WATER QUALITY OF THE THREE RIVERS OF PITTSBURGH
A FINAL REPORT

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ENVIRONMENTAL STUDIES 102
PROFS. KEGLEY, ART & DETHIER
MAY 10, 1991

I. Introduction

I chose to do my research on a topic that directly affects all of the residents of the Pittsburgh area. The research deals with the current water quality of the three rivers of Pittsburgh: the Allegheny, the Monongahela and the Ohio. Our drinking water is drawn from these rivers. I am interested in learning about the quality of the water before it is treated; I hope to reassure my family and friends that there is nothing in the river water that could pass through treatment plants and cause harm.

II. Pennsylvania Policy

Section 691.4 of the Pennsylvania Clean Streams Law determines the specific importance of clean water as is relevant to the Commonwealth of Pennsylvania. Figure 1 shows this:

691.4. DECLARATION OF POLICY

(1) Clean, unpolluted streams are absolutely essential if Pennsylvania is to attract new manufacturing? industries and to develop Penneylvania's full share of the tourist industry, and

(2) Clean, unpolluted water is absolutely essential if Pennsylvanians are to have adequate out of door recreational facilities in the decades ahead.

(3) It is the objective of the Clean Streams Law not only to prevent further pollution of the waters of the Commonwealth, but also to reclaim and restore to a clean, unpolluted condition every stream in Pennsylvania that is presently polluted;

(4) The prevention and elimination of water pollution is recognized as being directly related to the economic future of the Commonwealth, and

(5) The achievement of the objective herein set forth requires a comprehensive program of watershed management and control.

III. History and Setting

Pittsburgh was well-known in the past as the 'Steel City', one that thrived on its steel and coal industries. The Pittsburgh area has always been a major coal-producing region, which made it a perfect location for steel production. Appendix A (Map 1) highlights coal towns (Tarentum, Etna, New Kensington), steel towns (Homestead, McKees Rocks) as well as

Neville Island, current site of a nuclear power plant. The city's industry kept the economy going and produced approximately 20% of United States steel at its peak. Industry also had its setbacks though. Appendix B, a photograph taken at 9:00 A.M. in 1945 shows the permeation of the smog and soot that covered buildings and clouded the air.[1] In the late 1940's, the city, led by Mayor David Lawrence, made an intense effort to detoxify. Regulations were passed as to what could and could not be in the smoke from the mills, and buildings were revitalized with cleaning.

The economically troubled era of the late 1970's and early 1980's closed almost all of the steel mills down. Unemployment rates and inflation soared, but the atmosphere and environment cleared. In the early 1980's, Mayor Richard Caliguiri began 'Renaissance II", to follow Lawrence's example set in the 40's. This rebirth served to boost morale, bring in major corporations, and create new regulations on the environment. Hopefully such laws will prove themselves successful in an analysis of the water quality of the Allegheny, Monongahela and Ohio rivers.

IV. Site Locations

Maps 2, 3, and 4 show my site locations: red dots mark collection points and blue arrows show water flow direction. Site numbers are noted in blue-boxed numbers.

A. Site 1 is east of the city on the Allegheny River at Fox Chapel, approximately 16 miles from the Point where the Allegheny and

