WYATT EARLY HARRIS & WHEELER, L.L.P.
ATTORNEYS AND COUNSELLORS AT LAW
1912 EASTCHESTER DRIVE
P.O. DRAWER 2086
HIGH POINT, NORTH CAROLINA 27261

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WILLIAM P. HARRIS
A. DOYLE EARLY, JR.
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KIM W. GALLIMORE
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ROBERT E. HAUSER
RETIRED

OFFICE ADDRESS
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HIGH POINT, NC 27260

TELEPHONE
(910) 884-4444

FACSIMILE
(910) 884-1102

March 16, 1998

FAX MEMORANDUM

FACSIMILE NO.: (336)771-4632

TO: Sherri Knight-DEHNR

FROM: Frederick G. Sawyer

RE: Lowery Street Property-City of Winston Salem I-40 Industrial Park (former Hawksnest Property)

Dear Sherri:

As discussed this morning, enclosed please find the legal description for the Lowery Street property Mr. Lowder is considering buying from the City of Winston Salem.

I look forward to hearing from you.

FGS:drd
Enclosure

CONFIDENTIALITY CODE

The information contained in this facsimile message is legally privileged and confidential information intended only for the use of the individual or entity names above. If the reader of this message is not the intended recipient, you are hereby notified that any dissemination, distribution, or copy of this telecopy is strictly prohibited. If you have received this telecopy in error, please immediately notify

EXHIBIT A

BEING ALL of Parcel B as shown on that map entitled "I-40 INDUSTRIAL PARK," #P-657, dated June 27, 1995, on file in the Engineering Records Center, Engineering Division, Public Works Department, City of Winston-Salem, and more particularly described as follows:

BEGINNING at point A in the eastern property line of W. Stokes Huff [Tax Lot 118, Block 544, Deed Book 1738, Page 1710], also a common corner of Huff Properties [Tax Lot 202, Block 2440; Deed Book 1818, Page 2479] and the City of Winston-Salem [Tax Lot 204, Block 2440]; thence with the southern boundary of Huff Properties S 75° 12'12" E 357.05 feet to a point, the southwest corner of Dimmette Realty Company [Tax Lot 107-K, Block 2440; Deed Book 1693, Page 628]; thence with the southern boundary of Dimmette Realty the following three courses: S 72° 51' 34" E 246.67, feet S 86° 09'59" East 138.51 feet; and 48° 53'28" E 30.9 feet to a point, the southwest corner of Taracorp, Inc. [Tax Lot 107-T, Block 2440; Deed Book 1767, page 4179]; thence with the southeasterly boundary of Taracorp, Inc. The following two courses and distances: N 48° 53'28" E 358.69 feet and N 52° 15'49" E 430.54 feet to a point in the southern right-of-way line of Lowery Street; thence with the southern right-of-way line of Lowery Street the following three courses and distances: N 73° 00'53" E 60 feet to a point; thence with a curve to the right have a radius of 547.81 feet, a chord bearing and distance of N 85° 07'10" E, 229.75 feet, and a length of 231.47 feet to a point; thence S 82° 46'34"E 100.00 feet to a point in Brushy Fork Creek, the northwesterly corner of Flakt Products, Inc. [Tax Lot 107-Q, Block 2440; Deed Book 1590, page 1413]; thence with the meanderings of Brushy Fork Creek, also the western boundary of Flakt Products, Inc., the following eleven courses and distances: S 58° 27'27" W 125.21 feet; S 78° 16'09"W 206.32 feet; S 42° 10'50" W 71.51 feet; S 60° 45' 57" 143.27 feet; S 29° 22'21" W 91.79 feet; S 26° 33' 01" E 100.62 feet; S 24° 27'31" W 60.42 feet; S 36° 02'32" W 68.01 feet; S 75° 32'40" W 160.08 feet; S 35° 33'09" W 86.02 feet; S 59° 27'14" W 121.94 feet and S 47° 37'13" W 130.21 feet to a point in the northern right-of-way line of the Southern Railroad; thence with the northern right-of-way line of the Southern Railroad the following three courses and distances: N 83° 02'07" W 110.00 feet; S 52° 53'53" W 124.58 feet and thence with a curve to the right having a radius of 2,814.56 feet, a chord bearing and distance of N 76° 29' 07" W 653.42 feet, and a length of 654.90 feet to point C, also the southeastern corner of Parcel A of the within described map; thence with the eastern boundary of Parcel A N 10° 42'54" E 232.67 feet to point B, the northeast corner of said Parcel A and the southeast corner of W. Stokes Huff; thence with the eastern boundary of W. Stokes Huff N 10° 42'54" E 82.00 feet to the point and place of BEGINNING, containing 10.0778 acres, more or less.

Also commonly described as Tax Lot 204, Block 2440, Tax maps of Forsyth County as presently constituted.

The Grantor reserves unto itself an easement for ingress, egress, and regress [including, but not limited to, the right to construct, maintain, repair and replace a road] and for the construction, repair, replacement, and maintenance of public or private utilities, including but not limited to water, sewer, natural gas, telephone, and electric utilities. This easement extends twenty (20) feet in width on the easterly side of and adjacent and parallel to the western boundary of the tract herein conveyed, which easement is more particularly described on Map #P-657 hereinabove referred to.

NORTH CAROLINA DEPARTMENT OF
ENVIRONMENT AND NATURAL RESOURCES
WINSTON-SALEM REGIONAL OFFICE

NCDENR

JAMES B. HUNT JR.
GOVERNOR

WAYNE MCDEVITT
SECRETARY

DIVISION OF WATER QUALITY
GROUNDWATER SECTION

March 17, 1998

Mr. Gene Lowder
c/o Frederick G. Sawyer
Wyatt Early Harris & Wheeler, L.L.P.
P. O. Drawer 2086
High Point, NC 27261

SUBJECT: Lowery Street Property
City of Winston-Salem I-40 Industrial Park/Hawksnest Sports
Dunleith Avenue, Winston-Salem, Forsyth County

Dear Mr. Lowder:

In a phone conversation on March 12, 1998 with Rick Sawyer, he requested on your behalf that the Division of Water Quality provide a statement addressing the current regulatory status of the site. He also asked that we include any implication of effect the contamination present on the adjacent property could have on a purchaser of that parcel of land.

The State's rules concerning violations of the North Carolina groundwater standards are contained on Title 15A, Subchapter 2L, NCAC. When soil or groundwater contamination is identified at a site, these rules require assessment of the source, significance and extent of the contamination including delineation of both vertical and horizontal extent of contamination by the responsible party. Once assessment of the contamination is deemed complete by the Division, implementation of a corrective action plan is required.

Current Section policy requires that groundwater pollution incidents response be based on a priority ranking system, as there are more incidents of contamination that our staff can reasonably manage. Priority is given to sites where human health and safety are threatened by exposure to contaminants via consumptive and other direct use of groundwater, or by exposure to potentially explosive situations due to collected and concentrated vapors. We are not aware of any potentially affected receptors at this site although information is limited. Therefore, this site and the adjacent parcels are categorized as low priority, and as such, would receive no further regulatory review at this time including identification of responsible parties. However if the priority status of this site, system of site review, or regulatory rules should change, the Division would begin active review.

The contamination noted in the February 6, 1998 Engineering Tectonics report documents low level groundwater contamination of several tentatively identified compounds which do not have an established North Carolina groundwater standard. In these cases, any parameter identified above detection is considered in violation of the groundwater quality standards.

The responsibility for assessment and remediation of soil and groundwater contamination is assigned to the person or persons who conducted or controlled an activity which resulted in the groundwater contamination as defined by the groundwater rules. Liability is typically not assigned to a person or persons due to a purchase of contaminated property when a responsible party for the contamination can be identified. However, owning or controlling property from which contamination is discharging from an active source or from contaminated soil or groundwater could result in responsibility for a cleanup for the owner if other responsible parties cannot be identified. A review of the file indicated that the contaminants may be coming from a former asphalt batch plant located in the area (same site?/adjacent site?) although other potential sources were also identified in the past including demolition fill, storm drains and sewer lines. It is somewhat unclear which parcel is being considered. A 1990 report filed with this Division called the I-40 Industrial Park site as containing two parcels; one owned at that time by Hawksnest Sports of Lewisville and the other owned by the City of Winston-Salem.

I hope that this letter further clarifies the Division's position on this particular site. Please note that the Division is a regularity agency of the State and does not have the capacity to determine liability between parties involved in real estate transactions. If you have any questions, please feel free to contact me at the letterhead telephone or address.

Sincerely,

Sherri V. Knight

Sherri V. Knight
Groundwater Supervisor

cc: WSRO Files

WYATT EARLY HARRIS & WHEELER, L.L.P.
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HIGH POINT, NC 27265

TELEPHONE
(910) 884-4444

FACSIMILE
(910) 884-1102

February 12, 1998

FAX MEMORANDUM

FACSIMILE NO.: 771-4632

TO: Sherri Knight-DEHNR

FROM: Frederick G. Sawyer

RE: Gene Lowder, Potential Purchase of Property Located at I-40 and Industrial Park-Former Hawks Nest Sports-Dunleith Ave. site), Winston-Salem, NC

Dear Sherri:

I regret that we have been unable to speak by telephone this week. I have tried you several times, but I understand you are out of the office.

I assume by now you have had an opportunity to read Engineering Tectonics final groundwater assessment report, dated February 5, 1998 on the above-referenced property. I would appreciate an opportunity to discuss this report with you at your earliest convenience. Mr. Lowder is trying to finalize a closing on the property, but as you know from our prior conversations an important consideration for Mr. Lowder is your department's reaction to these test results and the regulatory status of the property.

Please call me at your earliest convenience to discuss the matter. My direct number is 884-1000, extension 237. I know you have a busy schedule, but I believe we can resolve this in a short time if we can speak about the matter. I look forward to hearing from you.

FGS:drd
cc: Gene Lowder (via telecopier 766-1943)
cc: Barry Nelson-Engineering Tectonics (via telecopier 724-7095)
cc: Ronald Matamoros (via telecopier 761-1530)

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NORTH CAROLINA DEPARTMENT OF
ENVIRONMENT AND NATURAL RESOURCES
WINSTON-SALEM REGIONAL OFFICE

NCDENR

JAMES B. HUNT JR.
GOVERNOR

WAYNE MCDEVITT
SECRETARY

DIVISION OF WATER QUALITY
GROUNDWATER SECTION

April 7, 1998

Mr. Gene Lowder
c/o Frederick G. Sawyer
Wyatt Early Harris & Wheeler, L.L.P.
P. O. Drawer 2086
High Point, NC 27261

SUBJECT: Lowery Street Property
City of Winston-Salem I-40 Industrial Park/Hawksnest Sports
Dunleith Avenue, Winston-Salem, Forsyth County

Dear Mr. Lowder:

I have reviewed the additional information received on March 31, 1998 for the subject site prepared by Engineering Tectonics. The additional information and maps clarify the sites in question and I agree that the contamination that has been identified on the tract that you are intending to purchase (Block 2440 - Lot 204) appears to be migrating onto the site from the adjacent property formerly owned by LA Reynolds and occupied by an asphalt facility.

As mentioned in my March 17, 1998 letter, the responsibility for assessment and remediation of soil and groundwater contamination is assigned to the person or persons who conducted or controlled an activity which resulted in groundwater contamination as defined by the groundwater rules. Liability is typically not assigned to a person due to a purchase of contaminated property when a responsible party for the contamination can be identified. However, owning or controlling property from which contamination is discharging from an active source or from contaminated soil or groundwater could result in responsibility for a cleanup for the property owner if other responsible parties cannot be identified. In this case, you would not be considered a responsible party for groundwater contamination migrating onto the property from an off site source and we are not requesting that you undertake any remedial action.

585 WAUGHTOWN STREET, WINSTON-SALEM, NORTH CAROLINA 27107
PHONE 336-771-4600 FAX 336-771-4632
AN EQUAL OPPORTUNITY / AFFIRMATIVE ACTION EMPLOYER - 50% RECYCLED/10% POST-CONSUMER PAPER

Obviously this letter would not absolve you from any contamination emanating from sources on your site that may not have been identified. If you have any questions, please feel free to give me a call.

Sincerely,

Sherri V. Knight

Sherri V. Knight
Groundwater Supervisor

cc: WSRO Files

ENGINEERING TECTONICS, P.A.
GEOTECHNICAL & ENVIRONMENTAL ENGINEERS
P.O. Box I, Winston-Salem, NC 27108 (336) 724-6994

RECEIVED
N.C. Dept. of EHNR
MAR 31 1998
Winston-Salem
Regional Office

Wednesday, March 25, 1998

North Carolina Department of Environment
and Natural Resources
Division of Water Quality - Groundwater Section
Winston-Salem Regional Office
585 Waughtown St.
Winston-Salem, NC 27107

Attention: Sherri Knight

Subject: LARCO Site

Dear Ms. Knight

As discussed in our meeting of Monday, March 23, 1998, Engineering Tectonics, P.A. has developed a map showing the relationship between the old LA Reynolds tract and the City of Winston-Salem's tract off Lowery Street. Our client, Gene Lowder is trying to purchase the tract owned by the city. Tracts are identified for each of the previous and current owners below:

Block----545 lot------202B.
Block----544 lots-----118Aand 118B.
These are old LA Reynolds sites where an asphalt plant was located.*

Block----2440—lot------204.
This lot is currently owned by the City of Winston-Salem and is in the process of being purchased by Gene Lowder.

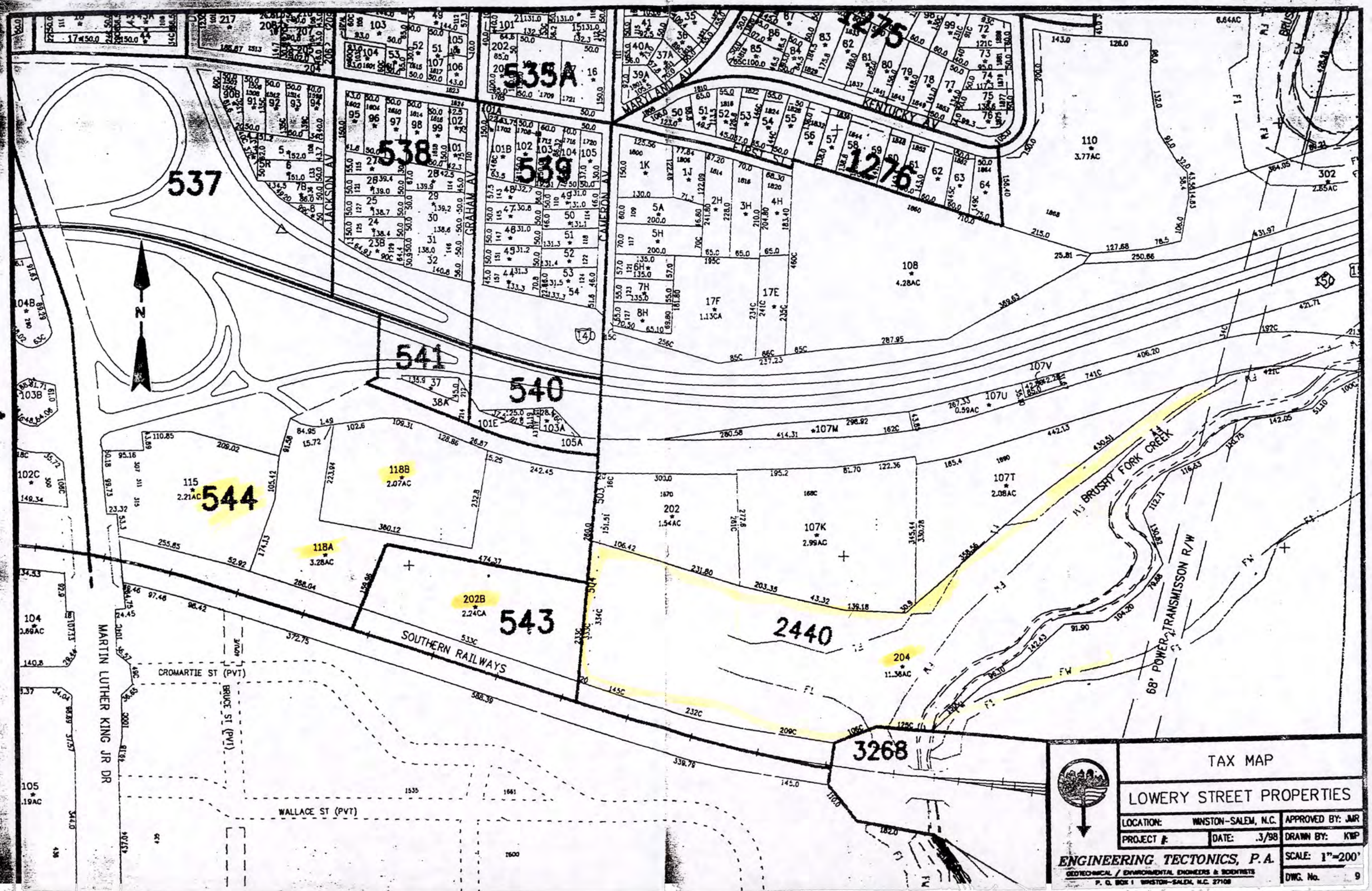
* Previously proposed as Piedmont Publishing Site.

Engineering Tectonics completed several assessments at the old LARCO site from 1987-1998. The results of the testing tends to support the contention that the LARCO site is the source of groundwater contamination on the tract Mr. Lowder wishes to develop.

If you have any questions, please contact me at (336) 724-6994 ext. 104.

Sincerely,

A.B. Nelson, P.G.
Senior Hydrogeologist



TAX MAP
LOWERY STREET PROPERTIES
LOCATION: WINSTON-SALEM, N.C.
APPROVED BY: JMR
PROJECT #:
DATE: .3/98
DRAWN BY: KWP
SCALE: 1"=200'
DWG. No. 9
ENGINEERING TECTONICS, P.A.
GEOTECHNICAL / ENVIRONMENTAL ENGINEERS & SCIENTISTS
P. O. BOX 1 WINSTON-SALEM, N.C. 27108
537
538
539
535A
1275
1276
541
540
544
543
2440
3268
MARYLAND AV
KENTUCKY AV
FIRST ST
JACKSON AV
GRAHAM AV
CAMERON AV
SOUTHERN RAILWAYS
BRUSHY FORK CREEK
68' POWER TRANSMISSON R/W
MARTIN LUTHER KING JR DR
CROMARTIE ST (PVT)
BRUCE ST (PVT)
WALLACE ST (PVT)
N

WYATT EARLY HARRIS & WHEELER, L.L.P.
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TELEPHONE
(910) 884-4444

FACSIMILE
(910) 884-1102

April 6, 1998

FAX MEMORANDUM

FACSIMILE NO.: 771-4632

TO: Sherri Knight-DEHNR

FROM: Frederick G. Sawyer

RE: Lowery Street Property-City of Winston Salem I-40 Industrial Park (former Hawksnest Property)

Dear Sherri:

I assume by now you have received Engineering Tectonics' March 25, 1998 letter with revised maps, which letter you had requested during our March 24, 1998 meeting at your office. We also understand, based on agreements we reached during that meeting, that DEHNR would issue a no further action letter on this site.

Because of the pending real estate purchase, we had hoped to have your letter last week. In any event, I would appreciate if you could fax this letter to my attention at your earliest convenience. My direct fax number is 884-1102.

Thanks for your attention to this request.

