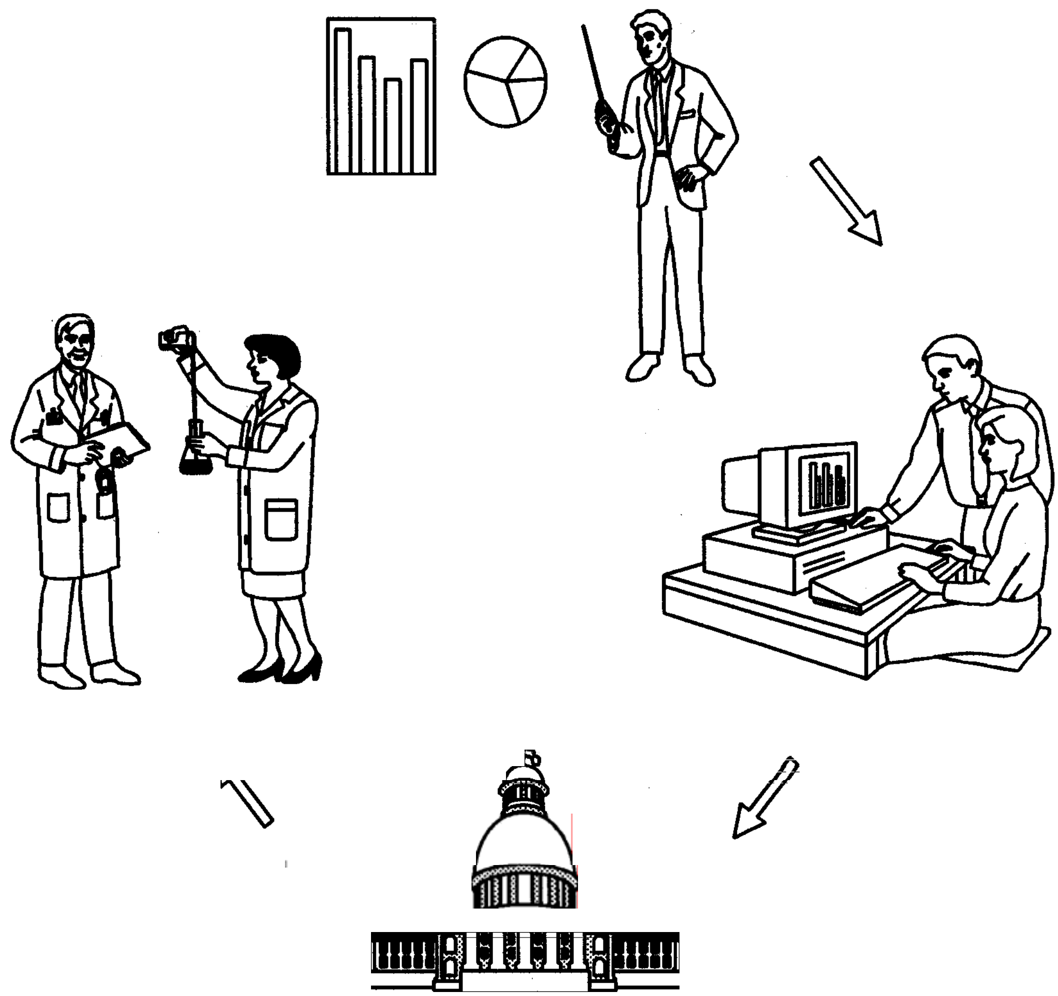
WRRC Report No. 141,

PROCEEDINGS WATER RESEARCH AT THE UNIVERSITY OF THE DISTRICT OF COLUMBIA

A Technical Symposium
Tuesday, April 28, 1992



D.C. WATER RESOURCES RESEARCH CENTER UNIVERSITY OF THE DISTRICT OF COLUMBIA
WASHINGTON, D.C.

WRRC Report No. 141

PROCEEDINGS

WATER RESEARCH AT THE UNIVERSITY OF THE DISTRICT OF COLUMBIA

A TECHNICAL SYMPOSIUM

Sponsored by

THE WATER RESOURCES RESEARCH CENTER OF THE UNIVERSITY OF THE DISTRICT OF COLUMBIA

TUESDAY, APRIL 28,1992

1:00PM to 4:OOPM

VAN NESS CAMPUS, BUILDING NO. 44, ROOM A-03
WASHINGTON, D.C.

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PREFACE

The D.C. Water Resources Research Center is proud, once again, to salute the faculty and students of the University of the District of Columbia, for their significant and long standing contributions in the field of water research and education, particularly as these issues impact on the health and well being of the citizens of the District of Columbia.

These proceedings present the results of the second forum in recent years, sponsored by the DC WRRC, to focus on the work of UDC faculty and students in the areas of water research and water resources. Earlier, in April of 1987, a half day seminar was convened by DC WRRC on "UDC Science Research on the Anacostia River."

This full day symposium reflects the broad range of current water research investigations and related activities engaged in by faculty members and students from several university colleges and by others from extension components such as the Agricultural Experiment Station, the Cooperative Extension Service and by members of the DC WRRC staff.

It is noted that due to technical difficulties, we have not been able to provide all the papers or the pertinent remarks that were presented during the symposium. We do apologize for that and for potential errors or mistakes that might be found in these proceedings.

OPENING REMARKS BY JAMES G. PETERS, PROJECT OFFICER

Office of the Hydrologist, U.S. Geological Survey (USGS)

I will keep my remarks short so as not to fall victim to the time keeper. I am very interested in the type of academic research being done here in the District of Columbia in various aspects of hydrology. It is in light of this research that I will talk about the U.S. Geological Survey and its water-related program. Included in these programs is the Water Resources Research Institute program, which I will discuss later.

As we all know, water-related issues are becoming an important concern on the part of national, state and local policy makers as public awareness has been refocused on the environment in recent years. The U.S. Geological Survey is the Federal Government's major scientific agency for evaluating natural resources. Within the last decade, water-resource issues have dominated USGS program growth, especially issues related to the quality of ground water. We anticipate this growth to continue well into the next century.

The USGS, headquarters is located in Reston, Virginia about 25 miles west of here. If you have not visited us, I suggest that you do so. We are very active in the water-resources community in the DC area. This morning, in fact, I had the pleasure of meeting two ex-employees of the USGS who are attending this symposium.

Briefly, let me mention that the work of the USGS in hydrology is in two broad areas. The first is data collection and applied research managed through offices in each state (usually located in the state capital) and usually done in cooperation with other federal and state agencies. Academic research is centered in Reston, Virginia; Denver, Colorado; and Menlo Park, California. This research provides new directions in the hydrologic sciences as well as support for the work of applied research in our state offices. For both programs, the USGS continues to give great emphasis

The design and preparation of these proceedings was a joint effort of Mr. James H. Hannaham, Mr. Mohammed Yusuf and Mrs. Jutta Schneider and Ms. Joseline Castanos of the DC WRRC staff. We also wish to thank Mr. Tom Kelly of the UDC Office of Public Affairs, for taking on the task of reviewing and editing the papers. Finally, we wish to thank the authors who provided their papers as well as various other persons including Dr. Victoria C. Guerrero, who volunteered to review these proceedings.

High among the charges of the USGS is the administration of the Federal Water Resources Research Institute Program. Although this program has existed for about 30 years, the USGS has been the program sponsor for only 5 years. Between $5 and $6 million dollars is allocated by the Congress each year, which is distributed equally among the 54 Institutes, located in every state, the District, and several trust territories. This amount provides about $100K annually to each Institute. There is a 2:1 matching requirement for these funds. Some Institutes do very well at securing additional research funds well beyond the Federal Program. For others the Program is their major funding source. But overall, the program provides a viable research institute at each location. Innovation in the use of Federal program funds is encouraged. For example, the Institute in Indiana is using all program funds for student assistantships. One individual present today who is funded in part by this program is Dr. Victoria Guerrero.

So as not to usurp time from other speakers, I will stop at this point to answer any questions you may have regarding the Federal Institute Program or the USGS. Thank you.

PROGRAM AGENDA

INTRODUCTIONS:

Hamé M. Watt, Director
Water Resources Research Center, UDC

James H. Hannaham
Water Resources Research Center, UDC

Leslie Elder, Acting Dean
College of Life Sciences, UDC

Marcellina M. Brooks, Acting Provost and Vice President for Academic Affairs, UDC

SESSION I: PHYSICAL SCIENCE AND ENGINEERING

Moderator: Jose Jones, Chairperson, Environmental Sciences Department

Remarks by James G. Peters, Project Officer, Office of the Hydrologist, U.S. Geological Survey

"Ground Water Assessment of the District of Columbia", Hamé M. Watt

"Drilling Into the District of Columbia Ground Water World", James V. O'Connor, Associate Professor, Department of Environmental Sciences and Norris Etienne, D.C. Dept. of Consumer & Regulatory Affairs

"The Anacostia River: Ecological Studies of River Pollution Biology", Vicki C. Guerrero, Professor, Department of Environmental Sciences

"Litter Layer Productivity and Decomposition", Winston Corona and Isidro Carranza, UDC students

"A Survey of Street Drainage Inlets in the District of Columbia". F.M. Chang, Professor & Chairperson, Department of Civil Engineering and Julius Elui, University of the District of Columbia student

"An Environmental Study of Melvin Hazen Park", Kathleen Robinson, University of the District of Columbia student

"A Preliminary Study for the Identification of Sediment Toxics in the Anacostia River". Harriette L. Phelps, Professor, Department of Biology

"Dry Weather Screening of Storm Water Outfalls in the District of Columbia", Clarence Wade, Adjunct Professor, Department of Chemistry

"Effect of Lime and Sludge on Metal Content of Vegetables" James R. Preer, Professor, Department of Environmental Sciences

QUESTION AND ANSWER PERIOD

BREAK

SESSION II: WATER RESOURCES PROGRAM MANAGEMENT

Moderator: James Allen, Director, Agricultural Experiment Station

"Citizens Attitudinal Survey on the District of Columbia Water Resources", Y. Choi and H. Azani, Associate Professors, Department of Business and Public Management

"Pesticide Applications and Effects on Water Quality and Urban Reforestation in the Anacostia River watershed" Program Overview and Introductions of CES Presenters, Pamela Ann Marshall and Mohamed S. Khan By Maurice Dorsey, Acting State Program Leader for the Cooperative Extension Service, UDC.

"Urban Land Use Activities and the Ground Water: A Background Survey" Jutta Schneider, Water Resources Research Center and Professors Fred Chang, Clarence Wade and James O'Connor

"Urban Stormwater Management & Sediment Control Clearinghouse", Hame M. Watt and Mohammed Y. Mohammed, Water Resources Research Center

"The Forgotten Tributaries of the Anacostia River in the District of Columbia", Professor James V. O'Connor, and Morris Etienne, D.C. Department of Consumer and Regulatory Affairs

"Local and Regional Perspectives on Water Resources Technology Transfer". James H. Hannaham, Water Resources Research Center

QUESTION AND ANSWER PERIOD

END

PART I:

PHYSICAL SCIENCE & ENGINEERING

UDC WATER RESEARCH SYMPOSIUM

DRILLING INTO THE GROUNDWATER GEOLOGY OF THE DISTRICT OF COLUMBIA

JAMES V. O'CONNOR DEPT. OF
ENVIRONMENTAL SCIENCE
UNIVERSITY OF D.C.

ABSTRACT

Three major specialized groundwater flow regimes exist in the District of Columbia. These underground flows are functions of different geological foundations. First is the fractured bedrock of the Piedmont Plateau Landscape Province (early Paleozoic age) exposed in northwest DC. Each type of bedrock encountered requires analysis of its fracture system. The Altantic Coastal Plain Province provides two different geologic environments with separate flow regimes. The younger ancestral Potomac fluvial-estuarine terrace deposits (late Cenozoic age)provide a series of shallow, perched water tables at set elevation zones especially downtown. The middle geologic regime is the confined regional aquifer of the Potomac Group (late Mesozoic age). This confined aquifer has a steep gradient to the southeast across the city. This interstate flow unit originates from a surficial recharge in the high mid section of the District but lies 300 meters below Southern Avenue southeast. The methods and economics of well construction in each groundwater georealm is quite different. A public data bank for well logs and groundwater data is lacking in this city causing time delays in endless repeat searches for past data. Urbanization over the past thirty years has drastically altered the quantity and quality of this city's groundwater natural resource without regard for its impact. Strong groundwater records are needed for proper resource management, safety and health issues related to contamination plume migration and long term protection for future use.

INTRODUCTION

Early residents of the District relied on the ground water resources of the city. Springs were the first clues to the subterranean sweet waters of the region. Indian camps and early settlers set up homes around drinking water from the Earth's interior. With estates and farms grew shallow dug wells and spring houses. The early city of Washington provided water for the downtown community with a spring pump supply. Springs were captured and piped to homes and businesses. As land uses polluted the shallow wells and slowed recharge,

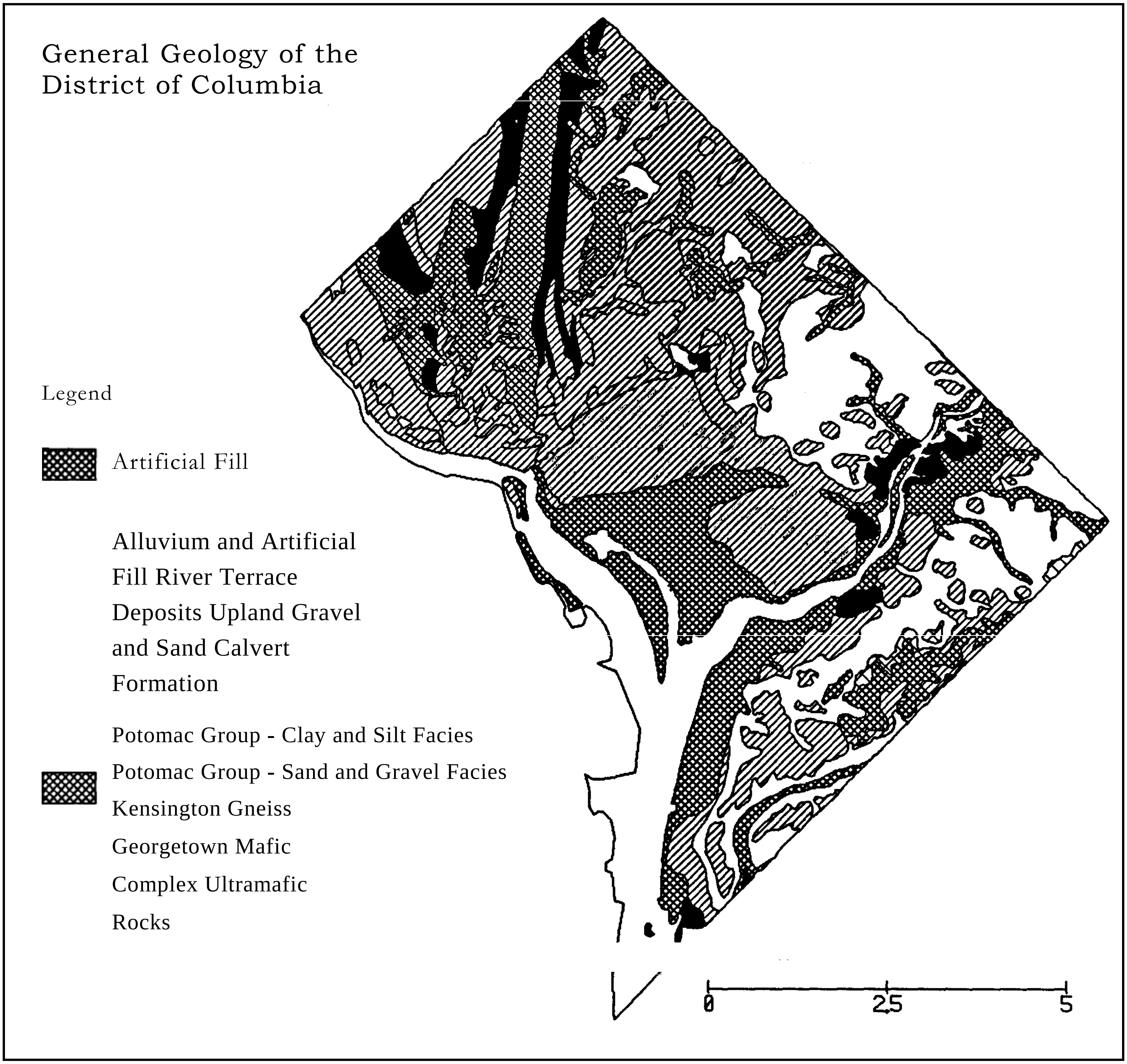

General Geology of the District of Columbia
Legend
Artificial Fill
Alluvium and Artificial Fill River Terrace Deposits Upland Gravel and Sand Calvert Formation
Potomac Group - Clay and Silt Facies
Potomac Group - Sand and Gravel Facies
Kensington Gneiss
Georgetown Mafic
Complex Ultramafic
Rocks
0
2.5
5

Figure 1.

deeper wells were drilled. At the turn of this century, D.C. Is industries and *institutions* needing water beyond the community supply drilled separate wells. Downtown wells in the mid part of this century were used primarily for cooling, related to early *air-conditioning* methods. The post Korean war boom in *population/housing* and racial equality movements forced public water supply to the whole District and marked the public awareness death knell for the unseen water resource. Ground water is no longer forced into a deep, dark second place in the scheme of resources. Now the importance of urban groundwater, especially related to health and safety, has resurfaced. A host of new federal and district laws and regulations requires assessment, management, and protection of this natural resource. Reports and data on the quality and quantity of city ground water is now part of a national assessment program and data bank. Since the city ground water resource has been neglected for forty years, a whole new citywide *monitoring* system was recently established to provide the city with data to assess and manage this vital but fragile resource.A brief report on the geology realm and drilling methods in each follows:

HYDROGEOLOGY OF UNDERGROUND D.C.

The hydrogeologic realm for the District has three different systems related to the historical geology of the region: *ancient* bedrock of the Piedmont; deltaic processes of the ancestral fall line coast (Potomac Group), and the sea level fluctuations causing the seven terrace/scarp zones related to perched tables and headwater springs for D.C. streams.

Figure 1 illustrates the city geologic units.

PIEDMONT PLATEAU PROVINCE of BEDROCK

zones may cave in or provide a water problem that must be sealed or cased off before well development. Cracks are pressurized with depth, so little water is found because of fracture tightness. after loom below sea level little water can be extracted from Piedmont wells, e.g. NPS well drilling project for irrigation of Mall off *Constitution* Ave.

ATLANTIC COASTAL PLAIN PROVINCE:

A SERIES OF COASTAL SEDIMENTARY ENVIRONMENTS REFLECTED BY CONSOLIDATED/UNCONSOLIDATED POTOMAC GROUP AQUIFER

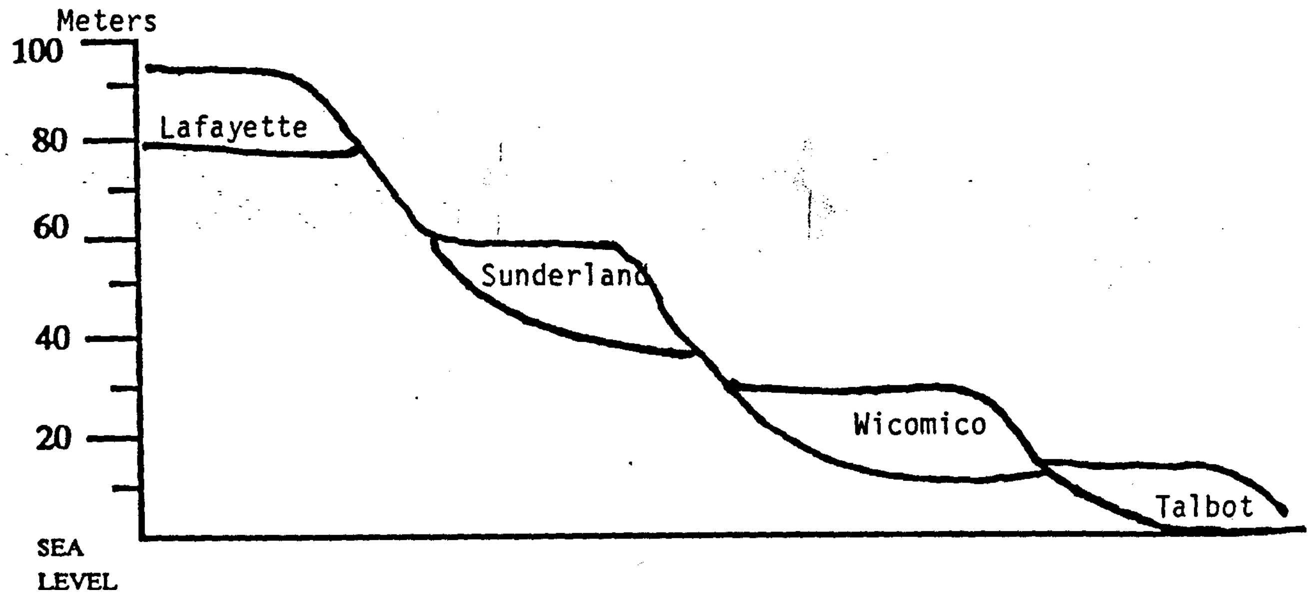
Northwest D.C. has the fractured bedrock of the Piedmont Province. Ground water seeps into the cracks of the bedrock. Two kinds of fractures exist: regional cracks based on tectonics, and cracks related to the rock type itself. Fractures produce secondary ground water regimes. Piedmont groundwater may flow unconfined to local streams, may be lost to chemical reactions within the rock, or may be held in the cracks. On hillsides, the boundary between the saprolite and the fresh bedrock creates springs. The groundwater may interact and decay the rock along the fault or joint fractures and develop an evolving blanket of saprolite (decayed metamorphic rock which may hold water). Saprolite thickness ranges from 0-100 meters in D.C. Saprolite is a water bearer or sponge like material. It usually *contains* the regular water table of the area. Bedrock drilling requires special air or water compression drilling tools. The air compression method is less environmentally damaging or waste producing than water compression. Fracture hydrology also requires core drilling to investigate and reveal the fracture systems and potential for water bearing zones. Fill or saprolitic water

D.C.'s Coastal Plain Province geology has two different major paleo-environments that serve as aquifers. The second city aquifer zone is the sandy units of the Cretaceous Age dinosaur deltaic system of the Potomac Group. In geologic mapping two or more formations with the same environmental history become a group.The oldest formation of this unit outcrops in midnorthern D.C. and is referred to as the Patuxent Formation or Aquifer. The recharge area occurs in the vicinity of Fort Stevens, Fort Totten, and the Soldiers Home. This sandy unit dives steeply and quickly to the southeast, under the District far below the Anacostia river. This geology is confined by the thick deltaic clay (Arundel Formation) on both sides of the Anacostia, from Rhode Island Metro, Fort *Lincoln* and Arboretum to the Anacostia Bluffs. Drilling through this plastic clay layer requires slurry drilling methods that are messy and may produce a large volume of muds. Care to control the artesian flow when the aquifer layer is penetrated must be taken.

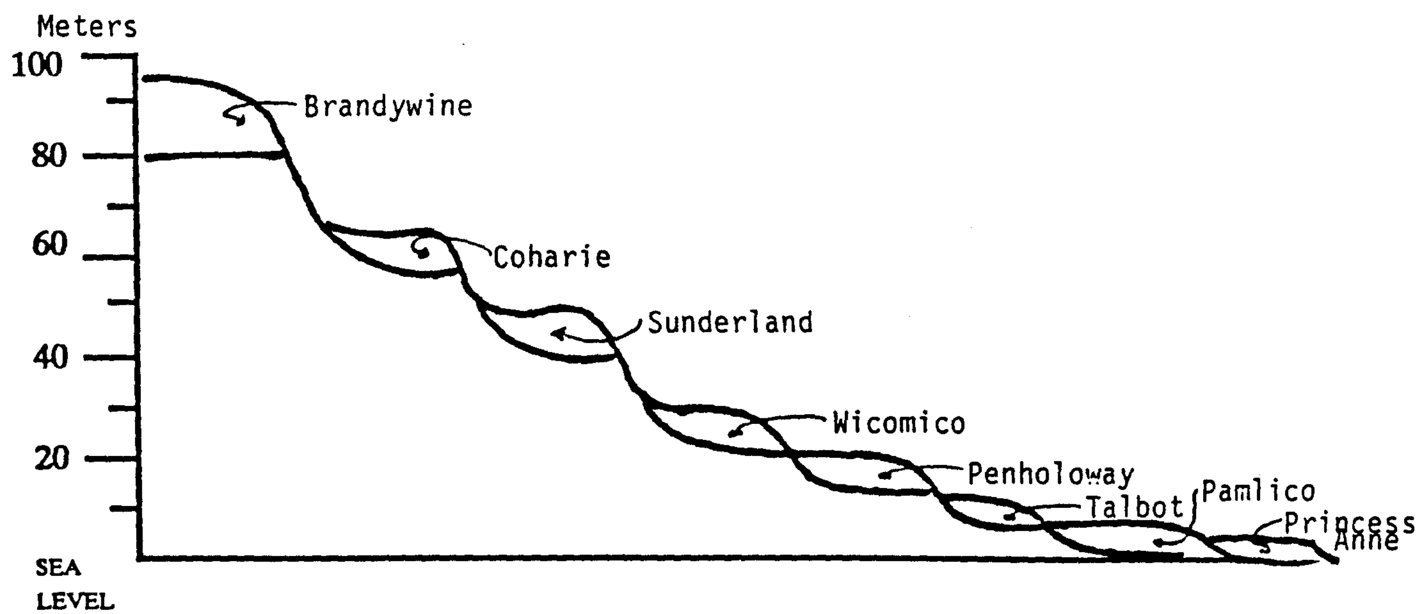
High yields occur in the down dip direction. Three wells are currently tapped into this unit (two at the Arboretum and one at Fort DuPont). An eroded outlier of this unit occurs in the Northwest on the western uplands of Rock Creek. Springs
and tributary streams of lower Rock Creek from the Zoo to Georgetown receive their water from this unconfined eroded outlier. Figure 2 is an east-west geologic cross section showing the dip of the confined aquifer.

TERRACE PERCHED AQUIFERS

The third city groundwater segment is linked with the sea level changes of the last 10 million years. The seven late Cenozoic sand-gravelly terraces are small and limited. The oldest terrace level is the highest. They bleed their water resources where cut or exposed on hillsides. These stacked terraces may produce perched tables where trapped. Perched tables may also occur in the isolated sandy pockets within the upper Potomac Group. Simple auger drilling can tap these shallow tables but each table needs to be screened off before proceeding to a lower table. Perched table *recognition* is important especially for *contamination* migration of leaks from Underground Storage Tanks (UST Program). Recent drilling



By Shattuck (1901, 1902, 1906)



By Cooke (1930, 1958)

Figure 3. The Marine Terrace Concept

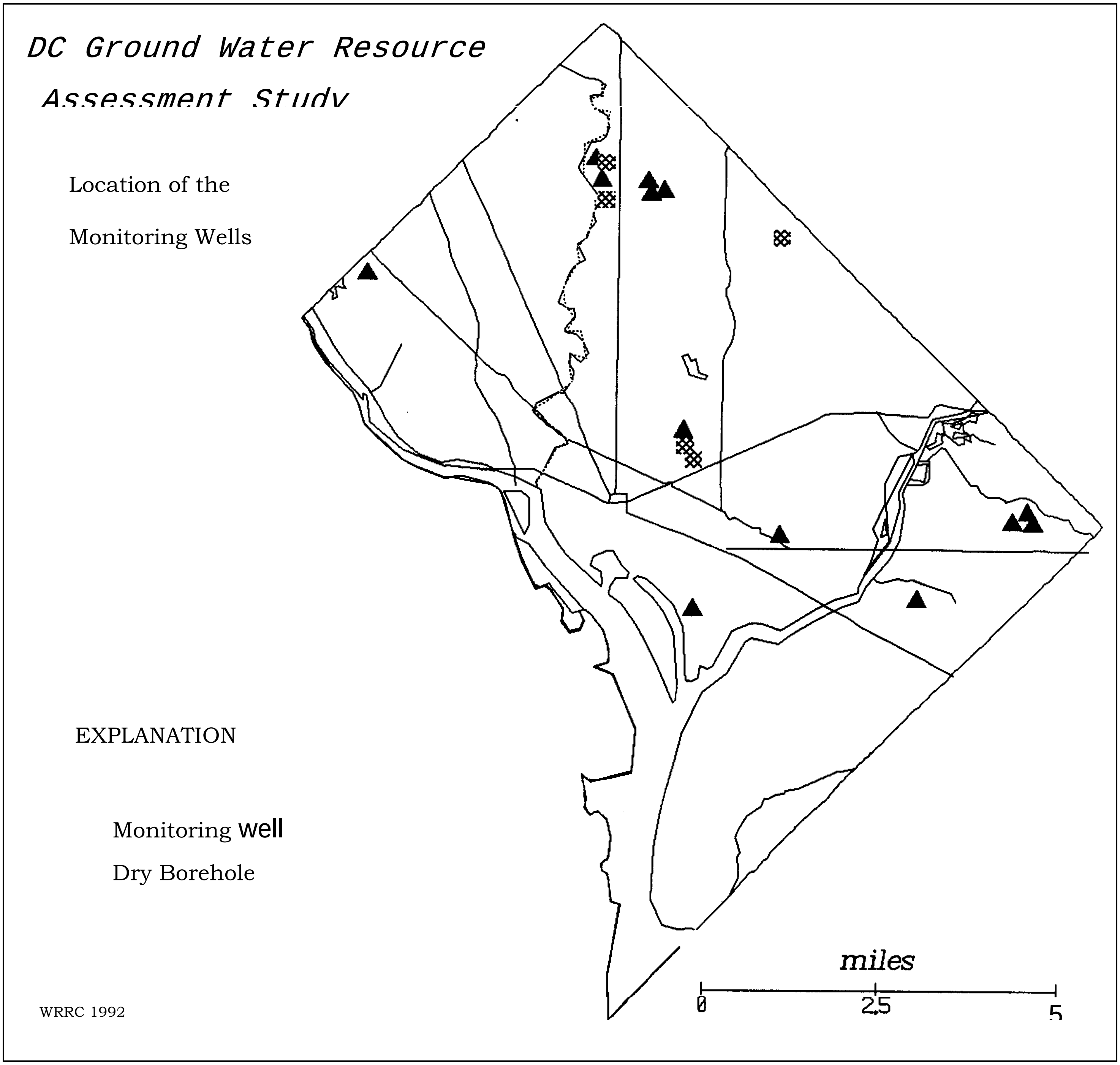

DC Ground Water Resource
Assessment Study
Location of the
Monitoring Wells
EXPLANATION
Monitoring well
Dry Borehole
miles
0
2.5
5
WRRC 1992

Figure 4.

revealed that some perched tables are dry. Dryness is due to massive *construction* de-watering and beheading of recharge zones. Without groundwater in these migration zones, natural gas leaks and pollution flows spread faster and farther than with the water as a mixer or barrier. Figure 3 is a diagram of the general terraces and thier elevations.