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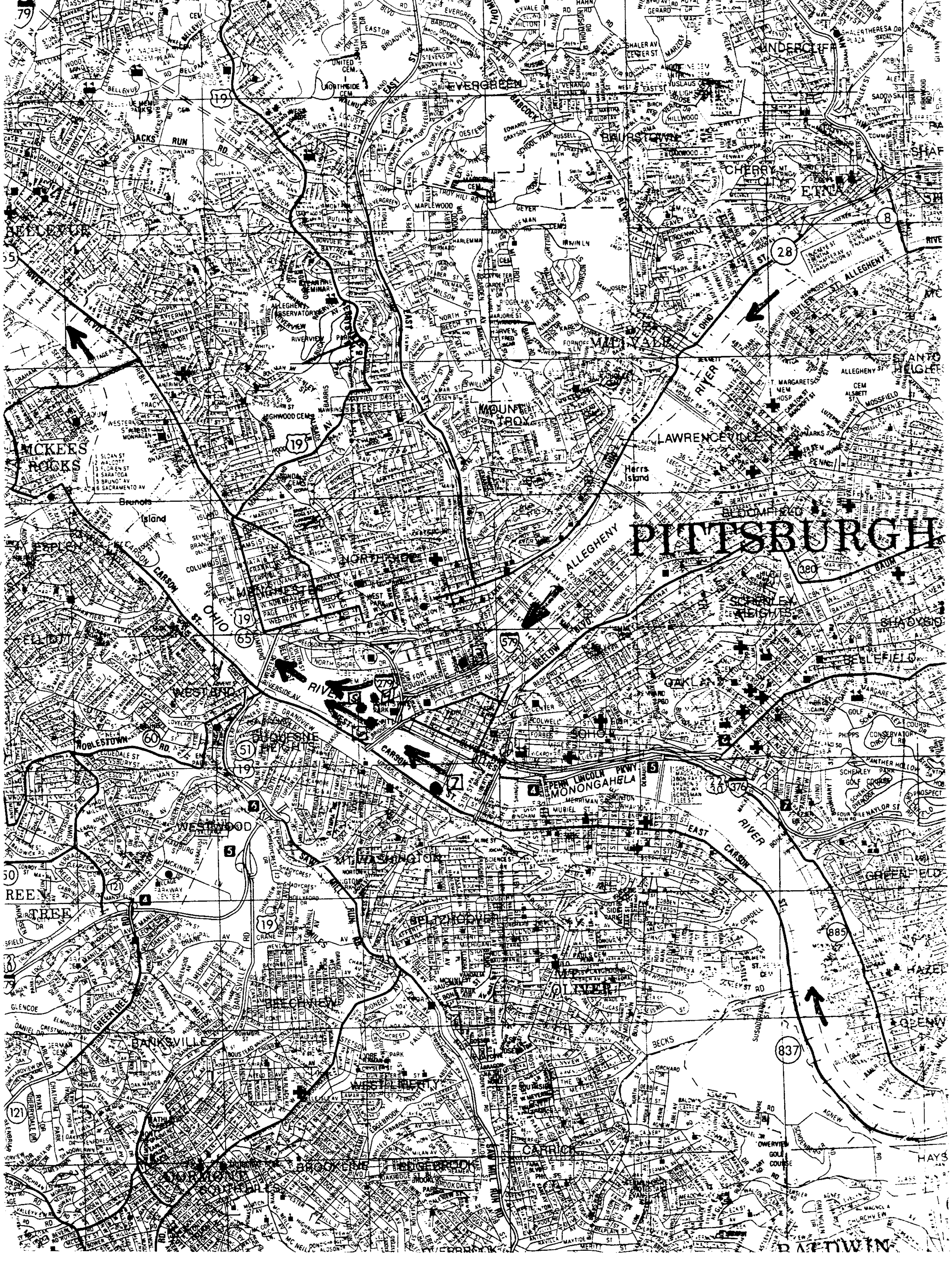
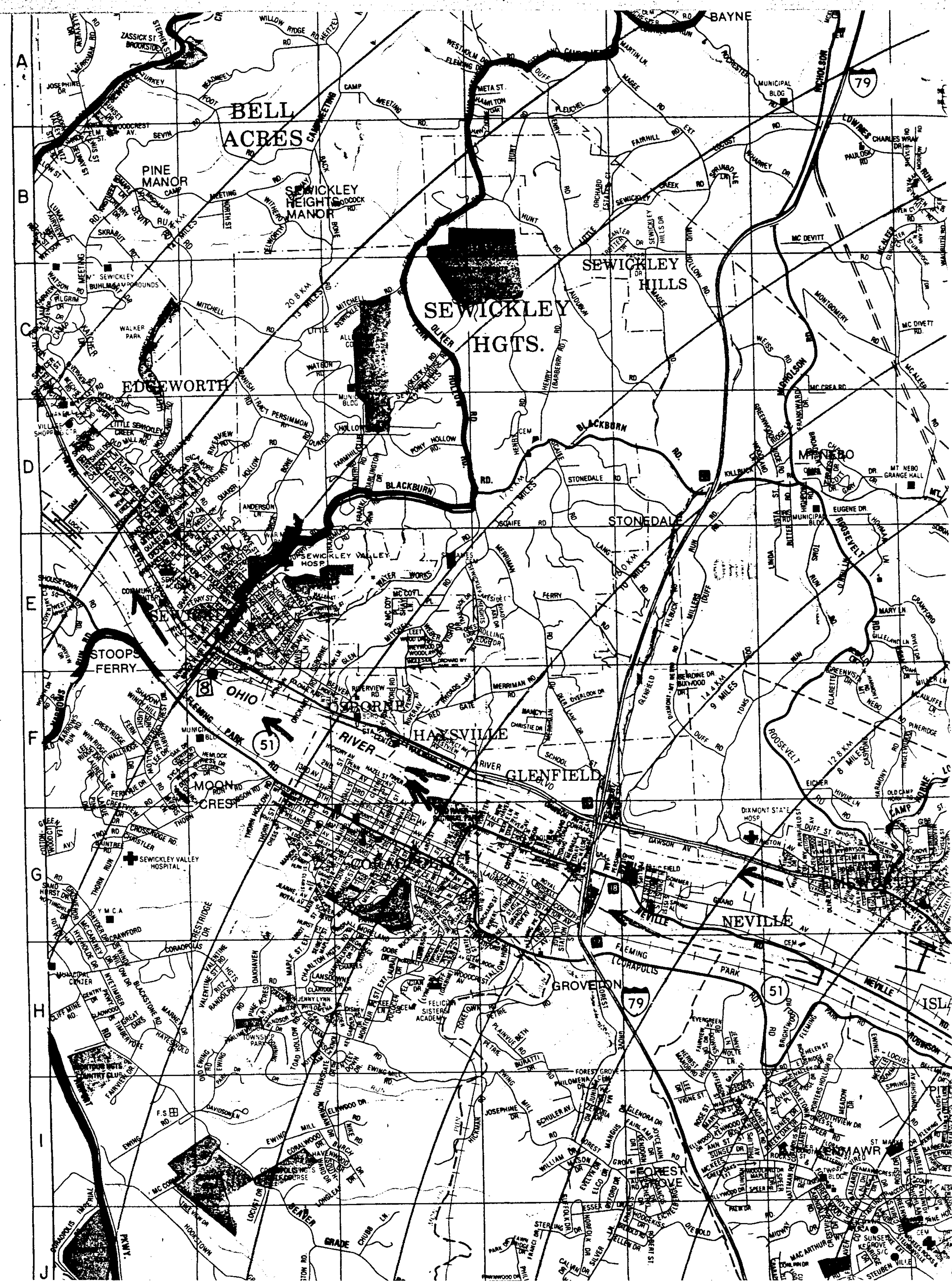
[1] Photo and information for this section comes primarily from Stefan Lorant's book Pittsburgh, pp. 373-423, as well as from my own knowledge of Pittsburgh history.

KR 6

FOX CHAPEL
HARTWOOD ACRES REGIONAL PARK
INDIANOLA
OAKMONT
VERONA
VERONA HILLS
FAIRVIEW HEIGHTS
HARMERVILLE
CROWN MEADOWS
MONTROSE HILL
BLAWNOX
ASPINWALL
SHARPSBURG
SHARPSVILL
PARKVIEW
PENN HILLS
LINCOLN PARK
SANDY CREEK
MORNINGSIDE
HIGHLAND PARK
MC CULLY
INDIANOLA RD.
HARTS RUN RD.
FREEPORT RD
ALLEGHENY RIVER BLVD.
PENNSYLVANIA TPK.
Twelvemile Island
Fourteenmile Island
Sixmile Island
Sycamore Is.
Ninemile Is.
SHADYSIDE ACADEMY
PITTSBURGH FIELD CLUB
ALLEGHENY COUNTY FARM
RIDC INDUSTRIAL PARK
V A HOSP
FOX CHAPEL PLAZA
Water Treatment


PITTSBURGH
BELLEVUE
MCKEES ROCKS
Brunots Island
NORTHSIDE
EVERGREEN
MOUNT TROY
MILLVALE
ETNA
UNDERCLIFF
LAWRENCEVILLE
Herrs Island
BLOOMFIELD
ALLEGHENY
RIVER
OHIO
SCHENLEY HEIGHTS
OAKLAND
BELLEFIELD
WEST END
DUQUESNE HEIGHTS
MONONGAHELA
PENN LINCOLN PKWY
MT WASHINGTON
WESTWOOD
GREEN TREE
BANKSVILLE
BEECHVIEW
MT OLIVER
WEST LIBERTY
CARRICK
BROOKLINE
DORMONT
GREENFIELD
HAZELWOOD
BALDWIN