FGS:drd
cc: Gene Lowder-Lowder Inc (via telecopier: 766-1943)

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RECEIVED
N.C. Dept. of
MAR 2 6 1998
Winston-Salem
Regional Office

Wednesday, March 25, 1998

North Carolina Department of Environment
and Natural Resources
Division of Water Quality - Groundwater Section
Winston-Salem Regional Office
585 Waughtown St.
Winston-Salem, NC 27107

Attention: Linda Estowski

Subject: LARCO Site

Dear Ms. Estowski,

As discussed in our meeting of Monday, March 23, 1998, Engineering Tectonics, P.A. has developed a map showing the relationship between the old LA Reynolds tract and the City of Winston-Salem's tract off Lowery Street. Our client, Gene Lowder is trying to purchase the tract owned by the city. Tracts are identified for each of the previous and current owners below:

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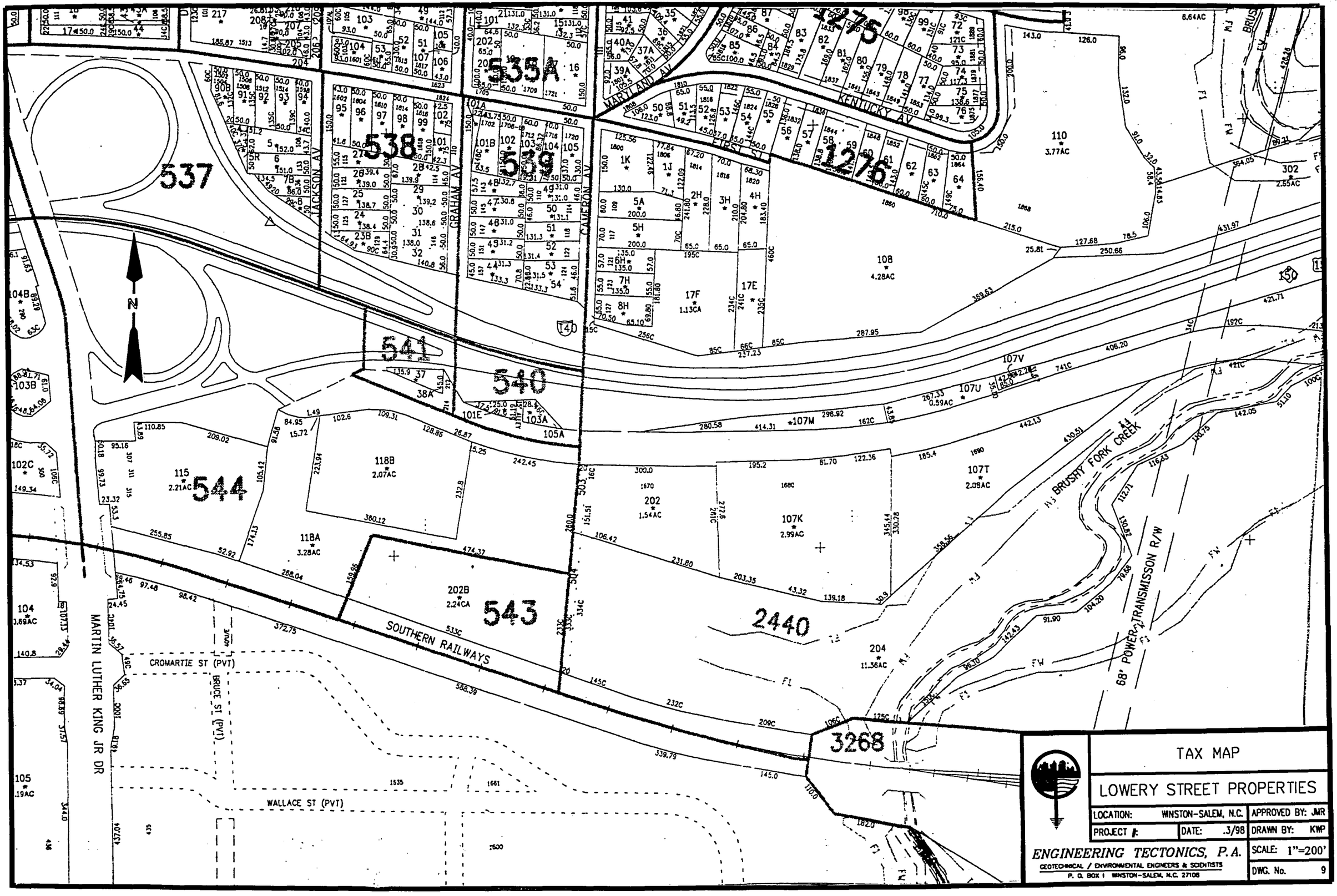
If you have any questions, please contact me at (336) 724-6994 ext. 104.

Sincerely,

A.B. Nelson, P.G.
Senior Hydrogeologist



TAX MAP

LOWERY STREET PROPERTIES

LOCATION: WINSTON-SALEM, N.C.		APPROVED BY: JMR
PROJECT #:	DATE: .3/98	DRAWN BY: KWP
		SCALE: 1"=200'
		DWG. No. 9

ENGINEERING TECTONICS, P.A.
GEOTECHNICAL / ENVIRONMENTAL ENGINEERS & SCIENTISTS
P. O. BOX 1 WINSTON-SALEM, N.C. 27108

Aerial Photograph

LOWERY STREET PROPERTIES

LOCATION: WINSTON-SALEM, N.C.		APPROVED BY: JMR
PROJECT #:	DATE: 3/98	DRAWN BY: KWP
		SCALE: 1"=200'
		DWG. No. 9

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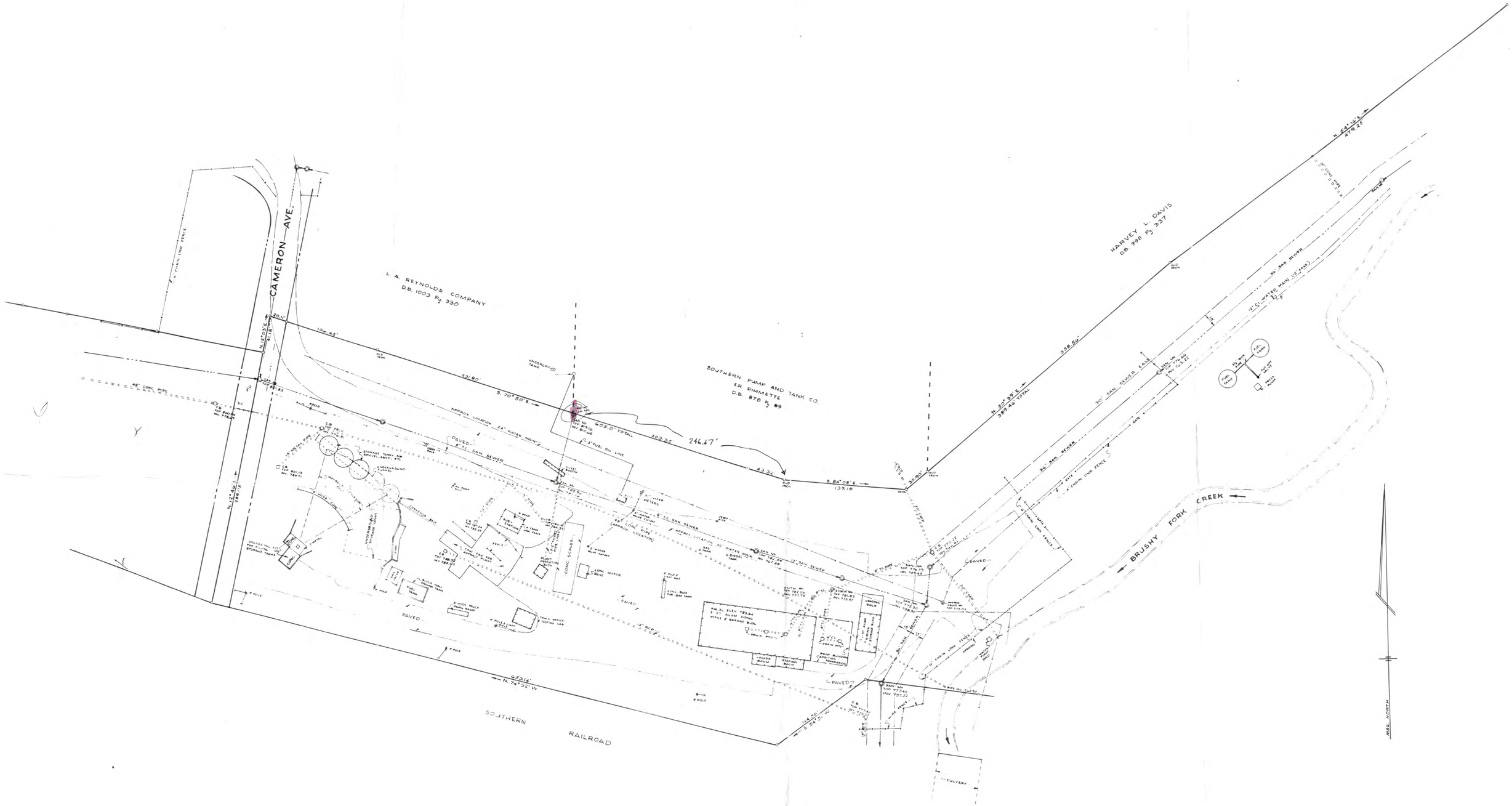
GEOTECHNICAL / ENVIRONMENTAL ENGINEERS & SCIENTISTS
P. O. BOX 1 WINSTON-SALEM, N.C. 27108

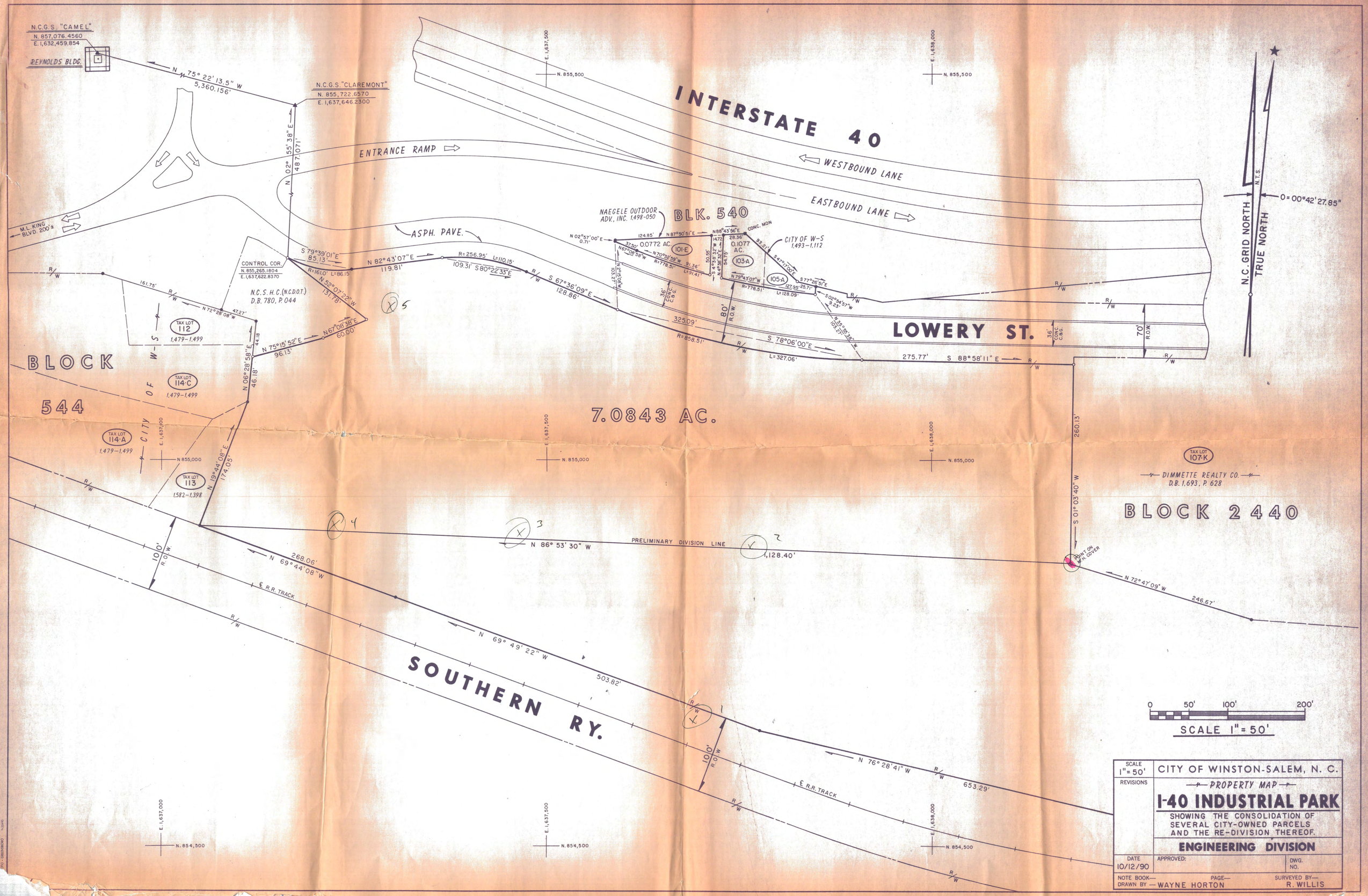


PREPARED FOR
L. A. REYNOLDS COMPANY
BY
JOYCE ENGINEERING & MAPPING CO., INC.
WINSTON SALEM, N.C.
BEING
A PART OF THE PROPERTY OF
L.A. REYNOLDS INDUSTRIAL DISTRICT, INC.

TOWNSHIP	COUNTY	STATE
WINSTON	FORSYTH	N.C.

DATE	SCALE 1" = 50'	MAP NO.
JAN. 1977	0 50' 100'	2-255-A

Thomas W. Joyce



N.C.G.S. "CAMEL"
N. 857,076.4560
E. 1,632,459.854
REYNOLDS BLDG.
N 75° 22' 13.5" W
5,360.156'
N.C.G.S. "CLAREMONT"
N. 855,722.6570
E. 1,637,646.2300
N 02° 55' 38" E
487.071'
INTERSTATE 40
ENTRANCE RAMP
WESTBOUND LANE
EASTBOUND LANE
M.L. KING BLVD. 200'±
ASPH. PAVE.
NAEGELE OUTDOOR ADV., INC. 1,498-050
BLK. 540
CONC. MON
CITY OF W-S 1,493-1,112
0.0772 AC.
0.1077 AC.
101-E
103-A
105-A
CONTROL COR.
N. 855,265.1804
E. 1,637,622.8370
N.C.S.H.C. (N.C.D.O.T.) D.B. 780, P. 044
S 79°39'01" E
85.13'
N 82°43'07" E
119.81'
R=256.95' L=110.15'
109.31' S 80°22'33" E
S 67°36'09" E
128.86'
N 52°07'22" W
131.78'
N 75°15'52" E
96.13'
N 67°08'38" E
60.00'
N 06°28'58" E
46.18'
N 19°44'08" E
174.05'
TAX LOT 112
1,479-1,499
TAX LOT 114-C
1,479-1,499
TAX LOT 114-A
1,479-1,499
TAX LOT 113
1,582-1,398
BLOCK 544
CITY OF W-S
7.0843 AC.
325.09'
R=858.51'
S 78°06'00" E
L=327.06'
275.77'
S 88°58'11" E
LOWERY ST.
80' R.O.W.
70' R.O.W.
36' CONC. C.&G.
260.13'
S 01°03'40" W
TAX LOT 107-K
DIMMETTE REALTY CO. D.B. 1,693, P. 628
BLOCK 2440
N 86° 53' 30" W
PRELIMINARY DIVISION LINE
1,128.40'
POINT ON M.H. COVER
N 72°47'09" W
246.67'
268.06'
N 69°44'08" W
100' R.O.W.
℄ R.R. TRACK
N 69° 49' 22" W
503.82'
SOUTHERN RY.
N 76° 28' 41" W
653.29'
N.C. GRID NORTH
TRUE NORTH
N.T.S.
0=00°42'27.85"
0 50' 100' 200'
SCALE 1"=50'
SCALE 1"=50'
REVISIONS
CITY OF WINSTON-SALEM, N. C.
PROPERTY MAP
I-40 INDUSTRIAL PARK
SHOWING THE CONSOLIDATION OF SEVERAL CITY-OWNED PARCELS AND THE RE-DIVISION THEREOF.
ENGINEERING DIVISION
DATE 10/12/90
APPROVED:
DWG. NO.
NOTE BOOK—
DRAWN BY — WAYNE HORTON
PAGE—
SURVEYED BY— R. WILLIS

LOWERY STREET
I-40
INDUSTRIAL PARK
EXTENSION

N

R.O.W. FUTURE STREET
FUTURE STREET
APPROXIMATE LOCATION OF NATURAL GAS LINE

PROPOSED WELL LOCATIONS
3/90

TEMPORARY WAREHOUSE

PROPOSED ASPHALT PAVING

FUTURE DISTRIBUTION

ACCESS ROAD

FUTURE OFFICE

FUTURE PRESS

PROPOSED WAREHOUSE
FIN. FL. ELEV. 842.00'±

SOUTHERN RAILWAY

B1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 B18 B19 B20 B21 W B22 B23 B24 W B25 W B26 B27

LEGEND

- 1987 BORINGS
- 1988 BORINGS
- W BORINGS WITH MONITORING WELL
- PROPERTY LINE
- TOPOGRAPHY

NOTE 1: EXISTING STOCKPILES OF FILLS IN AREA OF FUTURE DISTRIBUTION, PRESS AND OFFICES HAVE BEEN LEVELED AND REGRADED SINCE THE 6-22-87 TOPOGRAPHIC SURVEY. TOPOGRAPHY IN THESE AREAS MAY THEREFORE BE INACCURATE.

NOTE 2: PROPERTY LINE INFORMATION TAKEN FROM A MAP ENTITLED "NEWSPRINT STORAGE FACILITIES - PIEDMONT PUBLISHING CO. INC." SHEET A-1 SUPPLIED BY CUNDIFF ASSOCIATES, WINSTON-SALEM, NC. TOPOGRAPHIC INFORMATION TAKEN FROM A MAP ENTITLED PORTION OF LOT 202 AND 111, TAX BLOCK 544 - PIEDMONT PUBLISHING CO." COMPILED BY JOHN G. BANE & ASSOCIATES, PA. AND IS NOT AN ACTUAL FIELD SURVEY BY ENGINEERING TECTONICS, P.A.

ENGINEERING TECTONICS, P.A.
ENGINEERS • GEOLOGISTS • HYDROLOGISTS
P.O. Box 11846, Winston-Salem, NC 27116

BORING AND WELL DIAGRAM

PIEDMONT PUBLISHING CO. INC.
WINSTON - SALEM, NORTH CAROLINA

3 - - 88	87 - 177 A&E
DRAWN BY: JB	APPROVED BY:

1" = 40' 40 0 40 80

SCALE: 1" = 40' FIGURE 2

VICINITY MAP

LEGEND

- CURB INLET
- IRON PIPE (SET)
- GAS VALVE
- LIGHT POLE
- UTILITY POLE
- WATER VALVE
- IRON PIPE (FND.)
- SANITARY MANHOLE
- STORM MANHOLE
- BDRY POINT
- FIRE HYDRANT
- CATCH BASIN
- HANDICAP PARKING

NC GRID NAD 83

LOWERY STREET

TO LOWERY STREET

EXISTING 40' UTILITY, INGRESS, EGRESS & REGRESS EASEMENT

PROPOSED 40' UTILITY, INGRESS, EGRESS & REGRESS EASEMENT

HUFF PROPERTIES
DB 1818 PG 2479
TAX LOT 202

TAX LOT 118
BLOCK 544

Vinyl SIDING

DIMMETTE REALTY CO.
DB 1693 PG 628
TAX LOT 107K

CITY OF WINSTON-SALEM
DB 1710 PG 2359
TAX LOT 204
BLOCK 2440

TARACORP, INC.
DB 1767 PG 4179
TAX LOT 107T

FLAKT PRODUCTS, INC.
DB 1590 PG 1413
TAX LOT 107O
BLOCK 2440

TAX LOT 202B
BLOCK 543

WATER & SANITARY SEWER EASEMENT

100 YR FLOOD PLAIN

FLOOD WAY (APPROX.)

BRUSHY FORK CREEK

SOUTHERN RAILROAD
100' R/W

N 10°42'54" E 82.00'
S 75°12'12" E 357.05'
821+/-
S 72°51'34" E 246.67'
S 86°09'59" E 38.51'
N 48°53'28" E 30.90'
N 48°53'28" E 358.69'
N 52°15'49" E 430.54'
S 37°27'21" W 91.79'
S 26°33'01" E 100.62'
S 24°27'31" W 60.42'
S 36°02'32" W 68.01'
S 75°32'40" W 160.08'
S 35°33'09" W 86.02'
S 59°27'14" W 121.94'
S 47°37'13" W 130.21'
N 83°02'07" W 110.00'
S 52°53'53" W 124.56'
825+/-
N 76°29'07" W
RADIUS = 2814.56
CH= 653.42'
829+/-
N 10°42'54" E 232.67'

N 73°00'53" E 60.00'
CH= N 85°07'10" E 229.75'
RADIUS = 547.81
S 82°46'34" E 100.00'
S 58°27'27" W 125.21'
S 78°00'39" W 206.74'
S 42°10'50" W 71.51'
S 60°45'57" W 143.27'
80.00

820 810 800 790 780 825 826 827 828

NOTES:

1. THIS PLAN IS THE RENDERING OF A CONCEPTUAL IDEA ONLY.
2. THIS MAP IS NOT INTENDED FOR RECORDATION OR CONSTRUCTION.
3. TOPO WAS TAKEN FROM W-S AERIAL TOPO.
4. BOUNDRAY WAS TAKEN FROM CITY OF W-S PLAT P-656.
5. PROPERTY IS ZONED GENERAL INDUSTRIAL.