HYDROLOGIC CYCLE

Normal ground water is *unconfined* and feeds each local stream. Every local stream has its own corresponding groundwater shed. The 40" (1000mm)average precipitation in DC yields about 25% groundwater recharge. Some of that groundwater becomes trapped in the confined systems and does not directly flow back to the streams as part of the short hydrologic cycle. The well drilling program, by *monitoring* water levels should help solve the relationships between the precipitation and groundwater behavior, or geology and groundwater. The drilling program provides not only a handle for quantity but also migration patterns of pollution types for quality and computer model control. Figure 4 shows the location of the thirteen *monitoring* wells for this project.

URBANIZATION ISSUES

Construction trenching or excavation as well as de-watering also may deflect the flow, draw down the water table, or pond groundwater.

Urbanization also imparted its share of extra issues to consider in groundwater flow behavior. Artificial recharge occurs in a variety of ways even in total impervious surfaces.Fill has its own role to play in migration and drilling. Metro logs provide a general *foundation* for pre and post changes in the water table. Call Miss Utility laws require one to search out the areas of different utilities in the drilling region. Laws and data banks are needed for quick and careful review of where the water tables are in a given neighborhood: before, during and after construction. With the cost and impact of drilling, accurate pre drilling data needs to be in public hands for public access. Drilling blindly leads to dry holes; loss of time; preparing new permits and assessments; or *finding environmental* surprises. The economics of the drilling process should require the city to provide and *maintain* a useful data bank and knowledge of the problems related to searching for, disposing, or interfering with groundwater anywhere under the District.

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THE ANACOSTIA RIVER: ECOLOGICAL STUDIES OF RIVER POLLUTION BIOLOGY

by

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ABSTRACT

The water quality of the Anacostia River is poor. Population density of plankton and benthic organisms fluctuate with water and substrate quality. The plankton - benthic community is dependent on the quality of the substrate as well as on the quality of the water.

Basic data on water and water related tests obtained from water samples collected within regular periods and examined within the 24-hour period showed low population of plankton and benthic species. Sensitive values for temperature, pH, conductivity, and dissolved oxygen, *including* high and low concentrations of substances caused largely by forces of erosion and sedimentation. The productivity of the Anacostia River is being adversely affected by anthropogenic activities and urbanization. This study shows that the three major problems facing the

Anacostia River are: (1) high sewage discharge: (2) low plankton and benthos species; and (3) high sedimentation, siltation and erosion.

The Anacostia River: Ecological Studies of Water Pollution Biology

by

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Washington, D.C. 20008

INTRODUCTION

The water quality of the Anacostia River is poor. Unless technology is developed that will protect the river from continuous deterioration and degradation, the river will soon be dead. Part of the visible degradation of the river is brought about by man. Human activities, particularly the extensive littering and open dumping of non-biodegradeable trash, has changed the concentration of the nutrients above natural levels, accelerating and increasing algal growth and euthrophication, and contributing to changes in the river's biotic resources.

1. To obtain the basic data on water, and water-related variables such as water quality values for pH, dissolved oxygen, turbidity, temperature, conducitivity, dissolved solids, and chemical, and bacterial properties.

2. To provide a taxonomic survey of the plankton and benthic organisms and to identify the extent of pollution using the biotic community of organisms as indicator species.

3. To study the chemical composition of the river bottom sediments.

4. To determine the community ecology of the river.

A total of nine stations was established to survey the ecology and water quality of the Anacostia River for three years: August 1987 to July 1988; August 1988 to July 1989; August 1989 to July 1990 (See Figures 1.0 a and b). The collecting stations selected are located close to drainage outlets of either combined or separate storm sewers. Water samples were taken from the main channel of the river. Sloughs, inlets, and backwater areas were given attention for comparison with the main river waters. Phytoplankton and zooplankton were collected using the Petersen Grabber and water bottles. The samples were taken from depths of 0 ft. to 5 ft. Water samples were analyzed for dissolved oxygen, temperature, pH, conductivity, and other water quality parameters using a Hydrolab apparatus. Soil samples and sediments were analyzed using the Soil Test Kit. Identification and actual counting of the organisms were made possible with the aid of a counting cell and a microscope.

PRINCIPLE FINDINGS AND SIGNIFICANCE:

PHASE I

Life in the Anacostia River is threatened by factors such as sedimentation, siltation, sewer overflow, water run-off, and other anthropogenic activities. Non-biodegradeable materials from construction sites, as well as natural litter are continuously poured out into the river. Overall water samples collected were yellowish, slightly turbid, and at times had a pungent odor. The physiography and ecology of the river have been changed tremendously by sedimentation, siltation and accumulation of litter. Existing vegetation and the watershed are being turned into a swampland.

Water quality tests conducted from April to August 1988 showed high temperature values (13.1 - 28.8 o C); low dissolved oxygen (DO) in the majority of the stations; slightly acidic waters (6.1 - 6.9); and conductivity values [298 - 606 us/cm] (See Table 1.0).

Water quality tests conducted during storm events for the months of April, June and July 1988 showed no significant difference between the water quality data during non-storm events and after a heavy storm for temperature, pH, and conductivity. However, the amount of dissolved oxygen (DO) appears to be a few mg/1 higher in the majority of the stations and significantly lower in two of the study stations (# 25 and # 26). Conductance values for these stations were several times lower after a storm event (See Tables 1.0 and 2.0).

Turbidity data showed the highest amount of suspended matter and particulates on April 13, 1988, and had the lowest reading three months after. Turbidity ranged from 7.0 in Station # 26 to 25.0 NTU in Stations # 25 and # 26 (See Table 2.0).

Analysis of bottom sediments showed high magnesium (Station # 14); high phosphorus (Stationh # 5, 24, 25, 26 and 12); high ammonia (Stations # 4 and # 5); and high calcium (Station # 8 and 12). Total dissolved solids ranged from 160 - 380 TSS, the highest being in Station # 24. The results obtained for magnesium, iron, and nitrate appear to be statistically significant, with iron, magnesium, and nitrate exceeding the standard amount required for safe levels. Overall pH level of the substrate is alkaline (See Table 3.0).

Four stations (# 12, 14, 24, and 26) have been tested for coliform. The results show a high concentration of coliform bacteria at these stations (See Table 4.0).

The frequency and occurrence of phytoplankton and *zooplankton* were extremely low *An all stations.* The species diversity composition were extremely low. The Chlorophyta had the highest percentage of occurrence followed by Flagellata, Cyanophyta, then Desmediaceae. Tubifex sp., copepods, Diaptomus and Keratella are the most commonly occurring benthic species. These species were found in Stations # 4, 12, 14, 16, 25, and 26 which were located at drains. Soil and water analyses for stations # 8 and 16 show high readings of phosphates, ammonia, and nitrates. These three substances are vital nutrients for phytoplankton species and can result in creating "cultural eutrophication". The presence of diatoms and desmids can also be correlated with the high concentration of calcium and carbonate compounds which are derived from heavy calcite runoffs in the nearby construction sites (See Figures 2.0 and 3.0; and Table 3.0).

PHASE II

Water quality tests were continued from August 1988 to July 1989. The data obtained for temperature, dissolved oxygen (DO), pH, conductivity, and for chemical elements such as calcium, magnesium, chlorides, iron, dissolved solids, nitrates, and phosphorus, appear to be influenced by the nature of the outflow and the sediments. The values were high in some stations and in others fell below the standards. The results for dissolved oxygen and iron values exceeding the standard amount required for safe levels. The values were within close ranges with the exception of August and September when the dissolved oxygen ranged from 2.3 to 5.0, before and after rain events in Station # 4. Dissolved oxygen *concentrations* were low *in* all *stations.* Turbidity readings were high in the spring season in Station # 12. Ammonia, nitrates, and cyanide were found at higher *concentrations* at the drainage site than the river itself. The pH values remain alkaline in all stations which, however, showed acidic values in December (See Tables 1:0 and 2.0).

Soil samples collected and analyzed showed high readings for magnesium, phosphorus, and calcium in Stations # 14, 24, 25 and 26.

There was a significant abundance of Flagellata from September 1988 to July 1989, followed by the Cyanophyceae, Chlorphyceae and Desmediaceae. From September to December 1989, the order of occurrence were Flagellata, Desmediaceae, Cyanophyceae, and Chlorophyceae, with the Desmediaceae appearing to be seasonally high during the months of October and November. The high levels of *nutrients,* primarily ammonia, nitrates, and phosphorus appear to be the *nutrients* responsible for the abundance of these plankton groups. Soil and water analyses showed high values for these substances. Seven out of the nine stations (# 4, 5, 8, 12, 14, 16, and 25) showed high values in ammonia, calcium, iron, phosphorus, and nitrates.

Tubifex/sludegworm was found in practically all the samples. Nymphs, snails, and midges are extremely rare. Next to Tubifex, Copepods/cyclops and rotifers were the most common benthic species found in all samples. The quantity and quality of benthic species appear to be influenced by the nature of the outflow as well as the susbtrate. Seasonal changes, combined with variations in the concentrations of dissolved solids, alkalinity, water hardness, cyanide, and iron can contribute to the fluctuations of species during the year. The results for diversity index of all species during this year are much lower compared to the 1988 sampling period (See Figures 2.0 and 3.0).

Overall, water samples collected were similar to the preceding year: pale-beige, turbid, and pungent malodorous water. Oil films were consistently found along the banks.

The river banks are denuded of vegetation. The banks west of the Department of Public Works and south of the Benning Road access are gone and have now been replaced by accumulation of waste materials and cement (See Figure 4.0).

PHASE III

This is the final phase of the ecological examination of the Anacostia River from August 1989 to July 1990. Temperature for each station site varies from 10.9 to 15.8 o C, given the type of season. Temperature ranges for these months were from 12.1 to 17.8 o C, and tended to fluctuate in the Fall. Monthly dissolved oxygen (g/ml) varies from 1.75 to 15.7. Dissolved oxygen concentration impacts on pH (6.4 to 1.1); conductivity (280 - 311). Dissolved oxygen for this phase varied from 4.3 to 4.9 g/ml and also adversely affected the order of ecological equilibrium, resulting in eutrophication, and the decline of the phytoplankton and zooplankton, as well as the majority of the benthos species. Water from this river is best described as acidic. Calcium and calcium carbonate readings were high in some stations. As a result, Chrysophyceae, Desmediaceae, Gyrosigma, Melosira, Navicula, Nitzschia, and Stephanodiscus appeared at some stations, notably at all stations especially occurring after heavy storm. These species prefer high calcium and calcium carbonate. The organisms sampled showed very low appearance of tolerant plankton and benthic species but a high count of pollution tolerant species. Protozoa are the primary constituent of the zooplankton along with somke species of the Euglenophyceae and Phyrrophyceae. There were very few colpedium and paramecia. The prevailing or dominant species were the sludgeworm/tubificid worms which were recorded as abundant and tolerant species within the benthos group, followed by copepods, rotifers, watermites, and enchytaeids (Annelida). The stations with the most benthic species are # 25 and # 8. These stations also showed high readings for ammonia, calcium, iron, manganese, and phosphorus. The dominant species for these two stations also showed high readings for ammonia, calcium, iron, manganese, and phosphorus. The dominant species for these two stations were the tubificid worms and copepods. The diversity of plankton and benthic organisms could be the result of the combined effects of water run-off, high concentrations and variations of some of the chemical substances, sedimentation and siltation, and sheer human neglect and abuse in this part of the river (See Figures 2.0 and 3.0).

The group of organisms categorized as to their pollutional status represents species that can withstand high levels of pollution. The presence and abundance of these species were influenced by controlling factors such as pH, nutrients, temperature, DO, conductivity, and turbidity. The river is constantly plagued by eutrophication and fish kill.

Sediment analyses showed high content of phosphorus, manganese, ammonia, calcium, and iron. Substrate samples were alkaline. The stations consistently high in these chemicals were Stations # 4, 5, 8, 12, 14, 16, 24, and 25.

The basis of many of the perturbations occurring in the river bed which are important for the existence and survival of the plankton and benthic organisms are the physical and chemical processes taking place in this environment. This study showed a significant abundance of green algae and diatoms. This indicates that this aquatic community received high organic loads, i.e. the effluent source of pollution primarily from ammonia, nitrates, and phosphates. These nutrients encourage temporary overgrowth resulting in the process of eutrophication. The presence of such nutrients is reflected in the water and soil samples.

The Biotic Index Readings summarizes the general quality of the river. This indicates that there was a high level of pollution, where intolerant species were low and subtolerant and facultative species were found in practically all the nine stations (See Table 5.0).

RESULTS

Figure 1.0 a shows the map of the Anacostia River

Figure 1.0 b shows the station locations in the Anacostia River tributaries

Figure 2.0 summarizes the plankton species collected from April 1988 to March 1990.

Figure 3.0 summarizes the benthic species indentified from April 1988 to March 1990

Figure 4.0 is a photograph taken in a nearby concrete factory. Continuous flow of trash, cement and scraps, which are carried and settled in the Anacostia River bed is noticeable.

Table 1.0 summarizes the water quality data

Table 2.0 summarizes the turbidity data

Table 3.0 summarizes the chemicals present in the sediments

Table 4.0 shows the concentrations of coliform

Table 5.0 shows the Biotic Index of Pollutional status of Water Quality of the Anacostia River

CONCLUSION

The constant recurrence of algae constitutes the main problem facing the Anacostia River. Continuous monitoring of the river is necessary to estimate the level of degradation as well as to provide some kind of measure to restore and maintain the quality and scenic beauty of the river. This study shows that the ecology of the river has changed tremendously. That the river is polluted is clearly marked in the organisms found and identified. The use of plankton and benthic organisms as indicators of water quality in river management is clearly marked by their reaction to certain changes in the natural features of the river. During the past three years of the study, there has been a turn towards eutrophic conditions with increased algae and few intolerant species.

It is apparent that life in the Anacostia River has already been changed by the various limiting factors discussed in this study. The river has changed drastically and is beginning to turn into a swampland. This study identifies these problems and brings attention to the urgent need for measures to restore the once pristine ecosystem of the Anacostia River.

ACKNOWLEDGEMENTS

The author wishes to thank the U. S. Geological Survey-, for the generous grant awarded to the D. C. Water Resources Research Center to undertake this study. Assistance in the laboratory and the field were provided by Maria Salguerro-Hille, Cecile Grant and Mohammad Ali. The assistance of Allioune Cisse, computer programmer, is also gratefully appreciated.

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FIGURE 1.0

THE MAP OF ANACOSTIA RIVER

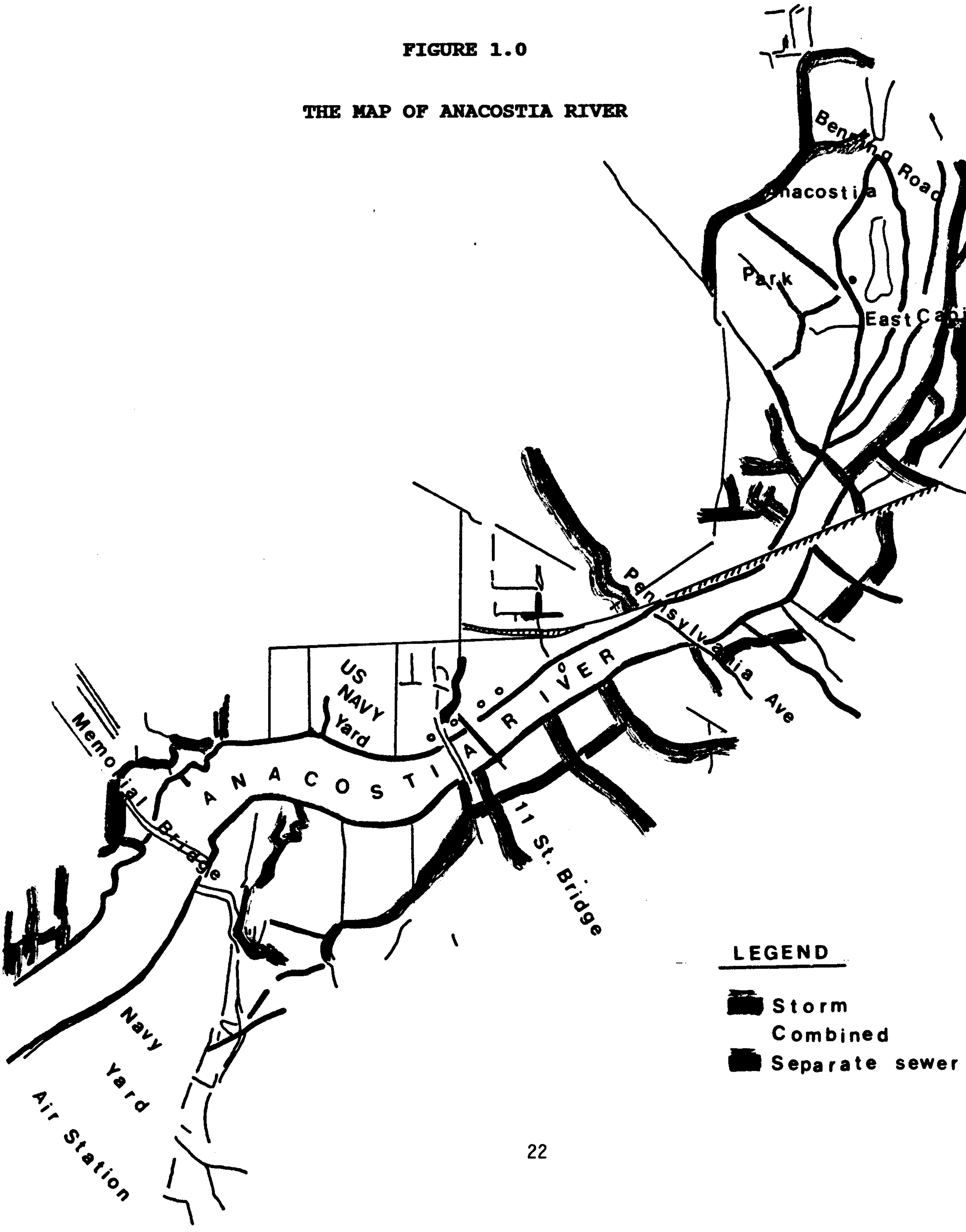


FIGURE 1.0 A

STATION LOCATIONS IN THE ANACOSTIA RIVER TRIBUTARIES

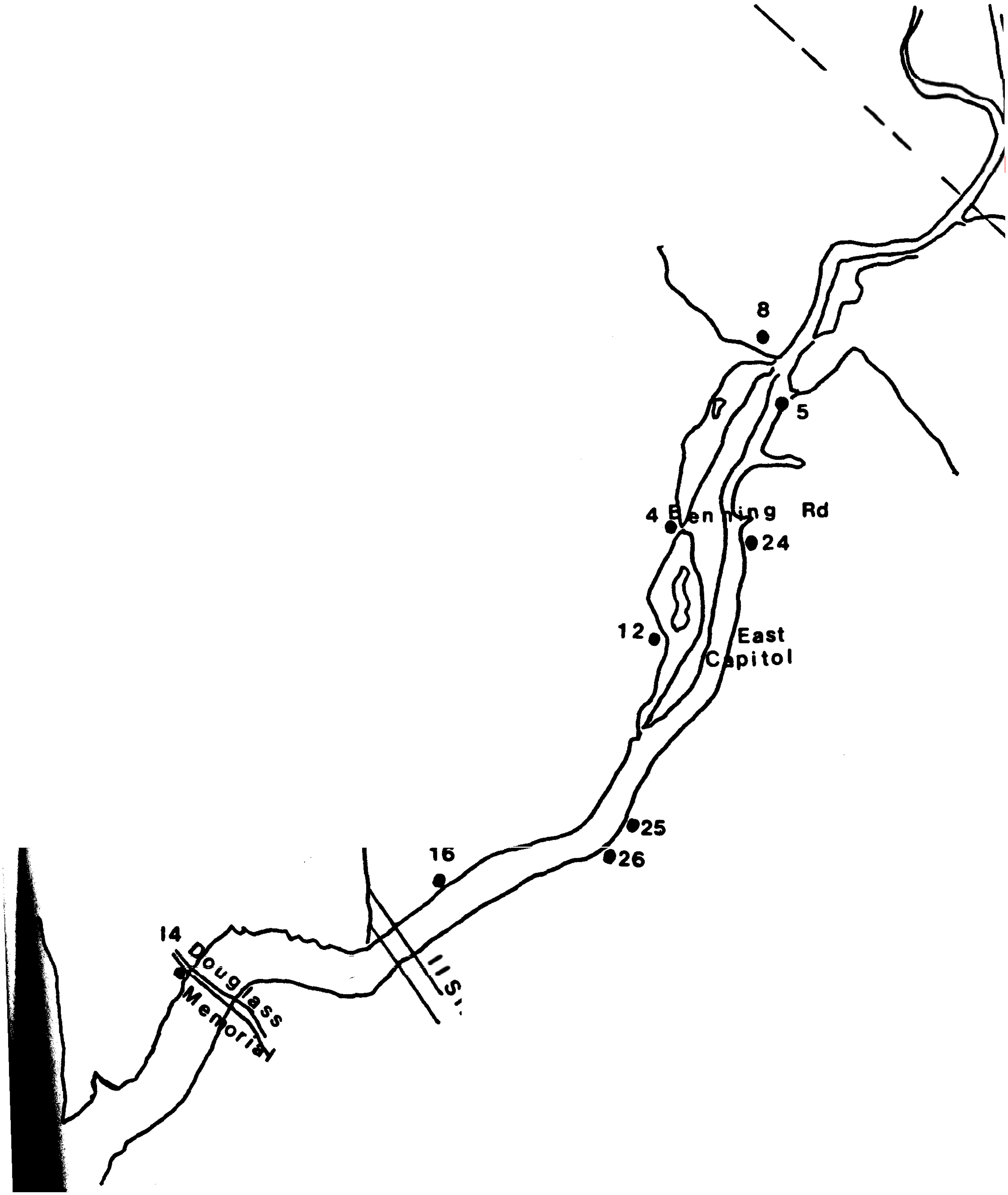


FIGURE 2

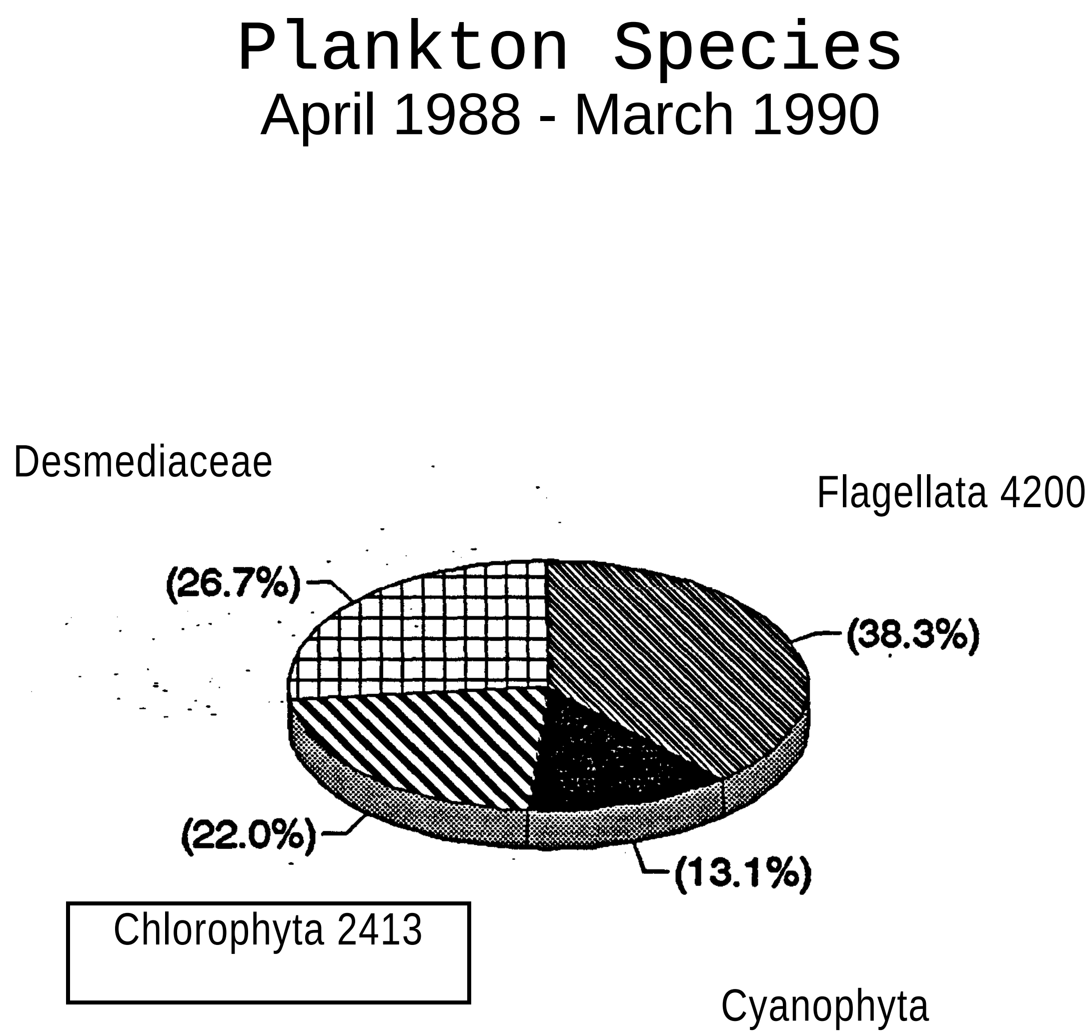

Plankton Species
April 1988 - March 1990
Desmediaceae
Flagellata 4200
(26.7%)
(38.3%)
(22.0%)
(13.1%)
Chlorophyta 2413
Cyanophyta