BAYNE
BELL ACRES
PINE MANOR
SEWICKLEY HEIGHTS MANOR
SEWICKLEY HILLS
SEWICKLEY HGTS.
EDGEWORTH
MT NEBO
STONEDALE
STOOPS FERRY
OHIO RIVER
OSBORNE
HAYSVILLE
GLENFIELD
MOON CREST
CORAOPOLIS
NEVILLE
GROVETON
FOREST GROVE
SEWICKLEY VALLEY HOSPITAL
DIXMONT STATE HOSP
79
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8
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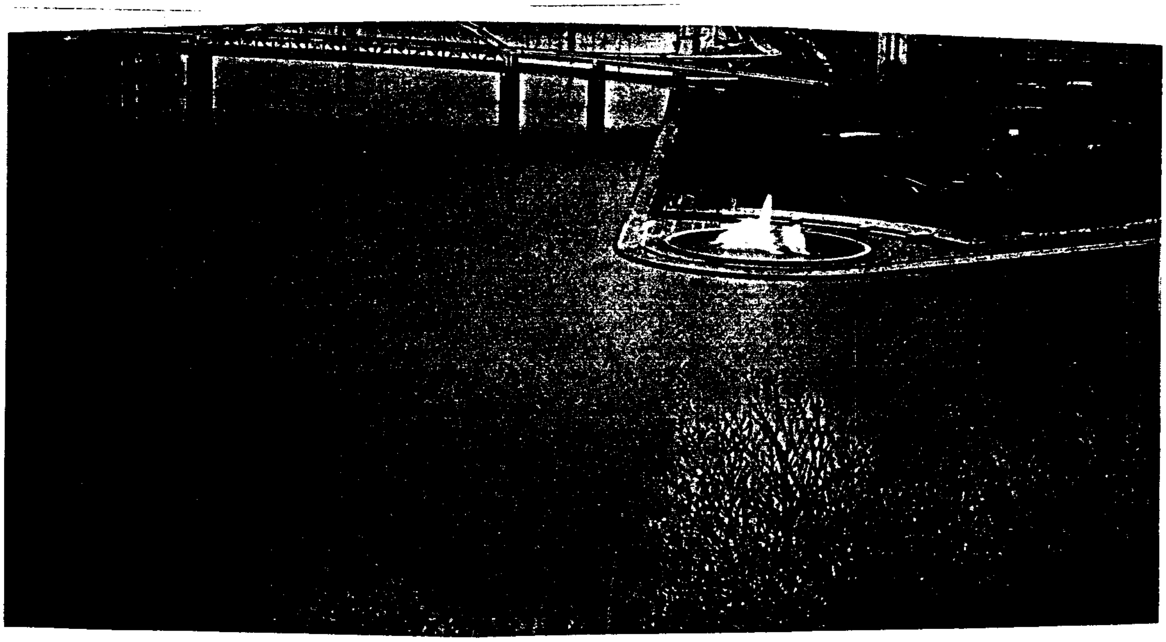
Monongahela meet.[2] The Allegheny runs from the northeast into Pittsburgh. This location is 2 miles upstream from the water treatment plant in Fox Chapel.

B. Site 2 is also also along the Allegheny, 4 miles west of site 1. This site lies 2 miles downstream from the treatment plant.

C. Site 3, the Allegheny 'city' sample, is just outside of the central commercial district. It is in this area that the famed steel mills operated in the past. This spot is 11 miles from site 2 and .75 miles from the Point.

D. Site 4 is the line where the Allegheny merges and becomes the Ohio. A floating mass of scum was attached to the concrete Point here, composed of dead stems of vegetation mixed with human litter: cans, food wrappers and cigarette butts. This area had a foul odor. This site, as well as the next two, lie in the heart of the city. Figure 2 shows both the obvious color change in the water here, and Point State Park. The Allegheny flows in from the top of the photo, the Mon from the right. The Ohio flows into the lower left corner.



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2 These mileage figures are approximate, based on estimations from legends of several area maps.

E. Site 5 is the junction of the Allegheny, Ohio and Monongahela Rivers. Here the Allegheny and Mon join to form the Ohio. This sample was collected from the tip of the point, as seen in Figure 2.

F. Site 6 is similar to site 4 but instead joins the Mon and the Ohio. Though photographs are not as clear here, but there is also an abrupt color change at this junction. This sample was also collected from the Point, on the Mon side.

G. Site 7 is the Monongahela River city sample. This spot is closer to the Point than the Allegheny city sample was, only about .5 miles away.

H. Site 8 is the Ohio River sample, taken 15 miles from the Point in a town called Sewickley. This sample was collected beneath a large bridge.

V. Methods

I collected my samples, with the above-and-beyond-the-call-of-duty help of my family and a friend, on March 24, 1991. The weather was cold and wet; the temperature was around 30 degrees Fahrenheit, with light but steady rain and snow falling all day. After my return to the college, I tested each of the eight samples for fecal coliform, pH/ANC, anion and cation content.

lovely weather!

A. Fecal coliform

First, I tested for bacteria. Fecal coliform are those bacteria that reside in animal intestines and serve as one indicator of human/animal contamination of water. By feeding and incubating a filtered water sample with specific nutrients, colonies of bacteria form. This test is ideally run within 24 hours of sample collection. Each colony represents one original bacteria in the sample.

And yours were run when?

B. pH

The next test which should be run within 24 hours of collection is pH. pH measures the acidity of a sample. The range runs from 0-14, from the least to the most acidic, with 7 being purely neutral. These range numbers represent the negative log of H30+ concentration defined in moles per liter. pH itself does not have a unit. The calibrated pH meter uses electrodes containing a known H30+ concentration to determine the acidity of a sample.

C. ANC

ANC, or alkalinity is the final test that should be conducted within 24 hours. This test uses bases, CO3-2, HCO3-, and OH- to determine the capacity of a sample to neutralize measured amounts of acid to a specified pH. Alkalinity testing also utilizes the pH meter. In this case, I detected ANC by the number of drops of sulfuric acid necessary to reach a pH of 4.5. This identified the resistance to a change in pH in the Pittsburgh river samples.

D. Anions

The testing for anions is done with a ion chromatograph. Varying amounts of Cl- (chloride), SO4-2 (sulfate), NO3- (nitrate) and F- (flouride) were found in my samples. After entering through the injector, the solution passes to the separator column, where

KBC

beads with various ions attract the ions of the sample. Different ions are attracted to these beads for different lengths of time according to the strength of their electronegative charge. Next, the suppressor column adds acid and the sample moves to its final destination, the detector.

E. Cations

Atomic absorption spectroscopy is the method employed to detect specific cations in a sample. I tested for Ca+2, Na+, Mg+2 and K+. By noting the intensity of flame color (wavelength) after atomizing a sample, the AA spectrophotometer is able to detect amounts of those cations. When each element is excited, its wavelength is a specified color, the intensity of which determines the amount of that ion in the sample.

VI. Margin for error

Due to difficulties with transportation logistics and illness, my pH, ANC and fecal coliform tests were not conducted within the preferable 24-hour period. I did coliform testing on April 2, and pH/ANC on April 21. My anions ran on May 3; cations were tested around April 23 and May 5. Nonetheless, the samples were kept cool and dark until they were tested, and each of the tests were conducted collectively (i.e., all of the samples at the same time). Thus the results are still relative. Secondly, while my fecal coliform petri dishes were incubating, water accidentally got into the incubator and flooded some, but not all of my samples. The water was immediately poured off though, and since all of the samples had the same results it is likely that those that got wet were still fairly accurate,

KB (1

considering that it is coliform testing which usually tends to be rather sketchy anyhow.