MAP REFERENCES
CITY OF W-S P-656
DEED REFERENCES
DB 1710 PG 2359

CONCEPTUAL PLAN

PREPARED FOR MARVIN EUGENE LOWDER

I-40 INDUSTRIAL PARK

TAX BLOCK 2440 LOT 204

WINSTON TOWNSHIP
FORSYTH COUNTY, NORTH CAROLINA

KUHN CONSTRUCTION SURVEYS
168 BUCKEYE TRAIL
MOCKSVILLE, NC 27028
(910) 998 - 3681

JOB NUMBER:	119-L
FILE NAME:	LOWDER1.DWG
ORIENTED TO:	GRID NORTH NAD 83
SURVEY BY:	NONE
SCALE:	1" = 60'
DATE:	02/27/97
PRECISION:	NA

60 0 30 60
(IN FEET)
1 INCH = 60 FEET
GRAPHIC SCALE

LAST REVISED

PROFESSIONAL SEAL

State of North Carolina
Department of Natural Resources and Community Development
Winston-Salem Regional Office

James G. Martin, Governor

William W. Cobey, Jr., Secretary

DIVISION OF ENVIRONMENTAL MANAGEMENT
GROUNDWATER SECTION

March 13, 1990

Hawksnest Sports
c/o A. Barry Nelson
Engineering Tectonics
P.O. Box 11846
Winston-Salem, N.c. 27116

Dear Gentlemen:

SUBJECT: MONITOR WELL CONSTRUCTION
PERMIT NO. 33-0375-WM-0113
FORSYTH COUNTY

In accordance with your application received March 9, 1990, we are forwarding herewith Monitor Well Construction Permit No. 33-0375-WM-0113 for the construction of three monitor wells in the Milton Belt Hydrogeologic Unit.

This Permit will be effective from the date of its issuance and shall be subject to the conditions and limitations as specified therein.

Sincerely,

Andrew M. Raring

Andrew M. Raring
Hydrogeological Regional
Supervisor

AMR/LDC/ahl
Enclosure
cc: Groundwater Section - Central Office
WSRO
County Health Department

NORTH CAROLINA

ENVIRONMENTAL MANAGEMENT COMMISSION

DEPARTMENT OF ENVIRONMENT, HEALTH AND NATURAL RESOURCES

PERMIT FOR THE CONSTRUCTION OF

A MONITOR WELL OR WELL SYSTEM

In accordance with the provisions of Article 7, Chapter 87, North Carolina General Statutes, and other applicable Laws, Rules, and Regulations.

PERMISSION IS HEREBY GRANTED TO

Hawksnest Sports

FOR THE CONSTRUCTION OF THREE MONITOR WELLS in the Milton Belt Hydrogeologic unit located at off Dunleith Avenue, Winston-Salem, North Carolina in Forsyth County in accordance with the application dated March 7, 1990, and in conformity with the specifications and supporting data, all of which are filed with the Department of Environment, Health and Natural Resources and are considered a part of this Permit.

This Permit is for well construction only, and does not waive any provisions or requirements or any other applicable laws or regulations.

Construction of a well under this Permit shall be in compliance with the North Carolina Well Construction Regulations and Standards, and any other laws and regulations pertaining to well construction.

This Permit will be effective from the date of its issuance until September 13, 1990, and shall be subject to other specified conditions, limitations or exceptions as follows:

1. A permanent identification plate with the date of construction, depth of well, screen interval, depth of grout, drilling contractor, and his registration number shall be attached to the well head or the outer protective steel casing.

2. The well construction completion form and all water quality data are to be submitted to the Central Office of the Groundwater Section P. O. Box 27687, Raleigh, North Carolina 27611.

3. All laboratory analysis of Groundwater samples collected from the permitted monitor wells are to be submitted to North Carolina Department of Environment, Health, and Natural Resources, Groundwater Section, P. O. Box 27687, Raleigh, N. C. 27611 with a copy to the North Carolina Department of Environment, Health and Natural Resources, Groundwater Section, 8025 North Point Boulevard, Suite 100, Winston-Salem, N. C. 27106 within 60 days of well completion, and quarterly thereafter.

4. All additional investigative findings in relation to the pollution sources being monitored, as indicated in item J of permit application, are to be submitted to North Carolina Department of Environment, Health and Natural Resources, Groundwater Section, P. O. Box 27687, Raleigh, N. C. 27611 with a copy to North Carolina Department of Environment, Health, and Natural Resources, Groundwater Section, 8025 North Point Boulevard, Suite 100, Winston-Salem, N. C. 27106 within 60 days of well completion, and quarterly thereafter.

5. The well shall be afforded a means of protection against vandalism, damage, or unauthorized use.

6. When any monitor well is no longer useful for its intended purpose, it shall be abandoned in compliance with North Carolina Administrative Code 15. 2C.0113 and a well abandonment form sent to the North Carolina Department of Environment, Health, and Natural Resources, Groundwater Section, P. O. Box 27687, Raleigh, N. C. 27611 with a copy to North Carolina Department of Environment, Health and Natural Resources, Groundwater Section, 8025 North Point Boulevard, Suite 100, Winston-Salem, N. C. 27106.

7. The monitor well shall be constructed in accordance with the Groundwater Section's recommended construction details as outlined in attachment #1.

Permit issued this the 13th day of March 1990

FOR THE NORTH CAROLINA ENVIRONMENTAL MANAGEMENT COMMISSION

Larry D. Coble

Larry D. Coble, Regional Supervisor
Division of Environmental Management

By Authority of the Environmental Management Commission

Permit No. 33-0375-WM-0113

MONITOR WELL PERMIT

DATE 3-13-90

NAME Hawksnest Sports

ADDRESS c/c A Barry Nelson
Engineering Tectonics
PO Box 11846, W-S, NC 27116

SALUTATION Dear Sir:

PERMIT NO. 33-0375-WM-0113

COUNTY Forsyth

DATE RECEIVED 3-9-1990

NUMBER OF WELLS 3

HYDRO UNIT Milton Belt

COMPNAY Hawksnest Sports

M.W. LOCATION off Dunleith ave, W-S, forsyth county, NC

APP DATE 3-7-90

EXP. DATE 9-13-90

DAY ISSUED 3-13-90

MONTH/YEAR ISSUED

ENGINEERING TECTONICS, P.A.
ENGINEERS • GEOLOGISTS • HYDROLOGISTS
P.O. Box 11846, Winston-Salem, NC 27116 (919) 767-8807

RECEIVED
N.C. Dept. NRCD
MAR 9 1990
Winston-Salem
Regional Office

March 7, 1990

NC Division of Environmental Management
Groundwater Section
8003 Northpoint Blvd.
Winston-Salem, N.C. 27106

Attention: Steve Williams

Gentlemen:

Please find enclosed a permit application for the construction of two groundwater monitoring wells at the old L.A. Reynolds site on Dunleith Avenue beside WSSU. I have attached a well schematic and a location diagram.

Please forward a copy of the permit to my attention. Thank you.

Very truly yours,
ENGINEERING TECTONICS, PA

A. Barry Nelson, PG
Chief Hydrolgeologist

NORTH CAROLINA
ENVIRONMENTAL MANAGEMENT COMMISSION
DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT

APPLICATION FOR PERMIT TO CONSTRUCT MONITOR/RECOVERY WELL(S)

To: NORTH CAROLINA ENVIRONMENTAL MANAGEMENT COMMISSION March 7, 1990

Gentlemen:

In accordance with the provisions of Article 7, Chapter 87, General Statutes of North Carolina, and regulations pursuant thereto, application is hereby made by Hawksnest Sports (name of well owner) for a permit to construct a monitor/recovery well(s) as described below and in the accompanying data submitted as a part of this application.

(a) Name of property owner: Hawksnest Sports

(b) Location of property: Off Dunleith Avenue, Winston-Salem, Forsyth (Road, Industry, Community, etc.) Town County

(c) Type of facility or site being monitored: Old industrial site

(d) Types of contamination being monitored or recovered: library scan to determine if pollutants are present

(e) Existing monitor well numbers: none

(f) Existing monitor wells showing contamination (well no.):

(g) Estimated water-table depth: 25 feet

(h) Estimated date of construction: Begin 3/12/90 Complete 3/15/90

(i) Drilling constractor: Engineering Tectonics, P.A.

(j) Location of well: Provide a detailed map showing the location of the proposed well(s), and of any wells in an existing monitoring system (if applicable), in relation to the pollution source(s) being monitored and to at least two (2) nearby permanent reference points such as roads, intersections, and streams. Identify roads with State Highway road identification numbers. (Show all existing water supply wells within a radius of 1,000 feet of the proposed well.)

(k) Well construction diagram: Provide a diagram showing proposed construction specifications, including diameter, estimated depth, screens, sand pack, grout, type of materials, etc.

The Applicant hereby agrees the proposed well will be constructed in accordance with approved specifications and conditions of the Well Construction Permit. As regulated under the Well Construction Standards (Title 15 - North Carolina Administrative Code, Subchapter 2C)

Signature of Well Owner or Agent

A. Barry Nelson, PG 165 Chief Hydrologist

Title (if applicable)

NORTH CAROLINA REGISTERED GEOLOGIST SEAL 165 A. BARRY NELSON

(Mailing Address of Well Owner-Required)

P.O. Box 11846 Winston-Salem, NC 27106

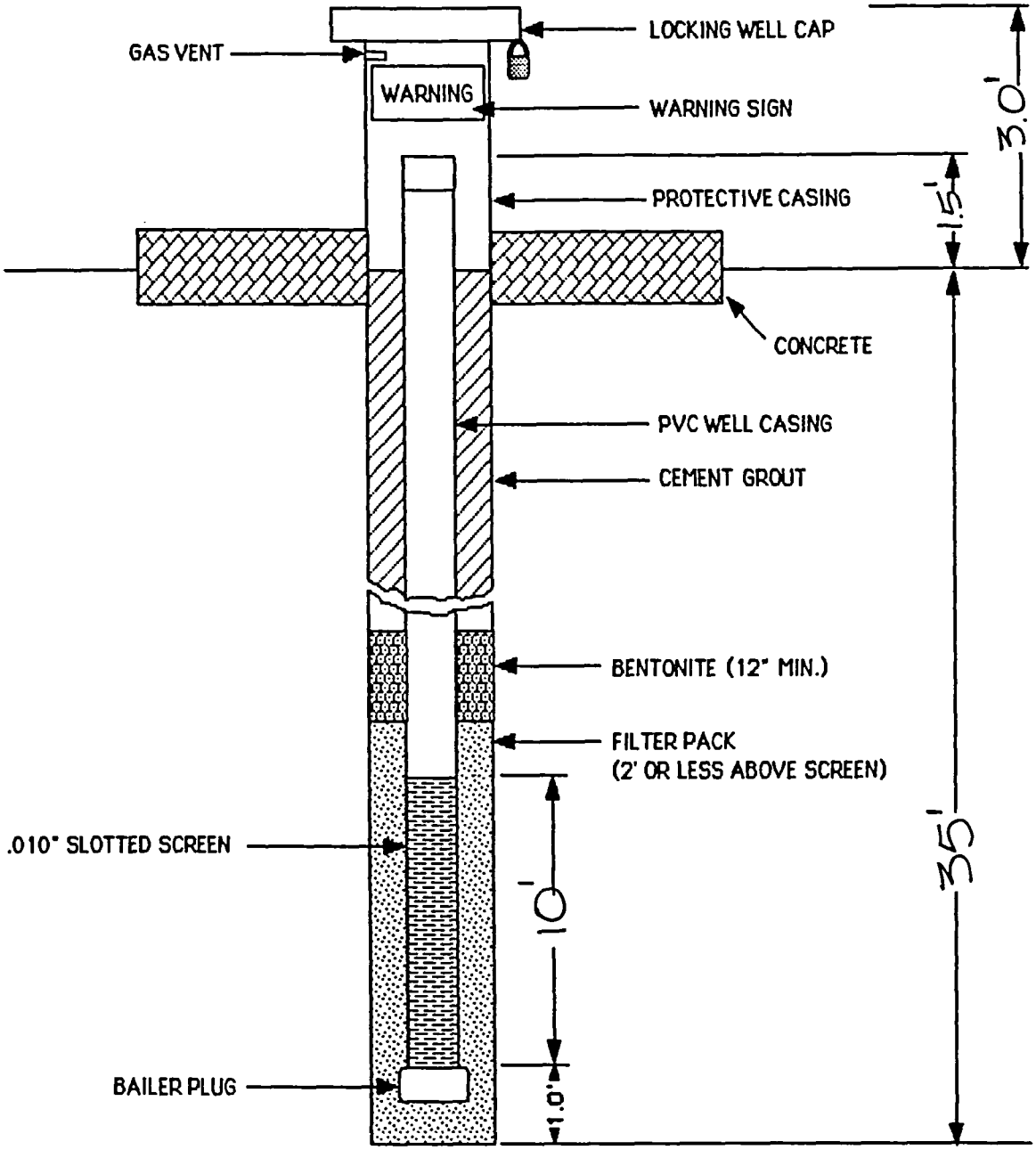
(Mailing Address of Agent-if other than above)

FOR OFFICE USE ONLY

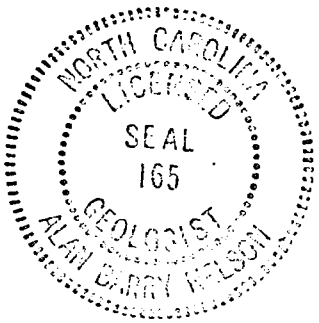
PERMIT NO. _____ issued _____ 19__

33-0375-WM-0113

GW-22B



DETAIL OF MONITORING WELL



MEMO

DATE: 5/1/90

TO: File

SUBJECT:

BARRY NELSON
Eng. Tectonics

I40 x 311 Interchange - Piedmont Publishing
1ST Client

1977 Engineering study showed poor substrata inhomogeneous fill (geotechnical consideration)

additional Geotechnical study - involved GW monitoring wells - high levels TOX TOC

City & Hawks Nest Sports owned two adj. tracts of land. City wanted to buy other, got Piedmont Publ. report (from Eng. ~~Editor~~)

L. A. Reynolds Asphalt Plant next door (former)

several months ago. 3 good wells better analysis

TOX = halogenated

North Carolina Department of Environment, Health, and Natural Resources

Reynolds brought in fill

so did others

Owner of Reynolds owns Hawk's Nest.

5/10/90

ROW Matamoras City of WINSTON-SALEM

HAWKS NEST PROPERTY : CITY INDUSTRIAL PARK
behind W-S St Univ. its east
supposed to be office park
Opened for bids - Webb Companies
(had built 1 Triad Center) ~~to~~ bid -
City designated several sites on the property
for initial building. Money concerns led to
City assigning contract to buy Mr Reynolds
(Hawks' Nest) property. No Environ. Study
had been done - None done by Webb ~~it~~ either -
last extension came up - Reynolds wants its purchased
Webb and/or City doesn't want, for financial
reasons, to buy - really can't
Tried flipping to Piedmont Publishing ~~&~~ .
The geo-engineering study done by ~~Piedmont Pub.~~.
Engineering Tectonics - hinted at old asphalt
plant soil contam. Second Study hinted
at worse environmental problems - G. W.
City has negotiated lower price but wants
feel for liability/or response
(They will buy and then Sue Webb for damages)

Making a pitch for continued monitoring as
extent of risk. Alternative is not buy. Fight
~~Reynolds~~ Reynolds in Court.

AR

My Response

Sources:

Soil — ① Asphalt plant
② fill material

G Water ① Upgradient City ~~Water~~ Property

Surface Water discharge

① Roads drain pipe
② W.S. St. Univ.

OPTIONS

① NOVs to Reynolds and City
full site Assessment
Remediation Plans
SOC for clean-up

② Site Specific source elimination

③ Appeal water classification

Actions to be Recommended

① ~~E~~ Immediate effort to fix run-off problem
both City and W-S St Univ.

② at least 2 more monitoring wells
voluntary

Look for at least biweekly updates
and real progress in one month

MEMO.

DATE: 5/14

TO: Hawks Nest file

SUBJECT: W S St Univ.

Mr. Willie Grissum of W-S St Univ. He got call from Univ. System H.Q. in Chapel Hill about Contamination - no background. We discussed. Primarily a discharge problem - put in oil & grease separator

He will (1) Call Barry Nelson of Eng. Tectonics for details

(2) Get with Physical Plant people for discription of process Boiler Blow-down

North Carolina Department of Natural Resources & Community Development

HOUSE & BLANCO, P.A.
ATTORNEYS AT LAW
STRATFORD EXECUTIVE PARK
215 EXECUTIVE PARK BOULEVARD
WINSTON-SALEM, NORTH CAROLINA 27103-1594

MAILING ADDRESS:
P.O. DRAWER 25008
WINSTON-SALEM, NC 27114-5008

DON R. HOUSE
DAVID B. BLANCO
NEAL E. TACKABERY
SUSAN L. CHRISTIANSEN
REGINALD F. COMBS
RONALD A. MATAMOROS
JOHN S. HARRISON
GENE B. TARR
MICHAEL D. HURST
STEVEN C. GARLAND
PETER J. JURAN
BRIAN L. HERNDON
BOWEN C. HOUFF
GEORGE E. HOLLODICK
CYNTHIA J. LOWERY

TELEPHONE
(919) 768-1130
TELECOPIER
(919) 765-4830

REFER TO:

June 6, 1990

RECEIVED
N.C. Dept. NRCD
JUN 7 1990
Winston-Salem
Regional Office

Mr. Andrew Raring
Environmental Supervisor I
Division of Environmental Management
North Carolina Department of Environment,
Health and Natural Resources
8025 Northpoint Blvd. Suite 100
Winston-Salem, NC 27106

Re: I-40 Industrial Park

Dear Mr. Raring:

This letter will confirm our recent telephone conversations and meetings,culminating with our meeting of May 21, relating to certain tract of land presently owned by Hawksnest Sports Inc. ("Hawksnest") located off Dunleith Avenue in Winston-Salem, NC (the "Site").

This firm represents the City of Winston-Salem (the "City") which has now completed negotiations with Hawksnest to acquire the property in question in settlement of certain outstanding claims and disputes.

Our discussions with regard to the groundwater and surface water conditions of the Site resulted from a report dated April 22, 1990 prepared by Engineering Tectonics. That report described the analytical results of certain groundwater monitoring wells installed by that company.

As a result of that report your office has requested that certain remedial work be undertaken.

As I understand your concerns, you have identified the condition of the groundwater and the surface water as being such that some attempted mitigation and future monitoring would be necessary. You have further requested that additional analysis be undertaken so as to confirm your initial assessment.

We further understand if this subsequent analysis is consistent with your preliminary estimates, and you have been shown that substanial efforts have commenced with regard to certain surface water conditions, your office will defer any future enforcement, including the issuance of Notice Of Violation. We confirm our understanding that such deferral is to be available only to the extent that future monitoring of both the surface and groundwater conditions confirm levels of contamination materially no greater than those reflected in the April 22nd report and the subsequent additional analysis.

Specifically, we understand your request to be as follows:

1. Implementation of additional testing, including the installation of two additional groundwater monitoring wells in order to confirm your preliminary analysis of the situation. Enclosed please find a letter from Engineering Tectonics outlining their proposal which will be converted to a formal engagement letter and, subject to the approval of the Board of Aldermen, be approved by the City. Subject to that approval, we anticipate that the work would commence on or about June 19. We will request that Engineering Tectonics coordinate closely with your office with regard to the proposed activities and the results.

2. Coordination and cooperation by the City and Winston-Salem State University relating to certain surface water contamination. As a result of our meeting of May 21, we understand representatives of both the City and Winston-Salem State will be proposing remediation efforts to address the sources of their alleged contamination. Specifically, the City is reviewing and investigating the storm drainage system crossing the property to determine its integrity. Winston-Salem State is reviewing its boiler "blowout" procedure to determine whether or not the blowout liquid can be directly placed into the sanitary sewer system. Additionally, we understand that they will be investigating the integrity of the above ground field tanks.

As mentioned above, the City subject to final Board approval, will be acquiring the property in question. This purchase is, being undertaken, partially, upon the results of our recent meetings and your preliminary assessment and proposals. It is obviously important to the City to be assured that this process continue at a level acceptable to you and your agency. Therefore, we would request that you notify us at any time that the assumptions and statements of this letter become inaccurate. This would include, obviously, your analysis of the results of the secondary testing to be performed by Engineering Tectonics along with the activities of the City and Winston-Salem State relating to surface

water conditions. We further assume that you will coordinate with your surface water section in order to confirm their agreement to proceed as described above.

We greatly appreciate you and your division of operation and understanding in this matter and look forward to working with you in the future.

Sincerely,

HOUSE & BLANCO, P.A.

Ronald A. Matamoros

RAM/jh
cc: Ronald G. Seeber, Esq.