FIGURE 3

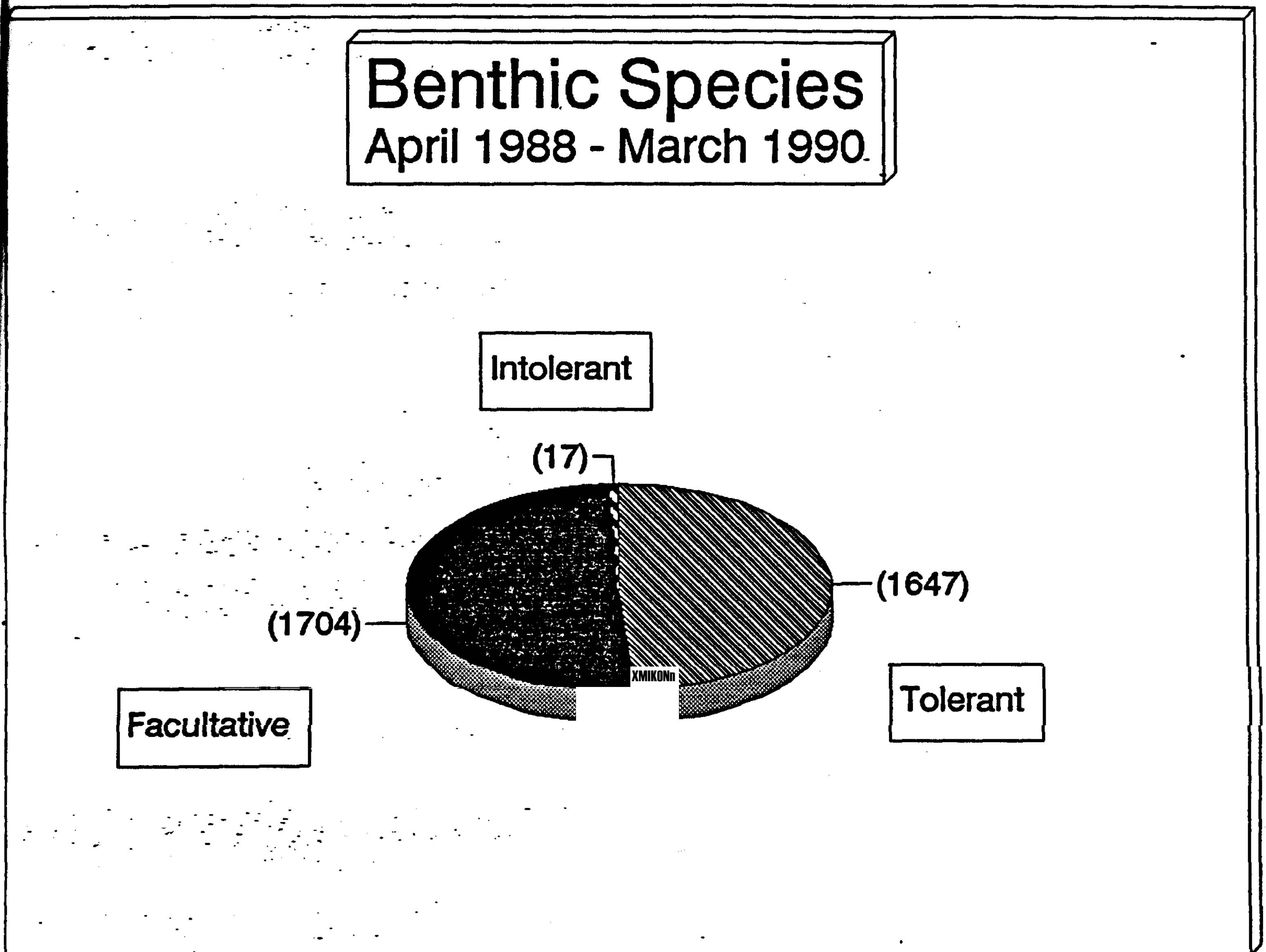
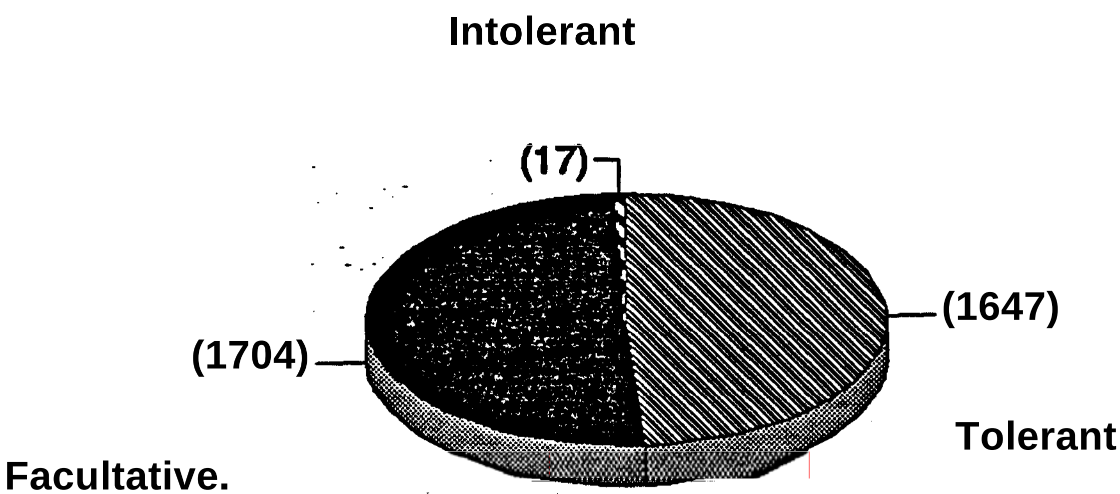

Benthic Species
April 1988 - March 1990
Intolerant
(17)
(1647)
(1704)
Tolerant
Facultative

FIGURE 3

Benthic Species
April 1988 - March 1990



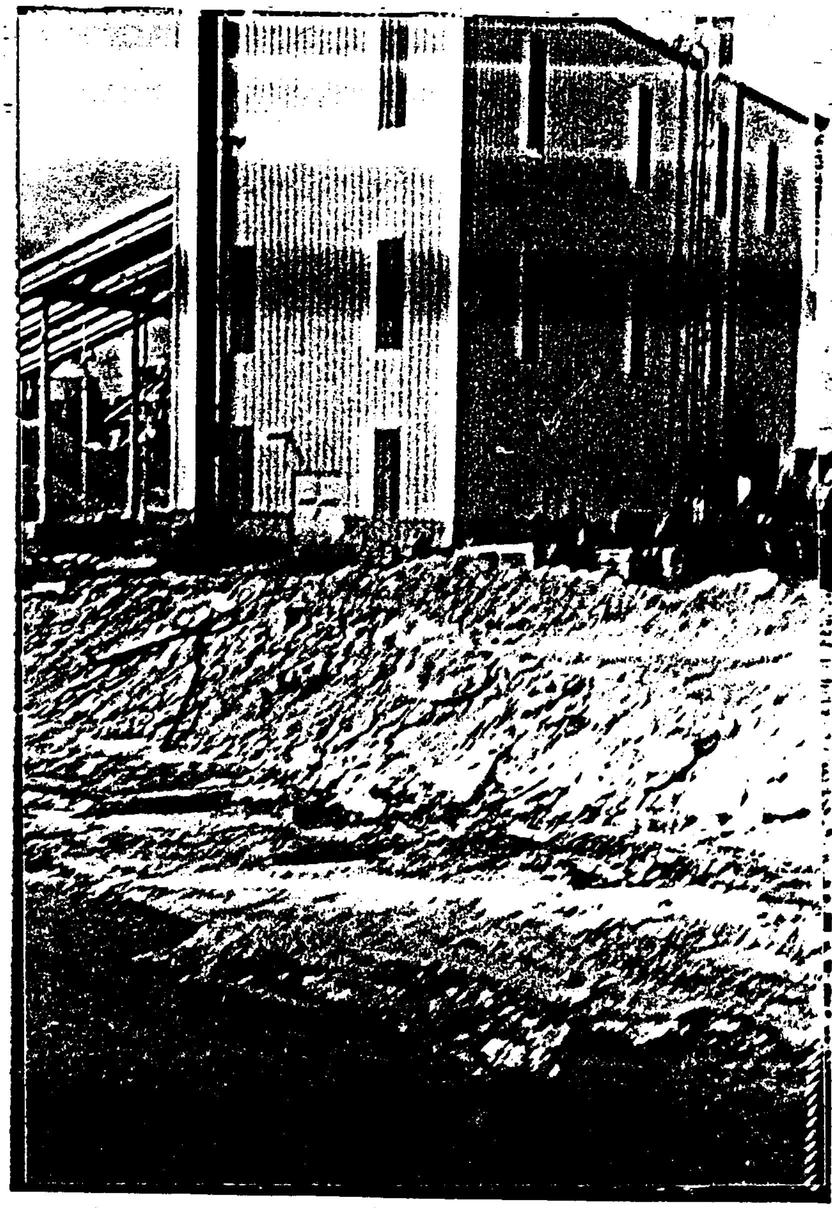


FIGURE 4''. The nearby concrete factory provides continuous flow of trash, cement, and scraps, which are carried and settled in the river bed.-(Station # 14, behind the Department of Public, Works)

Table 1

USGS/DC WRRC PROJECT TOTAL MEAN
OF WATER QUALITY DATA

(A) 1988

STATION (totals)	TEMPERATURE (OC)	pH	DISSOLVED OXYGEN (mg/1)	CONDUCTIVITY (US/cm)	TOTAL READINGS
4	20.4	7.0	5.4	385.0	2
5	31.0	6.7	3.0	395.0	1
8	25.2	7.1	2.8	354.0	2
12	23.0	6.6	8.3	430.7	3
14	28.8	10.2	7.5	345.5	2
16	27.5	6.9	5.8	298.0	1
24	19.3	6.5	5.7	389.3	3
25	19.5	6.3	4.0	606.0	3
26	22.9	6.7	3.7	347.5	6
9	24.2	7.1	5.1	394.6	23

(8)1989

STATION (Totals)	TEMPERATURE (OC)	pH	DISSOLVED OXYGEN (mg/1)	CONDUCTIVITY (US/cm)	TOTAL READINGS
4	13.1	7.0	4.7	308.3	9
5	12.6	7.2	4.1	207.0	10
8	13.3	7.1	4.5	128.1	9
12	11.0	6.1	4.4	520.1	7
14	12.3	7.1	5.1	194.7	6
16	11.1	7.2	4.2	193.7	6
24	10.6	6.4	5.9	431.8	11
25	11.7	7.3	5.9	248.6	7
8	12.0	6.9	4.9	279.0	65

(C)1990

STATION (Totals)	TEMPERATURE (OC)	pH	DISSOLVED OXYGEN (mg/1)	CONDUCTIVITY (US/cm)	TOTAL READINGS
4	12.3	7.1	5.3	289.6	18
5	17.2	7.1	4.9	295.2	10
8	17.8	7.0	4.6	286.7	10
12	13.0	7.0	5.1	310.7	13
14	14.5	7.1	5.7	292.0	7
16	14.8	6.8	5.2	282.6	7
24	12.3	7.0	4.3	375.6	14
25	12.1	6.4	4.3	280.1	12
8	14.3	6.9	4.9	301.6	91

<u>TABLE 2</u>

TURBIDITY DATA (NTU units)

MONTHS	1988 - 1990 LOCATION	1988	1990
April	4		73
	12	20	66
	14	22	
	16		18
	24	10	
	26	25	
May	4		21
	8		22
	24		18
	25		22
June	4		34
	8		25
	12		24
	14		32
	16		27
	24		29
	25		17
July	4	8	
	5		15
	8	14	
	12	16	
	14	15	
	16	9	
	24	11	
	`25	25	

Table 3

USGS/DC WRRC PROJECT TOTAL MEAN FOR
WATER ANALYSIS DATA

A

CHEMICAL ANALYSIS(ppm)	April - July 1988 *Sta.4	Sta.12	Sta.14	Sta.16	Sta.24	Sta.25	Sta.26
Alkalinity	92	102	144	88	24	98	117
Ammonia	0.02	0.05	0.01	0.36	0.27	0.09	0.23
Calcium	56	40	140	62	20	64	92
C02	7.00	9.50	2.00	9.00	5.75	12.50	13.00
Chlorides	40	44	48	32	45	96	60
Chlorine	0.01	-	-	-	-	-	-
Chromium	-	-	-	-	0.03	-	-
Copper	-	0.01	-	0.08	0.03	0.01	0.03
Cyanide	0.25	0.05	0.28	0.18	0.04	0.70	0.73
Dislvd. Solids	180	310	172	207	85	310	279
Hardness(CaC03)	88	102	148	88	78	126	144
Iron	0.01	0.25	0.13	1.00	1.69	2.13	1.50
Magnesium	32	16	12	27	10	62	52
Nitrate	3.00	5.00	2.00	2.33	0.50	3.50	2.50
Phosphate	-	0.10	0.13	0.02	-	0.28	0.40
Salinity(ppt)	-	1.00	1.40	0.84	0.54	0.66	2.07

*Only 1 sample was taken from this station

B

CHEMICAL(ppm) September 1988 - July 1989

ANALYSIS		Sta.4	Sta.5	Sta.8	Sta.12	Sta.14	Sta.16	Sta.24	Sta.25
Alkalinity	59	43	38	96	46	69	91	74	92
Ammonia	0.15	0.13	-	0.41	1.00	0.45	0.25	0.25	0.20
Calcium	49	28	58	66	46	76	55	67	88
C02	7.70	9.75	6.00	6.63	13.00	11.00	9.80	8.50	7.00
Chlorides	55	48	18	63	24	37	78	62	62
Chlorine	-	-	-	0.01	-	0.03	-	0.02	0.05
Chromium	-	-	-	-	-	-	-	-	-
Copper	0.003	-	-	-	-	-	-	0.005	-
cyanide	0.37	0.69	0.20	0.53	0.80	0.55	0.23	0.20	1.40
Dissolved Solids	94	-	-	175	-	140	182	183	310
Hardness (CaC03)	71	83	66	100	78	99	103	84	76
Iron	1.00	2.19	0.38	1.34	0.75	0.63	1.33	1.75	4.50
Magnesium	22	27	8	35	32	23	48	25	40
Nitrate	1.15	-	1.00	2.88	-	2.63	3.25	2.01	5.00
Phosphate	0.35	-	-	0.42	-	0.38	0.38	0.40	3.00
Salinity (ppt)	0.90	0.60	1.80	1.60	0.80	1.70	1.72	1.40	5.60

Table 3

C

CHEMICAL ANALYSIS(ppm)	September - November 1989							
	Sta.4	Sta.5	Sta.8	Sta.12	Sta.14	Sta.16	Sta.24	Sta.25
Alkalinity	61	101	139	153	102	94	64	67
Ammonia	-	0.02	0.02	0.41	0.34	0.06	-	0.01
Calcium	70	-87	84	49	87	40	100	70
C02	4.50	7.25	3.75	7.25	8.50	4.50	2.00	2.00
Chlorides	40	50	51	55	32	32	44	40
Chlorine	-	-	-	0.13	-	-	0.13	-
Chromium	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-
Cyanide	0.20	0.37	0.70	1.20	0.63	0.09	0.15	0.49
Dislvd. Solids	-	-	-	-	-	-	-	-
Hardness(CaC03)	70	110	109	134	106	100	88	69
Iron	1.75	2.38	1.13	0.44	2.88	0.69	1.07	1.25
Magnesium	25	37	25	85	19	13	-14	-14
Nitrate	-	-	-	-	-	-	-	-
Phosphate	1.07	0.75	0.13	0.38	0.69	0.25	0.44	0.69
Salinity(ppt)	0.90-	1.10	1.00	1.10	0.90	0.90	1.20	1.30
Sulfide	-	-	-	-	0.05	-	-	-

D

CHEMICAL ANALYSIS(ppm)	February - July 1990							
	Sta.4	Sta.5	Sta.8	Sta.12	Sta.14	Sta.16	Sta.24	Sta.25
Alkalinity	74	72	82	86	84	85	87	71
Ammonia	0.12	0.02	0.03	0.06	0.07	0.06	0.08	0.07
Calcium	62	61	72	70	78	74	81	64
C02	7.80	7.75	8.88	15.25	4.75	5.88	9.00	10.90
Chlorides	48	45	51	49	37	42	52	40
Chlorine	0.02	0.19	0.06	0.06	-	0.13	0.02	0.05
Chromium	-	-	-	-	-	-	-	-
Copper	0.01	-	-	0.01	-	-	-	0.01
Cyanide	0.42	0.36	0.54	0.90	1.98	0.48	0.51	0.39
Dislvd. Solids	204	223	233	176	200	195	214	184
Hardness(CaC03)	94	89	103	104	105	101	107	86
Iron	3.00	0.63	0.63	0.88	0.44	1.16	1.85	1.00
Magnesium	31	28	31	34	27	27	26	22
Nitrate	0.65	1.19	1.31	2.81	1.63	2.19	1.20	1.15
Phosphate	0.40	0.50	0.41	0.50	0.41	0.97	0.45	0.43
Salinity(ppt)	1.12	2.30	2.10	2.00	0.95	0.95	1.04	0.96
Sulfide	-	-	-	-	-	-	-	-

TABLE 4

THE TOTAL MEAN FOR
COLIFORM TEST
(April -July 1988)

DATE	STATION	MEAN MPN per 10a ml*)
4/08	12	59.7
4/13	26	41.0
4/15	24	39.3
4/22	14	3.7
7/04	12	63.7
7/06	16	5.7
7/08	14	17.0
7/11	24	4.3
7/13	26	19.7
7/15	25	1966.7
7/18	8	406.0
7/20	5	2400.0
7/22	4	136.0

* From MPN Index for Positive and Negative results when three 10 ml, three 1 ml and three 0.1 portions are used.

<u>TABLE 5</u>

BIOTIC INDEX OF POLLUTIONAL STATUS OF WATER QUALITY OF ANACOSTIA RIVER

STATION	POLLUTIONAL		EQUATION		BIOTIC INDEX READINGS
4D	2(0)	+	1	1	Moderate Pollution
5	2(0)	+	8	8	Clean with slow current
8	2(0)	+	1	1	Moderate pollution
*12	2(0)	+	0	0	Gross pollution
12D	2(0)	+	8	8	Clean with slow current
14D	2(1)	+	1	3	Moderate pollution
16D	2(0)	+	7	= 7	Moderate pollution
16	No Organism was found				
24D	2(1) + 0 = 2				Moderate pollution
*24S	2(0)	+	0	= 0	Gross pollution
25D	2(1)	+	0	= 2	Moderate pollution
*26D	2(0)	+	0	= 0	Gross pollution
*26R	2(0)	+	0	= 0	Gross pollution

* Indicate the most polluted station sites located along the Anacostia River

Standard Values adapted from the Michigan Water Resources Commission, 1970.

Index range from 1-40 and correlated accordingly.

0 - gross pollution
1 – 6 - moderate pollution
4 - 9 – clean with slow current
10-40 - clean

by

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ABSTRACT

By studying the organisms in the litter layer, the dynamics and the productivity role of the woodland ecosystem can be understood.

This study was conducted by collecting 6 litter samples at different locations in the District of Columbia on February 20, 1992. A special point of reference was made by collecting litter layer samples from Melvin Hazen Park, which is a tributary of Rock Creek Park.

The samples were immediately taken to the laboratory for further identification and quantification. The study was performed by following the procedure of J.P. Jass and B. Klausmeirer (1987) and V.C. Guerrero (1990).

The species diversity was determined by the ratio between the number of individuals and the total number of individuals per sample.

Simple statistical analysis was done. The following organisms in order of abundance were:earthworm, ant larvae, insect larvae, mite, pillbug, snail, centipede, beetle, may fly, nymph, millipede, and nematoda.

Most of the organisms were larval forms. Adult organisms were found to consume fresh materials. Partially decomposed materials were also observed. The productivity of the litter layer depends on these organisms; the energy associated with them contributes to the whole cycle for which conservation of the ecosystem is the final goal.

It must be emphasized that the data summarized here are preliminary, therefore we cannot arrive at a final conclusion. Further and periodic investigation would be necessary to obtain more meaningful results.

Winston Corona and Isidro Carranza are environmental science majors. This research project was conducted as part of the requirements in Dr. Victoria C. Guerrero's course, Conservation of Natural Resources, Spring Semester 1992.

LITTER LAYER PRODUCTIVITY AND DECOMPOSITION

The diversity of organisms is represented by the relationship between the density, on the Y axis, and the types of organisms found, on the X axis, as shown in figures 1.0 and 1.1

Figure 1.0

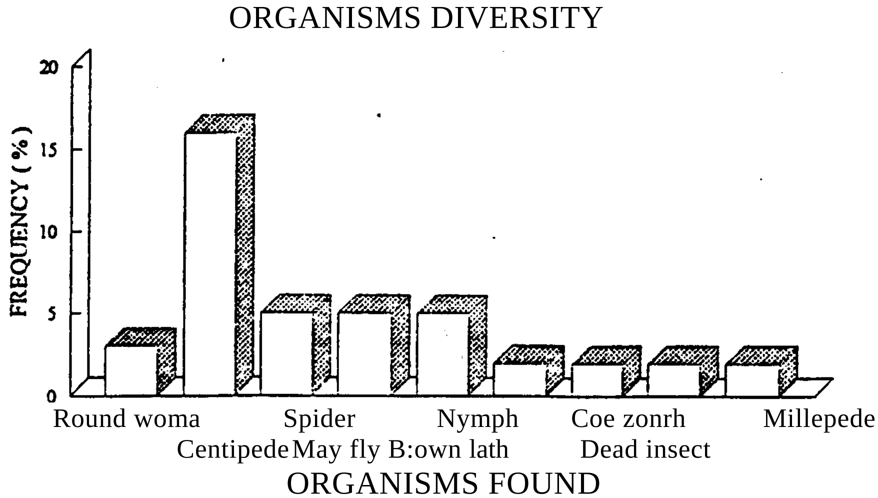
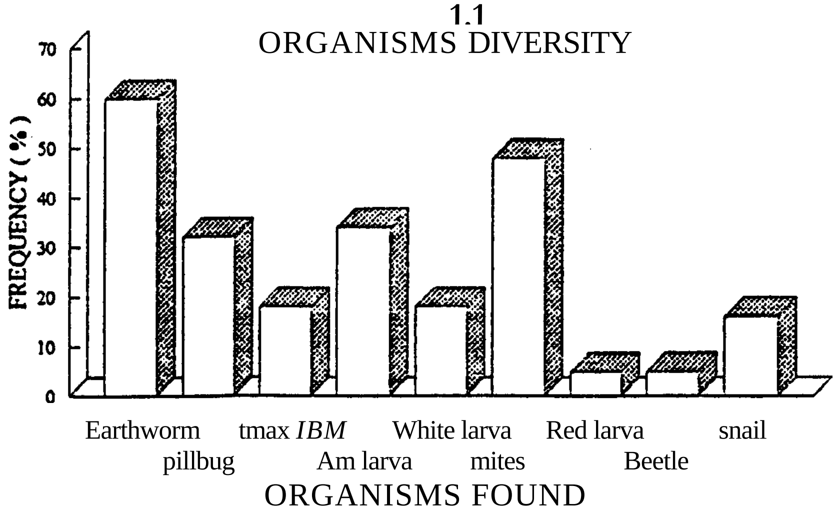


Figure 1.1



As it can be observed, the highest percentages are represented by earthworm, mite, pillbug, centipede, and some other members of the insecta family. Of all these organisms the most active are the earthworms. Their constant burrowing facilitates aeration and drainage, and since they feed on fresh and partially decomposed organic matter they contribute to the process of litter decomposition. Since mineral matter is also ingested in feeding, the earthworm moves quantities of soil about and this activity tends to mix minerals and organic materials.

Pillbug, centipede, millipede, snail, and bettles hydrolyze cellulose and some other plant polysacharides. They are able to do it because they possess the widest range of enzymes that serve as catalysts for their biochemical reactions.

LITTER LAYER PRODUCTIVITY AND DECOMPOSITION

Organisms Diversify

Table 1.0 corresponding to Figures 1.0 and 1.1

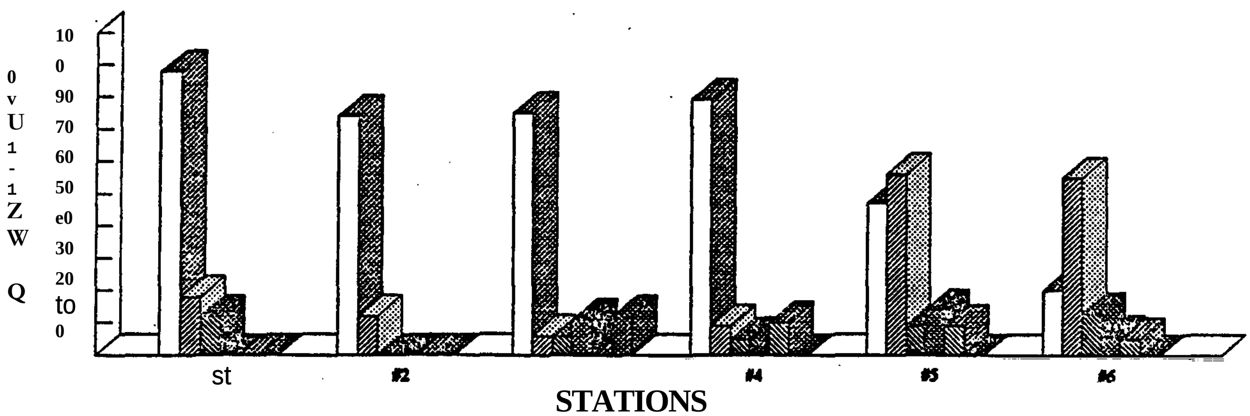
Percentage (%)' of Organisms by Stations						
			STATIONS			
Organisms	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**
Pillbug	**12**	**5.9**	**-**	**5.26**	**3.8**	**19.05**
Insect larva	**87.5**	**-**	**-**	**-**	**-**	**-**
Earthworm	**-**	**17.6**	**-**	**5.26**	**55.2**	**3.5**
Insecta	**-**	**73.5**	**75**	**78.9**	**20.7**	**47.6**
Centipede	**-**	**-**	**-**	**10.53**	**3.4**	**9.5**
Snail	**-**	**-**	**12.5**	**-**	**3.4**	**14.3**
Millipede	**-**	**-**	**-**	**-**	**3.4**	**-**
Round worm	**-**	**-**	**12.5**	**-**	**-**	**-**

LITTER LAYER PRODUCTIVITY AND DECOMPOSITION

It can be observed that the highest organism density corresponds to the members of the class insects-stations #1 through #4, followed by members of the class annelida, shown in stations #S and #6 in figure 1.2.

Figure 1.2

DIVERSITY OF ORGANISMS



LEGEND: Insecta. Mollusca Annelida Chiiopoda Crustacea Nematoda

In her study of the Anacostia River in 1991, V.C. Guerrero (1990) found that the quantity and quality of benthic species appears to be influenced by the river outflow and substrate. Apparently the most tolerant and abundant species in the benthic region was the Tubifex worm of the class Annelida.

The organisms of the insecta family contribute substantially to the return of organic material to the soil by feeding upon excreta and by tunneling. Such activities facilitate organic decomposition and redistribution of the soil which contribute to nutrient production necessary to the survival of other populations, such as forest and higher animals on the surface. The energy attached to this whole community that remains as living protoplasm or organic matter is the net productivity.

Organisms Diversity

Table 1.2 corresponding to Figure 1.2

Organisms Type	Number of Individuals	Percentage (%)
Earthworm	25	60
Pillbug	12	32
Insect larva	7	18
Ant larva	13	34
Mite larva	17	18
Red Larva	2	5.3
Mite.........	18........	47
Beetle	2	5.3
Snail.........	6........	16 i
Round worm.........	1.........	2.6
Centipede	5	13.2
Spiders	2	5.3
Mayfly.........	2	5.3
Nymph	2	5.3
Cockroach	1	2.6
Dead Insect	1	2.6
Millipede	1	2.6

Conclusion

The diversity of animal life in the litter layer is far greater than might generally be believed. Of the different kinds of organisms constituting the litter fauna the most important are the annelida, the arthropod and the nematodes. They make their home temporarily or permanently underground, or utilize the litter layer for some purposes during their lives. These organisms owe their existence to the decomposition of the organic matter, in turn, they support the existence of other more complex forms of life.

This study of litter production and decomposition has been a valuable experience because it gave us a useful introduction to the field of soils which is of vital importance to life.

Acknowledgement

The authors would like to thank Dr. Victoria C. Guerrero for her encouragement and invaluable suggestions for this research.

The authors also express their appreciation to the Water Resource Research Center of the University of the District of Columbia for allowing us to participate in the Water Research Symposium held on April *28, 1992*.

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A SURVEY OF STREET DRAINAGE INLETS IN THE DISTRICT OF COLUMBIA

By Fred F. M. Chang and Julius Elui

ABSTRACT

As a result of the rampant urban developments in the District of Columbia, storm runoff has been increasing during the last three decades. The sights of flooded streets become common, particularly in the old section of the district. Two reasons are associated with this. One is that the capacity of the old sewage system is no longer sufficient to drain the increased storm runoff. The other reason is plugging of street drainage inlets. When a street inlet is plugged by debris, storm water ceases to flow and the street will be flooded. The detained water causes traffic and pedestrian safety problems. When the water is detained for a longer time, it culminates in health problems due to the growth of micro organisms.

This study is intended to be the first phase of a long-term study on street drainage inlets aimed at the design of debris-free street inlets and inlet structures, suitable for urban environment. Three streets were selected to survey the existing condition of the street drainage inlets. These three streets included 1) Georgia Avenue, N.W., between Irving street and Allison Street, 2) Rhode Island Avenue, N.E., between 17th Street and 30th Street, and 3) Alabama Avenue, S.E., between Naylor Road and Pennsylvania Avenue. For each drainage inlet, the condition of the inlet was noted. If it was plugged by debris, the degree of plugging, type of debris, and possible cause of the plugging were noted.