VII. Raw data and Pennsylvania Water Quality Standards[3]

Table 1 shows the numerical data measured in the various tests. ANC, anions and cations are measured in mg/L; pH has no units.

Site	pH	ANC	Ca+2	Mg+2	Cl-	SO4-2	F-
All - up	7.22	24.00	18.90	4.90	8.20	43.30	0.00
All - down	7.25	24.00	17.80	4.70	8.40	42.10	0.00
All - city	7.07	24.00	18.70	5.10	8.40	45.00	0.00
All - Ohio	6.98	21.00	14.20	6.20	8.10	46.10	0.00
All-Oh-Mon	7.13	21.00	19.90	5.00	5.70	49.30	0.00
Mon - Ohio	7.31	20.00	19.60	4.90	3.90	51.20	0.10
Mon - city	6.93	16.00	20.00	4.80	3.00	50.80	0.10
Ohio - city	7.20	17.00	19.70	4.90	9.90	44.60	0.00

Site	NO3-	K+	Na+
	0.00	1.60	11.10
	0.00	1.70	11.10
	0.00	2.30	10.10
	0.00	1.30	9.50
	0.00	1.70	10.00
	0.00	1.20	9.80
	0.00	1.20	8.60
	0.20	1.40	11.70

It's useful to insert another "Site" column so you can tell what's going on.

The river data I collected falls safely within the threshold level of Penna. General Water Quality Criteria.[4] Table 2 displays some safe levels for water supply standards relevant to my data:

3 According to Pa. water laws as listed in the Environment Reporter. These standards established 1-5-90.

4 The threshold level is defined as the "safe level below which no adverse effects will be seen" (Environmental Reporter, 891-1002).

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Table 2:

Item	H2O Supply Standard
1. Fecal Coliforms	max. 5000/100mL water
2. SO_4^{-2}	max. 250 mg/L
3. Cl^-	max. 250 mg/L
4. NO_3^- (as nitrite with nitrate)	max. 10 mg/L as nitrogen
5. F^-	max 2.0 mg/L

Comparison of Tables 1 and 2 shows that all of my data falls within the threshold level in the Pittsburgh rivers.

Several trends are especially important to note in the raw data. First, none of my samples produced any fecal coliform colonies. This led me to wonder what might be in the water that was killing all of the bacteria, or if my data was simply wrong. All of the pH's are fairly neutral, ranging from 6.93 to 7.31. Alkalinity falls within an expected range: 16-24 mg/L.[5]

The cations follow a couple of common patterns. First, Ca^{+2} is the dominant cation and the K^+ are the lowest values. My potassium values are, however higher than D. Dethier suggested they might be. Secondly, analysis of cation values show the relationship between calcium and magnesium, where Mg^{+2} values are on the average around 1/5 less than Ca^{+2} values.[6] Graph 1 shows this fairly proportional arrangement, which does have one exception.

5 The following 'expected levels' of chemical data come from those given by Prof. Dethier 5/6 in class.
6 From Summary Stats data of Kaleidagraph; the table is not really necessary to include here.

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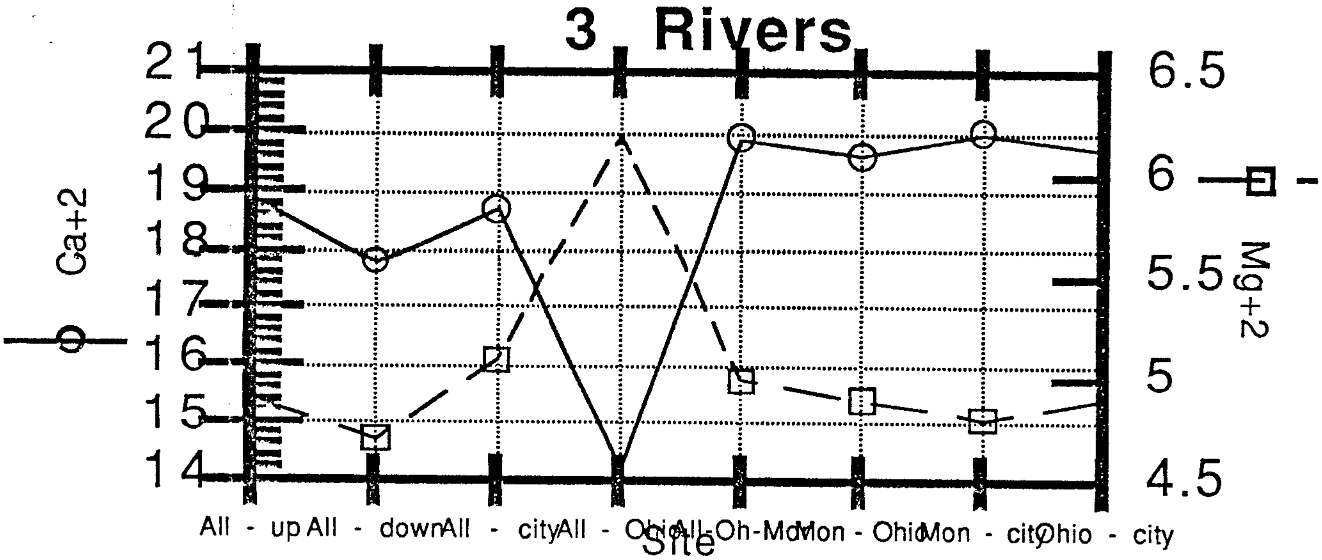

Anions also provided interesting results. Sulfate levels, usually around 5-12mg/L in clean water streams, showed extraordinarily high values in the Three Rivers. Only one site, the Ohio city sample, showed any NO3-. In this site where it did appear on the charts, only 0.2 mg/L was detected. This is to be expected because NO3- is an algal nutrient that is utilized and firmly held by the ecosystem. Only rarely and in small amounts is it usually found.[7]

VIII. Interpretation of Data

The Allegheny, Monongahela and Ohio River samples showed interesting trends both generally and locationally. Professor Dethier suggested that our sulfate levels would range from 5-12 mg/L. My samples, however, were much higher, between 42.1 and 51.2 mg/L as shown by Graph 2.