RECEIVED
N.C. Dept. NRCD
JUN 18 1990
Winston-Salem
Regional Office

HOUSE & BLANCO, P.A.
ATTORNEYS AT LAW
STRATFORD EXECUTIVE PARK
215 EXECUTIVE PARK BOULEVARD
WINSTON-SALEM, NORTH CAROLINA 27103-1594

MAILING ADDRESS:
P.O. DRAWER 25008
WINSTON-SALEM, NC 27114-5008

TELEPHONE
(919) 768-1130
TELECOPIER
(919) 765-4830

REFER TO:

DON R. HOUSE
DAVID B. BLANCO
NEAL E. TACKABERY
SUSAN L. CHRISTIANSEN
REGINALD F. COMBS
RONALD A. MATAMOROS
JOHN S. HARRISON
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BOWEN C. HOUFF
GEORGE E. HOLLODICK
CYNTHIA J. LOWERY

June 14, 1990

Mr. Andrew Raring
Environmental Supervisor I
Division of Environmental Management
N. C. Department of Environment, Health
and Natural Resources
8025 Northpoint Blvd., Ste. 100
Winston-Salem, NC 27106

Re: Hawksnest Sports, Inc. v. City of Winston-Salem v. Dudley Webb and Companies, Inc., etc.; 89 CVS 3102

Dear Mr. Raring:

I am writing to advise that the above-referenced matter appears on the June 25, 1990 trial calendar in Forsyth County Superior Court. Given its position on the calendar, it is difficult to say whether the case will be reached for trial that week. In my judgment, it probably will not. Nevertheless, we must prepare for trial on the assumption that it will be reached. There is a possibility that we may need to call upon you to testify concerning the position you and your department have taken regarding the proposed I-40 Industrial Park site located near Dunleith Avenue in the City of Winston-Salem. I will therefore be issuing a Subpoena for your attendance at trial in the event your testimony is needed. In the unlikely event that we have to call you to testify, I will give you as much advance notice as possible by telephone so that your appearance can be coordinated and your time in court kept to a minimum.

I was out of town - did not get Subpoena

You will note when the Subpoena is served that you are requested to bring with you any documents contained in your department's file on this matter.

If any of the foregoing presents a problem, or if you have any questions or comments about it, please feel free to give me a call.

Best wishes.

Very truly yours,

HOUSE & BLANCO, P.A.

Reginald F. Combs

RFC/jwl

cc: Ron Seeber, Esq.

RECEIVED
N.C. Dept. NRCD
JUN 2 8 1990
Winston-Salem
Regional Office

City of Winston-Salem

OFFICE OF
THE CITY ATTORNEY

Telephone (919) 727-2056
Telecopier (919) 727-2880

June 27, 1990

Mr. Andrew Raring
Environmental Supervisor I
N.C. Department of Environment,
Health and Natural Resources
8025 North Point Boulevard, Suite 106
Winston-Salem, North Carolina 27106

Re: I-40 Industrial Park (formerly Hawksnest Sports, Inc., property)

Dear Mr. Raring:

On Monday evening, June 25, 1990, the Winston-Salem Board of Aldermen approved settlement of the Hawksnest Sports, Inc., lawsuit, agreeing to purchase of the 19+ acres of property located in the I-40 Industrial Park. We expect to close on that property and take title by Friday, June 29.

The City has also obtained a service agreement proposal from Engineering Tectonics, P.A., for the testing you have requested on the subject property. (Copy enclosed for your information) That service agreement has been executed by the City Manager and mailed to Engineering Tectonics, P.A. I have also called the contractor to let it know the service agreement is in the mail, and have requested that the work begin immediately. As you can see, the City intends and has taken steps to be environmentally responsible, consistent with the understanding negotiated between Mr. Matamoros and your office.

Please give me a call if you have any questions.

Yours truly,

Ronald G. Seeber,
City Attorney

RGS/pd

Enclosure

OFFICE OF
THE CITY ATTORNEY

City of Winston-Salem

Telephone (919) 727-2056
Telecopier (919) 727-2880

June 27, 1990

Mr. A. Barry Nelson, P.G., Vice President
Engineering Tectonics, P.A.
Post Office Box 11846
Winston-Salem, N.C. 27116

Dear Mr. Nelson:

Attached please find an original copy of your proposed service agreement, executed by City Manager Bill Stuart. Your letter of June 6, 1990, the proposed acceptance sheet and your letter of quotation of May 17, 1990, taken together, make up our service agreement, including the scope of service and $10,680.00 fee. Please accept this letter as the City's direction to commence work immediately.

Yours truly,

Ronald G. Seeber

Ronald G. Seeber,
City Attorney

RGS/pd

Enclosure

ENGINEERING TECTONICS, P.A.
ENGINEERS • GEOLOGISTS • HYDROLOGISTS
P.O. Box 11846, Winston-Salem, NC 27116 (919) 767-8807

HOUSE & BLANCO, P.A.
JUN 0 8 90

June 6, 1990

City of Winston-Salem
c/o Ron Matamoros
House & Blanco, P.A.
P.O. Drawer 25008
Winston-Salem, NC 27114

Subject: Installation and Testing of Groundwater Monitoring Wells I-40 Industrial Park

Gentlemen:

This letter and attached proposal acceptance sheet will serve as a service agreement for the above referenced project. Our scope of services and fees were provided in our quotation to Mr. Walter Pitt dated May 17, 1990.

We understand that the work is to commence after June 19, 1990.

Please sign the attached proposal acceptance sheet and return one copy to us.

Should you have any questions, please contact us.

Very truly yours,

ENGINEERING TECTONICS, P.A.

A. Barry Nelson, P.G.
Chief Hydrologist
Vice President

ABN/jg

attachment

Approved as to form and legality

This 26 day of June 1990

By Ronald G. Sulser Attorney

ENGINEERING TECTONICS, P.A.

PROPOSAL ACCEPTANCE SHEET

Description of Services Installation & Testing of Groundwater Monitoring Wells
Project Name I-40 Industrial Park
Project Location Winston-Salem, North Carolina
Date and Proposal No. May 17, 1990
Office Designation EES

FOR PAYMENT OF CHARGES:

Charge Invoice to the Account of:

Firm: City of Winston-Salem
Address: City Hall
City: Winston-Salem State NC Zip 27102
Attention: City Attorney's Office

PROPOSAL ACCEPTED BY: [signature] 6/27/90
Signature & Title Date

PAYMENT TERMS: Net 30 days from invoice date

PROPERTY OWNER IDENTIFICATION (If Other Than Above):

Name:
Address:
Zip Code
Attention:

FOR APPROVAL OF CHARGES:

Send Invoice To:
Firm: Same as above.
Address:
Zip Code
Attention:

If the invoice is to be mailed to someone other than account charged, please indicate in the appropriate space above.

Invoices for completed work will be issued every four weeks for continuous or extended projects unless otherwise agreed.

SPECIAL INSTRUCTIONS: Please do not commence until notified by the City Attorney's office or by House & Blanco P.A.

ENGINEERING TECTONICS, P.A.
ENGINEERS • GEOLOGISTS • HYDROLOGISTS
P.O. Box 11846, Winston-Salem, NC 27116 (919) 767-8807

May 25, 1990

City of Winston-Salem
c/o Hawksnest Sports
P.O. Box 489
Lewisville, NC 27023

Attention: Mr. John Reynolds

Subject: Costs for completion of
Groundwater Investigation
Hawksnest Property
I-40 Industrial Park
Winston-Salem, NC

Dear John:

As discussed with Mr. Andrew Raring of NC DEM and attorneys for the City of Winston-Salem during our meeting on Monday May 21, 1990, these are the projected costs for the additional groundwater investigations at the site:

Install 2 groundwater monitoring wells	$1200/ea	X	2	$2400.00
Collect groundwater samples	$35/hr	X	8 hrs	280.00
Analytical GC Library Scan	$2000/ea	X	1	2000.00
Additional testing of 3 existing wells (for unknowns)	$1000/ea	X	3	3000.00
Testing of 2 new wells	$1500/ea	X	2	3000.00
Total				$10,680.00

Please forward this information to Mr. Walter Pitt, your attorney, so he can give it to the City.

If you have any questions, please call.

Very Truly Yours:

ENGINEERING TECTONICS, P.A.

A. Barry Nelson, P.G.
Chief Hydrogeologist

ABN/jmb

RECEIVED
N.C. Dept. NRCD
AUG 10 1990
Winston-Salem
Regional Office

HOUSE & BLANCO, P.A.
ATTORNEYS AT LAW
STRATFORD EXECUTIVE PARK
215 EXECUTIVE PARK BOULEVARD
WINSTON-SALEM, NORTH CAROLINA 27103-1594

MAILING ADDRESS:
P.O. DRAWER 25008
WINSTON-SALEM, NC 27114-5008

TELEPHONE
(919) 768-1130
COPIER
(919) 765-4830

DON R. HOUSE
DAVID B. BLANCO
NEAL E. TACKABERY
SUSAN L. CHRISTIANSEN
REGINALD F. COMBS
RONALD A. MATAMOROS
JOHN S. HARRISON
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PETER J. JURAN
BRIAN L. HERNDON
BOWEN C. HOUFF
GEORGE E. HOLLODICK
CYNTHIA J. LOWERY
RONALD S. GAYNOR

REFER TO:

August 9, 1990

Mr. Andrew Raring
Environmental Supervisor I
Division of Environmental Management
North Carolina Department of Environment,
Health and Natural Resources
8025 Northpoint Boulevard, Suite 100
Winston-Salem, NC 27106

Re: Hawksnest Sports, Inc. v. City of Winston-Salem v. Dudley Webb and Companies, Inc., etc.; 89 CVS 3102

Dear Mr. Raring:

The above-referenced matter appears on the August 27, 1990 trial calendar in Forsyth County Superior Court. It is the seventh case set for trial that week, with six others peremptorily set ahead of it. I am thus unable to say with complete confidence whether the case will be reached that week or not.

As I mentioned to you in my letter of June 14, 1990, there is a possibility that we will need to call upon you to testify concerning your department's position on the proposed I-40 Industrial Park site located near Dunleith Avenue in the City of Winston-Salem. I will be issuing a subpoena for your attendance at trial in the event your testimony is needed. Please be assured that I will give you as much advance notice as possible by telephone in order that we may coordinate your appearance and minimize your time in court.

Please note when you receive the subpoena that you are requested to bring with you any documents contained in your department's file on this matter.

If any of the foregoing presents a problem, or if you have any questions or comments about it, please feel free to give me a call. Best wishes.

Very truly yours,

HOUSE & BLANCO, P.A.

Reginald F. Combs

RFC/jl

cc: Ronald G. Seeber, Esq.

STATE OF NORTH CAROLINA

File No. 89 CVS 3102

FORSYTH County

In The General Court Of Justice
☐ District ☒ Superior Court Division

HAWKSNEST SPORTS, INC.
CITY OF WINSTON-SALEM
v.
VERSUS
DUDLEY WEBB AND COMPANIES, INC., a North Carolina Corporation

SUBPOENA

☒ TO APPEAR IN PERSON
☒ TO PRODUCE DOCUMENT

G.S. 1A-1, Rule 45

Party Requesting Subpoena:
☐ State/Plaintiff ☒ Defendant ☐ Other (specify)

TO

Name Of Person Subpoenaed
Mr. Andrew Raring, Environmental Supervisor I
Division of Environmental Management

~~*Name Of Second Person Subpoenaed*~~

~~*Name Of Third Person Subpoenaed*~~ N. C. Dept. of Environment, Health & Natural Resources

Address
8025 Northpoint Blvd., Ste. 100

City, State, Zip
Winston-Salem, NC 27106

Telephone
919/ 761-2351

(Note: *A single subpoena may be used for as many as three persons if all have the same address. If documents are subpoenaed, only one person may be named.)*

Alternate Address

City, State, Zip

Telephone

YOU ARE COMMANDED TO:
(check all that apply)

☒ appear and testify, in the above entitled action, before the court at the place, date and time indicated below.

☒ produce for the court the following items, at the place, date and time indicated below.

Any and all documents contained in the file of the North Carolina Department of Environment, Health & Natural Resources, concerning the proposed I-40 Industrial Park site located near Dunleith Avenue, Winston-Salem, North Carolina, being the same property referred to in the report of Engineering Tectonics, P.A. dated April 22, 1990.

Name And Location Of Court
Forsyth County Superior Court
Hall of Justice
Winston-Salem, NC 27101

Date To Appear/Produce
August 27, 1990

Time To Appear/Produce
10:00 * ☒ AM ☐ PM

Name And Address Of Applicant's Attorney
Reginald F. Combs, Esq.
HOUSE & BLANCO, P.A.
Post Office Drawer 25008

Telephone No.
Winston-Salem, NC 27114-5008
919/768-1130

Date
August 9, 1990

Signature
Reginald F. Combs

☐ Deputy CSC ☐ Assistant CSC ☐ Clerk Of Superior Court
☐ Magistrate ☒ Attorney ☐ Party

* YOU NEED NOT COME TO COURT UNTIL YOU ARE CALLED BY MR. COMBS.

AOC-G-100
Rev. 12/86

(Please See Reverse Side)

RETURN OF SERVICE

I certify that this subpoena was received and served as follows:

Date Received

For First Person Named On Front:

- ☐ by delivering a copy of the subpoena to the first person named on the front
- ☐ this subpoena WAS NOT served for the following reasons:
- ☐ by telephone communication with the first person named on the front (use only with subpoena to appear in person)
- ☐ by registered or certified mail return receipt requested on the first party named on the front

Service Fee		*Date Served*	*Signature Of Sheriff Or Other Officer*
$	☐ *Paid* ☐ *Due*		

For The Second Person Named on Front:

- ☐ by delivering a copy of the subpoena to the second person named on the front
- ☐ this subpoena WAS NOT served for the following reasons:
- ☐ by telephone communication with the second person named on the front (use only with subpoena to appear in person)
- ☐ by registered or certified mail return receipt requested on the second party named on the front

Service Fee		*Date Served*	*Signature Of Sheriff Or Other Officer*
$	☐ *Paid* ☐ *Due*		

For The Third Person Named On Front:

- ☐ by delivering a copy of the subpoena to the third person named on the front
- ☐ this subpoena WAS NOT served for the following reasons:
- ☐ by telephone communication with the third person named on the front (use only with subpoena to appear in person)
- ☐ by registered or certified mail return receipt requested on the third party named on the front

Service Fee		*Date Served*	*Signature Of Sheriff Or Other Officer*
$	☐ *Paid* ☐ *Due*		

INFORMATION FOR WITNESS

The Subpoena

The subpoena is a court order requiring you to appear in court on the day and at the time stated. You have been called (subpoenaed) to court to be a witness in a case.

Duties Of A Witness

- You must attend court on the day and at the time stated in the subpoena.
- Unless otherwise directed by the presiding judge, you must answer all questions asked when you are on the stand giving testimony.
- Your answers to questions must be truthful.

If you have any questions about being subpoenaed as a witness, you should contact the attorney or official who had the subpoena issued. The name of that person is on the other side of this subpoena form.

Understand The Question And Speak Out

When you are on the witness stand, listen carefully to any question, and make sure that you understand the question before you try to answer it. If necessary, ask that the question be repeated.

In answering questions, speak out clearly and loudly enough to be heard. If you are testifying before a jury, speak out so that all of the jurors can hear you.

Bribing Or Threatening A Witness

It is a violation of state law for anyone to attempt to bribe, threaten, harass, or intimidate a witness. If anyone attempts to do any of these things concerning your involvement as a witness in a case, you should promptly report that to the district attorney or the presiding judge.

Witness Fee

A witness is entitled to a small daily fee, and to travel expense reimbursement if it is necessary to travel from outside the county in order to testify. (The fee for an "expert witness" will be set by the presiding judge.) After you have been discharged as a witness, if you desire to collect the statutory fee, you should immediately contact the clerk's office and certify to your attendance as a witness so that you will be paid any amount due you.

HOUSE & BLANCO, P.A.
ATTORNEYS AT LAW
STRATFORD EXECUTIVE PARK
215 EXECUTIVE PARK BOULEVARD
WINSTON-SALEM, NORTH CAROLINA 27103-1594

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CYNTHIA J. LOWERY
RONALD S. GAYNOR

TELEPHONE
(919) 768-1130
TELECOPIER
(919) 765-4830

REFER TO:

September 21, 1990

RECEIVED
N.C. Dept. NRCD
SEP 25 1990
Winston-Salem
Regional Office

HAND DELIVERED

Mr. Andrew Raring
Environmental Supervisor I
Division of Environmental Management
North Carolina Department of Environment,
Health and Natural Resources
8025 North Point Boulevard, Suite 100
Winston-Salem, North Carolina 27106

RE: I-40 Industrial Park - City of Winston-Salem

Dear Andrew,

Enclosed please find a copy of a report prepared by Engineering Tectonics relating to supplemental investigations requested by you and your office as to the property owned by the City of Winston-Salem located off Dunleith Avenue and I-40.

This report was prepared in a manner consistent with your request and in accordance with my letter to you of June 6th.

As mentioned in that letter, the City of Winston-Salem has now acquired title to the property. The City is anticipating actively maarketing the sale of the property. In order to proceed with such a disposition I believe it is important to get a "final determination" from your office as to the status of the ground water and surface water issues which have been discussed over the last months.

Our review of the supplemental report indicates that is supports your original position that the unknown compound described in the original report were, more than likely, innocuous compounds which would not affect your preliminary analysis as to the public health concerns associated with the groundwater condition. The report further seems to indicate that the old storm drainage system may have had a substantial effect in creating this groundwater condition.

Once you have had an opportunity to review this report I would very much like to discuss this matter further with you to determine an updated status of this property and it's environmental conditions, in order to discuss the situation meaningfully with any prospective purchaser.

If it is acceptable to you, I would propose to call you the first of next week to discuss this matter. Of course, if you would like to have an additional meeting, on site or elsewhere, with representatives of the City please let me know and I will be happy to arrange it.

Upon your review of the enclosed any questions or problems please do hesitate to contact me.

Sincerely,

HOUSE & BLANCO, P.A.

Ronald A. Matamoros

RAM/sml

Enclosure

cc: Ronald G. Seeber, Esq.

c:ar.ltr/sml

MEMO

TO: File (CSW)

DATE: 9/25/90

SUBJECT: W-S Indust. Park
(Hawksnest)

Site is fully characterized
~~Massive~~ GW contam. throughout
unknown compounds in tens of ppb.
Full library search would be in order
as would off site wells, perhaps 2,
to establish pervasiveness of contaminants
in environs, as opposed to localized.
(point source) contamination event.
Responsible party will be all but impossible
to ~~date~~ determine. Best to have them
seek ~~RD~~ RS designation with passive remediation
and periodic sampling. (see ZL ~~next doc~~)

From: AR

City has repaired storm sewers and W-S St. Univ. has audited and improved their operations (per Ron Matamoros 10/4/90)

North Carolina Department of Environment, Health, and Natural Resources

Printed on Recycled Paper

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
P.O. BOX 25201
RALEIGH 27611-5201

JAMES G. MARTIN
GOVERNOR

THOMAS J. HARRELSON
SECRETARY

DIVISION OF HIGHWAYS

WILLIAM G. MARLEY, JR., P.E.
STATE HIGHWAY ADMINISTRATOR

October 15, 1990

Mr. Kirk Rife
Trigon Engineering
P. O. Box 18846
Greensboro, N. C. 27419-8846

Dear Mr. Rife:

Enclosed please find copies of the field notes and lab results of our survey of the old Larco site in Forsyth County. As you can see, none of our solvents were found at the approximate location of the lab site.

If you need more information, you might give Mr. Rick Alexander a call at 667-9111.

I hope we have been of some assistance to you.

Sincerely,

Thomas W. Werner

Thomas W. Werner, CSP, P.E., REP
Safety Development Coordinator
Occ. Safety & Emer. Planning

TWW/mw

Enclosures

ASPHALT PLANT SAMPLING FORM

Date 4/27/89 Person Sampling R.E. Alexander LARCO on site

Current Owner Jon Reynolds Sample Type (Soil/Water) soil

OSEP Code # (CN- N-SN) Cnty/plnt/sample 67-06-01

Location of Plant abandoned Asphalt plant site near Winston-Salem State University

General Slope of Land (from sample point) 3°-5° falling to the East

Soil Type (Loamy, Granular, Rocky, Clay, Sandy, Other) granular & rocky

Approximate Time & Durations of DOT site use 15 yrs. plant was moved 2 years ago.

Previous or Simultaneous Use of site by other than DOT parties? (Y,N) yes

Independent labs & City of Winston-Salem

In the event that multiple screening samples are conducted with a VOA or similar instrument, list the sample numbers and results here.

Sample #	Reading	Sample #	Reading	Sample #	Reading
1	NONE	7	1'45" & 2'50"		
2	NONE	8	NONE		
3	ON GC 1'45"	9	NONE		
4	NONE				
5	NONE ON GC				
6	NONE				

Comments: Property is currently for sale. All buildings have been removed and grading has been completed to clean up debris. Sample readings were taken in vicinity of old Asphalt lab as best that could be located by experienced inspectors that worked at the lab for several years. The City of Winston-Salem has also performed soil & water test on the property.

Lab Analysis: None detected

HAWKSNEST Sports, Inc.
P.O. Box 489
Lewisville, N.C. 27023

Note: A copy of any lab analysis should be attached to this form.