A statistical analysis was made to summarize the findings. Among the street drainage inlets surveyed, 40% were clean, 35% were plugged less than 50% of the opening areas and 25% were plugged more than 50% of the opening areas. Contrary to the general conception that pop bottles and cans are the major cause of inlet plugging, the likely major cause of the plugging was found to be the firmly compacted soil at the entrance of the inlet. Pop bottles and cans are the secondary cause of the inlet plugging. Because inlet openings are normally designed large enough to freely pass these containers; plugging occurs only when soil layers were built up at the entrance of the inlet and the size of the opening was reduced.

The conclusions here are based on the limited data from the survey of these three streets. Whether these findings can be generalized and applied to other D.C. streets, a further investigation is needed.

“A Survey of Street Drainage Inlets in the District of Columbia"

Fred Chang and Julius Elui

I. INTRODUCTION

As a result of the urban developments, the magnitude of storm runoffs in the District of Columbia has been gradually increased during the past three decades. It is not uncommon in the District to sight during storms that many streets are flooded with storm runoff. These phenomena are observed more frequently in the older sections of the District where economically disadvantaged people live. Two compelling reasons are that the magnitude of storm runoffs is larger in recent years due to urbanization and that the capacity of the street drainage systems designed based on the storm runoffs many years ago is inadequate for current runoffs. The size of storm sewage is not sufficiently large enough to convey the runoff much larger than that originally designed for. This includes the insufficient capacities of drainage inlets along streets. These inlets no longer serve properly to drain a storm runoff of a larger magnitude now. To make this matter worse, it has been observed that many drainage inlets in the old sections of the District are partly or totally clogged with sediment and debris. This causes the storm runoff to detained over the pavement at the inlets. If an inlet is completely clogged, the water is detained over the pavement for a longer time causing serious traffic problems. This water, when it cultivates micro-organisms, develops environmental problems and health hazards to the residents.

(a) Selection of Study Sites

II. OBJECTIVE AND SCOPE

The proposed study is the first phase of a long-term research project to solve street flooding problems in underclass urban areas. The study is limited to take a survey and to document the current status of street drainage inlets along selected D.C. streets and the impact to the environment. The results will be used to initiate a long-term research project in order to mitigate street flooding problem and thus to improve the environment of impoverished areas and the health of underclass residents and to relieve traffic problems.

III. TASKS

The tasks are divided into two parts: 1) Survey of street inlets, and 2) Compilation and analysis of the data.

(1) Survey of Street Inlets

(a) Selection of Study Sites

The three study sites are selected based on the following four criteria: i) even geographic distribution of the sites, ii) the sites are in underclass areas, iii) the sites are where there are potential sources of debris problems, and iv) streets with one or more sag points where storm runoff converges.

Six sections of streets were considered for possible study sites. The street sections are:

1. Georgia Avenue, N.W., between Irving Street and Allison Street
2. Nineth Street, N.W., between Irving Street and Allison Street.
3. South Dakota Avenue, N.E., between 11th Street and 20th Street.
4. Rhode Island Avenue, N.E., between 17th Street and 30th Street.
5. Minnesota Avenue, S.E., between 14th Street and 35th street.
6. Alabama Avenue, S.E., between Naylor Road and Pennsylvania Avenue.

A reconnaissance was made in early June 1990 to select the three sites for the study based on the above criteria. The sections of streets listed below are finally selected:

1. Georgia Avenue, N.W., between Barry place and Upshur Street(1.75 miles).
2. Rhode Island Avenue, N.E., between 10th Street and South . Dakota Avenue(1.3 miles).
3. Alabama Avenue, S.E., between Naylor Road and Pennsylvania Avenue(1.1 miles).

(b) Survey of Inlet Condition

The survey of each site was conducted during June and July of 1990 by the principal investigator and a research assistant. The principal investigator worked closely with the assistant during the survey" of the first sites to give specific instructions regarding data collection and compilation. The data for the other two sites were collected by the research assistant alone by following the instruction.

The following data were collected using Form S-1 included in Appendix A:

i) A 1:2400 scale topographic maps showing streets and housings.

ii) Dimensions of streets and pavement materials: width and number of lanes.

iii) Location, type, and dimensions of each street drainage inlet. The conditions of the inlet at the time of survey were also included. Description and characteristics of debris were also recorded and some photographs depicting the inlet condition were taken.

iv) For a clogged inlet, the causes, either structural or debris related, were noted.

v) Types of materials in debris were recorded. The quantities were not recorded.

vi) Types of business establishments along streets: restaurants, stores, public buildings, etc.

(2) <u>Compilation and Analysis of Data</u>

(a) Compilation of Data

1. Cross Sections of the Streets.

The cross section of the centerline of each street was obtained from a 1:2400 D.C. street map and replotted in Figure 1 to show clearly the vertical curves, slopes and sag points of the street

The survey data of the street drainage inlets are shown in Tables 1 to 6. The locations of the inlets are plotted on reduced scale D.C. maps as shown separately in Figures 2 to 4.

(b) Data Analysis

1. Inlet Conditions.

The analysis of the survey data are shown in Tables 7 to 9 and in Figures 5 to 10. Tables 7 to 9 shows the number of the inlets plugged and the extent of blockage at the time of the survey. The percentages of plugged inlets were also computed. Figure 5, 6, 7 show the bar graphs of the number of inlets plugged and Figures 8, 9, 10 show the circular graphs of the percent of inlets plugged.
Along Georgia Avenue, 19% of the inlets were plugged more than 50% at the inlet throat and 36% were free from debris. Along Rhode Island Avenue, these figures were 29% plugged and 29% clean. Along Alabama Avenue, 16% of the inlets were plugged more than 50% and 47% were clean.

As debris on urban streets is produced and distributed by human being, the population and their activities including businesses have a close relationship with the amount of debris produced. Therefore, it is natural that debris problems exist where human activities are brisk and debris are likely to accumulate.

The Rhode Island Avenue is a six-lane street with heavy traffic as compared with the Georgia Avenue and the Alabama Avenue which are four-lane streets. Its obvious from the figure above, that Rhode Island Avenue inlets are prone to debris problems. The Alabama Avenue is less populated and the street pavement was almost free from trash at the time of observation and more about 50% of the inlets were clean.

At a sag point of a street, storm runoff converges from the both sides of the slopes and thus drainage inlets placed at such a location are normally designed to drain all the runoff including debris contained in the flow. Therefore, the inlets at a sag point are subject to more debris problems. The fourth inlet on the right side of the Alabama Avenue is located near the sag point, which was 90% plagged with soils and debris even though the streets at this location were very clean. Several inlets at the sag point of the Georgia Avenue between Taylor Street and Upshur Street were plogged more than 50%.

Debris accumulates as surface runoff flows down a long slope. Two inlets on the both sides of the lower end of a 1600ft slope along the Rhode Island Avenue were completely plugged with debris. The debris composed of soils and plants from the parking lots on the both sides of the street. The street was clean and free of cans and bottles.

In the section of the Rhode Island Avenue between 14th street and 16th street, four streets meet laterally from a higher elevation. These four streets accumulate debris from the high ground and dump it on the Rhode Island Avenue. As the ground is mostly used as parking lots, debris was composed of soils and weeds.

The ground along the Georgia Avenue between Morton Street and Princeton Street slopes down from the east to the west. Debris uptake by surface runoff from the east side of the ground will be carried onto the west side of the street causing debris problems. Most of the drainage inlets on the east side of this section of the street were partially plugged while inlets on the west side were all clean. As this section of the street goes through a residential area, debris was composed of cans, papers, flexible bottles and small amount of soils.

From these observations, street inlets in the areas listed below can be considered to be susceptible to debris clogging.

I. Populated areas with business establishments.

ii. Street sags where storm runoff converges from the both sides of the slopes.
iii. Lower end of a long street.

iv. Where lateral streets join from a higher elevation.

v.Streets where adjoining areas sloping down toward the streets.
vi. Street inlets along parking areas are prone to debris clogging.

2. Effect of Inlet Size on Inlet Plugging.

A larger inlet is generally believed to be less prone to debris clogging for its larger space to pass through the debris. However, on the contrary, the observations showed an opposite trend.

Along the Georgia Avenue study section, there are 29 small inlets of 5-in high and 5-ft long, and 13 larger inlets of 5-in high and 10-ft long or longer. Of these inlets the observation showed that 55% of the small inlets as compared with 85% of the larger inlets were debris-plugged 5% or more of the inlet openings. The similar observations were made along the Rhode Island Avenue

and the Alabama Avenue study sites. The probability of the longer inlets being plugged by debris was higher.

The observation data are presented in the table below:

Street	Number of Inlets		Number of Inlets Plugged	
	Size		5% or more Opening	
	Small*	Larger*	Small	Larger
Georgia Ave.	29	13	16(55$)	11(85%)
Rhode Island Ave.	16	29	8(50%)	23(79$)
Alabama Ave.	12	7	6(50%)	4(57%)

* Small Inlet 5-in high, 5-ft long

Larger Inlet 5-in high, 10-ft long or longer

This puzzling phenomena can be explained as follow. A larger inlet is installed to receive surface runoff from a larger drainage area. The amount of runoff is normally considered linearly proportional to the drainage area. This means that if the drainage area is doubled, the inlet size, or length of the curb inlet, should be doubled to receive the double amount of runoff. The amount of debris carried by the runoff, however, will increase more than double.

Debris is composed of various materials of different sizes. A small runoff can carry debris of only smaller sizes. When the runoff is doubled, it can uptake larger size materials in addition to the small size materials and the concentration of debris in the flow increases. As the amount of debris carried by the flow is the product of the concentration and the flow, not only the magnitude of the flow but also the concentration of debris in the flow need to be considered for a correct determination of the amount of debris. For example, if the flow is doubled and concentration increased by 20%, then the amount of debris would increase to 2.4 times (2 X 1.2 = 2.4) the debris for the original flow.

This factor which might not be considered for the design of inlets in the past, resulting in an underestimation of debris for longer curb inlets.

3. Characteristics of Debris

Debris found at the surveyed inlets was composed of mostly man-made materials, including cans, bottles, paper products, cups, glasses, woods, clothes, and toys, see Figure 11. There were also natural materials such as, soils, pebbles and leaves, and weeds and plants grown on the soils deposited at some inlets, see Figure 12.

These materials were divided into four categories listed below based on uptaking and depositing patterns of the materials in flowing water.

Soils - including soils, dirt, pebbles, and rocks.

Rigid Materials - including solid containers, cans, bottles, cups, and glasses.

Flexible Materials - including papers, paper products, plastic products, and clothes.

Natural Materials - including weeds, leaves, plants, and branches.

A statistical analysis was made on the debris samples at the 71 inlets that were at least 5% plugged by the debris at the times of the observations..The result is shown in the table below.

The numbers indicate the percent of time the specified materials were found in the debris; they do not reflect the quantitative value of the materials.

Material	Probability of Containment, %
Soils	75
Rigid Materials	35
Flexible Materials	35
Natural Materials	46

4. Noteworthy Observations.

In the following some noteworthy qualitative observations are presented in order to understand some mechanism of inlet cloggings by debris.

* In the three sections of the streets where survey was made, the streets were very clean. Although some amount of common trashes were observed on the street pavements, they were fresh - being there not more than few days, indicating that the street sweepings had been enforced by the government fairly well, see Figures 13.

* All drainage inlets along the three streets surveyed were curb inlets with the opening of 5-in high and 5 to 14-ft long. If the openings were not partly blocked by other trash, the openings were sufficiently large enough to pass individual, bottles, cans and cups of common sizes, i.e., 2.5 to 3.5-in diameter. The observation confirms this fact. Common size containers were occasionally found in plugged

inlets always mixed with other debris. Often they were wrapped by papers, paper products and rugs, forming the sizes larger than the height of the inlet openings.

* At the floors of many plugged inlets, firmly compacted soils were observed. The soils were composed of well graded fine particles, some decomposed tree leaves and grass, forming a soil cement glued on the floor firmly. Small plants and grass were found growing in some inlets, indicating that the soils were there for a considerably long period of time.

Judging from the facts that these streets had been cleaned regularly and that the soils had been deposited at inlets for a long time, it is speculated that the cleaning machines used for cleaning the streets were incapable of removing the soils deposited on the floors of the inlet openings. The compacted soils were formed probably through a long process in which a thin layer of soil layer was built at each time of surface runoff or even of street cleaning when water was used. As street dirt was well graded, each soil layer became a cemented layer when dried and firmly adhered onto the old layers.

* More soil related clogging problems were observed at the inlets where the floors of the openings were built with a flatter slope. Soil related clogging problems were not found at the inlets where the opening floors were built steeper than about 30 degree angle from the horizon.

IV. CONCLUSIONS AND COUNTER MEASURES

Conclusions presented here are based on the limited data from the three streets sections suveyed in the summer of 1990. Whether these conclusions may be generalized and applied to other D. C. streets need a further investigation. As the inlets surveyed were all curb inlets, the conclusion and counter measures suggested here apply only to curb inlets.The conclusions are:

1. Street drainage inlets in Washington, D.C. are about 30 to 50% clean and about 20 to 30% are clogged more than 50% of the inlet openings.

2. The likely major cause of the clogging problems is soils deposited and firmly compacted on the floors of the inlet openings.

3. Pop bottles and cans of common sizes on streets only play a secondary role as related to inlet cloggings. These containers

cause plugging problems only when the inlet openings were partly plugged by other trash and mostly by soils.

4. D.C. streets are clean indicating the street cleanings are regularly performed.

5. The height of the inlet opening is an important factor related to the inlet cloggings and the length is a secondary factor. Longer drainage inlets appeared from this study to be more susceptible to debris cloggings, it is not conclusive unless more data are gathered.

Counter Measures suggested here apply only to curb inlets; they do not apply to other types of inlets, such as grate inlets, slotted inlets, and combination inlets.

1. Street drainage inlets need to be flushed occasionally with a water jet to remove soils deposited at the inlets. This will prevent soil cement layers from building up to block the inlet openings. For the inlets where substantial amounts of compacted soils were accumulated, the soils should be removed mechanically or manually using a shovel. Also care should be exercised to frequently inspect the conditions of street inlets to prevent soil accumulation before the clogging problem become serious. This type of preventive measure is usually cost effective.

2. The floor of the opening of a curb inlet should be designed to have a slope of more than 35 degree to avoid soil deposit.

3. If possible, street pavements should be recessed, about one inch, at a curb inlet to add one inch to the height of the opening so that debris may pass through the opening smoothly.

4. In order to alleviate inlet related debris problems, a short curb inlet is recommended. However, as a short curb inlet is hydraulically much inefficient to drain storm water, the use of shorter inlets certainly leads to a less economical design in terms of hydraulics. An engineering system analysis is required to perfect the design, considering hydraulic problems as well as debris problems.

V. FURTHER RESEARCH SUGGESTED

1. As this study was based on a set of limited survey data, an additional survey of this kind on other D.C. streets should be conducted in order, to obtain conclusive results. The survey needs to be in more details, including the detail dimensions of inlets and quantities of debris.

2. Based on the results obtained in Item 1, to examine the current design criteria for street inlets in conjunction with problems related to traffic safety, hydraulics, and debris.

3.To update, if necessary, the manual currently used by D.C. Engineers on design of pavement drainage inlets, including selection of inlet size and location and example computations.

Table 1.

Street Inlet Survey Data: Georgia Ave. N.W. Jun 18, 1990

Street Segment Surveyed: From Barry Place To Upshur Street

Street Geometry: 6 lanes
Side of Street Surveyed: Right side from Barry Place to Upshur Survey done by: Dr. F.M. Chang & J. Elui

The following letter symbols denote debris types:

S - for soils, pebbles, stones, and pieces of rocks F - for flexible materials: paper, plastic products R - for rigid materials: solid containers, metal cans, glass bottles N - for weeds, grass All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Location	H x L	% clog	Debris
0+00	5" x 11'	5	F
2+00	5" x 11'	20	N,R,S
9+00	5" x 11'	50	S
12 + 30	5" x 5'	5	F
20 + 80	5" x 5'	0	
23 + 80	5" x 5'	0	
28 + 80	5" x 5'	50	F,S
33+80	5" x 5'	45	F,S
36 + 80	5" x 5'	30	F,S
40 + 80	5" x 5'	2	F
43 + 30	5" x 5'	90	F
44 + 30	5" x 5'	3	S
46 + 30	5" x 5'	0	
48 + 30	5" x 5'	10	F
51 + 30	5" x 5'	40	F,R
55+30	5" x 5'	5	F,S
58 + 80	5" x 5'	5	S
62 + 80	5" x 5'	75	F,S
66 + 30	5" x 14'	60	N,S
69 + 30	5" x 14'	40	R,S
69 + 50	5" x 14'	30	F,S
70 + 50	5" x 5'	8	S

Table 2.

Street Inlet Survey Data: Georgia Ave. N.W. Jun 18, 1990

Street Segment Surveyed: From Barry Place To Upshur Street

Street Geometry: 6 lanes

Side of Street Surveyed: Left side from Barry Place To Upshur Street Survey done by: Dr. F.M. Chang & J. Elui

The following letter symbols denote debris types:

S - for soils, pebbles, stones, and pieces of rocks F - for flexible materials: paper, plastic products R - for rigid materials: solid containers, metal cans, glass bottles N - for weeds, grass All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Loc	ation	H x L	% clog	Debris
04	+00	5" x 10'	10	F,S
11	+ 30	5" x 14'	55	F,N,R
12	+ 30	5" x 14'	10	F,S
22	+ 30	5" x 5'	0	
26	+30	5" x 5'	0	
	+ 30	5" x 5'	0	
29	+ 80	5" x 5'	8	F
36	+ 80	5" x 5'	20	F,S
40	+ 30	5" x 5'	85	F, S
43	+ 30	5" x 5'	0	
46	+ 30	5" x 5'	0	
50	+ 80	5" x 5'	0	
	+ 30	5" x 5'	0	
51	+ 30	5" x 5'	0	
53	+30	5" x 5'	0	
57	+ 30	5" x 5'	10	F
62	+ 30	5" x 11'	45	F,R
69	+ 30	5" x 5'	15	S
73	+ 30	5" x 14'	65	R,S
74	+ 60	5" x 5'	0	

Table 3.

Street Inlet Survey Data: Rhode Island Ave. N.E. Jun 20/21 1990

Street Segment Surveyed: From 10th St. To South Dakota Avenue

Street Geometry: 6 lanes

Side of Street: Right side from 10th St. To South Dakota Avenue Survey done by: Dr. F.M. Chang & I Elui

The following letter symbols denote debris types:

S - for soils, pebbles, stones, and pieces of rocks F - for flexible materials:
paper, plastic products
R - for rigid materials: solid containers, metal cans, glass bottles N - for weeds, grass

All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Location	H	x	L	% clog	Debris
0+00	5"	x	11'	100	N,S
2+00	5"	x	10	45	N,R,S
7 + 00	5"	x	11	0	
9+50	5"	x	11'	30	S
13+00	5"	x	11'	30	S
19 + 00	5"	x	11'	100	N,S
23 + 00	5"	x	5'	90	N,S
24 + 00	5"	x	11'	100	S
26 + 50	5"	x	5'	100	N,S
28 + 50	5"	x	11'	6	F
30 + 50	5"	x	5'	90	N,S
32 + 50	5"	x	5'	20	F,S
36 + 00	5"	x	5'	100	S
40 + 00	5"	x	11'	25	N,S
43 + 00	5"	x	5'	0	
45 + 00	5"	x	5'	2	N,S
46 + 00	5"	x	5'	0	
46 + 30	5"	x	5'	0	
51 + 80	5"	x	5'	15	S
52 + 80	5"	x	11'	100	R,S
55 + 80	5"	x	5'	0	
58 + 30	5"	x	11'	80	R,S
60 + 30	5"	x	11'	45	N,R,S
62 + 30	5"	x	11'	0	
66 + 30	5"	x	5'	0	

Table 4.

Street Inlet Survey Data: Rhode Island Ave. N.E. Jun 20/21 1990

Street Segment Surveyed: From 10th St. To South Dakota Avenue

Street Geometry: 6 lanes
Side of Steet: Left side from 10th St. To South Dakota Avenue Survey done by: Dr. F.M. Chang & J. Elui

The following letter symbols denote debris types:

S - for soils, pebbles, stones, and pieces of rocks F - for flexible materials: paper, plastic products R - for rigid materials: solid containers, metal cans, glass bottles N - for weeds, grass
All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Location	H x L	% clog	Debris
0+00	5" x 11'	80	F,N,S
3 + 00	5" x 11'	30	F
7 + 00	5" x 11	8	F,N
9+00	5" x 11'	50	F,R,S
13 + 00	5" x 11'	85	R,S
19 + 00	5" x 11'	30	N,R,S
21 + 00	5" x 5'	0	N,S
23 + 00	5" x 11'	40	N,R,S
25 + 00	5" x 11	15	S
26 + 60	5" x 5'	10	S
29+60	5" x 11'	10	S
31 + 00	5" x 11'	3	N,S
33 + 00	5" x 11'	5	N,S
35 + 00	5" x 11'	0	
38 + 00	5" x 5'	0	
49 + 50	5" x 11'	0	
52 + 70	5" x 11	40	
57 +00	5" x 11'	35	N,S
61 + 50	5" x 11'	50	F,N,S
64 + 50	5" x 5'	10	N,S

Table 5.

Street Inlet Survey Data: Alabama Ave. S.E. Jun 22, 1990

Street Segment Surveyed: From 25th St. To Pennsylvania Avenue

Sreet Geometry: 4 lanes
Side of Street: Right side from 25th St. To Pennsylvania Avenue Survey done by: Dr. F.M. Chang & J. Elui

The following letter symbols denote debris types:

S - for soils, pebbles, stones, and pieces of rocks

F - for flexible materials: paper, plastic products

R - for rigid materials: solid containers, metal cans, glass bottles

N - for weeds, grass
All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Location	H x L	% clog	Debris
0+00	5" x 5'	5	N
3+50	5" x 14'	100	N,S
7+00	5" x 14'	8	N,R
8+00	5" x 14'	90	F,R,S
13 +30	5" x 14'	70	S
36 + 50	5" x 5'	0	
37+50	5" x 5'	2	N
41 + 00	5" x 5'	3	S
42 + 00	5" x 5'	40	N,R,S
50 + 00	5" x 11'	0	
51 + 00	5" x 5'	0	
53 + 00	5" x 5'	10	F,S
65 + 50	5" x 14'	0	

Table 6.

Street Inlet Survey Data: Alabama Ave. S.E. Jun 22, 1990

Street Segment Surveyed: From 25th St. To Pennsylvania Avenue

Sreet Geometry: 4 lanes
Side of Street: Left side from 25th St. To Pennsylvania Avenue Survey done by: Dr. F.M. Chang & J. Elui

The following letter symbols denote debris types:

S - for soils, pebbles, stones, and pieces of rocks

F - for flexible materials: paper, plastic products

R - for rigid materials: solid containers, metal cans, glass bottles

N - for weeds, grass

All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Location	H x L	% clog	Debris
0 + 00	5" x 5'	50	N,S
10 + 00	5" x 5'	30	N,S
17 + 50	5" x 5'	30	N,R,S
38 + 00	5" x 5'	0	
46 + 50	5" x 11'	0	
49 + 50	5" x 5'	2	N
62 + 00	5" x 14'	10	N,F

TABLE 7
STATISTICS OF CLOGGED INLETS ALONG GEORGIS AVENUE

Sample Inlet Survey Data: Georgia Ave. N.W.

	0 – 5	5 - 25	25 - 50	50 - 75	75 - 100
Number Plugged	15	13	6	5	3
Number Plugged %	36	31	14	12	7

Total Number of inlets in the sample = 42

TABLE 8 STATISTICS OF CLOGGED INLETS ALONG RHODE ISLAND AVENUE

Sample Inlet Survey Data: Rhode Island Ave. N.E.

Percent Interval	0 - 5	5 - 25	25 - 50	50 - 75	75 - 100
Number Plugged	13	9	10	2	11
Number Plugged as %	29	20	22.2	4.4	24.4

Total Number of inlets in the sample = 45

TABLE 9 STATISTICS OF CLOGGED INLETS ALONG ALABAMA AVENUE

Sample Inlet Survey Data: Alabama Ave. S.E.

Percent Interval	0 – 5	5 – 25	25 - 50	50 - 75	75 - 100
Number Plugged	9	4	3	2	2
Number Plugged	%	45	20	15	10