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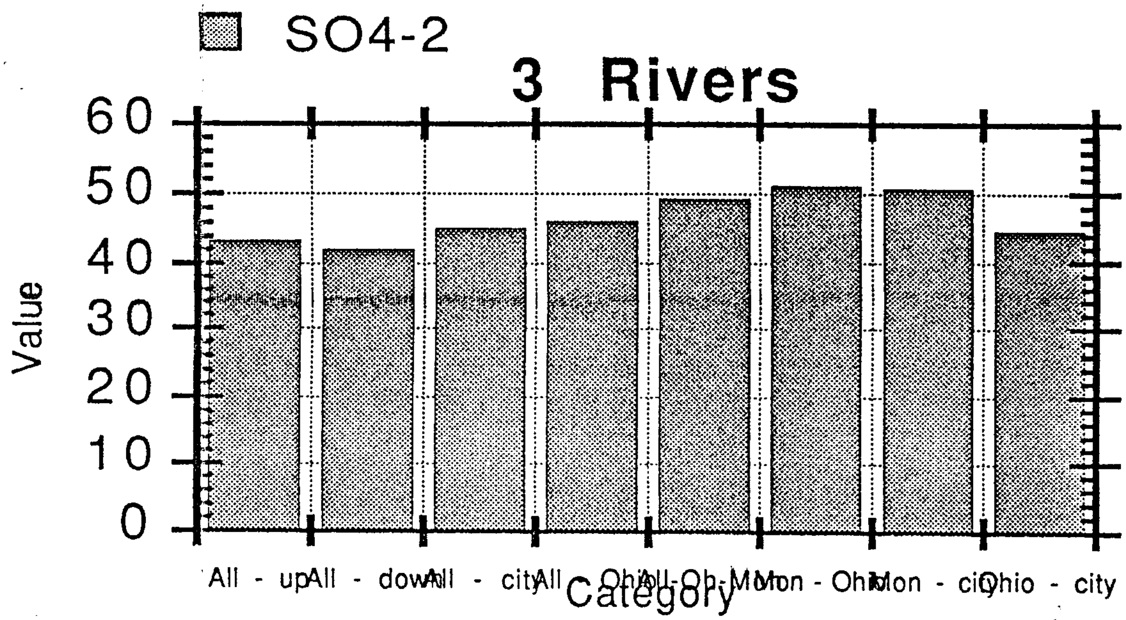
[7] From Prof. Kegley's 'mailbox information' as well as Prof. Dethier's lecture.



Considering the history of the area, these figures are not surprising. The Pennsylvania coal mines, located along all three of the rivers, put sulfur from the coal into the river which forms sulfate *on exposure to oxygen* in water. The steel mills also deposited coal waste into the rivers which added still more sulfur. It would seem that this 'acid mine water', as Prof. Kegley's handout calls it, would considerably acidify the pH's of all of the rivers. A glance at pH levels shows that this is not true. Instead, the pH's of the rivers are very close to a pure 7. Investigation of calcium levels show that these are higher than expected also. This indicates that the waters receive the weathering effects of limestone, marble and other carbonate-rich rocks, which send excess Ca+2 into the water. It is *the carbonate* ~~this calcium~~ that neutralizes the acidity of the *sulfuric acid formed on rxn. w/ $S + O_2 + H_2O$* ~~sulfate.~~ The Monongahela River had the highest amounts of both sulfate and calcium. This is not surprising since this river is the best known for its crowding of coal fields all along the river, starting in West Virginia and moving northeast into the city, where the steel mills dominated this river because of its coal fields. All of the rivers receive coal additives, but the Monongahela probably receives the most because it has the greatest number of mines and mills.[8] Graphs 3 and 4 show the relationships between Ca+2 vs. SO4-2 and Ca+2 vs. pH. While the patterns

[8] This information comes from my mom, a fifth grade teacher who studied her textbooks and the World Book Encyclopedia for me. She's the best. (!)

If you really want to show relationships, plot one variable on the x-axis + one on the y-axis. Then you can get a correlation coefficient that has meaning.

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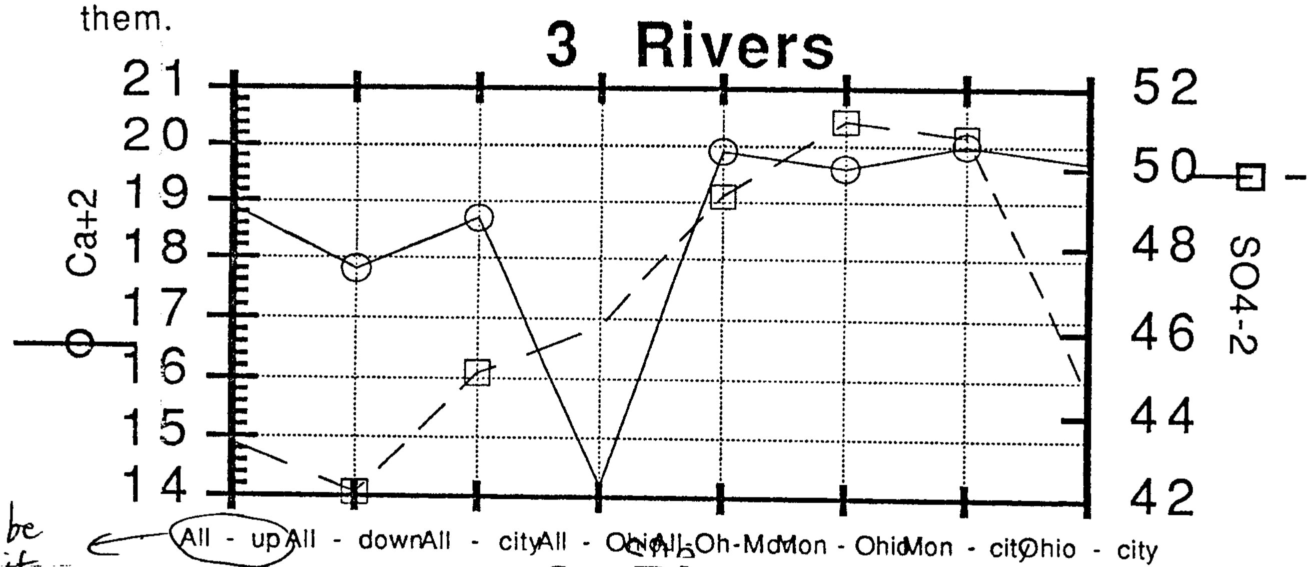
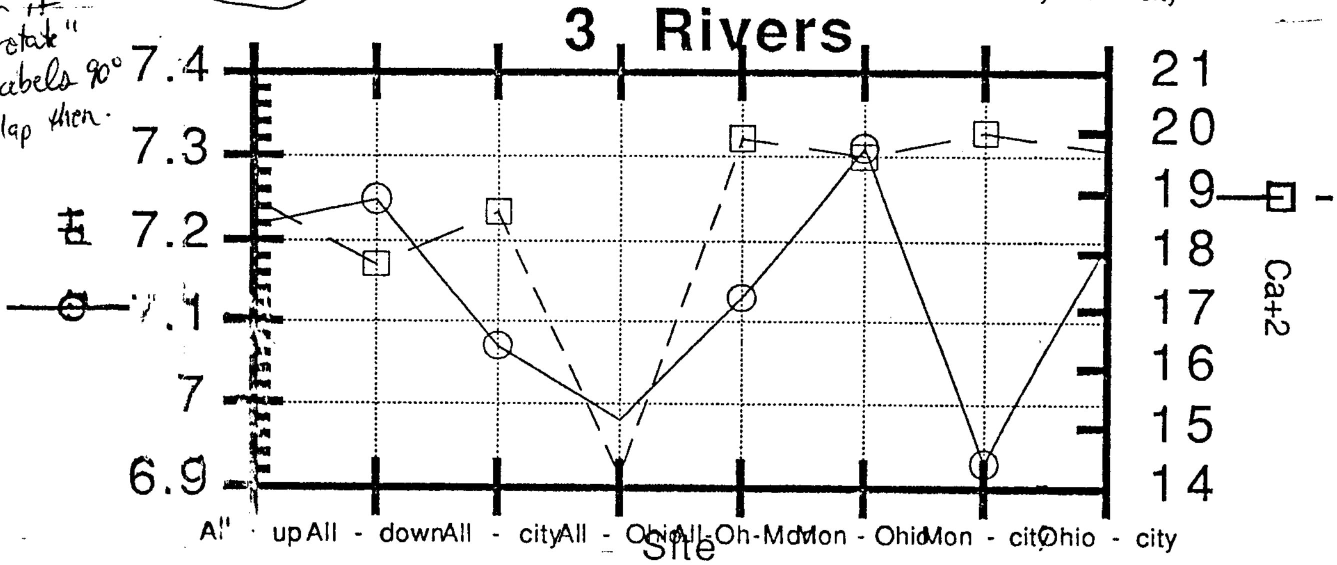
do not follow exactly, there is clearly some proportionality between the them.