TWW/1/89

CERTIFICATE OF ANALYSIS

EMS Laboratories, Inc
4132 Pompano Street
Charlotte, N. Carolina 28216
(704) 393-1853

N.C. Waste Lab Cert. No. 98
N.C. Water Lab Cert. No. 37727
S.C. Lab Cert. No. 99011
U.S. EPA id 00118

EMS SAMPLE : B14929
REPORT DATE : 05/15/89
DATE RECEIVED : 04/28/89
DATE COMPLETE : 05/12/89

REPORT TO

RICK E. ALEXANDER
STATE OF NORTH CAROLINA
DEPT. OF TRANSPORTATION
P.O. BOX 250
N. WILKESBORO NC 28659

BILL TO

G.R. FLEMING
STATE OF NORTH CAROLINA
DEPT. OF TRANSPORTATION
P.O. BOX 25201
RALIEGH NC 27611-5201

DESCRIPTION

SAMPLE 62-06-01
LARCO
P.O. NUMBER : 512634

DATE : 04/27/89
TIME : 12:15:00

TEST DESCRIPTION / ANALYTE	RESULT	METHOD	DATE / DET. LIMIT	ANALYST / UNITS
VOLATILE ORGANICS, RCRA		SW846-8240	05/10/89	JEW
GC/MS File	CV3227		NA	NA
Date/Time of Analysis	05/10/89			
Continuing Calibration File	CV3224.C			
Method Blank File	CV2335.B			
MS/MSD File				
SURROGATE LIST (spike conc)	uG/KG			
Dichloroethane-d4	91		(50)	% Rec
Toluene-d8	95		(50)	% Rec
Bromofluorobenzene	94		(50)	% Rec
TARGET COMPOUND LIST				
Carbon tetrachloride	ND		25.	uG/KG
1,1,1-Trichloroethane	ND		25.	uG/KG
Trichloroethene	ND		25.	uG/KG
() = Estimated Concentration				

ND - Not Detected
NA - Not Applicable
BDL - Below Detection Limit
Sample was accompanied by chain of custody papers

Approved by : Nichole E. Sobrun

meeting w/ Ronald
Matamoros - House + Blanco
Counsel f/ City of Winston - Salem

(1)

Samples wer of Nov. 3. 9:00 10/23/90.

CNM - Dumpster Boxes.

Carolina
Investmt Robin team - Lexington. Developer
Prop

City will sell ½ price to developer
take 6% note

CNM locks in rent based on cost
(approx 25% below normal).

82 City Bought.
86 Deal w/ WeBB.

(For site)

88. Engineering tectonics.
Says is fill + tainted.

~~NOV at this point.~~

La Reynolds liquidated
Hawkinest Worthler.

Sues city
City sues WeBB.

Everybody says test GW.

April 1990.

① ADD'L TESTING.
ADD'L WELLS.

SEE IF WS STATE LOOK AT PLANT.
- OPERATE BOILER SYSTEM
- SECONDARY
- FUEL-OIL CONDENSER.
- OVER GND TANKS.
- PERIODICALLY FLUSH OUT ONTO S SIDE OF TRACK.

LOOK AT SYSTEM AND BE SURE NOT DUMPING, INTEGRITY GOOD.

② · ANOTHER UPGRADIENT SOURCE.
STORM DRAIN. 48"
W-S STATE. ?
TRAIN STATION ?

PUT MW-5 UPGRADIENT F/ THIS PURPOSE.

DRAIN IN GOOD SHAPE FR ENGINEERING CITY OF W-S.

ET SAYS — IS ON SITE ROCK.

③ EXPAND LIBRARY SEARCH F/ UNKNOWN

W-S BOYS LAND.

SO WE'RE GOING TO TAKE OUR TIME TO DO STUFF. (Sept. 18).

BUT PROSPECTIVE BUYER COMES UP. (Sept. 22).

SUPPLEMENTAL REPORT.

TRIGON COMES IN - WANTS TO DO MORE. (DICK).
BUT AGREES THAT ET'S TESTING IS GOOD ENOUGH.
ANALYZE DATA THAT'S ALREADY THERE.

TRIGONS. ET - 15-19 Week

BY 11/3

(1) RETEST MW-2, MW-3, MW-5, LOOK F/ ASPHALT DERIVATIVES METHOD 625. ONLY.

(2) WILL HAVE TO REMOVE UNCOMPACTABLE FILL FOR FOUNDATION

NORMALLY WE WOULD NEGOTION
MORE. - NORMAL. NOW STRUCTURE. SOC
WHY BUYER-SELLER IS SATISFIED.

(1) HAS A BUYER WHO KNOWS IS
CONTAMINATED

(2) W/ VERY SOPHISTICATED CONSULTANT.
BUYER WILL HAVE

(3) 2 LENDERS | CONSTRUCTION WACHOVIA
JPilot | PERMANENT.
LONG-TERM - PAY OFF
CONSTRUCTION LENDS

SO HAVE TO SELL 2 LENDERS.

(4) BOTH LENDERS HAVE GOOD ENVIRONMENTAL
~~LENDER~~. LAWYERS.

SO:
WILL HAVE
SERIES OF REPORTS FR ET (2)
TRIGON. (1)

(1) KNOW EVERYTHING ABOUT

(2) WILL QUALIFY FOR INNOCENT ~~BUYER~~ LANDOWNER.
CERCLA.
| IF BUY.
CONTAMINATION.
|

COURTS ESTABLISHED DEFENSE. (5)

BUY.

① DON'T DO PHASE I BNA

② FIND PLUME

③ BUYER RESPONSIBLE

EPA is EXPANDING PROGRAM TO LENDERS.

IF NOT ACTIVELY INVOLVED IN SUPERVISING OPERATION (LENDER).

"ONLY WHEN LENDER is ACTIVELY INVOLVED IN BUSINESS OPERATION"

IF DO GO BANKRUPT on SUCH PT. LENDER CAN FORECLOSE, BUT is NOT RESPONSIBLE (FLEET.

- COURTS, CONGRESS. SAYS BE REASONABLE

④ SITE WILL BE OK.

⑤ OK, BUT LENDERS SAY, "WHAT WILL STATE SAY.

CITY OF W-S WOULD LIKE LETTER SAYING "WHILE LEVELS ABOVE STANDARDS, NO ~~NOTICE OF~~ YOU WILL

BE ISSUED AND NO FURTHER.
REQUIREMENT WILL BE IMPOSED."

BEYOND (1) EXCAVATION.
(2) W-S CITY WILL AGREE TO PERIODIC
2 YEARS MONITORING
(3) ~~WHAT IF LEVELS GO UP?~~

(4) NO PRECEDENT.
(5) TOXICOLOGICAL REPORT.

NO PLANT PLAN MAY NEVER BE BUILT.
ANSWER. ARGUMENT OF WITH NO ABSOLUTE
(1). NO PUBLIC HEALTH ISSUES CLEANUP
- NO USES OF WELLS
- HISTORIC COMMERCIAL - INDUSTRIAL
USE - USERS TO OVERLAY.
2L STANDARDS.
(2) DO NOT ANTICIPATE NATURE OF
GW
- NO ODORS (WICHITA)

(3) NO IDEA HOW. RENEDIATE COMPANY
CAN NOT ECONOMICALLY REMOVE TO
0.

(4) ALL THAT CAN COULD HAVE BEEN
DONE ON SITE INVESTIGATION HAS BEEN.

10.

(7).

SLID INTO SOC

NO NOV BECAUSE

(1) PUBLICITY AVOIDANCE.

(2) ASSIGN BLAME ONLY TO DEFUNCT COMPANIES.

(3) FEELING CONTAMINATION NOT HIGH AND NOT DANGEROUS.

I SAID.

(1) I WOULD LIKE LEVELS' CHARTER. (OF MAIN CONSTITUENTS 62)-

(2) I WOULD LIKE A CROSS SECTION OF PROPOSED FILL REMOVAL WRT WATER TABLE & MW'S.

(3) TOXICOLOGICAL REPORT ON:

PHENANTHRENE
FLUORANTHENE
PYRENE.

PRESENT IN MW-2.

MATAMOROS WOULD LIKE TO MEET W/ PETER ROSCOE TO MEET ANY OBSTACLES. I SAID I WILL CALL ROSCOE BEFORE FRIDAY. W/ AMENDMENTS. UNLESS F/ FOURTH AGREEMENT / SOC.

MEMO

DATE: 10/24/90

TO: File

SUBJECT: W-S City

Fr/: Peter Rascoe.

W-S. will have to enter into agreement:

① "...enter into agreement pursuant with 143.215.2." as the responsible party

② ~~If not en~~ aside from this (in some other respect) may be treated as party proper.

public.

From: CSW.

North Carolina Department of Environment, Health, and Natural Resources

Printed on Recycled Paper

HOUSE & BLANCO, P.A.
ATTORNEYS AT LAW
STRATFORD EXECUTIVE PARK
215 EXECUTIVE PARK BOULEVARD
WINSTON-SALEM, NORTH CAROLINA 27103-1594

MAILING ADDRESS:
P.O. DRAWER 25008
WINSTON-SALEM, NC 27114-5008

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GEORGE E. HOLLODICK
CYNTHIA J. LOWERY
RONALD S. GAYNOR

TELEPHONE
(919) 768-1130
TELECOPIER
(919) 765-4830

REFER TO:

November 12, 1990

RECEIVED
N.C. Dept. NRCD
NOV 14 1990
Winston-Salem
Regional Office

HAND DELIVERED

Mr. Steve Weiss
Division of Environmental Management
North Carolina Department of Environmental,
Health and Natural Resources
8025 North Point Boulevard, Suite 100
Winston-Salem, North Carolina 27106

RE: I-40 Industrial Park - City of Winston-Salem Property

Dear Steve,

Enclosed please find a copy of the ground water sampling results compiled and presented by Trigon Engineering Consultants, Inc. relating to the Winston-Salem business park.

As you can see all compounds are below quantitation limits.

Please review this report at your earliest convenience. I will be contacting you shortly to discuss the situation further.

I had a good conversation with your counsel, Peter Rasco. He confirmed the legal position of the division that neither state law or regulation would impose any liability on the City of Winston-Salem, or prospective purchaser and its lender, relating to the property in question. Any liability for potential remediation costs would only be assessed to the party determined to be responsible for the discharge of the materials into the environment. The reports clearly indicate that no such discharge is occurring at this time nor has such a discharge occurred since the City acquired the property.

Subject to your final analysis of the information at hand, I believe that no further action would be appropriate or necessary

to satisfy any prospective purchaser as to the environmental condition of the property nor would any action be mandated by state law or your regulations.

I look forward to hearing your comments on this report.

Sincerely,

HOUSE & BLANCO, P.A.

Ronald A. Matamoros

RAM/sml
Enclosure
cc: Ronald G. Seeber, Esq.

c:sw.ltr/sml

TRIGON
ENGINEERING CONSULTANTS, INC.

Geotechnical, Environmental,
Construction Materials, & Roofing Engineers

P.O. Box 18846•Zip 27419•8846•313 Gallimore Dairy Rd. Greensboro, N.C. 27409•(919)668-0093

November 12, 1990

Carolina Income Properties
Post Office Box 1066
Lexington, North Carolina 27292

Attention: Mr. Robin Team

Reference: Groundwater Sampling Results
Winston-Salem Business Park
Winston-Salem, North Carolina
Trigon Job No. 015-90-105

Gentlemen:

Trigon Engineering Consultants, Inc. is pleased to provide this initial report of work in regards to Trigon Proposal No. 011-90-114-P associated with the request to provide limited sampling and analysis of three existing groundwater monitoring wells installed in 1990 by Engineering Tectonics, P.A. at the above-referenced site. Our results for the work performed are provided below.

On October 22, 1990 personnel from Trigon sampled three (3) groundwater monitoring wells (MW-2, MW-3 and MW-5) previously installed by Engineering Tectonics at the referenced property. Information concerning the construction of the groundwater monitoring wells MW-2 and MW-3 in well construction logs provided did not correspond directly with information indicated on monitoring well field tags. Therefore, well tag information is included in this report.

Information gathered from the well tags and well logs provided (Table 1 and attachments) indicates that the top of the well screen is below the static water level measured on October 22, 1990 by Trigon (Table 2). This condition would limit representative sampling for floating volatile organic compounds. An evaluation of environmental conditions for these compounds is therefore limited.

The static water levels as measured by Trigon in the monitoring wells sampled (MW-2, MW-3 and MW-5) ranged in depth from 22.0 feet to 28.3 feet below the surface of the ground (Table 2). Prior to the sampling of the groundwater monitoring wells, 2 well volumes were removed from each well with individually prepared laboratory bailers. Because of the slow recharge rates only 2 well volumes were removed during the well purging activities. Well data, including water pH,

water temperature, static water level and well volume were collected at each monitoring well (MW-2, MW-3 and MW-5) sampled (Table 2). Temperatures are within the range typical for the area but the pH is below typical values in monitoring wells MW-3 and MW-5.

The water samples from the three monitoring wells were screened in the field with an organic vapor analyzer (OVA) for volatile organic compounds (Table 3). The Foxboro Model 128 OVA used for the sample screening operates on flame ionization detection and provides a relative concentration of organic vapors in ambient air. Upon screening the water samples, no volatile organics were detected with the OVA.

After the water samples were retrieved from the monitoring wells, the water samples were placed in laboratory prepared jars and placed in coolers with ice packs (4°C) for shipment to Industrial and Environmental Analysts, Inc. (IEA) for chemical analysis. Based on compounds previously reported as being detected, the water samples from monitoring wells MW-2 and MW-5 were analyzed for Method 625 Base/Neutral compounds and MW-3 was analyzed for 625 acid extractable compounds. Analytical Method 625 Base/Neutral extraction was used to determine previously detected compounds (phenanthrene, flouranthene, pyrene) in MW-2 and MW-5 (phthalate) as indicated in the Engineering Tectonics report of April 22, 1990 to Hawknest, Inc. Method 625 Acid extractable analytical techniques were used to evaluate the presence of phenol compounds previously reported in MW-3. While the Engineering Tectonics April 22 report indicated minute quantities of pesticides also being detected in MW-2, a review of laboratory data submitted in the report copy to Trigon indicated values were undetected (Attachment A). Therefore pesticides analysis was not performed. Metals detected in MW-2 (arsenic, copper, zinc) and MW-3 (zinc) were within allowable state standards for groundwater so no analysis was performed during the sampling efforts by Trigon. An equipment wash blank was performed on the bailer used for MW-5 with subsequent analysis for 625 Base/Neutral/Acid extractable compounds.

The laboratory analysis are attached. Data reported by IEA indicated that compounds analyzed were below quantitation limits (Appendix B).

The results of the recent sampling indicates that the groundwater from the monitoring wells (MW-2, MW-3, MW-5) did not contain detectable concentrations of compounds identified, by the analytical reference methods selected, based on previously reported sampling by Engineering Tectonics. Some of the compounds detected previously are not readily soluble in water. The recent sampling results indicate that the compounds were undetected and may have migrated or degraded. Information contained in this report is based on limited retesting of existing monitoring wells with screens installed below the groundwater/subsoil interface and therefore groundwater conditions may not be completely representative of the sites environment including isolated areas of fill material.

Should site boundaries be extended south of MW-2 and MW-3 to the former asphalt batch plant or east to the area of the former Southern Pumps UST site,, additional investigations will be recommended. Additionally, outcome of the currently on-going Phase 1 environmental site assessment for the subject site may yield information which results in recommendation for additional site investigations. No additional testing of MW-2, MW-3 and MW-5 is recommended at this time for the above-referenced compounds.

Trigon Engineering Consultants, Inc. appreciates this opportunity to be of service to Carolina Income Properties. Should any questions arise concerning this report, please contact the undersigned at your convenience.

Very truly yours,

TRIGON ENGINEERING CONSULTANTS, INC.

J. Scott Pearce/mb
J. Scott Pearce
Staff Geologist

Kirk L. Rife/mb
Kirk L. Rife
Director, Environmental Affairs

Richard C. Wells/mb
Richard C. Wells, P.E.
President

JSP:KLR:RCW/mb

Enclosures

R5010501

TRIGON

TABLES

Winston-Salem Business Park
Winston-Salem, North Carolina
Trigon Job No. 015-90-105

TABLE 1

	WELL PLATE INFORMATION			WELL CONSTRUCTION LOGS* Provided to Trigon		
	MW-2	MW-3	MW-5	MW-2	MW-3	MW-5
Static Level (feet)	23.0	26.9	23.5	15	15	INP**
Screen Interval(feet)	35-45	30-40	29-39	30-40	30-40	INP
Total Depth (feet)	45	40	39	40	40	INP
Sand (feet)	33-45	29-40	28-29			INP
Bentonite (feet)	31-33	27-29	26-28	28-30	28-30	INP
Grout (feet)	0-31	0-27	0-26	0-28	0-28	INP

*Well construction logs provided to Trigon in copy of April 22, 1990 Engineering Tectonic's report to Hawknest Sports.

**Information not provided/included in reports given to Trigon.

CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
VISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH, N.C. 27611, PHONE (919) 733-3083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc ___
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

G CONTRACTOR Engineering Tectonics, P.A.
R REGISTRATION NUMBER 835

STATE WELL CONSTRUCTION PERMIT NUMBER: 33-0375-WM-0113 M2

LOCATION: (Show sketch of the location below)
t Town: Winston-Salem off Dunleith Avenue
proposed I-40 Industrial Park
Community, or Subdivision and Lot No.)
ER Hawksnest Sports
ESS P.O. Box 489 (Street or Route No.)
Lewisville, NC 27023
City or Town State Zip Code
DRILLED 3/16/90 USE OF WELL Monitoring
AL DEPTH 40 CUTTINGS COLLECTED ☒ Yes ☐ No
S WELL REPLACE EXISTING WELL? ☐ Yes ☒ No
TIC WATER LEVEL: 15 FT. ☐ above ☒ below TOP OF CASING.
TOP OF CASING IS 2.7 FT. ABOVE LAND SURFACE.
D (ppm): -- METHOD OF TEST
ER ZONES (depth):

ORINATION: Type NA Amount

County: Forsyth

Depth From	Depth To	DRILLING LOG Formation Description
		See attached boring log

If additional space is needed use back of form.

SING:

	Depth		Diameter	Wall Thickness or Weight/Ft.	Material
From	+2.7	To -30 Ft.	2"	Sch 40	PVC
From		To Ft.			
From		To Ft.			

OUT:

	Depth		Material	Method
From	0	To -28 Ft.	Neat Grout	Tremie
From		To Ft.		

CREEN:

	Depth		Diameter	Slot Size	Material
From	-30	To -40 Ft.	2" in.	.010 in.	PVC
From		To Ft.	in.	in.	
From		To Ft.	in.	in.	

RAVEL PACK:

	Depth		Size	Material
From	-28	To -40 Ft.	Pool Sand	
From		To Ft.		

EMARKS: Bentonite Seal @ -28 to -30

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

See attached boring location diagram

NORTH CAROLINA LICENSED SEAL 165 GEOLOGIST

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

4/23/90

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH,N.C. 27611, PHONE (919) 733-3083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR Engineering Tectonics, P.A.
DRILLER REGISTRATION NUMBER 835
STATE WELL CONSTRUCTION PERMIT NUMBER: 33-0375-WM-0113 M3

WELL LOCATION: (Show sketch of the location below)
Nearest Town: Winston-Salem off Dunleith Avenue at proposed I-40 Industrial Park
(Road, Community, or Subdivision and Lot No.)
County: Forsyth

OWNER Hawksnest Sports
ADDRESS P.O. Box 489 (Street or Route No.)
Lewisville, NC 27023
City or Town State Zip Code

DATE DRILLED 3/16/90 USE OF WELL Monitoring
TOTAL DEPTH 40 CUTTINGS COLLECTED ☒ Yes ☐ No
DOES WELL REPLACE EXISTING WELL? ☐ Yes ☒ No
STATIC WATER LEVEL: 15 FT. ☐ above ☒ below TOP OF CASING.
TOP OF CASING IS 2.7 FT. ABOVE LAND SURFACE.
YIELD (gpm): -- METHOD OF TEST _____
WATER ZONES (depth): _____
CHLORINATION: Type NA Amount _____

CASING:

	Depth		Diameter	Wall Thickness or Weight/Ft.	Material
From	+2.7	To -30 Ft.	2"	Sch 40	PVC
From		To Ft.			
From		To Ft.			

GROUT:

	Depth		Material	Method
From	0	To -28 Ft.	Neat Grout	Tremie
From		To Ft.		

SCREEN:

	Depth		Diameter	Slot Size	Material
From	-30	To -40 Ft.	2" in.	.010 in.	PVC
From		To Ft.	in.	in.	
From		To Ft.	in.	in.	

GRAVEL PACK:

	Depth		Size	Material
From	-28	To -40 Ft.	Pool Sand	
From		To Ft.		

REMARKS: Bentonite Seal @ -28 to -30

Depth From	Depth To	DRILLING LOG Formation Description
		See attached boring log

If additional space is needed use back of form.

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

See attached boring location diagram

NORTH CAROLINA LICENSED SEAL 65

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

4/23/90

Winston-Salem Business Park
Winston-Salem, North Carolina
Trigon Job No. 015-90-105

TABLE 2

October 22, 1990*	MW-2	MW-3	MW-5
pH Beginning	6.0	5.4	5.4
pH Final	6.6	5.8	5.5
Temperature °C Beginning	18.6	18.0	18.0
Temperature °C Final	18.0	17.3	17.6
Static Water Level (feet)	28.3	26.2	22.0
Total Depth (feet)	45.0	40.0	39.0
Well Volume (gallon)	2.9	2.4	2.9

*Date field measurements taken.