Total Number of inlets in the sample = 20

FIGURE 5

Bar Graph of Number of Inlets Plugged

Geogla Ave. N.W. Jun 18,1900

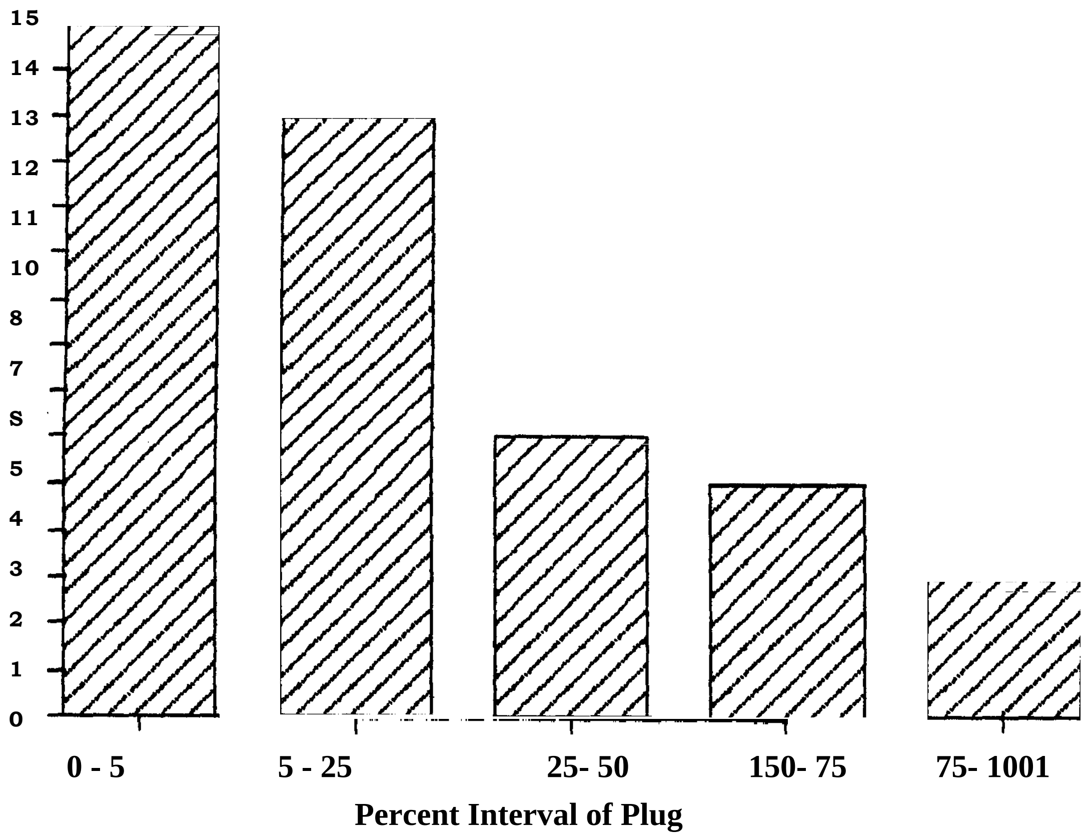

FIGURE 6

Bar Graph of Number of Inlets Plugged

Rhadt Wand Ave.N.E. Jun 20/21,1990

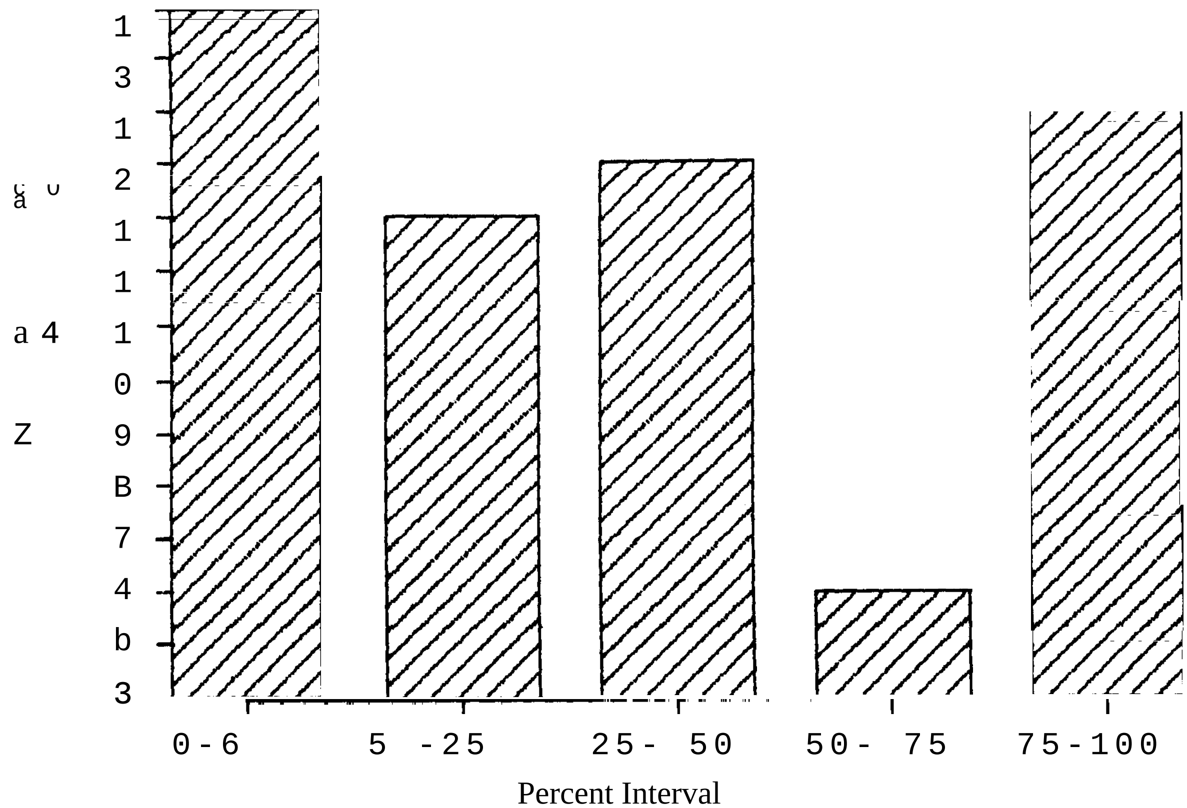

FIGURE 7

Bar Graph of Number of Inlets Plugged

Alabama Ave, 2.E. Jun 12, 1!W

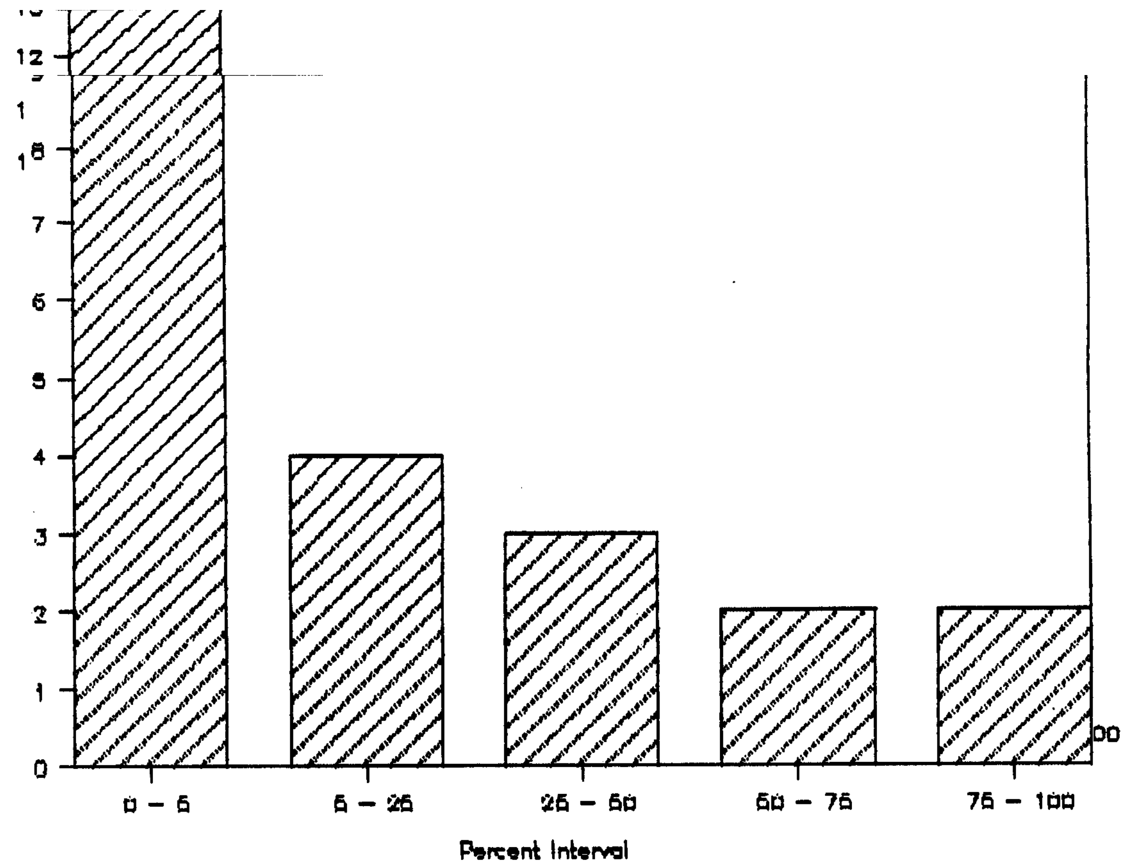

FIGURE 8

Pie Chart of Inlet Data:

Georgia Ave. NW
Jun 18,1990

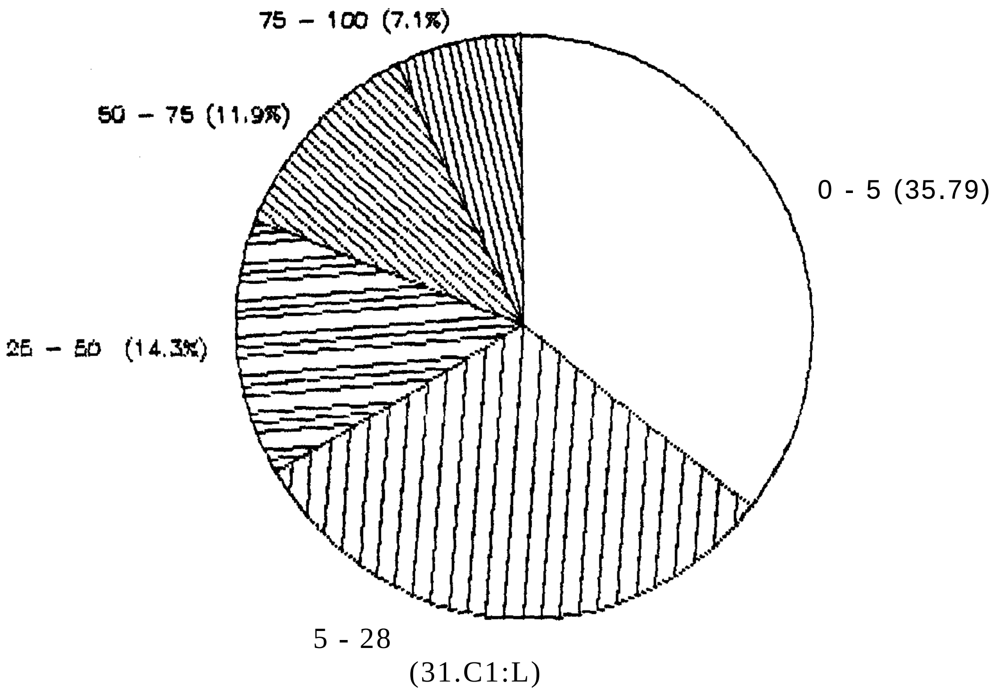

FIGURE 9

Pie (Circular) Graph of Inlet Data:

Rhode Island Ave N.E. June 20/21,1990

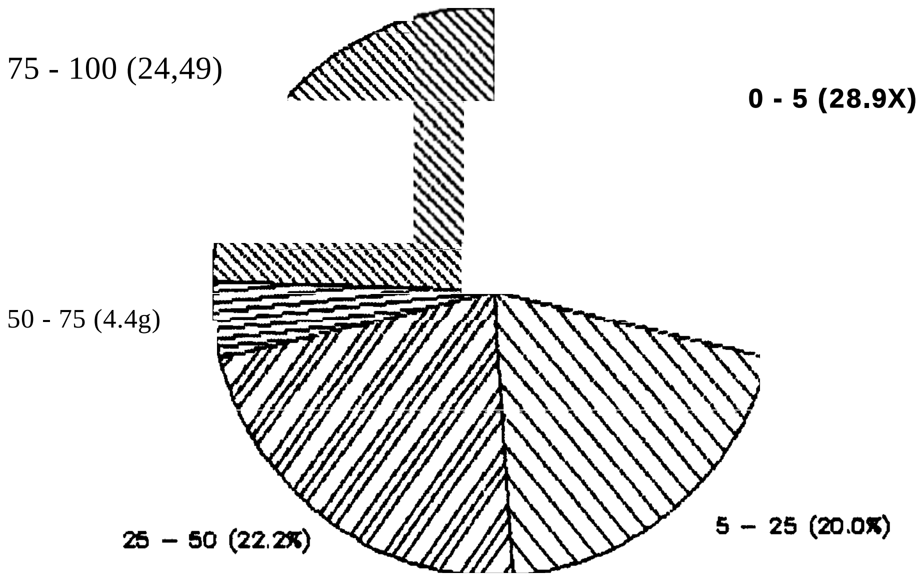

FIGURE 10

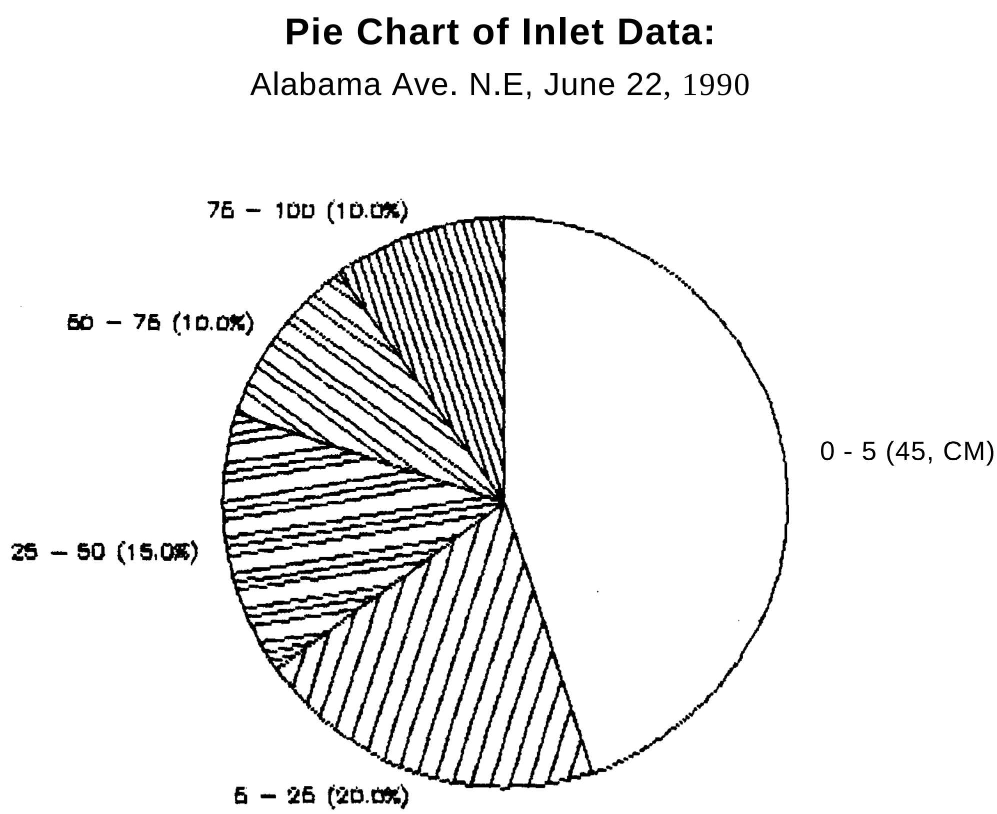
Pie Chart of Inlet Data:
Alabama Ave. N.E, June 22, 1990
75 - 100 (10.0%)
50 - 75 (10.0%)
0 - 5 (45, CM)
25 - 50 (15.0%)
5 - 25 (20.0%)

Table 1.

Street Inlet Survey Data: Georgia Ave. N.W. Jun 18, 1990

Street Segment Surveyed! From Barry Place To Upshur Street

Street Geometry: 6 lanes

Side of Street Surveyed: Right side from Barry Place to Upshur Survey done by: Dr. F.M. Chang & J. Elui
The following letter symbols denote debris types:

S - for soils, pebbles, stones, and pieces of rocks F - for flexible materials: paper, plastic products R - for rigid materials: solid containers, metal cans, glass bottles N - for weeds, grass
All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Location	H x L	% clog	Debris
0 + 00	5" x 11'	5	F
2 + 00	5" x 11'	20	N,R,S
9 + 00	5" x 11'	50	S
12 + 30	5" x 5'	5	F
20 + 80	5" x 5'	0	
23 + 80	5" x 5'	0	
28 + 80	5" x 5'	50	F,S
33 + 80	5" x 5'	45	F,S
36 + 80	5" x 5'	30	F,S
40 + 80	5" x 5'	2	F
43 + 30	5" x 5'	90	F
44 + 30	5" x 5'	3	S
46 + 30	5" x 5'	0	
48 + 30	5" x 5'	10	F
51+30	5" x 5'	40	F,R
55 + 30	5" x 5'	5	F,S
58 + 80	5" x 5'	5	S
62 + 80	5" x 5'	75	F,S
66 + 30	5" x 14'	60	N,S
69 + 30	5" x 14'	40	R,S
69 + 50	5" x 14'	30	F,S
70 + 50	5" x 5'	8	S

Table 1.

Street Inlet Survey Data: Georgia Ave. N.W. Jun 18, 1990

Street Segment Surveyed: From Barry Place To Upshur Street

Street Geometry: 6 lanes

Side of Street Surveyed: Right side from Barry Place to Upshur Survey done by: Dr. F.M. Chang & J. Elui

The following letter symbols denote debris types:

S - for soils, pebbles, stones, and pieces of rocks F - for flexible materials: paper, plastic products R - for rigid materials: solid containers, metal cans, glass bottles N - for weeds, grass

All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Location	H x L	% clog	Debris
0 + 00	5" x 11'	5	F
2 + 00	5" x 11'	20	N,R,S
9 + 00	5" x 11'	50	S
12 + 30	5" x 5'	5	F
20 + 80	5" x 5'	0	
23 + 80	5" x 5'	0	
28 + 80	5" x 5'	50	F,S
33 + 80	5" x 5'	45	F; S
36 + 80	5" x 5'	30	F,S
40 + 80	5" x 5'	2	F
43 + 30	5" x 5'	90	F
44 + 30	5" x 5'	3	S
46 + 30	5" x 5'	0	
48 + 30	5" x 5'	10	F
51 + 30	5" x 5'	40	F,R
55 + 30	5" x 5[1]	'5	F, S
58 + 80	5" x 5'	5	
62 + 80	5" x 5'	75	F,5
66 + 30	5" x 14'	60	N,S
69 + 30	5" x 14'	40	R,S
69 + 50	5" x 14'	30	F,S
70 + 50	5" x 5'	8	S

Table 2.

Street Inlet Survey Data: Georgia Ave. N.W. Jun 18, 1990 Street Segment Surveyed: From Barry Place To Upshur Street

Street Geometry: 6 lanes

Side of Street Surveyed: Left side from Barry Place To Upshur Street Survey done by: Dr. F.M. Chang & J. Elui

The following letter symbols denote debris types:

S - for soils, pebbles, stones, and pieces of rocks F - for flexible materials: paper, plastic products R - for rigid materials: solid containers, metal cans, glass bottles N - for weeds, grass

All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Location	H x L	a clog	Debris
0 + 00	5" x 10'	10	F,S
4 + 30	5" x 14'	55	F,N,R
11 + 30	5" x 14'	10	F,S
12 + 30	5" x 5'	0	
22 + 30	5" x 5'	0	
26 + 30	5" x 5'	0	
29 + 80	5" x 5'	8	F
36 + 80	5" x 5'	20	F,S
40 + 30	5" x 5'	85	F,S
43 + 30	5" x 5'	0	
46 + 30	5" x 5'	0	
50 + 80	5" x 5'	0	
51 + 30	5" x 5'	0	
53 + 30	5" x 5'	0	
57 + 30	5" x 5'	0	
62 + 30	5" x 5'	10	F
69 + 30	5" x 11'	45	F,R
73 + 30	5" x 5'	15	S
74 + 30	5" x 14'	65	R,S
74 + 60	5" x 5'	0	

Table 3.

Street Inlet Survey Data: Rhode Island Ave. N.E. Jun 20/21 1990

Street Segment Surveyed: From 10th St. To South Dakota Avenue

Street Geometry: 6 lanes

Side of Street: Right side from'10th St. To South Dakota Avenue Survey done by: Dr. F.M. Chang & J. Elui
The following letter symbols denote debris types:

S - for soils, pebbles, stones, and pieces of rocks F - for flexible materials: paper, plastic products R - for rigid materials: solid containers, metal cans, glass bottles N - for weeds, grass
All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Location	H x L	% clog	Debris
0 + 00	5" x 11'	100	N,S
2 + 00	5" x 10	45	N,R,S
7+00	5" x 11	0	
9 + 50	5" x 11'	30	S
13 + 00	5" x 11'	30	S
19 + 00	5" x 11'	100	N,S
23 + 00	5" x 5'	90	N,S
24 + 00	5" x 11'	100	S
26 + 50	5" x 5'	100	N,S
28 + 50	5" x 11'	6	F
30 + 50	5" x 5'	90	N,S
32 + 50	5" x 5'	20	F,S
36 + 00	5" x 5'	100	S
40 + 00	5" x 11'	25	- N,S
43 + 00	5" x 5'	0	
45 + 00	5" x 5'	2	N,S
46 + 00	5" x 5'	0	
46 + 30	5" x 5'	0	
51 + 80	5" x 5'	15	S
52 + 80	5" x 11'	100	R,S
55 + 80	5" x 5'	0	
58 + 30	5" x 11'	80	R,S
60 + 30	5" x 11'	45	N,R,S
62 + 30	5" x 11'	0	
66 + 30	5" x 5'	0	

Table 4.

Street Inlet Survey Data: Rhode Island Ave. N.E. Jun 20/21 1990

Street Segment Surveyed: From 10th St. To South Dakota Avenue

Street Geometry: 6 lanes

Side of Steet: Left side from 10th St. To South Dakota Avenue Survey done by: Dr. F.M. Chang & J. Elui
The following letter symbols denote debris types:

S - for soils, pebbles, stones, and pieces of rocks F - for flexible materials: paper, plastic products R - for rigid materials: solid *containers,* metal cans, glass bottles N - for weeds, grass
All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Location		H	x	L	% clog	Debris
0	+ 00	5"	x	11'	80	F,N,S
3	+ 00	5"	x	11'	30	F
7	+ 00	5"	x	11	8	F,N
9	+ 00	5"	x	11'	50	F,R,S
13	+ 00	5"	x	11'	85	R,S
19	+ 00	5"	x	11'	30	N,R,S
21	+ 00	5"	x	5'	0	N,S
23	+ 00	5"	x	11'	40	N,R,S
25	+ 00		x	11	15	S
26	+ 60	5"	x	5'	10	S
29	+ 60	5"	x	11'	10	S
31	+-00	5"	x	11'	3	N,S
33	+ 00	5"	x	11'	5	N,S
35	+ 00	5"	x	11'	0	
38	+ 00	5"	x	5'	0	
49	+ 50	5"	x	11'	0	
52	+ 70	5"	x	11	40	
57	+00	5"	x	11'	35	N,S
61	+ 50	5"	x	11'	50	F,N,S
64	+ 50	5"	x	5'	10	N,S

Table 5.

Street Inlet Survey Data: Alabama Ave. *S.E. Jun* 22, 1990

Street Segment Surveyed: From 25th St. To Pennsylvania Avenue

Sreet Geometry: 4 lanes

Side of Street: Right side from 25th St. To Pennsylvania Avenue Survey done by: Dr. F.M. Chang & *J. Elui*

The following letter symbols denote debris types:

S - for soils, pebbles, stones, and pieces of rocks F - for flexible materials: paper, plastic products
R"- for rigid materials: solid containers, metal cans, glass bottles N - for weeds, grass
All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Location	H x L	% clog	Debris
0 + 00	5" x 5'	5	N
3 + 50	5" x 14'	100	N,S
7 + 00	5" x 14'	8	N,R
8 + 00	5" x 14'	90	F,R,S
13 +30	5" x 14'	70	S
36 + 50	5" x 5'	0	
37 + 50	5" x 5'	2	N
41 + 00	5" x 5'	3	S
42 + 00	5" x 5'	40	N,R,S
50 + 00	5" x 11'	0	
51 + 00	5" x 5'	0	
53 + 00	5" x 5'	10	F,S
65 + 50	5" x 14'	0	

Table 6.

Street Inlet Survey Data: Alabama Ave. S.E. Jun 22, 1990

Street Segment Surveyed: From 25th St. To Pennsylvania Avenue

Sreet Geometry: 4 lanes

Side of Street: Left side from 25th St. To Pennsylvania Avenue Survey done by: Dr. F.M. Chang & J. Elui
The following letter symbols denote debris types:

S - for soils, pebbles,-stones, and pieces of rocks F - for flexible materials: paper, plastic products R - for rigid materials: solid containers, metal cans, glass bottles N - for weeds, grass
All inlets are curb inlets, and Height by Lenght is denoted H x L

Survey Data Table

Location	H x L	% clog	Debris
0 + 00	5" x 5'	50	N,S
10 + 00	5" x 5'	30	N,S
17 + 50	5" x 5'	30	N,R,S
38 + 00	5" x 5'	0	
46 + 50	5" x 11'	0	
49 + 50	5" x 5'	2	N
62 + 00	5" x 14'	10	N,F

AN ENVIRONMENTAL STUDY OF MELVIN HAZEN PARK

by

Kathleen Robinson

Philosophy Department
College of Liberal Arts
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Washington, D.C. 20008

ABSTRACT

The objective of this study was to determine the health of Melvin Hazen Park, a tributary of Rock Creek Park located in N. W., *Washington*, D. C., in regards to the water, soil, vegetation, and animal life present there. The water and soil were tested for acidity by the use of pH paper. The soil was further tested for mineral *content* and the presence of organic matter. A transect analysis was employed to study the vegetation, and visual observations were made to determine the presence and activity of animal life as well as to note the *condition* of the park's creek. The results of the study show the area to be an area in decline, an area in need of *conservation*. Because the deterioration of the quality of life is so pervasive within the park's boundaries, *intervention* is necessary if the area is to once again realize a level of health and productivity.

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1 Kathleen Robinson is a junior majoring in philosophy. This research project was conducted as part of the Honors Lecture Series sponsored by the Honors Program of the University of the District of Columbia on April 8, 1991. This project was conducted under the direction of Dr. Victoria C. Guerrero.

AN ENVIRONMENTAL STUDY OF MELVIN HAZEN PARK, WASHINGTON, D.C.

By

Kathleen Robinson

In 1890 the area now known as Rock Creek Park was marked by developers to become a real estate subdivision. Trees were cut, and plans were already underway for its development when Congress acted to purchase the region in order to preserve it as a "pleasuring ground for the benefit and enjoyment of the people of the United States" (Thomas 36). Despite its location directly within the nation's capital, the creek appeared remote from civilization and provided a tranquil haven for its many visitors, visitors such as the British Ambassador Viscount Bryce who wrote:

> What city in the world is there where a man can, within a quarter of an hour and on his own feet, get in a beautiful rocky glen such as you would find in the woods of Main or Scotland? (Thomas 37)

Almost 100 years have passed since Bryce wrote these words, however, and, with this passage of time, the city and the world have become vastly different places, places plagued by such environmental problems as overpopulation, urbanization, acidic fall-out, and global warming. Because of these other problems, the value of Rock Creek and other national parks has increased tenfold not only because they provide a connection with nature that is becoming increasingly difficult to find, but also because they provide the life-support system that we, as inhabitants of this planet so desperately need. Yet, what is the health of the parks in our country today? And what does the future hold for these protected lands? As an aid in discovering the answers to these park's current health, I also made observations of the vegetation present there. To aid me in my assessment of the vegetation, I employed a transect analysis provided by Dr. Guerrero. This analysis was helpful for two reasons: 1) it supplied a necessary qualitative description of the

questions, I have made a preliminary assessment of Melvin Hazen Park, a tributary of *Washington*, D.C.'s Rock Creek Park, located less than two blocks from where we stand today. To perform this assessment, I studied the park's stream and vegetation, using my own visual observations as well as data supplied to me by my instructor Dr. Guerrero, and information obtained from Cindy Donaldson of the National Park Service.

To determine the current health of Melvin Hazen Park, I first examined the creek that flows west to east within the park's interior, noting both the quality of the water and the effects of aging on the stream. There were two indicators of poor water quality: the occurance of blue-green algae, an algae that thrives in the presence of certain pollutants , and the lack of animal life in or around the creek area. Of these indicators of poor water quality, the lack of animal life was most startling. I tested the pH of the water, it was 6.2, and determined that the lack of animal life was not due to the acidic fall-out. Cindy Donaldson of the National Park Service ultimately informed me that there had been an oil spill from an apartment building a few years ago that had killed or driven animals away. The stream had yet to recover.

In considering the effects of aging on the tributary, I was faced with a creek whose banks were eroding and whose bed had fallen victim to the processes of both sedimentation and siltation. Further observations also showed that the eastern end of the stream had become so deteriorated that it was now in the process of drying up and *changing* into a meadow.

Beside observing the creek area in search of evidence of the of the woodland; and 2) it showed in which levels of stratifications in the woodland were referred to, from the highest to the lowest, as the overstory, the middle canopy, the understory, and the ground cover. One must also be aware that the term "dominant" refers to those species that grow to reach the uppermost level or the overstory (Oosting 22). According to the data derived from the *transection,* the dominant species in Melvin Hazen Park were Fagus, Tulip, Frauinus, Quercus, Juglans, and Betula. Of these dominant species, however, only the Fraxinus was found in any of the lower strata. This finding was significant because it showed an inevitable shift in the dominant species as there were few to no seedlings or younger trees in the lower strata to replace the individuals of the species in the overstory.

Another important finding of the transect analysis was its clear indication of the preponderance of English ivy in all but the uppermost stratum of the woodland. The data showed that this parasitic invader accounted for 46%of all of the individuals located within the transected area. My observations of the park only supported the *conclusion* drawn by the transect analysis as it was not difficult to note the ivy overtaking the park. This ivy was observed to be the principle groundcover and was further seen climbing up trees through the different levels of stratification toward the overstory, allthewhile choking these trees and ultimately depriving them of life.

The park's soil was tested as well, in order to determine the percentage of organic materials present there. Samples were taken from three sites: along the creek's edge, by the park's northern entrance, and within the woodlands. Test results indicate that the amount of organic matter present ranged from 4.11%-8.88%. It appears from these figures that the organic matter is low, and that the environment is-stressed as figures to be expected in an area such as this are in ranges upward of 50%. Further testing is currently underway to verify these initial findings.

Although only a fraction of the components that make up the ecosystem in Melvin Hazen Park have been discussed here, it is clear that this is an unproductive environment and, therefore, an environment in decline. This decline is evidenced by the water pollution, the invasion of the ivy, the lack of seedlings to replace the dominate species, and the absence of animal life. Although it is outside the scope of this paper to determine precisely what type of intervention is required to revive the park, it is certain that intervention is necessary if the park is to recover.

-WOODLAND HABITAT ANALYSIS

(FROM GUERRERO, 1991) METHOD: TRANSECT ANALYSIS - along the Creek

VERTICAL STRATIFICATION ALONG THE CREEK

OVERSTORY	SPECIES	TOTAL SPECIES	% COMPOSITION	0.4%
•Fag= o.	1	3	0.18	
• Tulio sir.	1	1	0.058	
.graxinua sp.	2	8	0.358	
•Quercus sue.	2	4	0.28	
• gagu8-s p.	2	3	0.1%	
•Juglans all	1	1	0.04%	
•Betula so.	1	1	0.04%	
MIDDLE CANOPY				0.4%
-Maxims so.	2	8	0.358	
• COrflUA SR..	1	2	0.18	
-Box elder	1	5	0.338	
-spice bush	10	50	2.18	
English Ivy	>20	>1000	50.08	
Rosa' sR.	4	> 45	2.08	
.Pr3Vms 82.	2	< 10	0.58	
vitis sn.	4	2: 80	3.58	
Poison Ivy	>10	> 10	0.58	
UNDERSTORY				51.0%
%-Viburnum sn.	3	8	0.4%	
Poison Ivy	>10	> 10	0.5%	
Honeysuckle	>25	> 500	27.0%	
Grape Vine	>25	> 100	3.5%	
English Ivy	>25	>1000	45.0%	
Sedges	2	10	0.5%	
Bamboo	>25	10	0.58	
Dead Trees	4	4	0.28	
-Ash (stunted) 25>		> 25	1.08	

DESCRIPTION

Eroded, sedimented and silted creek

Dry, greater portion transformed into a meadow

Invasion of the creek by bamboo, grape, honeysuckle, and ivy species

Parasitism of native species River birch in decline Woodland along the street invaded by chinese sumac

GROUND COVER 50.0%

Wild onion >20 Malva >100 10.0%

Poison Ivy Weeds

English Ivy

saplings

TOTAL SPECIES -	21
TOTAL INDIVIDUALS -	2170
.TOTAL NATIVE -	6
TOTAL INTRODUCED	8
TOTAL WEEDS -	9
TOTAL TRANSECT -	57
LENGTH OF TRANSECT	1 meter

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A PRELIMINARY STUDY FOR IDENTIFICATION OF SEDIMENT TOXICS IN THE TIDAL FRESHWATER ANACOSTIA RIVER

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University of the District of Columbia

ABSTRACT

Previous studies by the University of the District of Columbia found tidal Anacostia sediments were low in benthic life and identified Anacostia sediments as toxic to larvae of the Corbicula clam. The relative toxicity of sediments was mapped using a Corbicula larva bioassay developed at UDC, and the most toxic sediments were found in the lower third of the freshwater tidal Anacostia. Analyses of solid sediments for EPA Priority Pollutants were unable to specifically identify the source of toxicity. Recent studies have indicated that metal ions and ammonia can also be significant toxicants in fresh water sediments. In summer 1991, sediment from the lower Anacostia Navy Yard site which sometimes shows toxicity, was compared using the Corbicula larva bioassay with control sediment from the Potomac at Fort Foote. Sediments were tested for metal ion toxicity by addition of .001 M EDTA to complex metal ions. Sediment ammonia toxicity was determined by raising pH to 9, which releases unionized (toxic) ammonia. Results indicated the control and Navy Yard sediments did not have significant metal ion toxicity but Navy Yard sediment contained highly toxic amounts of ammonia. Since ammonia is generated in sediments through the decomposition of organic matter the primary cause of sediment toxicity in the Anacostia may be organic input combined with the long residence time of water in the lower basin.