would be clearer if you "rotate" these labels 90° No overlap then.



Chloride levels in the rivers are not exceedingly high, but high enough to suggest water treatment. It is important to note that the chloride level of the Allegheny river increases downstream from the water treatment plant in Fox Chapel, as is clear on Graph 5.

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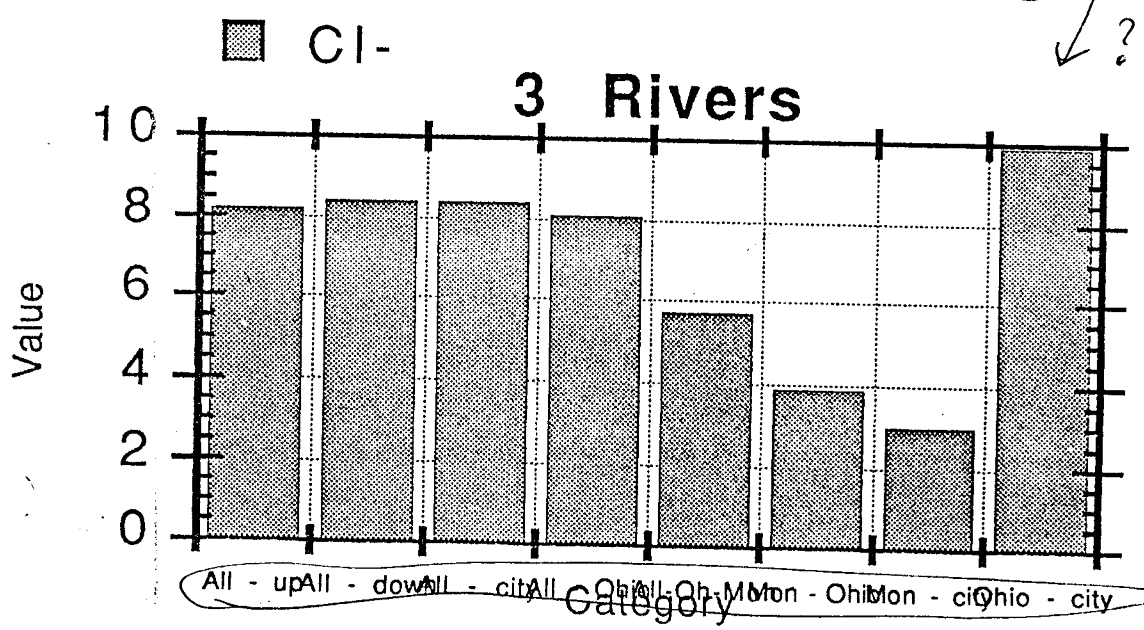


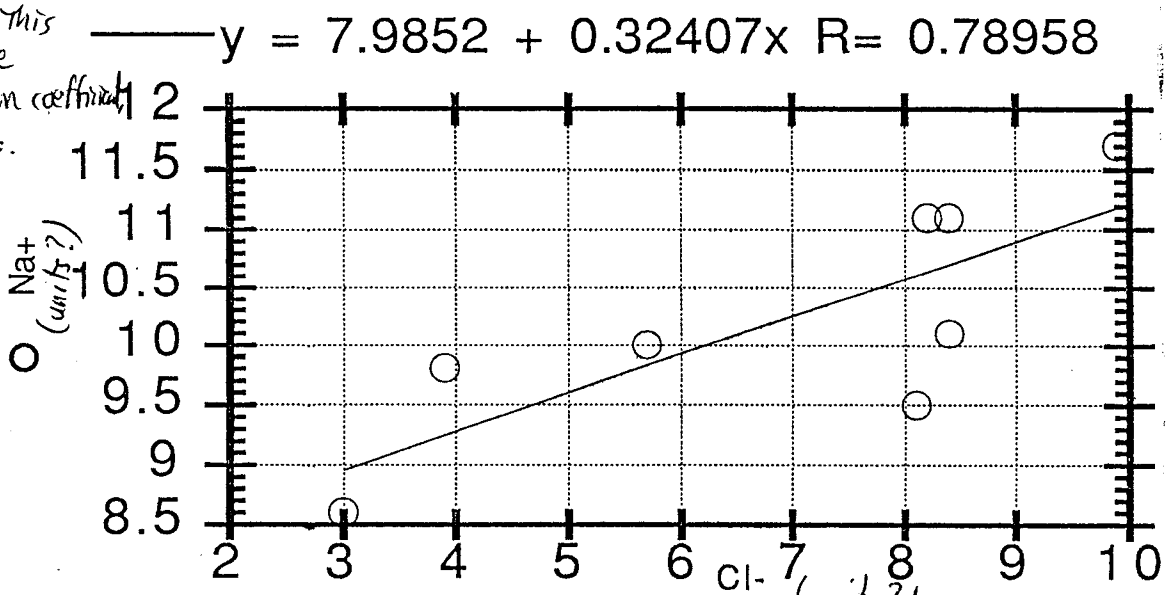
which site is upstream of another?

hard to tell what going on here.