APPENDIX A

TRIGON ENGINEERING CONSULTANTS, INC.
SUMMARY OF OVA MONITORING
TABLE 3

Job Name: Winston-Salem Business Park
Job Location: Winston-Salem, North Carolina
Job No: 015-90-105
Date: October 22, 1990

Sample Number	OVA[1] (Field) (ppm)[2]	Comments
MW-2 (1)	0	S.T. 11:30 AM
MW-3 (1)	0	S.T. 12:50 PM
MW-5 (1)	0	S.T. 1:30 PM
Eq. Blk. (1)	0	S.T. 2:00 PM

Notes: [1]Organic Vapor Analyzer (OVA) measures the concentration of organic vapors in the air.
[2]ppm = parts per million
S.T. = Sample Time

AnalytiKEM

IV. Analytical Results (Cont'd)

Pesticide Compounds and Polychlorinated Biphenyls

Parameter	Method Blank	Sample Designation A60258-1 Well 1	A60258-2 Well 2
alpha-BHC	10 U	10 U	10 U
beta-BHC	10 U	10 U	10 U
delta-BHC	10 U	10 U	10 U
gamma-BHC (Lindane)	10 U	10 U	10 U
Heptachlor	10 U	10 U	10 U
Aldrin	10 U	10 U	10 U
Heptachlor Epoxide	10 U	10 U	10 U
Endosulfan I	10 U	10 U	10 U
Dieldrin	10 U	10 U	10 U
4,4'-DDE	10 U	10 U	10 U
Endrin	10 U	10 U	10 U
Endosulfan II	10 U	10 U	10 U
4,4'-DDD	10 U	10 U	10 U
Endosulfan Sulfate	10 U	10 U	10 U
4,4'-DDT	10 U	10 U	10 U
Endrin Aldehyde	10 U	10 U	10 U
Chlordane	10 U	10 U	10 U
Toxaphene	10 U	10 U	10 U
Aroclor 1016	10 U	10 U	10 U
Aroclor 1221	10 U	10 U	10 U
Aroclor 1232	10 U	10 U	10 U
Aroclor 1242	10 U	10 U	10 U
Aroclor 1248	10 U	10 U	10 U
Aroclor 1254	10 U	10 U	10 U
Aroclor 1260	10 U	10 U	10 U
Units	(ug/l)	(ug/l)	(ug/l)

Note: All compounds reported at levels exceeding the PQL have been confirmed by alternate column GC.

iea

GC/MS BASE/NEUTRAL EXTRACTABLES
EPA 625 COMPOUND LIST

IEA Sample Number: 471-113-1
Sample Identification: MW-2
Date Extracted: 10/29/90
Date Analyzed: 10/29/90 By: Mace

Number	Compound	Quantitation Limit (ug/L)	Results Concentration (ug/L)
1	Acenaphthene	5	BQL
2	Acenaphthylene	5	BQL
3	Anthracene	5	BQL
4	Benzo(a)anthracene	5	BQL
5	Benzo(a)pyrene	5	BQL
6	Benzo(b)fluoranthene	5	BQL
7	Benzo(g,h,i)perylene	5	BQL
8	Benzo(k)fluoranthene	5	BQL
9	bis(2-Chloroethoxy)methane	5	BQL
10	bis(2-Chloroethyl)ether	5	BQL
11	bis(2-Chloroisopropyl)ether	5	BQL
12	bis(2-Ethylhexyl)phthalate	5	BQL
13	4-Bromophenyl phenyl ether	5	BQL
14	Benzyl butyl phthalate	5	BQL
15	2-Chloronaphthalene	5	BQL
16	4-Chlorophenyl phenyl ether	5	BQL
17	Chrysene	5	BQL
18	Dibenzo(a,h)anthracene	5	BQL
19	1,2-Dichlorobenzene	5	BQL
20	1,3-Dichlorobenzene	5	BQL
21	1,4-Dichlorobenzene	5	BQL
22	3,3'-Dichlorobenzidine	5	BQL
23	Diethyl phthalate	5	BQL
24	Dimethyl phthalate	5	BQL
25	Di-n-butylphthalate	5	BQL
26	2,4-Dinitrotoluene	5	BQL
27	2,6-Dinitrotoluene	5	BQL
28	Di-n-octylphthalate	5	BQL
29	Fluoranthene	5	BQL
30	Fluorene	5	BQL
31	Hexachlorobenzene	5	BQL
32	Hexachlorobutadiene	5	BQL
33	Hexachlorocyclopentadiene	5	BQL
34	Hexachloroethane	5	BQL
35	Indeno(1,2,3-cd)pyrene	5	BQL
36	Isophorone	5	BQL
37	Naphthalene	5	BQL

iea

GC/MS BASE/NEUTRAL EXTRACTABLES
EPA 625 COMPOUND LIST

IEA Sample Number: 471-113-1
Sample Identification: MW-2
Date Extracted: 10/29/90
Date Analyzed: 10/29/90 By: Mace

Number	Compound	Quantitation Limit (ug/L)	Results Concentration (ug/L)
38	Nitrobenzene	5	BQL
39	N-Nitroso-di-n-propylamine	5	BQL
40	N-Nitrosodiphenylamine	5	BQL
41	Phenanthrene	5	BQL
42	Pyrene	5	BQL
43	1,2,4-Trichlorobenzene	5	BQL
44	Benzidine	25	BQL
45	N-Nitrosodimethylamine	5	BQL

Comments:

BQL = Below Quantitation Limit

iea

GC/MS ACID EXTRACTABLES
EPA 625 COMPOUND LIST

IEA Sample Number: 471-113-2
Sample Identification: MW-3
Date Extracted: 10/29/90
Date Analyzed: 10/30/90 By: Mace

Number	Compound	Quantitation Limit (ug/L)	Results Concentration (ug/L)
1	4-Chloro-3-methylphenol	5	BQL
2	2-Chlorophenol	5	BQL
3	2,4-Dichlorophenol	5	BQL
4	2,4-Dimethylphenol	5	BQL
5	2,4-Dinitrophenol	25	BQL
6	2-Methyl-4,6-dinitrophenol	25	BQL
7	2-Nitrophenol	5	BQL
8	4-Nitrophenol	25	BQL
9	Pentachlorophenol	25	BQL
10	Phenol	5	BQL
11	2,4,6-Trichlorophenol	5	BQL

Comments:

BQL = Below Quantitation Limit

GC/MS BASE/NEUTRAL EXTRACTABLES
EPA 625 COMPOUND LIST

IEA Sample Number: 471-113-3
Sample Identification: MW-5
Date Extracted: 10/29/90
Date Analyzed: 10/30/90 By: Mace

Number	Compound	Quantitation Limit (ug/L)	Results Concentration (ug/L)
1	Acenaphthene	5	BQL
2	Acenaphthylene	5	BQL
3	Anthracene	5	BQL
4	Benzo(a)anthracene	5	BQL
5	Benzo(a)pyrene	5	BQL
6	Benzo(b)fluoranthene	5	BQL
7	Benzo(g,h,i)perylene	5	BQL
8	Benzo(k)fluoranthene	5	BQL
9	bis(2-Chloroethoxy)methane	5	BQL
10	bis(2-Chloroethyl)ether	5	BQL
11	bis(2-Chloroisopropyl)ether	5	BQL
12	bis(2-Ethylhexyl)phthalate	5	BQL
13	4-Bromophenyl phenyl ether	5	BQL
14	Benzyl butyl phthalate	5	BQL
15	2-Chloronaphthalene	5	BQL
16	4-Chlorophenyl phenyl ether	5	BQL
17	Chrysene	5	BQL
18	Dibenzo(a,h)anthracene	5	BQL
19	1,2-Dichlorobenzene	5	BQL
20	1,3-Dichlorobenzene	5	BQL
21	1,4-Dichlorobenzene	5	BQL
22	3,3'-Dichlorobenzidine	5	BQL
23	Diethyl phthalate	5	BQL
24	Dimethyl phthalate	5	BQL
25	Di-n-butylphthalate	5	BQL
26	2,4-Dinitrotoluene	5	BQL
27	2,6-Dinitrotoluene	5	BQL
28	Di-n-octylphthalate	5	BQL
29	Fluoranthene	5	BQL
30	Fluorene	5	BQL
31	Hexachlorobenzene	5	BQL
32	Hexachlorobutadiene	5	BQL
33	Hexachlorocyclopentadiene	5	BQL
34	Hexachloroethane	5	BQL
35	Indeno(1,2,3-cd)pyrene	5	BQL
36	Isophorone	5	BQL
37	Naphthalene	5	BQL

iea

GC/MS BASE/NEUTRAL EXTRACTABLES
EPA 625 COMPOUND LIST

IEA Sample Number: 471-113-3
Sample Identification: MW-5
Date Extracted: 10/29/90
Date Analyzed: 10/30/90 By: Mace

Number	Compound	Quantitation Limit (ug/L)	Results Concentration (ug/L)
38	Nitrobenzene	5	BQL
39	N-Nitroso-di-n-propylamine	5	BQL
40	N-Nitrosodiphenylamine	5	BQL
41	Phenanthrene	5	BQL
42	Pyrene	5	BQL
43	1,2,4-Trichlorobenzene	5	BQL
44	Benzidine	25	BQL
45	N-Nitrosodimethylamine	5	BQL

Comments:

BQL = Below Quantitation Limit

GC/MS BASE/NEUTRAL EXTRACTABLES
EPA 625 COMPOUND LIST

IEA Sample Number: 471-113-4
Sample Identification: MW-5 Equipment Blank
Date Extracted: 10/29/90
Date Analyzed: 10/31/90 By: Mace

Number	Compound	Quantitation Limit (ug/L)	Results Concentration (ug/L)
1	Acenaphthene	10	BQL
2	Acenaphthylene	10	BQL
3	Anthracene	10	BQL
4	Benzo(a)anthracene	10	BQL
5	Benzo(a)pyrene	10	BQL
6	Benzo(b)fluoranthene	10	BQL
7	Benzo(g,h,i)perylene	10	BQL
8	Benzo(k)fluoranthene	10	BQL
9	bis(2-Chloroethoxy)methane	10	BQL
10	bis(2-Chloroethyl)ether	10	BQL
11	bis(2-Chloroisopropyl)ether	10	BQL
12	bis(2-Ethylhexyl)phthalate	10	BQL
13	4-Bromophenyl phenyl ether	10	BQL
14	Benzyl butyl phthalate	10	BQL
15	2-Chloronaphthalene	10	BQL
16	4-Chlorophenyl phenyl ether	10	BQL
17	Chrysene	10	BQL
18	Dibenzo(a,h)anthracene	10	BQL
19	1,2-Dichlorobenzene	10	BQL
20	1,3-Dichlorobenzene	10	BQL
21	1,4-Dichlorobenzene	10	BQL
22	3,3'-Dichlorobenzidine	10	BQL
23	Diethyl phthalate	10	BQL
24	Dimethyl phthalate	10	BQL
25	Di-n-butylphthalate	10	BQL
26	2,4-Dinitrotoluene	10	BQL
27	2,6-Dinitrotoluene	10	BQL
28	Di-n-octylphthalate	10	BQL
29	Fluoranthene	10	BQL
30	Fluorene	10	BQL
31	Hexachlorobenzene	10	BQL
32	Hexachlorobutadiene	10	BQL
33	Hexachlorocyclopentadiene	10	BQL
34	Hexachloroethane	10	BQL
35	Indeno(1,2,3-cd)pyrene	10	BQL
36	Isophorone	10	BQL
37	Naphthalene	10	BQL

GC/MS BASE/NEUTRAL EXTRACTABLES
EPA 625 COMPOUND LIST

IEA Sample Number: 471-113-4
Sample Identification: MW-5 Equipment Blank
Date Extracted: 10/29/90
Date Analyzed: 10/31/90 By: Mace

Number	Compound	Quantitation Limit (ug/L)	Results Concentration (ug/L)
38	Nitrobenzene	10	BQL
39	N-Nitroso-di-n-propylamine	10	BQL
40	N-Nitrosodiphenylamine	10	BQL
41	Phenanthrene	10	BQL
42	Pyrene	10	BQL
43	1,2,4-Trichlorobenzene	10	BQL
44	Benzidine	50	BQL
45	N-Nitrosodimethylamine	10	BQL

Comments:

BQL = Below Quantitation Limit

GC/MS ACID EXTRACTABLES
EPA 625 COMPOUND LIST

IEA Sample Number: 471-113-4
Sample Identification: MW-5 Equipment Blank
Date Extracted: 10/29/90
Date Analyzed: 10/31/90 By: Mace

Number	Compound	Quantitation Limit (ug/L)	Results Concentration (ug/L)
1	4-Chloro-3-methylphenol	10	BQL
2	2-Chlorophenol	10	BQL
3	2,4-Dichlorophenol	10	BQL
4	2,4-Dimethylphenol	10	BQL
5	2,4-Dinitrophenol	50	BQL
6	2-Methyl-4,6-dinitrophenol	50	BQL
7	2-Nitrophenol	10	BQL
8	4-Nitrophenol	50	BQL
9	Pentachlorophenol	50	BQL
10	Phenol	10	BQL
11	2,4,6-Trichlorophenol	10	BQL

Comments:

BQL = Below Quantitation Limit

APPENDIX B

ENGINEERING TECTONICS, P.A.
ENGINEERS • GEOLOGISTS • HYDROLOGISTS
P.O. Box 11846, Winston-Salem, NC 27106 (919) 767-8807

RECEIVED
N.C. Dept. NRCD
NOV 5 1990
Winston-Salem
Regional Office

November 1, 1990

Mr. Steve Weiss, Hydrogeologist
Groundwater Section-D.E.M.
8025 Northpoint Blvd., Suite 100
Winston-Salem, NC 27106-3208

Reference: Toxicology of Pyrene, Fluoranthene, and Phenanthrene;
Winston-Salem Industrial Park, Forsyth County

Dear Mr. Weiss:

In a recent meeting with Mr. Ron Matamoros of House and Blanco, representing the City of Winston-Salem, you asked for information of the toxicology of the three compounds identified as present in the ground water at the subject site. The information below was obtained from TOXNET, a National Library of Medicine service. The print-outs resulting from our data search are available if you would like additional information.

The three compounds are closely related polycyclic aromatic hydrocarbons. Each has three benzene rings. The molecular formulas are as follows: Pyrene and Fluoranthene, C16-H10; pyranthene, C14-H10. These and similar polycyclic aromatics are common in the environment, being constituents of fossil fuels and products of incomplete combustion of organic materials. They have low soluabilities in water, are strongly adsorbed to soil, and have low volatilities. According to the International Agency for Research on Cancer (IARC), phenanthrene, pyrene, and fluoranthene are not classifiable as to their carcinogenicity to humans; there is no data on human populations and animal studies are inadequate.

Pathways to Human exposure are primarily related the adsorbtive properties of these compounds. In the atmosphere, their vapors are photolysised quickly; the reported half-lives range from hours to several days. However, a common exposure is from eating smoked or charcoal broiled foods. The molecules, produced in the combustion, have adsorbed to the food from the vapor phase. Another pathway is

adsorption through the skin from direct contact with materials containing these compounds. The polycyclic aromatics are highly soluble in fats (lipids). Limited data reported from animal studies show that uptake after ingestion is rapid but that within days concentrations had fallen exponentially.

Dissolved in water, these compounds degrade quickly by photolysis or photooxidation, as they do in the atmosphere. Their strong adsorptive tendencies partition their concentrations strongly in favor of the solid, rather than dissolved phase. In soils they should not be mobile but despite this have been reported in groundwaters. All three compounds have been shown to biodegrade from soils and ground waters.

A portion of the data search materials is enclosed. Let me know if you would like further information.

Sincerely,

ENGINEERING TECTONICS, P.A.

Andrew Raring

Andrew Raring, P.G.
Senior Geologist

cc: Mr. Ron Matamoros

NAME OF SUBSTANCE	PYRENE
SYNONYMS	BENZO(D,E,F)PHENANTHRENE **PEER REVIEWED**
SYNONYMS	BENZO(DEF)PHENANTHRENE **PEER REVIEWED**
SYNONYMS	BETA-PYRENE **PEER REVIEWED**
MOLECULAR FORMULA	C16-H10 **PEER REVIEWED**

MAJOR USES

Biochemical research [Sax, N.I. and R.J. Lewis, Sr. (eds.). Hawley's Condensed Chemical Dictionary. 11th ed. New York: Van Nostrand Reinhold Co., 1987. , p. 981] **PEER REVIEWED**

MAJOR USES

No known use [IARC MONOGRAPHS 1972-PRESENT V32 p.432] **PEER REVIEWED**

MAJOR USES

Pyrene from coal-tar has been used as a starting material for the synthesis of benzo(a)pyrene. [IARC MONOGRAPHS 1972-PRESENT V32 p.432] **PEER REVIEWED**

CONSUMPTION PATTERNS

ND [SRI] **PEER REVIEWED**

COLOR/FORM	MONOCLINIC PRISMATIC TABLETS FROM ALCOHOL OR BY SUBLIMATION; PURE PYRENE IS COLORLESS [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. , p. 1149] **PEER REVIEWED**
COLOR/FORM	PALE YELLOW PLATES (WHEN RECRYSTALLIZED FROM TOLUENE) [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 67th ed. Boca Raton, FL: CRC Press, Inc., 1986-87. C-461] **PEER REVIEWED**
COLOR/FORM	Colorless solid (tetracene impuritites give yellow color) [Sax, N.I. and R.J. Lewis, Sr. (eds.). Hawley's Condensed Chemical Dictionary. 11th ed. New York: Van Nostrand Reinhold Co., 1987. , p. 981] **PEER REVIEWED**
ODOR	ND
TASTE	ND
BOILING POINT	393 deg C at 760 mm Hg; 260 deg C at 60 mm Hg [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 67th ed. Boca Raton, FL: CRC Press, Inc., 1986-87. C-461] **PEER REVIEWED**
MELTING POINT	156 DEG C [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. , p. 1149] **PEER REVIEWED**
MOLECULAR WEIGHT	202.26 [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 67th ed. Boca Raton, FL: CRC Press, Inc., 1986-87. C-461] **PEER REVIEWED**
CORROSIVITY	ND
CRITICAL TEMPERATURE & PRESSURE	ND
DENSITY/SPECIFIC GRAVITY	1.271 AT 23 DEG C [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. , p. 1149] **PEER REVIEWED**
DISSOCIATION CONSTANTS	ND
HEAT OF COMBUSTION	ND
HEAT OF VAPORIZATION	ND

VAPOR PRESSURE	6.85x10-7 torr at 20 deg C [Callahan, M.A., M.W. Slimak, N.W. Gabel, et al. Water-Related Environmental Fate of 129 Priority Pollutants. Volume I. EPA-440/4 79-029a. Washington, DC: U.S. 97-3] **PEER REVIEWED**
RELATIVE EVAPORATION RATE	ND
VISCOSITY	ND
OTHER CHEMICAL/PHYSICAL PROPERTIES	ABSORPTION COEFFICIENT FOR THERMAL ELECTRONS: 6.0; IONIZATION POTENTIAL: 7.58; COEFFICIENT OF HIGHEST FILLED OR LOWEST EMPTY MOLECULAR ORBITAL: 0.445; K-REGION: BOND= 4,5, BOND ORDER= 1.777, (CLE) MIN CARBON LOCALIZATION ENERGY PLUS (BLE) BOND LOCALIZATION ENERGY= 3.33 [Searle, C. E. (ed.). Chemical Carcinogens. ACS Monograph 173. Washington, DC: American Chemical Society, 1976. , p. 279] **PEER REVIEWED**
OTHER CHEMICAL/PHYSICAL PROPERTIES	SOLID & SOLN HAVE SLIGHT BLUE FLUORESCENCE [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. , p. 1149] **PEER REVIEWED**
TOXICITY SUMMARY	ND

TOXIC HAZARD RATING

Mutagenic data have been reported. A skin irritant. An exptl equivocal tumorigenic agent. [Sax, N.I. Dangerous Properties of Industrial Materials. 6th ed. New York, NY: Van Nostrand Reinhold, 1984. , p. 2324] **PEER REVIEWED**

THE FOLLOWING OVERVIEW IS A SUMMARY. CONSULT THE COMPLETE POISINDEX (R) DATABASE FOR TREATMENT PURPOSES. COPYRIGHT 1974-YEAR MICROMEDEX, INC. ALL RIGHTS RESERVED. DUPLICATION PROHIBITED.

EMERGENCY MEDICAL TREATMENT

o LIFE SUPPORT :

This overview assumes that basic life support measures have been instituted.