METHODS

Sediment was collected on 12 June 1991 from the Navy Yard pier on the lower Anacostia using a hand-operated 6-inch Ekman dredge. This site had been found to have highly toxic sediment in previous surveys (Phelps, 1987, 1990). Control sediment was collected from the Fort Foote site on the Potomac on 10 June because, unlike the Anacostia, this site had live clam populations. All sediment bioassays were started on 13 June.

Larvae for sediment bioassays were obtained from adult Corbicula clams collected from Fort Foote below the Woodrow Wilson Bridge on the Potomac River. They were close to

shore and readily collected by wading and filtering the sediment with a wire mesh basket. Collected clams were transported on ice in an insulated container to the laboratory where they were placed in individual containers with distilled water at room temperature and examined over several days. Eggs were released from clams in late May but mature shelled larvae were not found until early June. The active, transparent mature shelled larvae could be separated from opaque, inactive immature larvae and transferred using fine pipettes and a dissecting microscope: Larvae were used for sediment bioassays within three days and did not require feeding.

For bioassays the sediment was screened through 75 micron Nytex screen as the great majority of toxics have been found associated with the size fraction less than 64 microns. The Navy Yard sediment was almost entirely mud-type: the Fort Foote sediment was primarily sandy. One ml of screened sediment was placed in a 2.5 ml well of a 24-well Falcon tissue culture plate. The sediment was overlaid with distilled water containing 1:100 tissue culture antibiotic mixture (Penicillin/Streptomycin/Neomycin, Sigma Chemical). Twenty or thirty Corbicula larvae were placed on the sediment in the well. Three wells were set up for each sediment sample and the plate held at room temperature. At 96 hours the sediment was removed and filtered with a 75 micron Nytex sieve that was backwashed to collect larvae.

Clam larvae were counted and scored as live or recently dead (nonmotile with gaping shell). The shells of larvae that had died early in the 96-hour bioassay are not recovered so recovery of living Corbicula larvae from the original number placed in the well was used to calculate mortality.

For some tests the sediment was manipulated before bioassay. To complex toxic free metal ions.001 M EDTA solution was added to sediment. To change sediment ammonia from the ionized (nontoxic) to the unionized (toxic) form, sediment pH was raised to 9 (Ankley, ea. 1990). Relative sediment ammonia was determined in the supernatent of a 1:10 sediment:water slurry using a standard aquarium test kit (Dry-Tab Ammonia Test, Aquarium Pharmaceuticals Inc.). Other sediment chemical analyses were not possible at this time due to limited funding.

RESULTS

Ammonia was found in Navy Yard sediment extract but not in control sediment extract (Table 1). Increasing Navy Yard sediment pH resulted in high toxicity to Corbicula larvae, but increasing pH did not increase mortality in control (Fort Foote) sediment. The slightly increased Navy Yard sediment toxicity with addition of .001M EDTA was not statistically significant (Fig. 1).

Table 1; Toxicity of Navy Yard Sediment

LOCATION/ TREATMENT	pH	NH3 (PPM)	%MORTALITY (avg.) (ind.)
Control (Fort Foote)	7.0'	0	13 (10,10,20)
pH 9	9.0		12 (0,15,20)
EDTA			7 (0,10,10)
Navy Yard	7.1	1	9 (3,10,13)
pH 9	9.0		98 (97,97,100)
EDTA			19 (10,23,23)

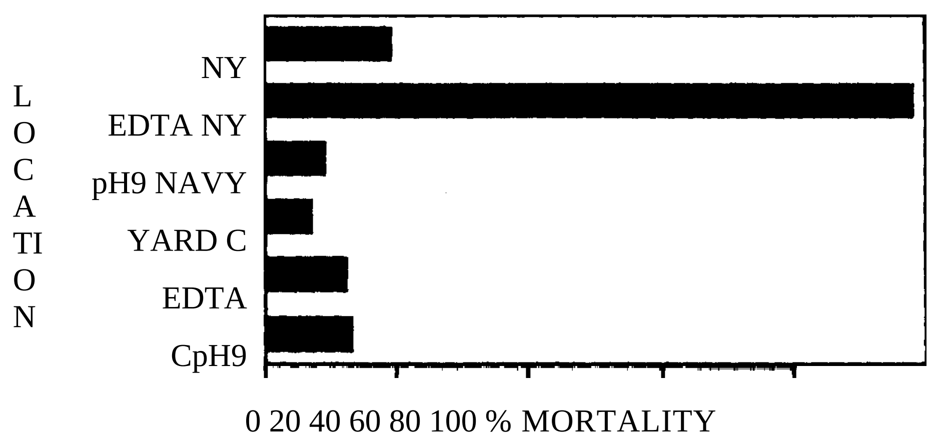

Figure 1. Average mortality of Corbicula larvae on treated and untreated Fort Foote Control (C) and Navy Yard (NY) sediment

CONCLUSIONS

The low toxicity of Navy Yard sediment was not expected, although a loss of toxicity had previously been found following a storm event (Phelps, 1990a). The highly significant increase in Navy Yard sediment toxicity with a pH increase to 9 was likely due to formation of unionized ammonia (Ankley, ea. 1990), as similar increase in toxicity was not found for the control sediment which had no relative ammonia concentration. The major source of sediment ammonia is decomposition

possible sources of organic material in the lower Anacostia including storm sewer outlets and the long residence time of water in the lower Anacostia basin would contribute to ammonia formation. A long period without rain preceeded a finding of sediment toxicity at the Navy Yard site (Phelps, 1990).

Addition of EDTA to complex toxic free metal ions did not correlate with signficant decrease in toxicity. This'indicated that metals, which are more toxic than organics in aquatic systems, probably are not a source of sediment toxicity at the Navy Yard site.

This study shows an apparent correlation between release of sediment-sorbed ammonia and sediment toxicity to Corbicula larvae. This is the first time a chemical has been identified in Anacostia sediments as a specific cause of bioassay mortality . The fluctuations in sediment toxicity reported for the Navy Yard site in the lower Anacostia basin could be related to changes in ammonia buildup due to decomposition of organic matter, pH changes and freshwater influx. These results are summarized in another publication (Phelps, in press).

ACKNOWLEDGEMENTS

Grateful acknowledgement is made to the Water Resources Research Center of the District of Columbia for funding of this project.

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Dry Weather Screening of Storm Water Outfalls in the

District of Columbia

By Dr. Clarence Wade

EXECUTIVE SUMMARY

One hundred and forty-eight designated storm water outfalls of thirty-six-inch diameter or greater, were examined during this study. These outfalls were located in the following areas of the city: Valley (Oxon Run), Southern, and Eastern Avenues; Watts Branch; Anacostia and Potomac Rivers; Washington Channel; Fort Chaplin Park; National Arboretum; and Rock Creek. The location of the outfalls are indicated in Fig 1.

The sampling and measurement of the water in the outfalls was done in accordance with the EPA recommended methods. Samples were taken from flowing water in accessible storm water outfalls (Fig 2) or in contiguous manholes (Fig 3), where outfalls were submerged. Samples were collected 72 hours after 0.1 inches or greater rainfall. Two grab samples were taken at each site, each within 24 hours of the other, but at least four hours apart. Quantitative analyzes were made for flow rate, pH, copper, fluoride, surfactants (detergents), phenols, and free chlorine. In addition, qualitative observations were made on each grab sample for color, odor, clarity, and floatables. Details of vegetation growth and outfall conditions, such as structural defects, stains, and deposits, were also collected at each outfall and the watershed surrounding the outfalls was described.

At the time of the visits, the 148 sites were found to be as follows:

67 sites (45%)	were dry (30 outfalls and 37 manholes)
46 sites (31%)	had a measurable flow rate (39 outfalls and 7 manholes)
1 outfall (< 1%)	was non-existent because of its deterioration
7 Manholes(5%)	had standing water (outfalls were submerged by tidal waters)
2 outfalls (1$)	were actually combined sewers
24 outfalls(16%)	were inaccessible because of construction or location on major traffic routes.
1 outfall (<1t)	was less than 36"

Concentrations of the analytes:

ANALYTES	RANGE. PPM
Fluoride	0.0 to 1.2
Chlorine	0.0 to 0.90
Copper	0.0 to 0.15
Surfactants	0.10 to 1.7
Phenols	< 0.10 to 0.50
pH	6.4 to 8.4
Flow Rates	0.00 cf/s to 1.35 cf/s

The attached (Table 1) gives a description of the screening sites. All dry sites (Fig. 5) and sites with non-measurable flows are classified as dry outfalls.

This project was headed by Dr. Clarence Wade (UDC Chemistry Department) assisted by Dr. James Preer (UDC Environmental Science Department) and Dr. Fred M. Chang (UDC Civil Engineering Dept.) About 10 students from the University of the District of Columbia, Catholic University of America, Howard University and George Washington University were recruited by the Center. They were: Devasia Karimpanal (HU), Cecile Grant (HU), Alborz Wozniak (GW), Allyson Ugarte (GW), Kayode Adenaiya (UDC),and Etim Etim (UDC. The responsible officers from the Department of Public Works were Mr. Ken Laden and Mr. Emmett Durrum.

Table 1

WATER RESOURCES RESEARCH CENTER: DRY WEATHER FIELD SCREENING

OF STORM WATER OUTFALLS DEPICTION OF STORM WATER SCREENING SITES COMPLETED

	1	cs 2	3*	4	5	6	7*	8	9*	10
			13	14	15	16	17	18	19	20
	[illegible]	22	23	24	25	26	<36" 27	28	[illegible]	[illegible]
	31	32	33	34	[illegible]		37			[illegible]
	[illegible]	[illegible]		44			47	48	49	50
	51	[illegible]	[illegible]	54	55*	56*	57	[illegible]	[illegible]	[illegible]
	61	62	[illegible]	[illegible]	65	66	67	68	69	[illegible]
	[illegible]	72	[illegible]	[illegible]	75	76	[illegible]	78	[illegible]	80
V	81	[illegible]	[illegible]	[illegible]	85	86	87	[illegible]	[illegible]	90
	91	[illegible]	93	94	[illegible]	96	97	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	104	105	106	107	108	[illegible]	[illegible]
	[illegible]	112	[illegible]	114	[illegible]	116	[illegible]	[illegible]	119	[illegible]
	121	[illegible]	123	[illegible]	125	126	127	128	[illegible]	[illegible]
	131	132	[illegible]			136	137	138	[illegible]	[illegible]
	[illegible]	142	143	144	145	146	147	148	[illegible]	[illegible]
	[illegible]	152	[illegible]	154	[illegible]		157	cs 158	[illegible]	

NOTE: There is no outfall assigned to the missing number of a blank box. A total of 148 outfalls are shown. Outfall #41 is inaccessible due to construction activities. Outfall #144 is collapsed and non-functional. Outfall #158 is a combined sewer/stormwater outfall.

EFFECT OF LIME AND SLUDGE ON VEGETABLE METAL CONTENT

by

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ABSTRACT

Split plots with and without added lime were established in a community garden on an Udorthentic soil known to produce vegetables with elevated Cd and Zn concentrations. Beet (Beta yglZaris, L.), lettuce (Lactuca sativ, L.), radish (Raphanus sativus. L.), and Swiss chard (Beta vulgaris, L., var. cicla) had lower Cd and Zn concentrations in limed than unlimed plots. Cd and Zn concentrations in vegetables raised on this site were higher than those from another community garden located on a reclaimed landfill where digested sewage sludge had been applied, and where soil Cd, Zn, and pH were higher. Cd and Zn in Swiss chard, lettuce, and beet leaves showed significant inverse correlations with soil pH (.64** < r^2 < .96**) in these soils, indicating that soil pH was the dominant factor controlling vegetable Cd and Zn levels under these conditions.. Cd and Zn in vegetables were closely correlated (r^2 = .85**) while other correlations between vegetable Cd, Cu, Pb, and Zn were weak or nonexistent.

INTRODUCTON

Increased amounts of sludge from municipal wastewater treatment plants are being applied to agricultural land, and thus concerns about the effect of sludge-borne Cd and Pb on human and animal health, and phytotoxicity of Cu, Ni, and Zn, have caused metal uptake from soils to receive increased attention (CAST, 1980; Logan and Chaney, 1983; Baker et all.., 1985). Excessive Cd intake has been implicated in proximal renal tubular dysfunction in humans, and is the cause of the "itai-itai" disease (a severe osteomalacia) in Japan (Chaney et all., 1987).

The recommended maximum average daily intake of dietary Cd is 70 gg/day (FAO/WHO, 1972). It has been known for some time that Cd uptake is strongly influenced by soil pH. Soybeans from high-Cd sludge plots showed an inverse relationship between Cd uptake and soil pH in the range pH 5.5 to 7.0 (Chaney et ,al_.., 1975).

While conducting a survey of urban community gardens in Washington, D. C., we found a garden on urban parkland soil which produced leafy vegetables with elevated Cd and Zn (Preer et all., 1980a). The site was not located near heavy traffic or industrial activity, nor was there any acknowledged history of dumping or sludge use on the site. Soil Cd and Zn were low, and soil pH was 5.

A second site produced vegetables with somewhat lower, though still elevated, Cd and Zn concentrations. This site was located o,, er a closed landfill which had been covered with a 6-inch layer of anaerobically digested sewage sludge and revegetated with grass some 14 years earlier. Soil Cd and Zn were several times higher than at the first site, and soil pH was 6.5.

Soil pH is known to be an important factor in controlling plant metal uptake, but the use of lime to control metal uptake in urban garden sites has not been well-studied. We sought to determine whether vegetable metal levels could be substantially reduced by liming these urban garden soils.

RESULTS AND DISCUSSION

Liming of split plots at Fort Dupont significantly reduced Cd and Zn in beet leaves and root, radish leaves and Swiss chard, and Zn in radish root in 1980. Liming had no effect on Pb or Cu content of these vegetables. In 1981, liming significantly reduced Cd and Zn in nearly all vegetables. No significant differences were observed in vegetable Pb content, and no consistent significant differences were observed in vegetable Cu content. In 1982 and 1983, there were no significant differences in vegetable metal content on liming. Limed and unlimed plots showed significant differences in soil pH in 1980 and 1981, but not in 1982 and 1983, because the entire area was limed in those years by the Park Service. As soil pH increased over time, the difference in soil pH between limed and unlimed plots decreased; vegetable Cd and Zn decreased, and the difference between vegetable Cd and Zn between limed and unlimed plots also decreased (Figures 1-2).

Data reported previously indicated Cd and Zn in lettuce and radish were higher at Fort Dupont and Kenilworth than in other gardens sampled in a city-wide survey (Preer et a,1.,1980a). Comparison between Fort Dupont and Kenilworth in 1979 showed similar results: Cd and Zn in beet leaves, Swiss chard, and lettuce were higher at Fort Dupont than Kenilworth, while soil pH, Cd, and Zn were higher at Kenilworth than Fort Dupont (Figures 3-4).

Linear regression of vegetable Cd and Zn on soil pH showed strong inverse correlations for beet leaves (r^2=.77** for Cd; .89** for Zn), Swiss chard (r^2=.64** for Cd; .86** for Zn), and lettuce (r^2=.96

for Cd; .81** for Zn). Vegetable Cu and Pb showed no significant correlation with soil pH.

Vegetable Cd and Zn were found to be highly correlated (r2=.85**), while Cu was weakly correlated with Cd (r^2=.15**) and Zn (r2=.22**). Pb was not correlated with Cd (r^2=.02), Zn (r^2=.01), or Cu (r^2=.05). These results support a common pH-dependent mechanism for Cd and Zn uptake, different from that for Cu and Pb..

ACKNOWLEDGEMENTS

Funding for this research was provided by the Agricultural Experiment Station of the University of the District of Columbia. We thank the National Capital Parks - East, National Park Service for providing space in community gardens for this project. We thank Rufus Chaney for helpful suggestions, and Josiah Akintoye, Gloria Cruz, Denise Renfroe, and Lloyd Smith for expert technical assistance.

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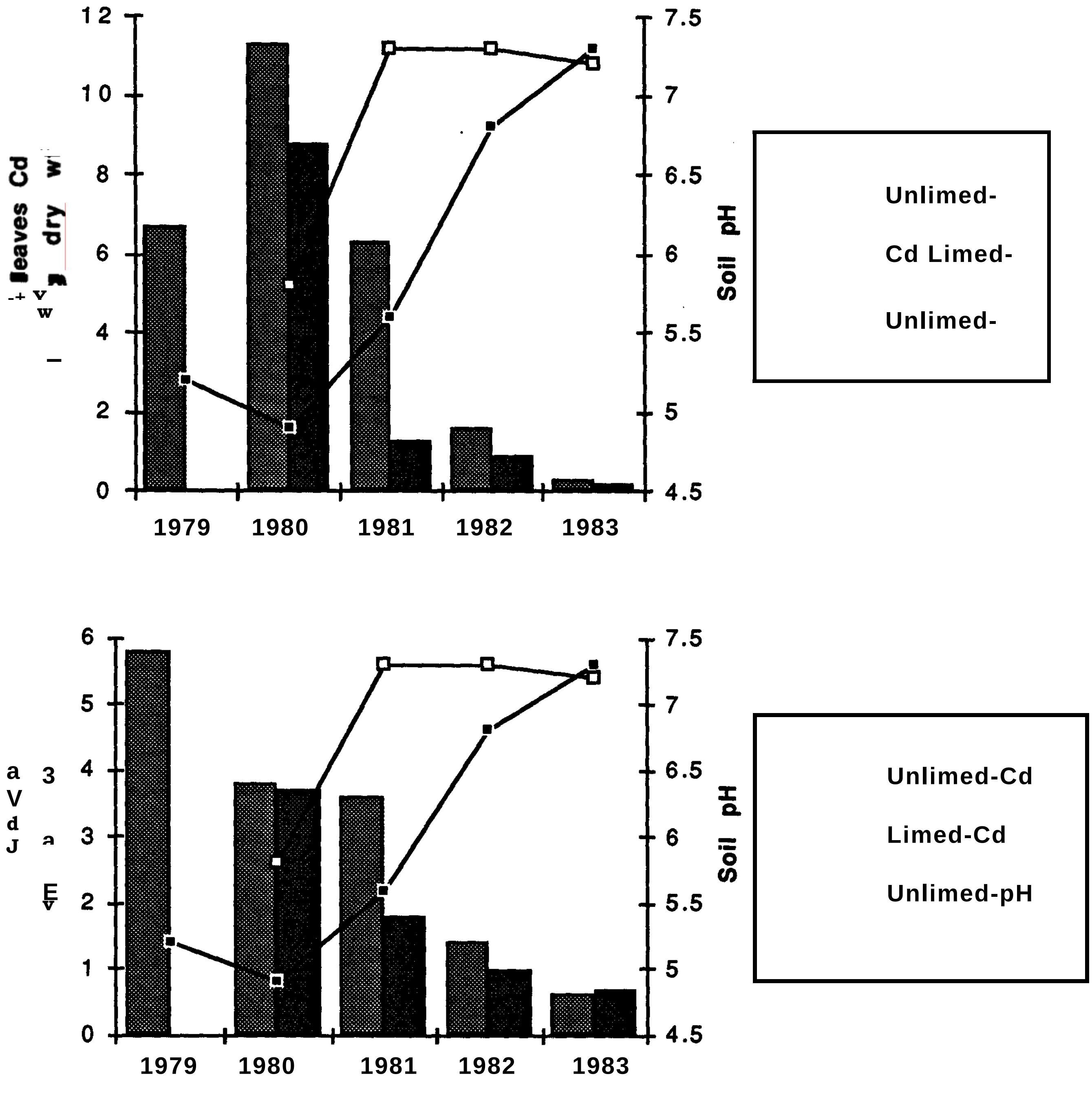


Figure 1. Cd in Leafy Vegetables, Ft. Dupont (1979 - 83)

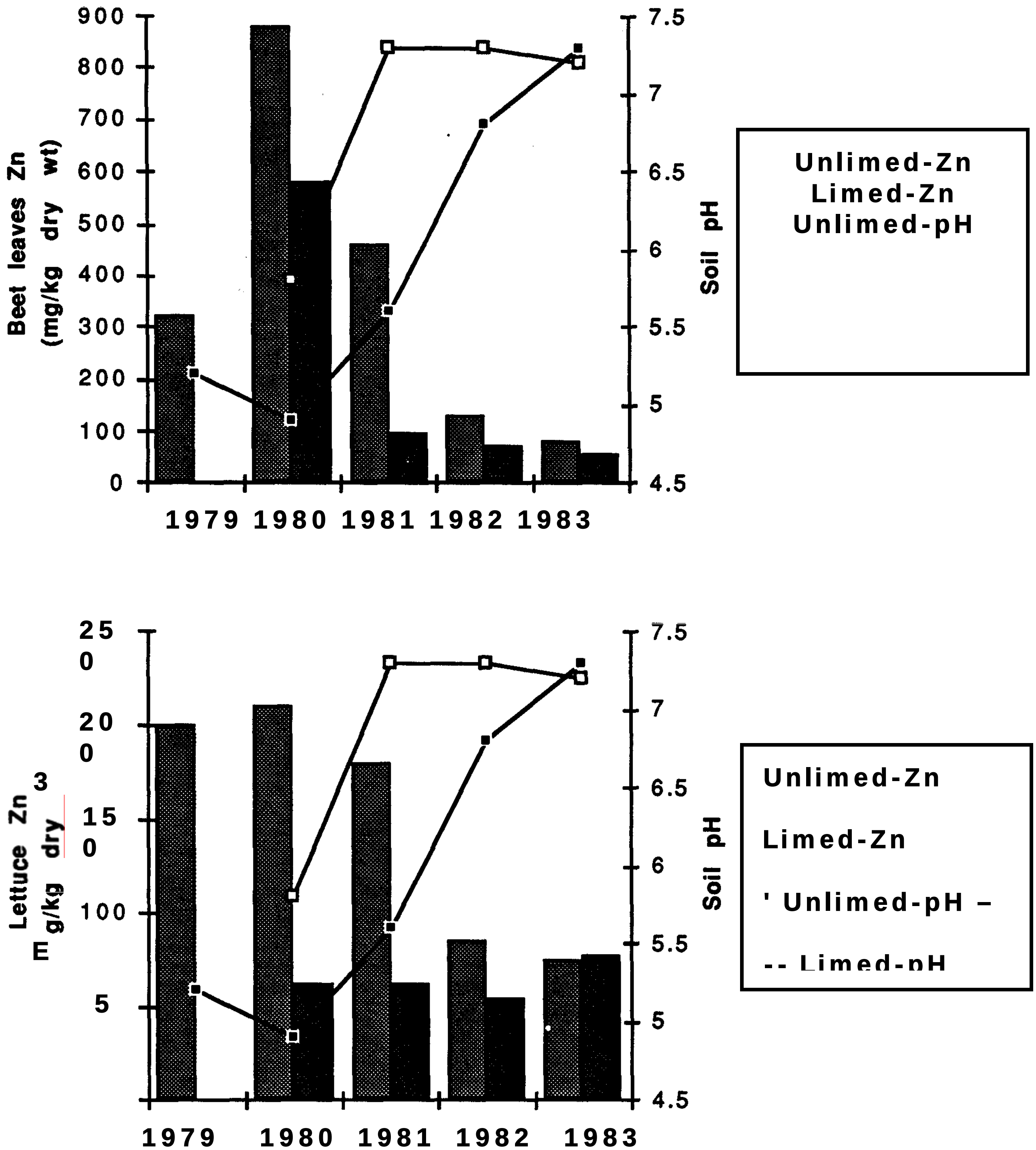


Figure 2. Zn in Leafy Vegetables, Ft. Dupont (1979 - 83)

PART II:

WATER RESOURCES

PROGRAM MANAGEMENT

Citizens Attitudinal Survey on the District of Columbia

By

Y. Choi, Associate Professor and H. Azani, Associate Professor

Department. of Business & Public Management
University of the District of Columbia

ABSTRACT

Society's attitudes about the value and use of water are changing, especially about what constitutes the beneficial use of water resources. The public's perception is increasingly reflected in the processes leading to policy adoption.

The public's perception is a key variable in the practice of representative democratic government, because democracy is based on citizens' wants and support. Increased environmental quality as an issue in American democracy requires citizen input and support.

Respondents' ethnic composition is representative of the District's population distribution (52 percent were female and 48 percent male with the average income of $25,456):

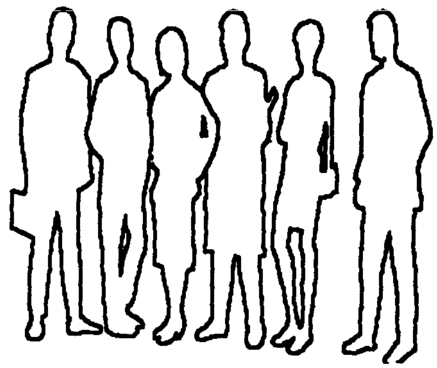
BLACK 73.5%	**CAUCASIAN 11.2%**
HISPANIC 6.5%	**OTHERS 8.8%**

55 percent of those surveyed use city water to water their lawn. 57 percent of respondents reported drinking bottled water once or more, and 31 percent use water filters. Although 42 percent of respondents trust modern technology being used in sewer plants, 82 percent do not think we should drink the water processed in a sewer plant. The majority (56%) prefer a regional waste water treatment plant to D.C.'s own plant, and prefer a regional drinking water supply for their homes. 68 percent of the respondents said they support regional water management. Regarding fairness of the water bill, the respondents were equally divided. Out of the total respondents, 76 percent foresee future problems in water supply, and about 78 percent think the Potomac River is now polluted. 82 percent of people surveyed believe the Potomac River has not been satisfactorily cleaned up in recent years. 77 percent of those surveyed think city administrators are not paying adequate attention to water supply and quality. The same number of respondents also do not think the media adequately covers resource issues and problems. Finally, the majority of D.C. residents surveyed believe that droughts and floods are acts of God. The respondents' level of income is not related to their degree of satisfaction with water quality, water supply, cost of water, administration and management of water resources, coverage of water resource issues and problems in the media, and the quality of service received. The satisfaction with administration and management on water resources is related to the price charged for water in the District (r=0.53). Moreover, a significant relationship exists between satisfaction with coverage of water-related issues and problems in the media and other variables in the study (e.g., handling of water related problems by authorities during accidents (r=0.50), administration and management of water resources (r=0.57), quality of service received in general (r=0.48)).

Overall, people are generally satisfied with D.C. water management. However, if their water and sewer bills increase, their level of satisfaction will decrease. They believe that although the Potomac River's pollution is bad, it is a necessary sacrifice of the environment. The regional media should increase their reporting on the Potomac River and River Basin areas' water and other natural resources to help keep District residents informed on their water resources.

"Citizens Attitudinal Survey on the District of Columbia"

Y. Choi and H. Asani



Society's attitudes about the value and use of water are changing, especially about what constitutes a beneficial use of water resources. Public perception is becoming more solidly embedded in policy designing processes. Warren Viessman reported in his work, "A Framework for Reshaping Water Management" in Environment (May 1990).

Society's attitudes and Public Perception are the important variables in the practice of democratic government, because democracy is based on Citizens' wants and support. The rise of environmental quality as an issue in American democracy requires citizens' environmental wants and support.

