations or other accounts indicated above until ____________ (Day - Month - Year) the expiration date of this order.

10a. TYPED NAME AND TITLE OF APPROVING OFFICER	b. SIGNATURE	c. DATE
JOHN H. BRANSBY Finance & Accounting Officer	J H Bransby	7-21-75

ACCEPTING OFFICER

11. THE ABOVE TERMS AND CONDITIONS ARE SATISFACTORY AND ARE ACCEPTED.

a. TYPED NAME AND TITLE OF ACCEPTING OFFICER	b. SIGNATURE	c. DATE ACCEPTED
DONALD T. WILLIAMS Chief, Planning Division	Donald T. Williams	7/23/75

DA FORM 2544, OCT 64 — REPLACES PREVIOUS EDITION OF THIS FORM AND DA FORM 1610, 1 JAN 56, EXISTING SUPPLIES OF WHICH WILL BE ISSUED AND USED UNTIL 1 OCT 65 UNLESS SOONER EXHAUSTED.

BIBLIOGRAPHY

[1] Almon, Clopper, Jr., Margaret B. Buckler, Lawrence M. Horwitz and Thomas C. Reimbold. 1985: Interindustry Forecasts of the American Economy. Lexington Books, D. C. Heath and Company, 1974.

[2] Barna, Tibor, editor. Structural Interdependence and Economic Development, New York: St. Martin's Press, 1963.

[3] Brems, Hans. Labor, Capital and Growth. Lexington, Mass.: D. C. Heath and Company, 1973.

[4] Carter, Anne P. Structural Change in the American Economy. Cambridge, Mass.: Harvard University Press, 1970.

[5] Conference on Research in Income and Wealth. Problems of Capital Formation: Concepts, Measurement and Wealth. A report of the National Bureau of Economic Research. Princeton, N.J.: Princeton University Press, 1957.

[6] Creamer, Daniel, Sergei P. Dobrovolsky and Israel Borenstein. Capital in Manufacturing and Mining. Princeton, N.J.: Princeton University Press, 1960.

[7] Goldsmith, Raymond W. The National Wealth of the United States in the Postwar Period. Princeton, N.J.: Princeton University Press, 1962.

[8] Hickman, Bert G. Investment Demand and U.S. Economic Growth. Washington, D.C.: The Brookings Institution, 1965.

[9] Institute for Urban and Regional Studies, Washington University. Analysis of Theories and Methods for Estimating Benefits of Urban Floodplains. IWR Report 74-14, Nov. 1974.

[10] INTASA. A Computer Simulation Model for Flood Plain Development Part I: Land Use Planning and Benefit Evaluation. IWR Report 72-1, Feb. 1972.

[11] ______________. Part II: Model Description and Applications. IWR Report 73-1, Nov. 1972.

[12] Kendrick, John W. Productivity Trends in the United States. National Bureau of Economic Research, Princeton, N.J.: Princeton University Press, 1961.

[13] Kentucky Department of Commerce. Kentucky Directory of Manufacturers. Frankfort, Kentucky: Kentucky Department of Commerce, various years.

[14] Kuznets, Simon. Capital in the American Economy: Its Formation and Financing. National Bureau of Economic Research. Princeton, N.J.: Princeton University Press, 1961.

[15] Lave, Lester B. Technological Change: Its Conception and Measurement. Edgewood Cliffs, N.J.: Prentice-Hall, Inc., 1966.

[16] Lutz, F.A. and D.C. Hague, editors. The Theory of Capital. Proceedings of a Conference held by the International Economic Association. New York: St. Martin's Press, 1968.

[17] Ohio Development Department. Directory of Ohio Manufacturers. Columbus, Ohio: Ohio Development Department, various years.

[18] Rymes, Thomas K. On Concepts of Capital and Technical Change. New York: Cambridge University Press, 1971.

[19] Studies in Income and Wealth. Measuring the Nation's Wealth. New York: Columbia University Press, 1964.

[20] Studies in Income and Wealth. Output, Input and Productivity Measurement. New York: Columbia University Press, 1961.

[21] U.S. Bureau of the Census. Annual Survey of Manufacturers. Washington, D.C.: U.S. Government Printing Office. Volumes for the years 1959-1960, 1961, 1962, 1964-1965, 1966, 1968-1969, and, 1970-1971.

[22] U.S. Bureau of the Census. Census of Manufacturers; Vol I: Summary Statistics. For census years 1958, 1963, and 1967. Washington, D.C.: U.S. Government Printing Office.

[23] U.S. Bureau of Domestic Commerce. Industry Profiles, 1958-1966 Washington, D.C.: U.S. Government Printing Office, Oct. 1971.

[24] U.S. Bureau of Economic Analysis. Fixed Nonresidential Business Capital in the United States, 1925-73. Springfield, Virginia: National Technical Information Service, Jan. 1974.

[25] U.S. Bureau of Labor Statistics. Employment and Earnings: United States, 1909-72. Washington, D.C.: U.S. Government Printing Office, 1974.

[26] Waddell, Robert M., Phillip M. Ritz, John DeWitt Norton, and Marshall K. Wood. Capacity Expansion Planning Factors. Washington, D.C.: National Planning Association, 1966.

[27] Weisz, Reuben Nathan and John C. Day. A Methodology for Planning Land Use and Engineering Alternatives for Floodplain Management: The Value of Land in Alternative Urban Uses. IWR Paper 74-15, Oct. 1974.