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o CLINICAL EFFECTS :

SUMMARY

- Pyrene is irritating to exposed skin and eyes. No other acute toxic effects in humans were mentioned in available literature at the time of this review. Exposed experimental animals have developed excitation and muscle spasticity. Pyrene is an experimental mutagen and an equivocal animal tumorigen. The IARC has listed pyrene as having no evidence for animal carcinogenesis and it was negative or inconclusive in all EPA GENETOX Program (1986) assays.

- Some unspecified teratogenic effects were noted in workers. Human exposures to polyaromatic hydrocarbons in general are approximately 99 percent from dietary sources. Although there may be reasonably high concentrations of pyrene in foods, there is little data to indicate that any serious health effects occur from its ingestion in dietary sources.

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o LABORATORY :

- A number of chemicals produce abnormalities of the hematopoietic system, liver, and kidneys. Monitoring complete blood count, urinalysis, and liver and kidney function tests is suggested for patients with significant exposure.
- If respiratory tract irritation is present, monitor arterial blood gases, chest x-ray, and pulmonary function tests.

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o TREATMENT OVERVIEW :

SUMMARY

- Move victims of inhalation exposure from the toxic environment and administer 100 percent humidified supplemental oxygen with assisted ventilation as required. Exposed skin and eyes should be copiously flushed with water. Because of the potential for esophageal or gastrointestinal tract irritation or burns following ingestion, EMESIS SHOULD NOT BE INDUCED and gastric lavage done only with caution. Immediate dilution with milk or water might be beneficial.

ORAL EXPOSURE

- DILUTION: Following ingestion and/or prior to gastric evacuation, immediately dilute with 4 to 8 ounces (120 to 240 mL) of milk or water (not to exceed 15 mL/kg in a child).
- GASTRIC LAVAGE: May be indicated if performed soon after ingestion, or in patients who are comatose or at risk of convulsing. After control of any seizures present, perform gastric lavage. Protect airway by placement in Trendelenburg and left lateral decubitus position or by cuffed endotracheal intubation. Lavage return should approximate fluid given.
- Observe patients with ingestion carefully for the possible development of esophageal or gastrointestinal tract irritation or burns. If signs or symptoms of esophageal irritation or burns are present, esophagoscopy may be considered to determine the extent of injury.
- Carefully observe patients with ingestion exposure for the development of any systemic signs or symptoms and administer symptomatic treatment as necessary.

MEDICAL SURVEILLANCE

Initial Medical Examination: Skin disease: Coal tar pitch volatiles are defatting agents and can cause dermatitis on prolonged exposure. Persons with existing skin disorders may be more susceptible to the effects of these agents. /Coal tar pitch volatiles/ [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication , p. 1] **PEER REVIEWED**

MEDICAL SURVEILLANCE

Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, and semi-annually for employees 45 years of age or older or with 10 or more years' exposure to coal tar pitch volatiles. /Coal tar pitch volatiles/ [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication , p. 1] **PEER REVIEWED**

HUMAN TOXICITY VALUES ND

POPULATIONS AT SPECIAL RISK ND

IARC SUMMARY AND EVALUATION

No data are available in humans. Inadequate evidence of carcinogenicity in animals. OVERALL EVALUATION: Group 3: The agent is not classifiable as to its carcinogenicity to humans. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-1985. (Multivolume work). S7 71 (1987)] **QC REVIEWED**

ABSORPTION, DISTRIBUTION AND EXCRETION

THE MECHANISM OF TRANSPORT BY POLYNUCLEAR AROMATIC HYDROCARBONS (PAH) INTO CELLS & BETWEEN INTRACELLULAR MEMBRANES IS DISCUSSED. FROM THE PARTITIONING PARAMETERS, THE RATE LIMITING STEP INVOLVES SOLVATION OF TRANSFER SPECIES IN THE INTERFACIAL WATER AT PHOSPHOLIPID SURFACE. TRANSFER OF PYRENE OUT OF THE PHOSPHATIDYLCHOLINE VESICLES WAS EXAMINED. [PLANT AL ET AL; CHEM-BIOL INTERACT 44 (3): 237-46 (1983)] **PEER REVIEWED**

ABSORPTION, DISTRIBUTION AND EXCRETION

TWELVE POLYCYCLIC AROMATIC HYDROCARBONS, ONE OF WHICH WAS PYRENE, WERE DETECTED IN SKIN OIL OF ROOFING WORKERS./SRP: IN 9 CASES, MEDIAN PYRENE CONCN WAS 1.3 (RANGE, 0.2-10.6) NG/MG SKIN LIPID. NO PYRENE WAS DETECTED IN SERUM/. [WOLFF MS ET AL; CHEMOSPHERE 11 (6): 595-600 (1982)] **PEER REVIEWED**

ABSORPTION, DISTRIBUTION AND EXCRETION

Polynuclear aromatic hydrocarbons are highly soluble in adipose tissue and lipids. /Polynuclear aromatic hydrocarbons/ [Sittig, M. Handbook of Toxic And Hazardous Chemicals. Park Ridge, NJ: Noyes Data Corporation, 1981. , p. 564] **PEER REVIEWED**

METABOLISM/METABOLITES

YIELDS TRANS-4,5-DIHYDRO-4,5-DIHYDROXYPYRENE, S-(4,5-DIHYDRO-4-HYDROXYPYREN-5-YL)GLUTATHIONE, 1,6-DIHYDROXYPYRENE, 1,8-DIHYDROXYPYRENE & 1-HYDROXYPYRENE IN RATS & RABBITS: BOYLAND E & SIMS P, BIOCHEM J 90: 391 (1964). [Goodwin, B.L. Handbook of Intermediary Metabolism of Aromatic Compounds. New York: Wiley, 1976. P-44] **PEER REVIEWED**

INTERACTIONS

COCARCINOGENIC STUDIES ON MOUSE SKIN (50 FEMALE ICR/HA MICE PER GROUP) WERE CONDUCTED. SIMULTANEOUS DERMAL APPLICATION OF 5 UG BENZO(A)PYRENE IN SAME SOLN WITH PYRENE (0.004 & 0.012 MG) 3 TIMES WEEKLY IN 0.1 ML ACETONE PER APPLICATION RESULTED IN 6/50 & 20/50 MICE WITH SQUAMOUS CARCINOMAS, RESPECTIVELY. NO NEOPLASMS WERE OBSERVED IN MICE TREATED WITH PYRENE ALONE. /FROM TABLE/ [Searle, C. E. (ed.). Chemical Carcinogens. ACS Monograph 173. Washington, DC: American Chemical Society, 1976. , p. 35] **PEER REVIEWED**

ENVIRONMENTAL FATE/EXPOSURE SUMMARY

Pyrene's release to the environment is ubiquitous since it is a ubiquitous product of incomplete combustion. It is largely associated with particulate matter, soils and sediments. Although environmental concentrations are highest near sources, its presence in places distant from primary sources indicates that it is reasonably stable in the atmosphere and capable of long distance transport. When released to air it may be subject to direct photolysis, although adsorption to particulates apparently can retard this process. Half-lives for reaction of vapor phase pyrene with atmospheric pollutants are: O3, 0.67 days, NO2, 14 days; estimated half-life for reaction with photochemically produced hydroxyl radicals is 1.12 days. If released to water, it will adsorb very strongly to sediments and particulate matter, bioconcentrate in aquatic organisms slightly to moderately, but will not hydrolyze. It may be subject to significant biodegradation, and direct photolysis may be important near the surface of waters. Evaporation may be important with a half-life of 4.8 to 39.2 days predicted for evaporation from a river 1 m deep, flowing at 1 m/sec with a wind velocity of 3 m/sec; half-life for evaporation from a model pond was 1176 days. Adsorption to sediments and particulates will limit evaporation. If released to soil it will be expected to adsorb very strongly to the soil and will not be expected to appreciably leach to the groundwater, although its presence in groundwater illustrates that it can be transported there. It will not be expected to hydrolyze or significantly evaporate from soils and surfaces. It may be subject to appreciable biodegradation in soils. Human exposure will be from inhalation of contaminated air and consumption of contaminated food and water. Especially high exposure will occur through the smoking of cigarettes and the ingestion of certain foods (eg, smoked and charcoal-broiled meats and fish). (SRC) [CITATION] **PEER REVIEWED**

NATURAL OCCURRING SOURCES

Since pyrene is a product of incomplete combustion, there will be natural sources arising from volcanoes, forest fires etc(SRC). There is some evidence for biosynthesis by plants and bacteria(2). Fossil fuels and coal-tar(3); crude oil, 3.5-4.5 ppm(1). [(1) Verschueren K; Handbook of Environmental Data on Organic Chemicals 2nd ed Von Nostrand Reinhold NY (1983) p 1031 (1983) (2) Sims RC, Overcash MR; Res Rev 88: 1-68 (1983) (3) IARC; Monograph on the Evaluation of the Carcinogenic Risk of Chemicals to Humans 32: 432-45 (1983)] **PEER REVIEWED**

NATURAL OCCURRING SOURCES

/Found in the following natural sources:/ Kuwait Crude oil, 4.5 ppm; South Louisiana crude oil, 3.5 ppm [VERSCHUEREN. HDBK ENVIRON DATA ORG CHEM 1983 p.1031] **PEER REVIEWED**

ARTIFICIAL SOURCES

Ubiquitous product of incomplete combustion, occurring in exhaust from motor vehicles and other gasoline and diesel engines, emissions from coal-, oil-, and wood-burning stoves and furnaces, cigarette smoke; generally released from soot and smoke of industrial, municipal and domestic origin, and found in cooked foods, especially charcoal-broiled(1). Incinerators and coke ovens(2). [(1) IARC; Monograph on the Evaluation of the Carcinogenic Risk of Chemicals to Humans 32: 432-45 (1983) (2) Verschueren K; Handbook of Environmental Data on Organic Chemicals. 2nd ed Von Nostrand Reinhold NY (1983) p 1031-4 (1983)] **PEER REVIEWED**

ENVIRONMENTAL FATE

TERRESTRIAL FATE: If pyrene is released to soil, it will be expected to adsorb very strongly to the soil and will not be expected to leach to the groundwater. Although no information concerning biodegradation in soil was located, pyrene has been shown to be metabolized in laboratory tests by microorganisms isolated from soils and natural waters. This suggests that it may also be degraded in the soil. It will not hydrolyze and evaporation from soils and surfaces will not be expected to be significant. (SRC) [CITATION] **PEER REVIEWED**

ENVIRONMENTAL FATE

AQUATIC FATE: If released to water, pyrene will be expected to adsorb very strongly to sediments and particulate matter. It will not hydrolyze but may undergo slight to moderate bioconcentration. It may be subject to significant biodegradation in the water column. A near the surface half-life for direct photolysis in water of 0.68 hours suggests that photodegradation may be a significant removal process in the water column. Evaporation may be significant in certain waters with estimated half-lives ranging from 4.8 to 39.2 days for evaporation of pyrene from a river 1 m deep, flowing at 1 m/sec with a wind velocity of 3 m/sec(1,SRC); the reported half-life for evaporation from a model pond is 1176 days(2), suggesting that evaporation from such bodies of water may not be significant. It is expected that adsorption to sediments and particulates will limit evaporation(SRC). [(1) Lyman WJ et al; Handbook of Chemical Property Estimation Methods NY: McGraw-Hill pp. 15-1 to 15-34 (1982) (2) Davis EM et al; Biodeterioration 5: 176-84 (1983)] **PEER REVIEWED**

ENVIRONMENTAL FATE

ATMOSPHERIC FATE: Pyrene released to the atmosphere will likely be associated with particulate matter and may be subject to long distance transport, depending mainly on the particle size distribution and climatic conditions which will determine the rates of wet and dry deposition. Its presence in areas remote from primary sources demonstrates the potential for this long range transport as well as pyrene's considerable stability in the air. It may be subject to direct photooxidation but evidence suggests that this process is retarded by the material being in the adsorbed state. In the vapor phase pyrene will be subject to reaction with various atmospheric pollutants with reported half-lives of 0.67 days for O3 and 14 days for NO2(1). The estimated half-life for reaction with photochemically produced hydroxyl radicals is 1.12 days(2,SRC). [(1) National Research Council; Polycyclic Aromatic Hydrocarbons: Evaluation of Sources and Effects, National Acad Press Washington DC (1983) (2) GEMS: Graphical Exposure Modeling System. FAP. Fate of Atmospheric Pollutants (1985)] **PEER

REVIEWED**

BIODEGRADATION

Bacteria isolated from Colgate Creek, Chesapeake Bay, and cultured in Bay water degraded 19.6-22.4% pyrene present unspecfied time; Eastern Bay bacteria similiarly cultured affected 2.0-8.2% degradation(1). Pyrene at 5 ppm was 71% degraded with rapid adaptation after 7 days by microbes in settled domestic wastewater, 100% degraded 7 days after addition of the second subculture. At 10 ppm only 13% degradation was observed after 28 total days and the addition of three subcultures(2). Degradation in Center Hill Reservoir water, 4 weeks, 0-57.1%, avg 16.7%(3). In natural water from polluted steam, Urbana, IL, pyrene was cometabolized 63.3% (naphthalene as growth substrate) and 53.8% (phenanthrene growth substrate) in 4 weeks(4). Pyrene levels from sewage treatment plant: raw sewage, < 5 ppb, final effluent, < 5 ppb, waste activated sludge, < 5-423 ppb (wet weight), digester sludge, 50.5-563 ppb (wet weight)(5). Pyrene in contact with organics that are undergoing a high rate of composting was degraded 0 and 31% in 30-day duplicate tests; rate of degradation was higher over the last 23 days than it was the first 7 days(6). Pyrene has been shown to be bioconverted via oxidation by isolated soil bacteria without any growth substrate present(7). [(1) Walker JD, Colwell RR; p 783-90 in International Conference on Water Pollution Research Vol 7 (1974) (2) Tabak HH et al; J Water Pollut Control Fed 53: 1503-18 (1981) (3) Sayler GS, Serrill TW; Bacterial Degradation of Coal Conversion By-products (Polycyclic Aromatic Hydrocarbons) in Aquatic Environments Office of Water Res and Technol NTIS PB 83-187161 (1981) (4) McKenna EJ; Biodegradation of Polynuclear Aromatic Hydrocarbon Pollutants by Soil and Water Microorganisms Water Resources Center 113: 1-25 (1976) (5) Lue-Hing C et al; AIChE Symp Ser 77: 144-50 (1981) (6) Snell Environmental Group Inc; Rate of Biodegradation of Toxic Compounds While in Contact with Organics which are Actively Composting Lansing, MI NTIS PB 84-193150 (1982) (7) Sims RC, Overcash MR; Res Rev 88: 1-68 (1983)] **PEER REVIEWED**

BIODEGRADATION

Polycyclic aromatic hydrocarbons with 4 or less aromatic rings are degraded by microbes and are readily metabolized by multicellular organisms; biodegradation may be the ultimate fate process. /Polycyclic aromatic hydrocarbons/ [Callahan, M.A., M.W. Slimak, N.W. Gabel, et al. Water-Related Environmental Fate of 129 Priority Pollutants. Volume I. EPA-440/4 79-029a. Washington, DC: U.S. 97-17] **PEER REVIEWED**

ABIOTIC DEGRADATION

Polyaromatic hydrocarbons do not contain hydrolyzable groups and would therefore not be expected to hydrolyze(1). Photochemical studies of pyrene with sunlight and fluorescent lamps of wavelengths > 300 nm in cyclohexane and dichloromethane solution suggest that this compound is resistant to photochemical degradation(2). However, it has been reported that significant (90%) degradation occurred in cyclohexane solution irradiated with a sunlamp for only 7.7 hours(3). Exposure of a heptane solution of pyrene with 22 other polyaromatic hydrocarbons to sunlight for 1 month (Nov) resulted in a recovery of 0.9% of the original pyrene; recovery after 4 days of October exposure, 12%(4). The extent of photodegradation varies with whether the pyrene is pure or adsorbed, and the type of adsorbant(2,3,5-7). Pure unadsorbed pyrene under light in air degraded 42%, while pyrene adsorbed on soot under

light in air only degraded 1%; pure material degraded 83% and soot adsorbed material 58% with light under smog conditions(5). Degradation of pyrene adsorbed on fly ash: sunlamp, 24 hours, 13.1%, sunlight, 5 hours, 6.2%, fluorescent light (> 290 nm), 87 hours, 6.6%, no illumination, 430 hours, 1.3%(3). Near surface half-life for direct photolysis of pyrene in water by sunlight, 0.68 hours(6). Pyrene adsorbed on a variety of solids (fly ash, silica gel, alumina) has been shown to react with NO2 and O3 to give nitropyrenes and quinones, respectively(7). The estimated vapor half-life in the atmosphere is 1.12 days as a result of reaction with photochemically produced hydroxyl radicals(8). [(1) Callahan MA et al; p 98-8 in Water-Related Environmental Fate of 129 Priority Pollutants Vol 2 USEPA-440/4-79-029b (1979) (2) Santodonato J et al; Hazard Profiles on PAH Syracuse Res Corp Syracuse, NY p 53 TR 81-633 (1981) (3) Korfmacher WA et al; Environ Sci Technol 14: 1094-9 (1980) (4) Muel B, Saguem S; Intern J Environ Anal Chem 19: 111-31 (1985) (5) Santodonato J et al; J Environ Pathol Toxicol 5: 1-364 (1981) (6) Zepp RG, Schlotzhauer PF; p 141-58 in Polynuclear Aromatic Hydrocarbons Ann Arbor Science Ann Arbor MI (1979) (7) National Research Council; Polycyclic Aromatic Hydrocarbons: Evaluation of Sources and Effects, National Acad Press Washington DC (1983) (8) GEMS; Graphical Exposure Modeling System Fate of Atmospheric Pollutants (FAP) Data Base Office of Toxic Substances USEPA (1985)] **PEER REVIEWED**

BIOCONCENTRATION

Reported BCF: rainbow trout, 72(1); goldfish, 457(2); fathead minnow, 600-970(3). Based on these values, minimal to moderate bioconcentration of pyrene in aquatic organisms would be expected(SRC). [(1) Spehar RL et al; J Water Pollut Control Fed 52: 1703-74 (1980) (2) Ogata M et al; Bull Environ Contam Toxicol 33: 561-7 (1984) (3) Carlson RM et al; Implications to the Aquatic Environment of Polynuclear Aromatic Hydrocarbons Liberated from Northern Great Plains Coal USEPA-600/2-79-093 (1979)] **PEER REVIEWED**

BIOCONCENTRATION

POLYCYCLIC AROMATIC HYDROCARBONS (PAH) WERE ANALYZED IN SURFACIAL SEDIMENTS & BENTHIC ORGANISMS IN SOUTHEASTERN LAKE ERIE, NEAR A LARGE COAL-FIRED POWER PLANT. SEDIMENT CONCN (530-770 PPB PAH) WERE RELATIVELY HOMOGENOUS THROUGHOUT MOST OF THE 150 SQUARE KM AREA, ALTHOUGH RIVER & NEARSHORE CONCENTRATIONS REACHED 4 PPM. OLIGOCHAETE WORMS DID NOT BIOCONCENTRATE (ON WET WT BASIS) ANY OF THE PAH. CHIRONOMIDE MIDGES COLLECTED 1 KM OFFSHORE EXHIBITED BIOCONCENTRATION OF 5 PAH ONE OF WHICH WAS PYRENE. FURTHER OFFSHORE, THESE APPARENT BIOCONCENTRATIONS DISAPPEARED, WITH MIDGES AT NEAR EQUILIBRIUM WITH SEDIMENTS. [EADIE BJ ET AL; CHEMOSPHERE 11 (2): 185-92 (1982)] **PEER REVIEWED**

BIOCONCENTRATION

... Some marine organisms have no detectable aryl hydrocarbons hydroxylase enzyme systems, namely: phytoplankton, certain zooplankton, mussels (Mytilus edulis), scallops (Placopecten sp), and snails (Litternia littorea). ... Those organisms which lack a metabolic detoxification enzyme system, tend to accumulate polycyclic aromatic hydrocarbons. /Polycyclic aromatic hydrocarbons/ [Maling DC; Ann NY Acad Sci 298: 482-496 (1977) as cited in: Health and Welfare Canada; Polycyclic Aromatic Hydrocarbons p.37 (1979) Report No. 80-EHD-50] **PEER REVIEWED**

BIOCONCENTRATION

Bioaccumulation, especially in vertebrate organisms, is considered to be short-term, and is not considered an important fate process. /Polycyclic aromatic hydrocarbons/ [Callahan, M.A., M.W. Slimak, N.W. Gabel, et al. Water-Related Environmental Fate of 129 Priority Pollutants. Volume I. EPA-440/4 79-029a. Washington, DC: U.S. 95-9] **PEER REVIEWED**

SOIL ADSORPTION/MOBILITY

Koc for three soils, 57, 763-764, 706; Koc for three sediments, 48, 236-285, 256(1). Sediment from 2 ponds, 11,000 (sand) to 130,000 (medium silt); river sediment, 12,000 (sand) to 120,000 (medium silt)(2). Other reported Koc: 8,318(3) and 84,000(4). Based on these Koc values, pyrene would be expected to adsorb very strongly to soils and sediments(SRC). [(1) Sims RC, Overcash MR; Res Rev 88: 1-68 (1983) (2) Karikoff SW et al; Water Res 13: 241-8 (1979) (3) Sabljic A, Protic M; Agric Food Chem 32: 243-6 (1984) (4) Kenaga EE; Ecotox Environ Safety 4: 26-38 (1980)] **PEER REVIEWED**