The National Environmental Policy Act (NEPA) Section 102 Stipulates:

All agencies of Federal Government shall utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and Social Sciences and the environmental design arts in planning and in decision-making which may have an impact on man's environment.

the *NEPA* is a giant step forward in enabling the citizen to exact responsiveness from his government on environmental issues.

The role and responsibility of the private individual is critical to the effectiveness of democratic self-government. But the place of the citizens in the structure of American government has been somewhat neglected. The presidency, the congress and the court demonstrate American Political theory. Modern democracy has been also endangered by technical and scientific expertise. (Frederick Mosher, Democracy and the Public Service New York; Oxford University Press, 1968)

American citizenship has been acquiring the understanding of science and technology, But the citizenship's knowledge and understanding are limited when they are compared experts. We live in modern age of science and technology. Environmental knowledge and understanding are must for democratic citizenship in this age. However, sine* Lynton K. Caldwill, Lynton R. Hayes and Isabel M. MacWhiter's Citizens and the Environment, (Bloomington, IN: Indiana University Press, 1976) our efforts to link citizens and thc. environment not been impressive.

Passage of the Water Resources Development Act of 1986 Culminated Years of effort by the Carter and Reagan administrations to require greater levels of nonfederal cost sharing for water projects and programs. The act increased the likelihood that states would be more discriminating in pursuing water projects and ensured that water supply and quality control needs.

However, water has been an issue at the national level, not at the state and local level.' Stephen M. Born edited Redefining National Water Policy: New Roles and Directions (Bethesda, MD.: American Water Resources Association, 1989). Leonard B. Dworsky, Ronald M. North, and David J. Allee edited Water Resources Planning and Management in the United States Federal Systems (Henniker, NH: Engineering Foundation Conference, 1988). Charles H.W. Foster and Peter P. Rogers wrote federal Water Policy: Toward an Agenda f,Qr Action (Cambridge, MAs Harvard University Energy and Environmental Policy Center, 1988). Western Governors Conference Prepared White Payer: Federal Water Policy Coordination (Denver, 00: Western Governors Conference, 1989). _

Environmental management studies on state and local governments are still scarce. Alan H. Magazine published Environmental Management in local Governments A Study of Local Response to Federal Mandate (New York: Praeger, 1977). Yearn H. Choi's "Environmental Management in Mississippi Local Government" (Mississippi Municipalities, September/October/November 1981, a three-part series) Presented Mississippi local government officials' environmental perception, institutions/programs and intergovernmental relationships.

Washington, D.C. is a unique city-state. It is the nation's capital city with 600,000 citizens. No study has been directed to citizens attitude toward water resources and water resources management. This research is to fill the vacuum in water research in the District of Columbia. Findings of the citizens' attitudes perception and understanding will lead to making sound water and environmental policy and management, and to their environmental education.

METHODOLOGY:

In order to investigate the prevailing state of mind of D.C. residents regarding supply, price, and quality of water and. the related services, five propositions were established as following:

1. D.C. residents who are better-off financially are more concerned with water quality and water related issues. the environmental concern is stronger among the affluent. The lower middle class or the under class does not show much concern.
   The latter is more concerned about jobs than clean air and clean water. For example, Yearn Choi's research on the Portsmouth oil refinery project in the 1970's showed that the affluent citizens expressed their strong voice against the refinery project, whereas the underclass was careless. (Yearn Hong Choi, Portsmouth Oil Refinery, Martha M. Hamilton, Environment vs. Job= Landfill Proposal) divides a W. Vs town, The Washington Post. Nov. 4, 1990 P.M.2.

2. Washington D.C. residents are still live with myth and believe that droughts and floods are acts of God. Blair Lee wrote his environmental care on the Chesapeake Bay:
   The disappearance of the wildlife stems not from the bay's overharvesting but from the degradation of its water quality. Are we really ready to closa the factories and power plants that line the bay's tributaries? How about the shipping industry and its

associated dredging? Will we pay higher prices for chemical-free farm products and cars that don't leak oil? And will we give up the laundry detergents and lawn fertilizers that produce harmful run-off? "Our Bountiful Bay - And How to Keep it that Way, The Washington Post, Nov. 4, 1990. P.C8. The Washington metropolitan area has grown by 80,000 annually in the last five years. There are so many people moving into this area, and they will eventually strain the Potomac River and the Chesapeake Bay. Congressman-elect Jim Moran from the Northern virginia brought up an environmental issue in this year's election. He said that this region showed fragile ecology. He was endorsed by Clean Water Action and the League of Conservation Voters.

3: D.C. residents are satisfied with the care and management of water resources.

4: Water and sewer rate setting mechanism in D.C. is fair. Water and sewer bills come from the "Monopoly industry." The city provides water and sewer services, and also sets the rate. Electric power is provided by PEPCO, but is regulated by the utility regulatory commission. Rate setting should be fair and equitable to the consumers.

5: D.C. residents are satisfied with the way the water resource issues and problems are covered in the media. The Washington Post published occasionally oil leaking to the Potomac, Monster Hydrilla, Blue Plains Waste Water Treatment Plant, Water and Waste fees among others.

In order to test the validity of the above propositions and gather the facts to fulfill the purpose of the research, a questionnaire was designed (see appendix 1) and after proper validity and reliability tests was given to a random sample of 500 D.C. residents. The sample was drawn from the D.C. telephone directory and a number of attempts were made to interview all of the participants in the survey. But due to variety of reasons (e.g., disconnected telephone service, lack of answer the phone, etc.,), out of all the interviewers only 263 of them met the criteria for selection and included in the analysis. The structured questionnaires filled out by the interviewer during the interviews were then tabulated and coded for the statistical analysis. A program was written in SPSS-X programming language to analyze the data and find the interrelationship among the various variables of interest (see appendix 2).

RESEARCH FINDINGs:

A. Demographic characteristics of the total respondents 52 percent were female and 48 percent male with the average income of $25,456. Table 1 and 2 summarize the ethnic background and the marital status of the respondents respectively.

TABLE 1 ETHNIC

Value Label	**Percent**
BLACK	73.5
CAUCASIAN	11.2
HISPANIC	6.5
OTHER	8.8

TABLE 2 MARITAL STATUS

Value Label	Percent
SINGLE	55.9
MARRIED	32.8
SEPARATED DIVORCED	10.5

Table 3 shows the geographical and table 4 the income distribution of the respondents.

TABLE 3 WARD

Value Label	Percent
1	11.0
2	9.4
3	14.9
4	24.3
5	9.4
6	8.3

TABLE 4 LEVEL OF INCOME

Value Label	Percent
5	.4
1500	.4
15000	30.1
20000	6.0
21000	2.4
25000	34.1
30000	1.2
31000	2.0
35000	11.6
40000	.4
45000	8.0
50000	.4
55000	1.6
61000	.4
65000	.8

D. Satisfaction with water resources and services

As this shown in table 5, only about 35 percent of respondents were satisfied with the quality of drinking water while majority (about 59%) are pleased with the water supply in general (see tab' -t 6) and during the summer (table 7).

TABLE 5 WATER QUALITY

Value Label	Percent
VERY DISSATISFIED	.4
DISSATISFIED	13.7
NEITHER SATISFIED NOR	20.4
SATISFIED	30.2
VERY SATISFIED	31.4

TABLE 6 GENERAL WATER SUPPLY

Value Label	Percent
VERY DISSATISFIED	4.3
DISSATISFIED	12.5
NEITHER SATISFIED NOR	24.3
SATISFIED	47.5
VERY SATISFIED	11.4

TABLE 7 SUMMER WATER SUPPLY

Value Label	Percent
VERY DISSATISFIED	7.1
DISSATISFIED	12.6
NEITHER SATISFIED NOR	22.5
SATISFIED	47.4
VERY SATISFIED	10.3

With regard to the cost of water, about 35 percent of those surveyed are dissatisfied and only 30% felt satisfied (table 8). Almost half of the people surveyed reported satisfaction with the quality of service they have received in general (table 9) and only 35 percent felt satisfied by the way authorities have handled the water related problems during accidents (table 10). The percentage of those satisfied is even less (only about 28%) when it comes to the coverage of water resources issues and problems in the media. (table 11)

TABLE 8 COST OF WATER

Value label	Percent
VERY DISSATISFIED	11.3
DISSATISFIED	23.4
NEITHER SATISFIED NOR	35.1
SATISFIED	23.0
VERY SATISFIED	7.3

TABLE 9 QUALITY OF SERVICE

Value Label	Percent
VERY DISSATISFIED	4.3
DISSATISFIED	16.6
NEITHER SATISFIED NOR	32.0
SATISFIED	41.1
VERY SATISFIED	5.9

TABLE 10 WATER PROBLEM HANDLING

Value Label	Percent
VERY DISSATISFIED	9.0
DISSATISFIED	19.9
NEITHER SATISFIED NOR	36.3
SATISFIED	27.7
VERY SATISFIED	7.0

TABLE 11 MEDIA COVERAGE

Value Label	Percent
VERY DISSATISFIED	12.1
DISSATISFIED	21.8
NEITHER SATISFIED NOR	37.9
SATISFIED	22.2
VERY SATISFIED	6.0

On the question of administration and management of water resources, about one-third of the respondents reported a positive attitude. (table 12)

TABLE 12 WATER RESOURCE MANAGEMENT

Value Label	Percent
VERY DISSATISFIED	6.8
DISSATISFIED	21.3
NEITHER SATISFIED NOR	40.2
SATISFIED	26.5
VERY SATISFIED	5.2

C. Other water related findings

Fifty percent of those surveyed use city water to water their lawn and majority (57%) reported drinking bottled water. Only about 31 percent of respondents use water filter. Eventhough 42 percent trust modern technology being used in sewer plants, 82 percent do not think we should drink the water processed in a sewer plant. Also majority (about 56%) prefer a regional wastewater treatment plant to D.C. 's own plant, and prefer regional drinking water supply to their homes. 68 percent of the respondents said they support a regional water management agency. Majority of those surveyed think that their sewer bill is unfair and with regard to the fairness of water bill the respondents were equally divided.

Out of the total respondents 76 percent foresee future problems in water supply and about 78 percent think that Potomac River is polluted at the present time. 82 percent of people surveyed believe that the Potomac River has not been satisfactorily cleaned up in recent years. Seventy Seven percent of those surveyed think city administrators are not paying adequate attention to water supply and quality. The same number of respondents do not also think the media adequately covers resource issues and problems. Finally, majority of D.C. residents surveyed believe that droughts and floods are the acts of God.

D. Conclusion and Recomendations

In order to explain some of the major findings of the study, Pearson Moment Correlation Coefficients between the major variables in the research has been computed (see appendix).

Among other things, the study revealed no relationship between satisfaction with drinking water quantity and the level of D.C. residents' income. As a matter of fact the respondents level of income has nothing to do with their degree of satisfaction with water quantity, water supply, water cost administration and management of water resources, coverage of water resource issues and problems in the media, and the quality of service received in general. The study also concludes that satisfaction with quality of services received in general is significantly related to drinking water quality, water supply, cost of water, administration and management of water resources, coverage of water resource issues in the media, and the handling of water related problems by authorities during accidents. It is interesting to note that the satisfaction with administration and management of water resources is significantly related to the price charged for water in the District (r - .53). Pricing can also be effectively used to control water demand (see Washington Council of Government, The Economic and Legal Feasibility of Urban Water Demand Management Through Pricing. January 1973, P.7.). The degree of satisfaction with administration and management of water resources is also highly correlated with the public perception regarding the drinking water quality, supply of water, coverage of water resource issues in the media, handling of water related problems by authorities during accidents, and quality of service received in general. A relatively high but significant relationship between satisfaction with coverage of water related issues and problems in the media and other variables in the study (i.g., handling of water related problems by authorities during accidents (r=.60), administration and management of water resources (r=.57), quality of service received in general (r-.48), etc.,] shows that the general public are perhaps getting most of their information regarding the water quality, supply and management in the D.C. from the media and it is very likely that the media influences their opinion similar to any other areas of concern to the public.

The United States needs a better informed and educated public; modernized institutions; adequate resources; improved planning and forecasting capabilities; unified land and water management policies; united
technology and public policy; improved understanding and handling of risk; and the right forums for problem-solving. The Washington Post, the Washington Times, the Washington Monthly, and the Washingtonians are supposed to provide the forums for water and environmental problem-solving. And many universities in the District should explore citizen's education toward ecology and environmental management. Progress is being in teaching citizens to protect the Earth and in bringing about environmentally conscious electorate. (E.T. Smerdbn, "Education-Ray to Dealing with Social and Environmental Objectives," Journal of Water Resources Planning and Management (January 1989). pp. 44-45.1 The united States public is becoming increasingly concerned about protecting, enhancing, and restoring natural systems. (H. P. Caulfield, Jr. "Future Water Management Problems: The Federal Role in Their Solution," in A.I. Johnson and W. Viessman, Jr. (ads.) Water Management in the 21st Century (Bethesda, MD.: American Water Resources Association, 1989). However, the scientific knowledge needed to improve human understanding of these systems in the balance of the nature is limited. That is also the case of the District of Columbia residents.

Following are our Recommendations:

"Local" water problems are often regional in scale and, when analyzed in that context, yield efficient solutions that otherwise might not be identified. Such an approach was applied in the Washington, D.C.
metropolitan area, where a protocol was devised to manage all elements of the water supply system in concert, irrespective of ownership. The Protocol resulted in an ability to improve water supply during periods of drought without building major new supply projects. The savings in costs over more traditional plan was about $250 million. Not all of the District residents are aware of the regional water systems. Media and universities should provide right forums for their regional awareness and understanding. Proactive planning must be implemented, with more emphasis on regional planning and
--- In order to track changes in water quality, and better understand the Potomac River, local jurisdictions have fully supported a coordinated Potomac regional monitoring program since 1982. Through this Program, *which* is coordinated by the Council of Government, extensive amounts of data are collected and analyzed water quality trends. The data is also used in the development of water quality models and is a key component in the regulatory decision-making process concerning future pollution control efforts. Now, expanded research and monitoring programs on the region's economic growth, population growth, and the Potomac River Basin must be supported. Growth management policies that embrace the many dimensions associated with managing the Potomac River Basin, the Anacostia River Basin and natural systems are badly needed. The Public is rarely involved in developing water management plans. The Public should be invited to the making of water management plans.

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Master Gardener and Extension Volunteers Program

By

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MASTER GARDENER AND EXTENSION VOLUNTEERS PROGRAM

The Master Gardener Program started in the District of Columbia in 1978. The program in the District differed from that in the previous 12 states in that it was open to all citizens, regardless of previous experience in gardening, it was held in the evening so that working people could attend and volunteer opportunities were expanded to fit the needs of the city in a way that would best use the talents of the volunteers.
Arlington, Alexandria, and Prince William counties in Virginia joined with DC to form the Metro Master Gardener Program in 1980. The program received a national award 2 years later. The combined effort beneficial to all jurisdictions because horticultural expertise could be shared.

Because there were more agents working on the project, day and evening training sessions could be held each year. Volunteers could do their volunteer work in any jurisdiction which broadened the type of activities available. (Many more Virginia volunteers assisted DC projects than the reverse.) Twenty to 50 volunteers are active each year and over 300 remain in contact with CES. Master Gardener Volunteers have provided over $200,000 per year in service to the citizens of the District of Columbia.
In the spring of 1990, the Metro Master Gardeners approached the Cooperative Extension Service (CES) for additional training on environmental issues. The Extension Service developed a pilot environmental volunteer program for 20 Master Gardeners in the fall of 1990.

The Extension Service and class participants established a technical advisory committee composed of experts on environmental issues from Northern Virginia and the District of Columbia. Everyone who was asked to serve on the committee accepted. Many felt that the project was so important that even if their work schedules were full, they were willing to work on the project as volunteers on their own time.

Work was immediately begun on the development of a program training manual. Local experts were approached to write and review chapters. Nearly everyone contacted agreed to participate in the project. More than 100 writers, reviewers, and volunteers are currently compiling the training manual, which will be made available to volunteer trainers, 4H leaders, Master Gardener coordinators, Members of Congress, and other interested leaders in environmental efforts nationwide. Advisory committee members, authors, and reviewers have been impressed by the innovative approach to teaching the integration of environmental issues. They see the training manual as a tool to help eradicate misleading issue-related information about the environment that is often given to the public.
Based on evaluations from the 1990 pilot program, the EEVP was expanded and opened to the general public in September of 1991. Participants in the 1991 program represented a wide range of occupations, ages, ethnic groups, educational backgrounds, and environmental expertise. Enthusiasm for the program was so high that the group met after the formal training schedule was completed to continue work begun in class.

The EEVP training is scheduled for this fall. Due to the diversity of solutions to environmental issues in the various jurisdictions the training for 1992 has been revised. DC will conduct training in the District that highlights environmental efforts in the District.

FIFRA-How it Affects D.C. and the Role of U.D.C.

By

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ABSTRACT

The Interagency Agreement between USDA and EPA committed the land grant institutions to prepare training materials (manuals, bulletins, slides, tapes etc.) and to train pest control operators both private and commercial for certification and recertification. The UDC Cooperative Extension Service has been carrying out this mandate since the early 1970's. Recently, the most pressing issue is water quality and the fate of pesticides in the environment.

The Federal Insecticide, Fungicide and Rodenticide Act as amended was enacted in 1947 and amended in 1972. Previously, it was called the Federal Environmental Protection Act. It was agreed in the 70's that states (including D.C.) should write their own laws (rules and regulations). Since we do not have a Department of Agriculture or a governor, the mayor designated the D.C. department of Consumer and Regulatory Affairs (DCRA) as the action agency. The land grant institutions in each state (except Colorado and Nebraska) signed and agreement with the U.S. Department of Agriculture to perform the Pesticide Applicator Training (PAT).

I took on the responsibility to help DCRA write the rules and regulations for the District and produced much of the training materials (with help from EPA) which constituted the start of the PAT program. I continue to perform these duties.

There are eleven categories and several sub-categories in D.C., whereby people are trained and certified to use restricted use pesticides or any pesticide use where reimbursement is received for service recertification.

Categories covered include ground water,, endangered species, worker safety in addition to the original core including lawns, turfs, ornamental shade trees, structural, institutional, and health related pests. Several sub-categories are also included under the foregoing.

Environmental issues, storage, disposal, PIAP, SFIREG, IR-4 projects, IPM are included in training. D.C. has the most rigid training where the laboratory (practical) is a must. A small portion of the budget comes from pass through funds from EPA or USDA.

URBAN LAND USE ACTIVITIES AND THE GROUND WATER: A BACKGROUND SURVEY"

By Jutta Schneider, Dr. Fred Chang, Dr. Clarence Wade and

Prof. James V. O'Connor

ABSTRACT

The DC Water Resources Research Center is currently conducting a study investigating possible impacts of urban land use on the ground water. Study objective is the development of a pollution potential map using available physical and land use data for the District of Columbia. A second goal is the design of a ground water protection strategy applicable to a heterogeneous urban setting. To compile the multitude of data required to assess urban land use impacts on the ground water, a Geographic Information System (GIS) is being established by the Center. Results can be displayed by ward or neighborhood and used to educate residents and city planners on environmental conditions in any given part of the city.

1. Introduction

The DC Water Resources Research Center is currently conducting a study that investigates the possible impacts of urban land use on the ground water. The project, funded by the US Geological Survey (USGS), is expected to be completed by July 31, 1992 with the final report published by September 1992.

2. Purpose and Scope

The objective of the study is the development of a pollution potential map using available physical and land use data for the District of Columbia. A second goal is the design of a ground water protection strategy applicable to the unique challenge of a heterogeneous urban setting such as DC.

3. Methodology

The effects of urban land use activities on the ground water are many and varied. They range from the redirection of ground water flow patterns, for example through artificial fill, sewering of streams and dewatering activities, to the degradation of ground water quality through the introduction of pollutants into the ground water system. In order to compile the multitude of data required to assess urban land use impacts on the ground water, a Geographic Information System (GIS) is being established by the Center.

According to the USGS booklet on Geographic Information Systems, a GIS is "a computer system capable of assembling, storing, manipulating and displaying data ... identified according to their location." At times, this definition is expanded to include not only the computer hardware and software, but also the people operating the system.

For this study, the GIS used is Mapinfo. Data are assembled in four database types. Type 1 is the boundary file, used to work with areal data such as geology, soils or land use. Type 2 is the mapfile, which contains linear data such as streets or railroads. Data for boundary files and mapfiles are entered with a digitizer, i"e. an electronic tablet which transforms points on a paper map to points on a computer map. Type 3, the pointfile, includes information on point locations such as underground storage tanks (USTs)- Data such as addresses are entered in a format similar to dBase, i.e. as data files. Lastly, the image file (type 4) is used to identify objects through legends, labels, etc. Image file data are entered directly onto the computer map while the map is on screen. It must be kept in mind, that while the data display can be scaled to any format, data accuracy and resolution can never be more precise than the original paper map from which they were taken. Distortion may also occur to a slight degree during the process of digitizing. Therefore, the warning issued in the DC soil Survey of 1976, that the general soil map provides a broad perspective on conditions in DC, also applies for all maps created in this GIS.

With the GIS, areas vulnerable to ground water contamination are delineated. Ground water vulnerability is a function of natural factors such as geology, soils, depth to water, slope etc. A valley with sandy soils and a shallow water table is an example of a highly vulnerable area. By contrast, hill tops with silty soils and deep water tables are less vulnerable to ground water contamination.

An area that is vulnerable to ground water contamination but under a natural vegetation cover has a low pollution potential. Therefore, compilation of general land use and pollution source data follows as the second step in this background survey. High impact land use categories include industrial and transportation corridors, superfund sites, underground storage tanks, land fills, gardens, golf courses, cemeteries, sewer pipelines, yards etc. Pollutants introduced by these sources include petroleum products, road salts, pesticides, herbicides, fertilizer, heavy metals, sewage and leachate. While the pollution potential in residential areas, for example from accidental spills and backyard gardening, must not be neglected, it exceeded the scope of this study to attempt a quantitative or spatial assessment.

After the theoretical assessment of an area's pollution potential and ground water vulnerability, the next step is to determine areas already under heavy ground water stress. To this end, water quality data will be used to indicate the extent of any existing pollution. Data will be obtained from wells drilled for *construction* and remediation purposes. However, because of the confidentiality of most water quality records in DC, it is expected that data will be rather limited.

Using *information* on ground water vulnerability, pollution potential and existing water quality problems, it will be possible to create a composite map based on all three factors. This map showing either pollution potential or an already existing threat, can be used by city managers to designate areas in need of protection, to install *monitoring* systems and/or to take corrective action,if necessary to prevent large-scale pollution of important ground water resources. To determine the feasibility of ground water protection strategies in an urban setting such as the District of Columbia will be the last part of this study.

4. Data Requirements

Based on the above outline, the following *information* is currently being entered into the GIS:

4.1. Physical data

Physical data include geology, soils, depth to water and water quality.

The latest *information* on the geology of the District of Columbia is contained in the map by Froelich (1973) which was included in the DC Soil Survey of 1976. The same publication also *contains* the general soil map for DC.

Both geology and soil map indicate the high degree of man-made change that the natural system was subjected to. For the geology, the indicators are the large areas of artificial fill found particularly in the *downtown* area. Even more striking is the soil map which shows only three associations that are without the urban land unit. Of these three units, the Udorthent unit consists largely of cut soils, so that only two units can be considered natural units. One of these is the association of flood plain soils, the other is the Manor-Glenelg association found in the wooded areas of Rock Creek Park and the Delacarlia Reservoir area.

Depth to water and water quality data present their own set of challenges. First of all, the absence of a routine ground water *monitoring* network requires data acquisition from a variety of sources, with the resulting questionability of data quality. Secondly, the depth to water has changed over time and is still *changing* with dewatering activities from sump pumps (Federal Triangle area, METRO routes) and during *construction* (commercial, METRO). Therefore, depth to water data have a *high* degree of uncertainty. Thirdly, in addition to being also subjected to temporal changes, water quality data pose the additional problem of being confidential in a large number of cases. It should be kept in mind that depth to water and water quality maps can only present a rough estimate of the actual conditions.

4.2. Land Use data

Land use data were divided into two groups: One map shows the general land use in categories such as residential, commercial, federal, etc. The second group. involves a series of maps displaying specific pollution potential sources within the District. Among those are maps of USTs and yards for petroleum products; gardens and golf courses for pesticides, herbicides and fertilizer; land fills and cemeteries for leachate and heavy metals; transportation corridors for road salts and pesticides; and sewer systems for sewage.

5. Preliminary Results and Outlook

Some examples of already completed GIS maps are the soils map, the underground storage tank map, gardens, golf courses, cemeteries, and the sewer system.

While not all maps have been completed yet and the ranking system of potentially threatened or threatening areas is still being developed, some preliminary conclusions can be drawn at this point:

a. While ground water is not used as a drinking-water supply in the District, it is time to inform the inhabitants about other hazards associated with the indiscriminate pollution of their ground water resource: The possibility of contaminated ground water seeping into streams such as Hickey Run or into the sewer system as happened in Mexico City should no longer be ignored. The threat posed to the District's major surface waters (i.e., Potomac River, Anacostia River and Rock Creek] by infiltration of polluted ground , water needs to be considered before ground water protection is dismissed as unnecessary. Construction workers and sump pump engineers may be subject to health hazards if construction pits or sumps fill with contaminated ground water. Also, ground water use in fire hydrants or as an emergency drinking water supply may become a thing of the past if this valuable resource is not protected.

b. During the course of this project, many implications of urban land use and its impact on the ground water became apparent that have never been considered before. For example, the legacy of potential pollution sources left behind during previous stages of development will have to be investigated more fully. Another case in point is the impact of residential areas on ground water quality. As mentioned earlier, this problem is difficult to assess because of the lack of a monitoring system on the one hand and the lack of cooperation from citizens on the other. However, the cumulative effect of bad management practices in residential neighborhoods could be more detrimental to the ground water than a few community gardens or underground storage tanks, which are already being monitored.

c. Special considerations apply to the District of Columbia that are or may be detrimental both to the assessment of pollution potential and to the implementation of meaningful ground water protection strategies,: In addition to the consideration of the complex hydrogeologic settings present in the District, any protection strategy is dependent on and must therefore be tailored to the land owner's special interests. Land owners in the District of Columbia includes:

foreign embassies (8%)

federal owned land, e.g. agencies and National Park Service (40%)

District owned land, which is under the jurisdiction of various city agencies (5%)

privately owned land (47%)

d. Emphasis should be given to the education of city planners, federal and foreign agencies and private citizens. Based on this background survey, a viable approach to increasing awareness of ground water impact on all aspects of city life could be the assessment of conditions by ward and/or neighborhood.

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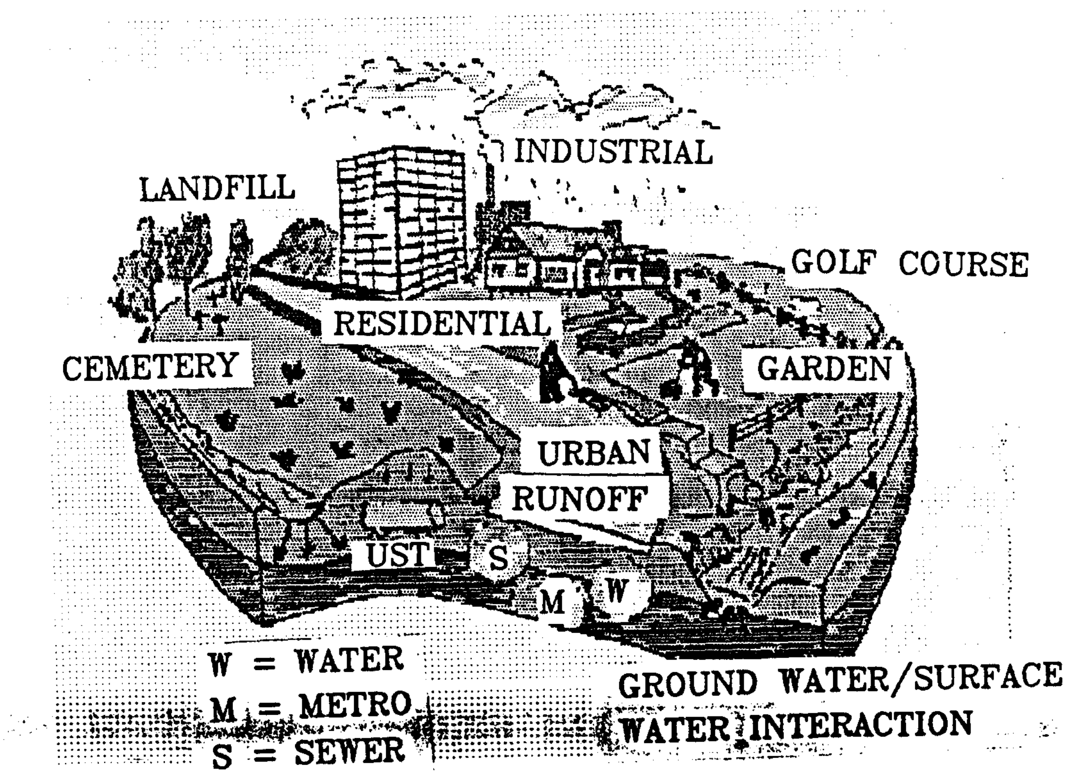
POTENTIAL LAND USE IMPACTS
ON THE GROUND WATER



UST = UNDERGROUND STORAGE TANK

URBAN STORMATER MANAGEMENT & SEDIMENT CONTROL CLEARINGHOUSE

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Abstract

To assist the community in understanding the control of urban stormwater and sediment movement, the District of Columbia Department of Consumer and Regulatory Affairs (DCRA), is establishing an information Clearinghouse at the University of the District of Columbia (UDC). The Clearinghouse working under the DCRA, will provide technical and non-technical *information* related to urban stormwater management and sediment control. The Clearinghouse will disseminate information to the community through a library which will maintain related publications, documents and books.