KB 15

Potassium and pH levels also rise past the treatment plant, which may be coincidental, but also suggest the addition of potassium and something basic to the water at the plant. Prof. Dethier said, though, that high Cl- and low Na+ readings are the indicators of treated water. Here, sodium is higher than chloride. Graph 6 shows a line between the two on which 78.9% of all of the points fall.

No. This is the regression coefficient not a %.



Thus, while Na+ is higher than expected, the two are quite proportional. This additional sodium is usually connected with salt-water pollution, and may kill plants.[9] This high sodium does not increase near the water treatment plant, though; instead these levels stay the same: 11.1 mg/L. The highest amount of sodium was detected in the Ohio River, the sampling site located downstream from the Neville Island nuclear power plant. This sodium excess may be an indicator of other things coming from the plant. Sodium in these concentrated amounts may also be the culprit of bacteria killing. It is important to note here that the Ohio city

Likely not in these amts.

[9] This ion source information, as well as most of my source information, comes from Prof. Kegley's handout and discussion with my professors.

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sample was the only one that showed any nitrate. While the amount of nitrate is very minimal and well below the threshold level, the fact that an algal nutrient shows up past the nuclear plant probably also indicates chemicals flowing into the water from Neville Island.

Those things that tested in their normal range, (alkalinity, magnesium, and potassium) all had their maximum amounts in Allegheny river water. The only flouride that appeared was in the Monongahela water in its city and Ohio merger samples, but only in minute amounts. As Professor Dethier predicted, no phosphate appeared, since the ecosystem clings tightly to any PO_4^{-3} If any phosphate had been detected it would have indicated highly polluted waters, thus these rivers are not that polluted in those terms.

IX. Conclusions

There was an article in The Pittsburgh Press that really got me started on the subject of Pittsburgh water quality.[10] I foolishly thought that I would remember the date of the paper, but of course I do not (It was, however, during the week of March 16). The headline reads, "Fish from three rivers dangerous to eat". The article goes on to explain how high levels of chlordane (a pesticide), and PCB's have been discovered in fish caught in the rivers. This made me nervous. After all, my family's own drinking water comes from the 'Mon', and others get theirs from the other two.

Other things I would like to look into would include further testing of what is being emitted by the Neville Island nuclear plant, and what

[10] A copy of this article is at the end of this paper, Appendix C.

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runoff, if any, is still coming from the closed steel mills. For the most part, though, my investigation eased my mind as to the general water quality of the rivers, but the Press article serves as a reminder that my tests do not nearly tell the whole story. Many other contaminants and pollutants are probably in the water that these basic chemistry tests were not able to indicate. Nonetheless, I am satisfied that those things that are considered essential to water quality showed no overly frightening or deadly results. Management of the environment has worked fairly well, it would seem, and in my future career as Senator of Pennsylvania (that's right before I get elected President) I will continue to watch over these three resources that are so important to Pittsburgh.

Great!

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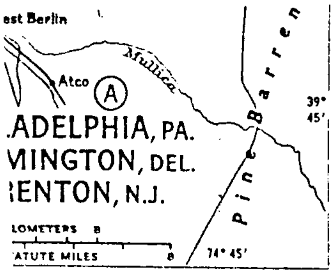
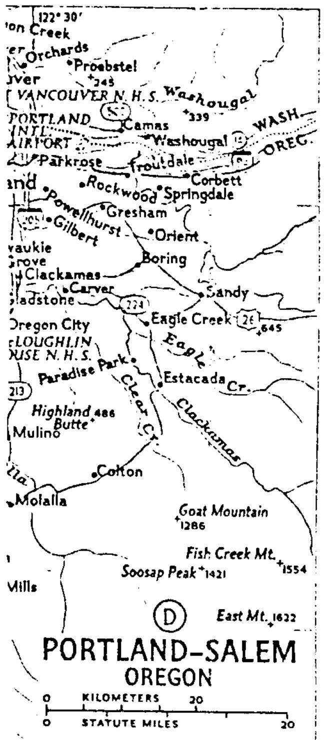
Appendix A – Map 1

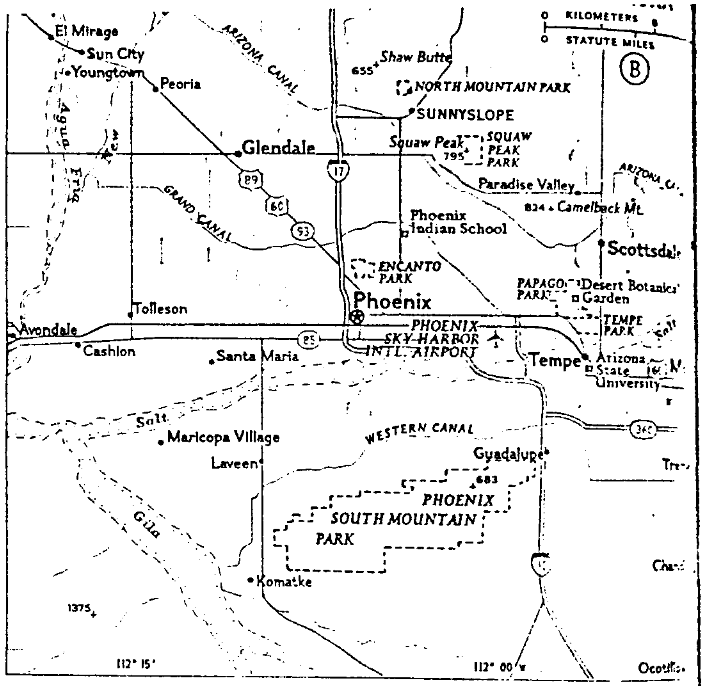


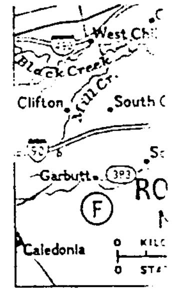


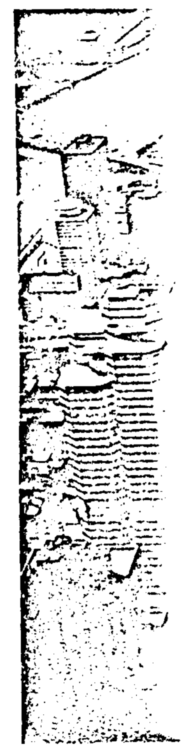
football Breakers.
***Metro Pop:** 1,341,000*

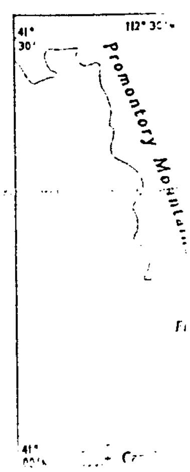
SALEM

State capital, agricultural center.
***Manufactures:** food products (vegetables, fruits, berries), lumber, wood products.*
***Attractions:** Bush House, Bush Barn Art Center, Mission Mill Village.*
***Metro Pop:** 255,000.*