Introduction

Urban areas are affected by soil erosion just like any other part of the country. Erosion chokes streams and fills reservoirs. Uncontrolled run-off may lead to floods that can damage city properties. Soil erosion is a process by which rains and moving surface water dislodge and carry soil particles, organic matter, and plant nutrients with their flow. The primary cause of soil erosion is the action of water on the soil with insufficient vegetative cover. Soil erosion can be due to natural processes and/or land disturbing activities that go with urban development. Remedies for soil erosion and sediment control are varied. These include appropriate land use control and design of stormwater facilities. The typical stormwater facilities in the District of Columbia are sand filter structures, filtration pond, water quality inlet, and run-off detention.

The District of Columbia Department of Consumer and Regulatory Affairs (DCRA), has initiated the establishment of an Urban Stormwater Management and Sediment Control Clearinghouse. through the soil resources branch of the Environmental Control Division. The agency has funded the University of the District of Columbia Water Resources Research Center (WRRC) to implement this project. The clearinghouse will be located in the Miner Building of the University of the District of Columbia, and shall serve all parties in the Chesapeake Bay (Virginia, District of Columbia, Maryland, Pennsylvania) interested in urban stormwater and sediment control matters.The purpose is to assemble and distribute technical policy information on urban non-point source issues to interested parties and Chesapeake Bay Program agencies to help in the urban run-off control programs. The Clearinghouse will

provide, among other things, examples of model ordinances and regulations to local agencies; and examples of performance standards and construction specifications for urban best management practices (BMPs), including emerging technology. Also provided will be related information on Bay area research and monitoring efforts in urban run-off and sediment control: and management support services, including costs. The Clearinghouse will maintain a record of the number of inquiries received, the jurisdiction of inquiry and the types of inquiries made. This record will be used as documentation for cost sharing and analysis related to the services provided to users.

Although the DCRA, which develops and administers rules and regulations governing stormwater and sediment, presently has sets of rules at its disposal, it strongly feels that, in the long run, its plans will best be served by having an informed community. As such, the Clearinghouse will serve as an information and educational outpost.

Objective

The objective of the Clearinghouse is to disseminate technical and non-technical information related to stormwater and sediment control practices in local jurisdictions (D.C, VA, MD, PA) having a bearing on regional development. As such, the Clearinghouse will collect, organize and make available to interested groups information on:

Local rules and regulations governing urban stormwater and sediment control practices

Construction techniques and standards specified by local rules and regulations governing stormwater management and sediment control

Best practicable emerging technology used in stormwater and sediment control

Activities related to Chesapeake Bay rehabilitation and management

Provide expert advice and know-how on engineering and design of stormwater management and sediment control

Direct or refer inquiring parties to knowledgeable or appropriate authorities when necessary

Clearinghouse Service Mode

The Clearinghouse will provide access to technical and nontechnical information on urban stormwater management and sediment control through a computerized bibliographical data base as well as a toll-free- 800 telephone number. It will also develop and maintain a reference library with publications. A schematic representation of the Clearinghouse service is attached (see Fig. 1). The- Clearinghouse is expected to deliver the services by september 1992.

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Schematic of the Clearing house Operations

Figure 1

INPUT	OUTPUT	USERS
Journals	Product	Primary
Books	Brochures	
F. Register		Construction &
	Bulletins	
Proceedings		development
	Bibliographies	
Copies of Laws,	Directories	Regulators
Bills & Regulations	Mailing lists	Engineers,
Monographs US do	Directory of	Designers do
Foreign	current R&D	Archtects
Bibliographies		
Abstracts	Service	Secondary
News publications of		
National, Regional do	Literature Search	Conservationsts
Local Clearinghouses	General inquiry service	College Professors
Methodology reports of	Review & translation of	Students
engineering design	documents	Teachers

THE ANACOSTIA ESTUARY

FORGOTTEN TRIBUTARIES OF THE EASTERN SHORE OF THE ANACOSTIA IN THE DISTRICT OF COLUMBIA

by

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ABSTRACT

A dozen forgotten streams flow from headwater springs to the ANACOSTIA ESTUARY. Most federal and regional management plans ignore these small urban sub-basins. With the arrival of two METRO lines on the east bank of the Anacostia River, land use changes are taking place. Awareness of the open space, erodibility, and flow regimes is critical before a management restoration plan takes place. Recognition and management plans are needed "YESTERDAY" for these stressed urban streams. The eastern shore streams of DC are unsewered in their upper reaches. Clean-up programs occur on Watts Branch, Hickey Run and St. James Creek (now a sewerline), but most trash removal or restoration programs ignore Nash, Piney, Fort DuPont, Fort Davis, Fort Stanton Runs plus Pope and Stickfoot Branches. Some other tributaries are already lost to urban burial. Last century topographic maps clearly and carefully outline the drainage networks of the Anacostia Estuary in DC. Current U.S. Geological Survey topographic maps show the stream valleys, but not the flow of these urbanized perennial streams. Our legacy for the 21st Century, fostered by the river poetry of Robert Frost and Langston Hughes, must include saving and restoring the city's forgotten jewels of our natural heritage and neighborhood natural resources.

PRELIMINARY SURVEY & ASSESSMENT

Tributaries are the main conduits for pollution flowing to the main Chesapeake Bay waters like the Anacostia and Potomac Rivers. If tributaries are not recognized, they cannot be researched nor the larger water bodies cleaned. Over a dozen streams flow from either highlands in Prince Georges County or drain off the Alabama Avenue Drainage Divide within the District. Requests for information about specific D.C. streams usually leads to blank stares or questions like " where's that stream- never heard of it!" Select stream awareness programs are set up to study and improve the quality of select local backyard streams. The ICPRB (Interstate Commission on the Potomac River) has two funded programs: Anacostia sub-basin stream monitoring program and a newsletter tool instructional information program. Figure 1 shows the standard ICPRB view of the basin excluding the major DC tributaries except for Watts Branch. The Anacostia Watershed Society provides another community awareness program. MCOG's (METROPOLITAN COUNCIL OF GOVERNMENTS) initiatives for the Anacostia Basin restoration agreement and the Alliance for the Chesapeake both have citizen input programs. These groups all use the COG computer schematic map which ignores most city tributaries to the Anacostia (Figure 2: MCOG computer map).

The D.C. polluted water atlas for EPA (Table 1) does not fully recognize all the small but vital river resources that flow through the neighborhoods of the far east side of the city. (Figures 3, 4, 5,). Table 2 list the major DC tributaries
to the Anacostia Estuary that should be on all maps. This background survey was conducted to establish four goals:

1. INCREASE COMMUNITY AWARENESS ABOUT THE IMPORTANCE OF THEIR STREAMS

2. ESTABLISH A FOUNDATION FOR ENVIRONMENTAL LITERACY AND EQUITY WITHIN THE LOWER ANACOSTIA BASIN

3. POINT OUT TO THE INSTITUTIONAL SEGMENT THE IMPORTANCE OF THESE FORGOTTEN TRIBUTARIES TO D.C.'S LIVING WATER CYCLE AND TO THE TOTAL MANAGEMENT AND RESTORATION PLANS FOR THE ANACOSTIA ESTUARY AND CHESAPEAKE BAY PROGRAMS

4. PREPARE AHEAD FOR DEVELOPMENT-LAND USE CHANGES WITH INNOVATIVE EROSION/SEDIMENTATION MANAGEMENT AND STREAM ENHANCEMENT/PROTECTION PROGRAMS FOR THESE VERY SENSITIVE BLUFFS THAT ALREADY REQUIRE A MANDATED GEOTECHNICAL REPORT.

A variety of historic maps (Figure 3: general landscapeNCPC,1976), (Figure 4: lost streams-WILLIAMS, 1979), Figure 5: Felton, 1992); HOPKINS, 1894) confirm the existence of a host of tributaries flowing into the Anacostia or old Eastern Branch estuary from both the east and west banks. Time required that we concentrate on the eastern bank first. The, valleys of these tributaries are very much in evidence (observed in the field, on Washington East & Anacostia USGS (U.S. Geographical Survey) topographic maps or plates in the D.C. Soil Survey).

Most of the streams have some open flow, usually on the upper reaches. Many of the streams are part of the Fort Circle System under the National Capital Parks-East and therefore have been preserved as true streams. These reaches are in open space controlled by the National Park Service but the water is under the protection of D.C. Department of Consumer & Regulatory Affairs.

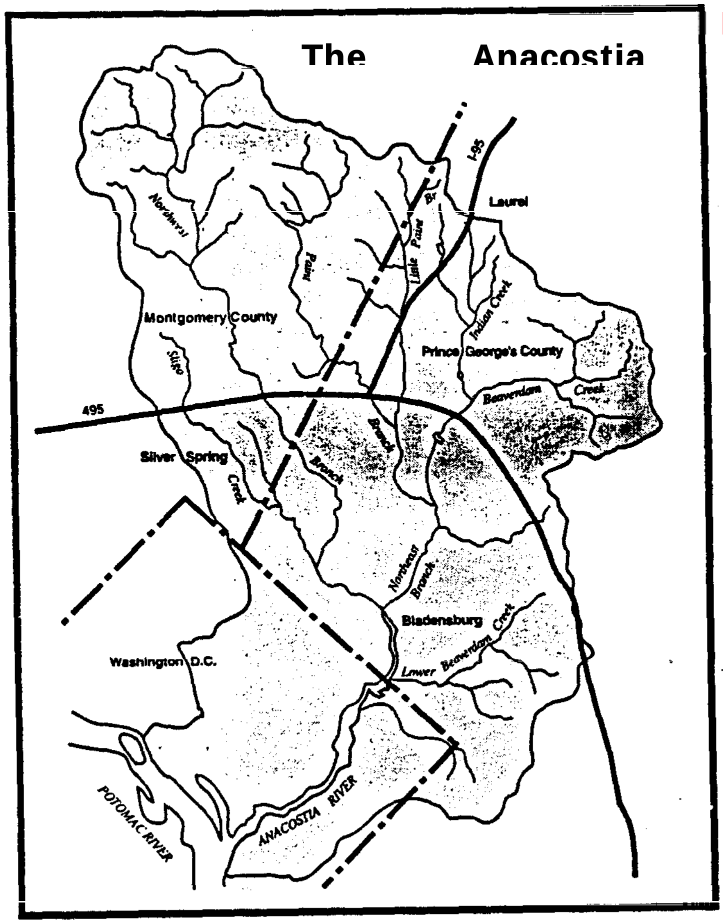

Figure 1. ICPRB

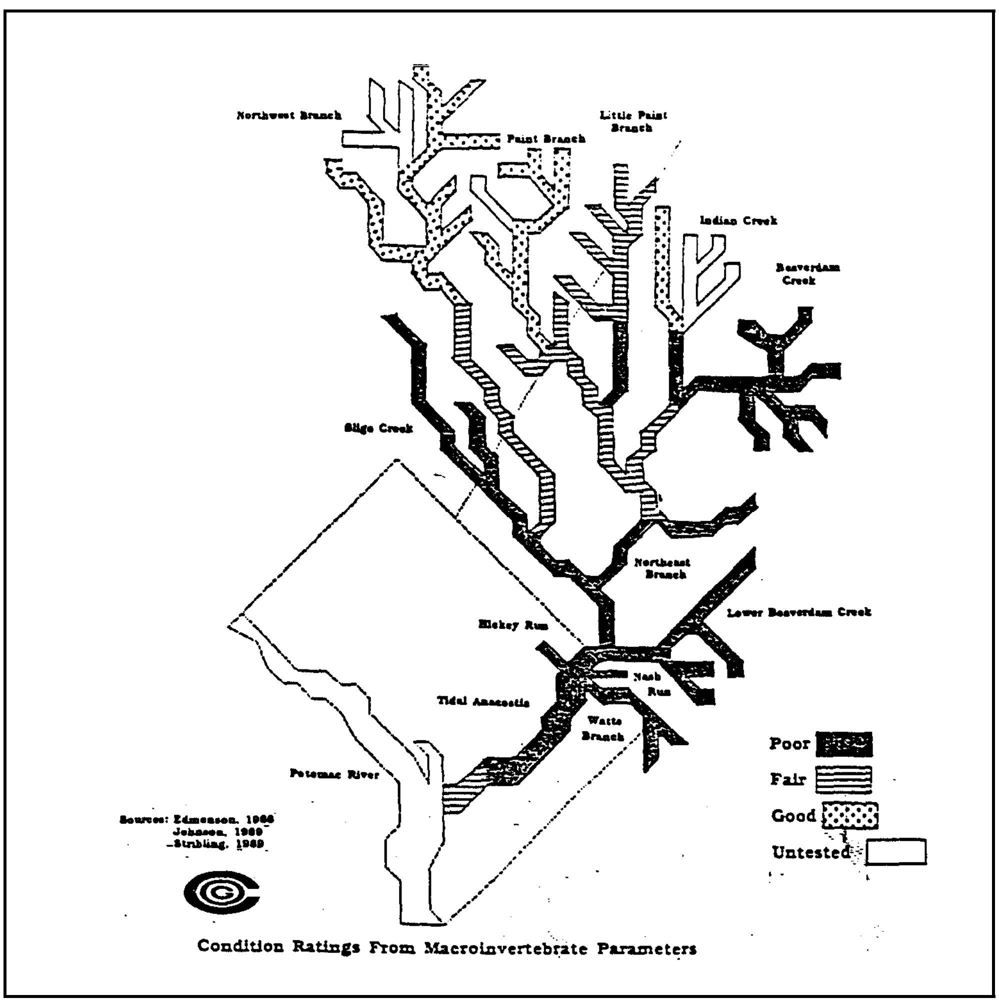

Figure 2.

Figure 3. D.C. Land Forms (NCPC, 1976)

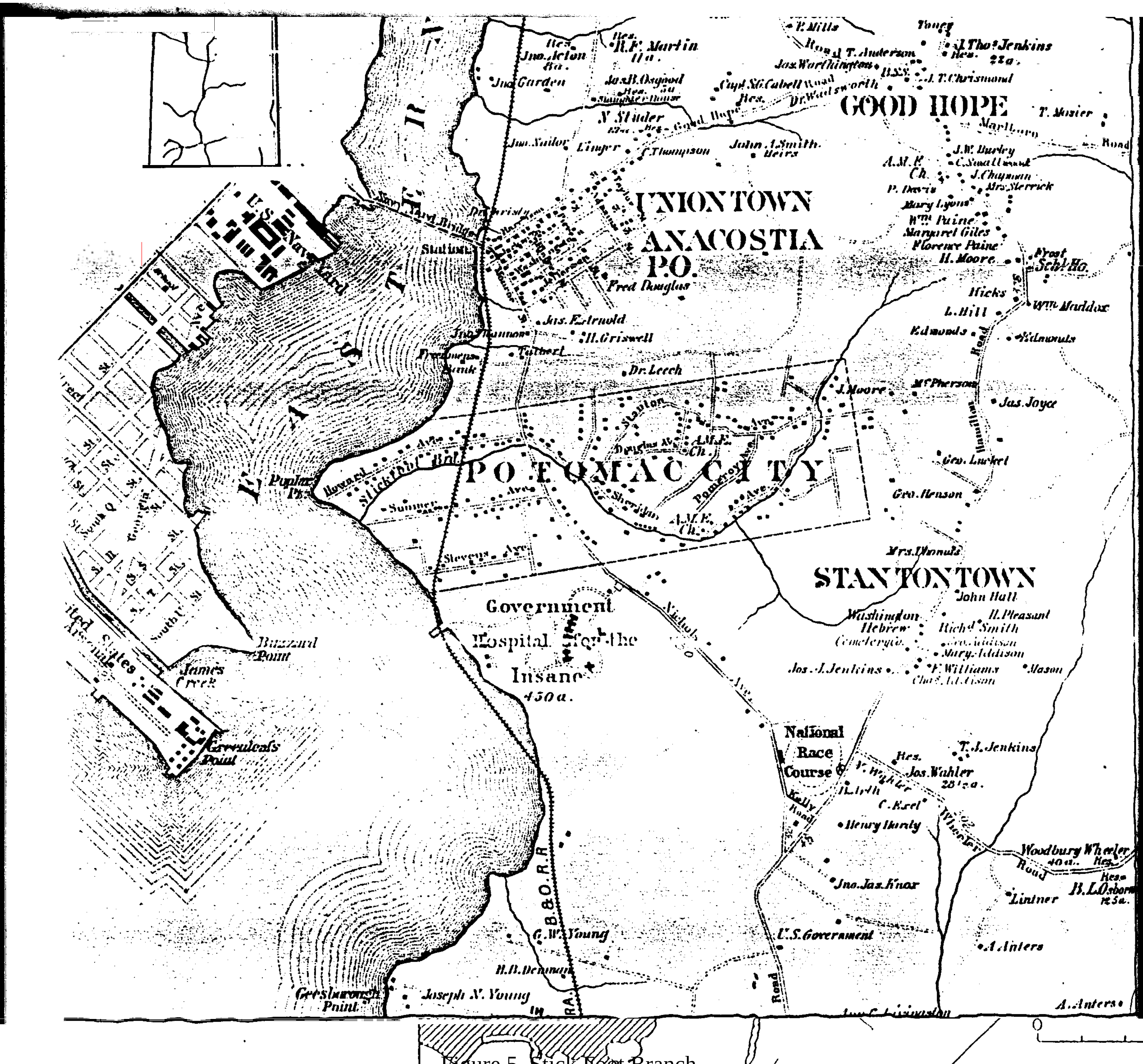

Figure 5. Stick Foot Branch
On 1878 Map (Felton, 1992)

TABLE 1

DISTRICT OF COLUMBIA 304 (1) WATERS

In June 1989, the U.S. EPA approved the District's 304(1) lists of quality-limited waters. Water quality-limited waters are waters adversely affected by toxic, conventional, and non-conventional, pollutants. Section 304(1) of the federal Clean Water Act (1987) requires states to identify these waters and to develop individual pollutants, Table - 1 shows these waters:

DISTRICT OF COLUMBIA 304 (1) (1) (A) (i) LISTS

304(1)(1)(A)(i) LIST'- MINI LIST		FOR	THE DISTRICT OF COLUMBIA
1.	Anacostia River	8.	Fort Stanton Tributary
2.	Lower Potomac River	9.	Hickey Run
3.	Battery Kemble Creek	10.	.Nash Run
4.	Fort Dupont Creek	11.	Oxon Run
5.	Foundry Branch	12.	Popes Branch
6.	Fort Chaplin	13.	Texas Avenue Tributary
7.	Fort Davis Tributary		

304(1)(1)(A)(ii) LIST - LONG LIST		FOR	THE DISTRICT OF COLUMBIA l
1.	Aquatic Gardens	17.	Lower Rock Creek
2.	Kingman Lake	18.	Battery Kemble Creek
3.	Upper Anacostia River	19.	C&O Canal
4.	Lower Anacostia River	20.	Dalecarlia Reservoir
5.	Ornamental Ponds	21.	Fort Dupont Creek
6.	Georgetown Reservoir	22.	Foundry Branch
7.	McMillian Reservoir	23.	fort Chaplin
8.	Channel Lagoon	24.	Fort Davis Tributary
9.	Little River	'25:'	Fort Stanton Tributary.
10.	Upper Potomac River	26.	Hickey Run
11.	Middle Potomac River	27.	Nash Run
12.	Lower Potomac River	28.	Oxon Run
13.	Oxon Creek	29.	Popes Branch
14.	Tidal Basin	30.	Texas Avenue Tributary
15.	Washington-Ship Channel	31.	Lower Watts Branch
16.	Upper Rock Creek	32:~	Upper Watts Branch.

TABLE 2: DC's EASTERN SHORE STREAM LIST- NORTH TO SOUTH:

LITTLE BEAVERDAM CREEK (mouth)
NASH RUN
WATTS BRANCH PINEY RUN FORT CHAPLIN BRANCH NO NAME RUN (?) FORT DUPONT RUN ' RANDALL BRANCH (tributary of Fort Dupont Run)* POPES BRANCH (M ST.) "O" STREET BRANCH (sewered from Pa Ave.) HILLCREST BRANCH (sewered on lower reaches) FORT DAVIS-GOD'S DUMP BRANCH
GOOD HOPE BRANCH (sewered from Good Hope Road)

FORT STANTON BRANCH (sewered from parklands at edge of Anacostia) STICKFOOT CREEK (sewered under Suitland Parkway) STICKFOOT BRANCH (the younger current unsewered surface flows)
ZORA FELTON BRANCH (from G.W. CARVER NATURE TRAIL- tributary of Stickfoot Br.) ST. ELIZABETH's EAST BRANCH (FROM ST E'S DUMPfilled valley trib of Stickfoot Br) OLMSTED BRANCH (ST E'S WEST SIDE)

* (confluence area creates FLOODPLAIN WETLAND west of Minnesota Avenue, S.E.)

These streams all appear on the national capital planning map of 1976. Each named stream needs to be rediscovered by the city and community. Each stream does have a name that needs field signage for recognition. These names have been lost. The names or stream segments must be added to all official maps, computer models or regional plans. Some university research plans were hampered because these streams are not officially recognized by city, regional, or federal funding programs.

Robert Frost's poem " A Brook in the city" fosters a rediscovery of our lost riverscapes. On earlier maps, these stream may be runs, branches or creeks, but the name remains. With time and select development, the streams were sewered in their lower regions, especially between the Anacostia River and Minnesota Ave. Each stream does have an outfall pipe along the shoreline within the Anacostia Park or associated federal territory. Those that have pipe-outlet mouths have gravel deltas exposed at low tide on the Anacostia. Signage to recognize these forgotten, pent up rivers should be instituted. The aesthetic and recreational value of our riverine resources should augment, but not be lost, within the urban environment.

Recent restoration initiatives for the Anacostia Basin and the Chesapeake Bay Program have focused attention on Watts Branch and Hickey Run within the District. These two streams are the largest and most visible streams. Watts Branch has been straightened. Its mid-section was placed underground, but its old meandering channel still attacks the houses built over it. Watts Branch is but one stream under stress only now being looked after and rediscovered by the community, government and schools.

We need students, citizens and government to celebrate the whole range of streams along the length of the Anacostia Bluffs in DC.

Protection and management can only happen if economicenvironmental awareness and resource education are coupled with community pride and neighborhood health. A healthy stream is a major amenity to any neighborhood. These forgotten streams are easy to explore from head waters to mouth. They have living resources and are relatively free from hard core urban pollution, so they provide the urbanite with a green alternative to the asphalt and concrete recreation known to all ages. Why would one explore what one does not recognize as significant?

Nature in the city, no matter how small or seemingly insignificant, needs to be enhanced and protected as a legacy - not buried and left fallow. This preliminary study seeks to create stewards by awareness and force the political management system to treat all our streams with equal value. The green and blue lines of the METRO system have awakened the developers to the real estate potential of the bluff's vistas overlooking the Capital City. As the poet, Langston Hughes, points out in "The Negro Speaks of Rivers", flowing water is deeply rooted in the African American experience. What price are the Anacostia's eastern shore communities willing to pay for losing their backyard forgotten resources? Neighborhoods must cry out for their streams, for who else will?

Summary on the Anacostia Estuary's FORGOTTEN BASINS:

1. The streams are open on National Park space
2. Some streams are protected as part of the Civil War Fort Circle lands
3. These streams are generally sewered/ urbanized in their lower reaches.
4. These streams are generally piped under Anacostia Park or Bolling Field.
5. Watts Branch is rerouted along most of its length by

6. The sewer sheds follow the topography or relic watersheds.

Alabama Ave. serves as a rough approximate drainage divide.

8. Headwaters are from springs recharged by the high terrace gravels.

9. Each drainage basin has a corresponding groundwater basin.

10. This Anacostia Bluffs region is highly erosive and listed as a zone susceptible to landslide-slump hazards.

11. The upper reaches of the eastern tributaries have very steep gradients based on terrace geology and sea level fluxes while the lower reaches flow in underfit valleys related to paleoestuaries of the ancestral Potomac.

12. Minn. Ave serves as the observable break between upper and lower reaches of the tributaries that cross it.

13. Current maps and computer models do not fully recognize most of these real satellite urban streams.

14. Neighborhoods need to adopt their local stream and celebrate it.

15. Some basins drain PGC but most are totally within DC. 16. Restoration and management programs must recognize the whole system and the behavior of all its parts to be successful, meaningful, and accountable to the citizen-taxpayer.

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APPENDICES

Appendix I

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Appendix II

DC Water Resources Research Center Background Brief

History/ Introduction

Water is essential for human survival. However, world wide problems concerning water resources are more and more complex as well as urgent and need to be solved. The DC Water Resources Research Center (WRRC) specializes in urban water/land related problems. The Center staff and investigators have accumulated vast experience on water quality, quantity and institutional/ management problems. A Full range of research areas are addressed by a multi disciplinary team of investigators selected from various universities. Multi level technology transfer, information dissemination and public education are also emphasized.

The WRRC of the University of the District of Columbia was created in 1973 by the Water Resources Research Act of 1964 (PL 88-379) which established a federal/state partnership in research, information transfer and education regarding water-related issues.

Mission

The D.C. WRRC mission is as follows:

Plan and conduct competent research, either basic or practical, with respect to water resources.

Promote the dissemination and application of the results of research. Provide for the training of scientists and engineers.
Cooperate closely with all colleges and universities in the District that have demonstrable research capabilities.

Cooperate with the HBCUs and other minority institutions, to effectively address regional water and land related problems.

Program Management

WRRC's programs are supported by appropriations from the Congress under a matching arrangement between the state and federal governments. The Center also receives grants from other government agencies. Coordination of the center network at the national level with 53 other centers assures that activities are directed toward the solution of local problems while contributing to broader issues of regional and national importance.

The Center is served by two advisory groups: a Research Advisory Council and a Technical Research Committee. The members of the advisory groups are drawn form universities and public or private water management organizations in the Washington D.C. area.

Research

The Center conducts, coordinates and funds research through teams of experts from among a pool of over 100 experienced researchers from D.C. based universities with specific projects selected according to local and regional water research priorities. Investigations sponsored by the Center range broadly from surface water, ground water, water quality, water resources conservation and management to fisheries.

Technology Transfer and Information Dissemination

The technology transfer/information dissemination program is designed to increase the communication of technical and scientific knowledge and to promote a general understanding of water resource problems. Under this program the Center:

- Organizes conferences/symposia.
- Maintains a library of documents in all water resources fields, from state and federal agencies.
- Publishes reports distributed locally and nation-wide through the National Technical Information Services (NTIS).
- Publishes a quarterly newsletter; "Water Highlights".

Water Information Management System

Provides a scientific and technical data base and a management information system on the District of Columbia's water resources.

Urban Stormwater Clearinghouse

The Center is coordinating an Urban Stormwater Sediment and Erosion Control Clearinghouse. for The Soil Resources Branch of the DC Dept. of Consumer and Regulatory Affairs.The clearinghouse will house documentation, provide access via an 800 number, and other communication systems.

Public Service

The Center's public service efforts include official representation of the District of Columbia on regional advisory commissions and committees. The Center provides advice and assistance on a continuing basis to a number of agencies including:

- D.C. Soil Conservation Board
- Interstate Commission on the Potomac River Basin
- Chesapeake Bay Program Scientific and Technical Advisory Committee

- Chesapeake Bay Local Governmental Advisory Committee Liaison
- Anacostia Watershed Society & D.C. Science Fair

Cooperative Arrangements

The Center has cooperative arrangements with:

Howard University

The Catholic University of America
The American University Georgetown
University
The George Washington University Central
State University, Wilberforce, OH

Training

Through its projects, the WRRC has trained more than 130 undergraduate and graduate students. Most of these students have obtained B.S., M.S. and Ph.D. degrees in the field of water resources. The WRRC also provides the opportunity for college and university faculty members in Washington, D.C., to develop their expertise in water resources.

Center Facilities

- Anacostia Ecology Laboratory
- Water Quality/Fisheries Lab
- Water Resources Demo Lab
- Water Information Center/ Storm water Clearinghouse

Services Offered

- Research from conceptual and proposal design through final report
- Proposal preparation & Project management
- Data collection and analysis
- Computer Searches & Program evaluation
- Technology Transfer
- Conferences and Seminars
- Design/conduct training program
- Coordination of research teams
- Expert speakers/lecturers