71° 15'
PROVIDENCE
RHODE ISLAND

PHOENIX

Arizona capital and fast-

PITTSBURGH

Redevelopment

Appendix B

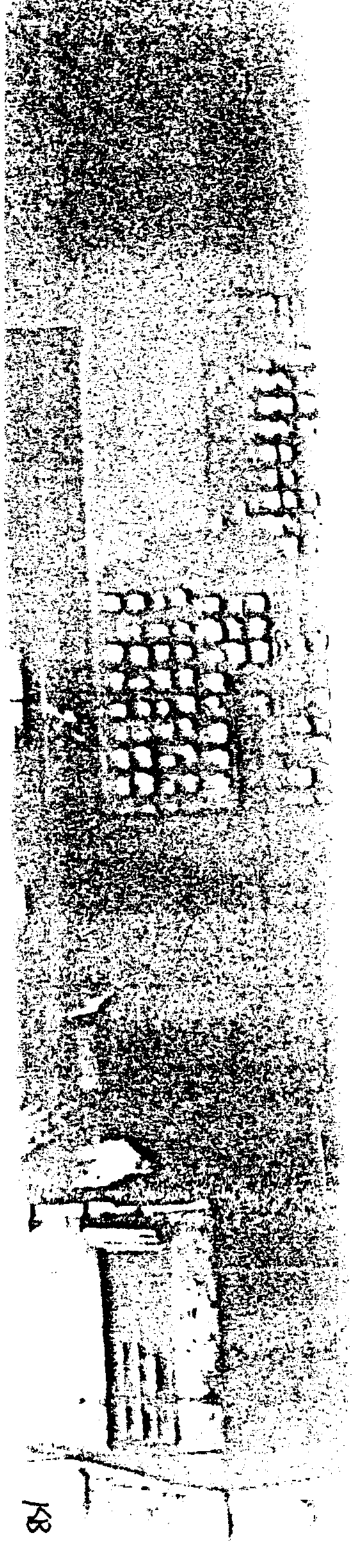
Courtesy *Allegheny Conference on Community Development.*

BEFORE SMOKE CONTROL — A PHOTOGRAPH IN THE WINTER OF 1945 AT 9 O'CLOCK IN THE MORNING.

formula for the prevention of smoke. Finally three men in Pittsburgh had decided it was time to act. This was the first battle for smoke control, fought and won before the coming of the Pittsburgh renaissance. The men who led

Abraham L. Wolk, a gentle and voluble man, filled with evangelistic fervor for the good causes his good heart taught him to embrace.

The mayor of the city, Cornelius D. Scully, gave them



Appendix C

...was dead. Nearby, ...ons and other drug

...ar-old man from the Presbyterian University ... erdose and released.

An... medics were ... block of Burrows Street, Hill Distr..., The unidentified man ran from medics ... aroused.

...burg ... pie," ... support ... we have

see Cuts, B4

St... bid... job — ...

Pleas...

Fish from three rivers dangerous to eat

Fish caught in Pittsburgh's three rivers could be hazardous to your health if eaten, three state agencies have warned.

The departments of Health and Environmental Resources and the Pennsylvania Fish Commission say they base their findings on 1990 data and that of previous years.

Certain fish taken last fall from parts of the rivers continued to show levels of chlordane and polychlorinated biphenyls (PCBs) above the "action levels" established by the U.S. Food and Drug Administration.

PCBs were widely used in transformer oils and other electrical products before 1977 when their manufacture was banned and use restricted. Chlordane, a pesticide widely used in the past, is now strictly regulated by the federal government.

PCBs and chlordane are suspected cancer-causing agents. PCBs are stored in the fish fat, so fattier fish normally have higher levels. Anglers may limit their exposure by eating smaller, younger fish.

The state agencies yesterday reaffirmed fish consumption advisories that the public not eat:

- Carp from the Allegheny River at Lock and Dam 3 at Acmetonia downstream to the Point in Pittsburgh; from the Monongahela River at Lock and Dam 2 at Braddock downstream to the Point at Pittsburgh; and from the Ohio River from the Point at Pittsburgh downstream to the state border in Beaver County.
- Channel catfish caught at the Montgomery Lock and Dam on the Ohio River at Ohio View in Beaver County.
- White bass from the Monongahela and Cheat rivers near Point Marion in Greene and Fayette counties.
- Carp and channel catfish from the Monongahela River at the Maxwell Lock and Dam in Washington and Fayette counties.
- Channel catfish from the Allegheny River at Lock and Dam 3.
- Channel catfish from the Ohio River at the Dashields Lock and Dam.

However, the agencies lifted an advisory last issued in 1989 for channel catfish taken from Lock and Dam 2 on the Monongahela River at Braddock.

The past four years of sampling at this location have shown declining levels of contamination in that type of fish, particularly for chlordane.

To prevent ingestion of contaminants from any type of fish, the agencies recommend the following food preparation tips:

- Remove the skin, and trim fat from under the dorsal fin along the fish's back, belly and side.
- Broil or grill fish to allow any fat to drip away and limit contaminate exposure. The juices and fats that remain after cooking the fish should not be eaten or reserved for cooking other foods.

Parents face trial after infection kills untreated son, 8

ALTOONA (AP) — An Altoona couple who relied on prayer rather than medicine must stand trial in the death of their 8-year-old who was so weak from an infection that he couldn't chew soup noodles.

Dennis Nixon, 35, and his wife, Lorie, 39, were ordered held for trial yesterday on charges of involuntary manslaughter and child endangerment. Their son Clayton died Jan. 6 after suffering ear and sinus infec... testified that he was told the child was so weak the day before his death he could not eat.

"He did not have the strength to swallow the stars from chicken-and-stars soup," Goertz said.

Clayton complained of an earache Christmas Eve and died less than two weeks later. His parents, members of the Faith Tabernacle Congregation where Dennis Nixon's father is pastor, sought no medical treat...

Defense attorney Charles Wasovich called no witnesses during the 90-minute hearing. Outside the courtroom, he questioned whether the Nixons' rights were being respected.

"There is a legal contradiction between religious freedom under the Constitution and the laws of the Commonwealth," he said.

District Attorney William Haberstroh said state law requires that ... bound over for trial. The Nixons waived their scheduled April 5 arraignment. No trial date was set.

During the preliminary hearing, a forensic pathologist testified the child weighed only 32 pounds at death. Dr. Harold Cottle said most 8-year-olds of Clayton's build and 49-inch height should weigh between 45 and 65 pounds.

Internal organs appeared to be starved for water, the boy's eyes had ...

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