VOLATILIZATION FROM WATER/SOIL

Percentage estimated maximum stripping removal in a simulated municipal wastewater treatment system was < 1%(1). Half-life for vaporization from model pond, 1176 days(4). Using reported Henry's Law constants of 1.09X10-4 to 5.42X10-5 atm-cu m/mol(1,2) a half-life ranging from 4.8 to 39.2 days was calculated for the evaporation of pyrene from a river 1 m deep, flowing at 1 m/sec with a wind velocity of 3 m/sec(3,SRC). [(1) Petrasek AC et al; J Water Pollut Control Fed 55: 1286-96 (1983) (2) Mackay D, Shiu WY; J Phys Chem Ref Data 10: 1175-99 (1981) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods Environmental Behavior of Organic Compounds McGraw-Hill NY p 15-1 to 15-34 (1982) (4) Davis EM et al; Biodeterioration 5: 176-84 (1983)] **PEER REVIEWED**

WATER CONCENTRATIONS

PYRENE WAS ONE OF THE POLYCYCLIC AROMATIC HYDROCARBONS (PAH) DETERMINED IN SAMPLES FROM BEKKELAGET SEWAGE TREATMENT PLANT IN OSLO RECEIVING INDUST WASTE WATER & HOUSEHOLD SEWAGE: DURING DRY PERIOD IN 1979 (189 NG/L); AFTER RAINFALL 1979 (168 NG/L); DRY PERIOD (SPRING) 1980 (248 NG/L); AFTER RAINFALL (SUMMER) 1980 (110 NG/L). STATIONARY MUSSELS OUTSIDE TREATMENT PLANT CONTAINED 90 NG/G DEC 8; 99 NG/G DEC 11; 82 NG/G DEC 15; 101 NG/G DEC 22; 132 NG/G JAN 6; & 80 NG/G APRIL 28; TRANSPLANTED MUSSELS OUTSIDE BEKKELAGET SEWAGE TREATMENT PLANT 16 NG/G DEC 11; 51 NG/G DEC 22; 40 NG/G JAN 6; 50 NG/G APRIL 28. FROM THE PAH-PROFILES OBSERVED IN MUSSELS NEAR THE DISCHARGE-POINT, IT WAS CONCLUDED THAT THE SEWAGE TREATMENT PLANT IS MAJOR PAH-SOURCE IN THE AREA. FIVE SAMPLES OF NORDIC TAP WATER WERE ANALYZED FOR POLYCYCLIC AROMATIC HYDROCARBONS. CONCENTRATIONS OF PYRENE FOUND WERE 12 NG/L, 8.5 NG/L, 0.31 NG/L, LESS THAN 0.30 NG/L, & LESS THAN 0.72 NG/L, RESPECTIVELY. [KVESETH K ET AL; CHEMOSPHERE 11 (7): 623-39 (1982)] **PEER REVIEWED**

WATER CONCENTRATIONS

DRINKING WATER: Norway, 1.1 ppt(1). Eastern Ontario, Canada, 5 municipal plants, June-October, 1978, 0.04-2.0 ppb, avg 0.6 ppb, raw water, avg 1.0 ppb(2). Great Lakes area, 12 systems, 1980, Jan, 1.3-72.0 ppt, July-Aug, not detected - 31.0 ppt(3). [(1) IARC; Monograph on the Evaluation of the Carcinogenic Risk of Chemicals to Humans 32: 432-45 (1983) (2) Santodonato J et al; Hazard Profiles on PAH p 53 TR-81-633 (1981) (3) Williams DT et al; Chemosphere 3: 263-76 (1982)] **PEER REVIEWED**

WATER CONCENTRATIONS

GROUNDWATER: 1.6-2.5 ppt(1). [(1) IARC; Monograph on the Evaluation of the Carcinogenic Risk of Chemicals to Humans 32: 432-45 (1983)] **PEER REVIEWED**

WATER CONCENTRATIONS

SURFACE WATER: Eastern Ontario, raw waters, June-Oct, 1978, 0.2-1.7 ppt(1). River water, < 0.001 ppm(1). Storet Database, 904 samples, 4.0% pos, avg < 10 ppb(2). [(1) Verschueren K; Handbook of Environmental Data on Organic Chemicals 2nd ed Von Nostrand Reinhold NY (1983) p 1033 (1983) (2) Staples CA et al; Environ Toxicol Chem 4: 131-42 (1985)] **PEER REVIEWED**

WATER CONCENTRATIONS

RAINWATER: Rainwater, 5.8-27.8 ppt(1). [(1) IARC; Monograph on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. 32: 432-45 (1983)] **PEER REVIEWED**

EFFLUENTS CONCENTRATIONS

DATA ON EMISSION LEVELS OF WASTEWATERS & SOLID RESIDUALS FROM PETROLEUM REFINING INDUSTRY ARE SUMMARIZED. TYPES OF WASTE WATER & RESIDUAL SAMPLES FOR WHICH DATA ARE PRESENTED INCL RAW WASTE LOADINGS FROM CLASS A THROUGH E REFINERIES, LOADING OF VARIOUS POLLUTANTS ACROSS SEVERAL PROCESS UNITS SUCH AS DISSOLVED AIR FLOTATION, ACTIVATED SLUDGE PROCESS, CARBON COLUMNS (POWDERED & GRANULAR), & CLARIFIERS, & OILY SOLIDS (TANK BOTTOMS, CRUDE OIL, BUNKER C, & WAXY PRODUCT). PYRENE CONCN RANGES FOUND IN REFINERY CATEGORY B, C, E, & AN UNDESIGNATED CATEGORY (BIOTREATMENT EFFLUENT < 0.1 TO 30 UG/L, 3 UG/L, 0.7 TO 16 UG/L, & 5.4 UG/L: FINAL EFFLUENT < 1 TO 7 UG/L, < 0.5 UG/L, < 1 UG/L, & < 0.1 UG/L) RESPECTIVELY. [SNIDER EH, MANNING FS; ENVIRON INT 7 (4): 237-58 (1982)] **PEER REVIEWED**

EFFLUENTS CONCENTRATIONS

STORET database, 1,271 samples, 5.2% positive, < 10 ppb(1). US National Urban Runoff Program, 15 cities, 40% positive, 86 samples, 11% positive, 0.3-10 ppb(2). Estimated emmissions from mobile sources, 1979, 950 metric tons(3). Domestic effluent, 1.8 ppb; sewage: high percentage industry, 2.56-3.12 ppb, dry weather, 0.25 ppb, heavy rain, 16.1 ppb(4). 1964: automobile, 47.5 ug/km travelled, truck 275.0 ug/km; petroleum cracking, 245 ug/cu m; municipal incineration, 17.6 ug/km open burning of municipal refuse, 1762 ug/kg(5). Tire manufacturing plant wastewater, 10 ppb(6). [(1) Staples CA et al; Environ Toxicol Chem 4: 131-42 (1985) (2) Cole RH et al; J Water Pollut Control Fed 56: 898-908 (1984) (3) National Research Council; Polycyclic Aromatic Hydrocarbons: Evaluation of Sources and Effects, National Acad Press Washington DC (1983) (4) Verschueren K; Handbook of Environmental Data on Organic Chemicals 2nd ed Von Nostrand Reinhold NY p 272 (1983) (5) Santodonato J et al; J Environ Pathol Toxicol 5: 1-364 (1981) (6) Jungclaus GA et al; Anal Chem 48: 1894-6 (1976)] **PEER REVIEWED**

SEDIMENT/SOIL CONCENTRATIONS

SEDIMENTS: Wilderness Lake, Ontario, Canada, 1976, 23 ppb (dry wt); Lake Constance, rapid sand filter solids, 0.2 ppm(1). Lake sediments, 0.38 ppm; rivers, 0.33 ppm; river particulates, 6.0 ppm(2). Buzzards Bay, MA, 0.12-0.96 ppm(2). Niagara River, Niagara-on-the-lake, 1975-82, suspended sediments (susp sed), trace-4,000 ppb(3). Columbia River, WA, 1979, 11 monthly samples, 24-410 ppb (dry wt)(max January, min June), avg 56 ppb(4). Woods Lake, remote Adirondack lake, NY, March, 1978, 16-930 ppb (max 0-4 cm depth)(5). Northwestern Atlantic, 13 samples, 2-12,000 ppb (dry wt)(6). 21 samples, not detected (nd)-13,000 (dry wt) (max Charles River. Boston, MA(7). W Germany, 4 rivers, water solids, 1.1-8.0 ppm(1). Severn Estuary, UK 0.5-3.5 ppm (dry wt)(1). SOILS: Nova Scotia, Canada, 29 samples, 10 sites, < 0.1-64 ppb (dry wt), median, 5 ppb(6). 17 soil samples, nd-410 ppb (dry wt)(7). [(1) Verschueren K; Handbook of Environmental Data on Organic Chemicals 2nd ed Von Nostrand Reinhold NY p 1033 (1983) (2) Santodonato J et al; J Environ Pathol Toxicol 5: 1-364 (1981) (3) Kuntz KW; Toxic Contaminants in the Niagara River, 1975-1982 Burlington, Ontario Tech Bull No.134 (1984) (4) Prahl FG et al; Environ Sci Technol 18: 687-93 (1984) (5) Tan YL, Heit M; Geochim Cosmochim Acta 45: 2267-79 (1981) (6) Windsor JG, Hites RA; Geochim Cosmochim Acta 43: 27-33 (1979) (7) Hites RA et al; Adv Chem Ser 185: 189-311 (1980)] **PEER REVIEWED**

ATMOSPHERIC CONCENTRATIONS

POLYNUCLEAR AROMATIC HYDROCARBONS IN URBAN ATMOSPHERES: PYRENE: TRACE-35 UG/1000 CU M IN 12 USA CITIES (1958). 1.3-19.3 UG/1000 CU M IN DETROIT (1962-63). /FROM TABLE/ [Searle, C. E. (ed.). Chemical Carcinogens. ACS Monograph 173. Washington, DC: American Chemical Society, 1976. , p. 341] **PEER REVIEWED**

ATMOSPHERIC CONCENTRATIONS

RURAL/REMOTE: Norway aerosols, winters, 1975-77, 0.12-4.89 ng/cu m; low concn occurs when origin of air is northern Norway and high concn is when origin of air is England and France(1,2). Riso, Denmark, 30 rural samples, 0.6 ng/cu m(5). URBAN/SUBURBAN: Greater Birmingham, AL, 10 sites, 1.0-11.2 ng/cu m; USA, 7 cities, winter, 1959, 0.19-36.0 ng/cu m, summer, 1958, 0.1-2.8 ng/cu m; 12 USA cities, trace-35 ng/cu m; 4 cities outside USA, 0.08-17.0 ng/cu m(1). 9 cities outside USA, 1.64-53.6 ng/cu m (max high traffic area); avg USA urban, 1963, 5 ng/cu m, 42 ppm particulates(4). Sutton-Coldfield, UK, suburban, total suspended particulates (TSP), 1.6 ng/cu m. 30.6 ppm(3). Suburban homes: outside, 2.62 ng/cu m, 54.3 ppm TSP, inside, 1.32 ng/cu m, 24.9 ppm TSP(4). Rorvik, Sweden, Feb-March, 1977, 0.22-21.5 ng/cu m(2). The Netherlands, 5 cities, summers, 1968-71, 1-5 ng/cu m, winters, 1968-69, 10-24 ng/cu m, 1970-71, 1-11 ng/cu m; Osaka, Japan, Nov 1981, Jan, March, Aug, 1982, 1.52-8.69 ng/cu m, avg 4.16 ng/cu m(6). SOURCE DOMINATED: Birmingham, UK area close to heavy vehicular traffic, TSP, 1.2 ng/cu m, 21.1 ppm(3). Baltimore Harbor Tunnel, 120 ng/cu m(1). [(1) Santodonato J et al; J Environ Pathol Toxicol 5: 1-364 (1981) (2) Bjorseth A, Olufsen BS; pp 507-24 in Handbook of Aromatic Hydrocarbons (1983) (3) Butler JD et al; Environ Pollut B 3: 109-23 (1982) (4) Verschueren K; Handbook of Environmental Data on Organic Chemicals 2nd ed Von Nostrand Reinhold NY p 1031-5 (1983) (5) Nielson T et al; Atmos Environ 18: 2159-65 (1984) (6) Matsumoto H, Kashimoto T; Bull Environ Contam Toxicol 34: 17-23 (1985)] **PEER REVIEWED**

PROBABLE EXPOSURES

Exposure to pyrene will be widespread due to its ubiquitous presence in the environment. NIOSH (NOES Survey 1981-1983) has statistically estimated that 28 workers are exposed to pyrene in the USA(1). NIOSH (NOHS Survey 1972-1974) has statistically estimated that 32 workers are exposed to pyrene in the USA(2). Coke plant: gaseous concn, 0-14 ug/cu m, TSP, 35-319 ug/cu m(3). Coal liquification plant, 7 work areas 0.1-24.9 ug/cu m(4). [(1) NIOSH; National Occupational Exposure Survey (NOES) (1984) (2) NIOSH; National Occupational Health Survey (NOHS) (1974) (3) Bjorseth A et al; Scand J Work Environ Health 4: 224-36 (1976) (4) Bjorseth A, Olufsen BS; p 507-24 in Handbook of Aromatic Hydrocarbons (1983)] **PEER REVIEWED**

PROBABLE EXPOSURES

GLASS CAPILLARY GAS CHROMATOGRAPHY SHOWED THAT WORKERS IN COKE PLANT WERE EXPOSED TO 5 TO 1000 MG POLYCYCLIC AROMATIC HYDROCARBONS (PAH)/CU M AIR (INCL ACENAPHTHYLENE). PARTICULATE MATTER CONTAINS 98% RESPIRABLE PAH. [BJOERSETH A ET AL; SCAND J WORK, ENVIRON HEALTH 4 (3): 224 (1978)] **PEER REVIEWED**

BODY BURDENS

Human liver, 270-470 ppt (wet wt); fat, 49-2,700 ppt (wet wt)(1). [(1) National Research Council; Polycyclic Aromatic Hydrocarbons: Evaluation of Sources and Effects, National Acad Press Washington DC pp 6-36 to 6-37 (1983)] **PEER REVIEWED**

WATER STANDARDS

For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms, ... therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 1x10-5, 1x10-6, and 1x10-7. The corresponding ambient water criteria are 28.0 ng/l, 2.8 ng/l, and 0.28 ng/l, rspectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0 ng/l, 31.1 ng/l, and 3.11 ng/l respectively. /Polynuclear aromatic hydrocarbons based on benzo(a)pyrene as the model PAH/ [USEPA; Ambient Water Quality Criteria Doc: Polynuclear Aromatic Hydrocarbons (Draft) p.C-121 (1980)] **PEER REVIEWED**

WATER STANDARDS

Toxic pollutant designated pursuant to section 307(a)(1) of the Clean Water Act and is subject to effluent limitations. /Polynuclear aromatic hydrocarbons/ [40 CFR 401.15 (7/1/87)] **PEER REVIEWED**

WATER STANDARDS

The attempt to develop a drinking water criterion for polynuclear aromatic hydrocarbons (PAH) as a class is hindered by several gaps in the scientific data base: (1) The PAH class is composed of numerous compounds having diverse biological effects and varying carcinogenic potential. A "representative" PAH mixture, has not been defined. (2) The common practice of using data derived from studies with benzo(a)pyrene to make generalizations concerning the effects of environmental PAH may not be scientifically sound. (3) No chronic animal toxicity studies involving oral exposure to PAH mixtures exist. (4) No direct human data concerning the effects of exposure to defined PAH mixtures exist. /Polynuclear aromatic hydrocarbons/ [USEPA; Ambient Water Quality Criteria Doc: Polynuclear Aromatic Hydrocarbons (Draft)

NAME OF SUBSTANCE	PHENANTHRENE
SYNONYMS	PHENANTHREN (GERMAN) **PEER REVIEWED**
MOLECULAR FORMULA	C14-H10 **PEER REVIEWED**
MAJOR USES	MFR OF DYESTUFFS; EXPLOSIVES; BIOLOGICAL RESEARCH [Hawley, G.G. The Condensed Chemical Dictionary. 10th ed. New York: Van Nostrand Reinhold Co., 1981. , p. 794] **PEER REVIEWED**
MAJOR USES	RESEARCH CHEMICAL [SRI] **PEER REVIEWED**
MAJOR USES	Synthesis of drugs ... /and/ phenanthrenequinone. [HAWLEY. CONDENSED CHEM DICTNRY 10TH ED 1981 p.794] **PEER REVIEWED**
CONSUMPTION PATTERNS	ND [SRI] **PEER REVIEWED**
COLOR/FORM	MONOCLINIC PLATES FROM ALCOHOL [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. , p. 1037] **PEER REVIEWED**
COLOR/FORM	COLORLESS SHINING CRYSTALS [Hawley, G.G. The Condensed Chemical Dictionary. 10th ed. New York: Van Nostrand Reinhold Co., 1981. , p. 794] **PEER REVIEWED**
COLOR/FORM	LEAFLETS [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 67th ed. Boca Raton, FL: CRC Press, Inc., 1986-87. C-402] **PEER REVIEWED**
ODOR	Faint aromatic odor [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication , p. 1] **PEER REVIEWED**
TASTE	ND
BOILING POINT	340 DEG C [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 67th ed. Boca Raton, FL: CRC Press, Inc., 1986-87. C-402] **PEER REVIEWED**
MELTING POINT	101 DEG C [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 67th ed. Boca Raton, FL: CRC Press, Inc., 1986-87. C-402] **PEER REVIEWED**
MOLECULAR WEIGHT	178.22 [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. , p. 1037] **PEER REVIEWED**
CORROSIVITY	ND
CRITICAL TEMPERATURE & PRESSURE	ND
DENSITY/SPECIFIC GRAVITY	0.9800 @ 4 DEG C [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 67th ed. Boca Raton, FL: CRC Press, Inc., 1986-87. C-402] **PEER REVIEWED**
DISSOCIATION CONSTANTS	ND
HEAT OF COMBUSTION	1,685.6 kcal @ 25 deg C [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 67th ed. Boca Raton, FL: CRC Press, Inc., 1986-87. D-276] **PEER REVIEWED**
HEAT OF VAPORIZATION	14,184.0 gcal/g mole [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 67th ed. Boca Raton, FL: CRC Press, Inc., 1986-87. C-675] **PEER REVIEWED**

OCTANOL/WATER PARTITION COEFFICIENT	Log Kow= 4.57 (measured) [Karickhoff SW; Chemosphere 10: 833-46 (1981)] **PEER REVIEWED**
PH	ND
SOLUBILITIES	1 G IN 60 ML COLD OR 10 ML BOILING 95% ALCOHOL; IN 25 ML ABSOLUTE ALCOHOL; 2.4 ML TOLUENE OR CARBON TETRACHLORIDE; 2.0 ML BENZENE; 1.0 ML CARBON DISULFIDE; 3.3 ML ANHYD ETHER; SOL IN GLACIAL ACETIC ACID; ORG SOLVENTS, ESPECIALLY IN AROMATIC HYDROCARBONS [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. , p. 1037] **PEER REVIEWED**
SOLUBILITIES	SOL IN HOT PYRIDINE, IN CHLOROFORM [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 67th ed. Boca Raton, FL: CRC Press, Inc., 1986-87. C-402] **PEER REVIEWED**
SOLUBILITIES	1.6 mg/l at 15 deg C; 0.423 ppm at 8.5 deg C; 0.816 ppm at 21 deg C; 0.6 + or - 0.1 ppm at 22 deg C 1.277 ppm at 30 deg C [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. , p. 970] **PEER REVIEWED**
SPECTRAL PROPERTIES	MAX ABSORPTION (HEPTANE): 187.5 NM (LOG E= 4.48); 211.5 NM (LOG E= 4.57); INDEX OF REFRACTION: 1.59427; SADTLER REFERENCE NUMBER: 810 (IR, PRISM); 8035 (IR, GRATING) [Weast, R.C. (ed.). Handbook of Chemistry and Physics. 60th ed. Boca Raton, Florida: CRC Press Inc., 1979. C-425] **QC REVIEWED**
SPECTRAL PROPERTIES	Max absorption (methanol-ethanol): 210, 219, 242, 251, 273.5, 281, 292.5, 308.5 314, 322.5, 329.5, 337, 345 nm [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-1985. (Multivolume work). V32 420 (1983)] **PEER REVIEWED**
SPECTRAL PROPERTIES	Intense mass spectral peaks: 178 m/z (100%), 176 m/z (25%), 179 m/z (23%), 177 m/z (15%) [Hites, R.A. Handbook of Mass Spectra of Environmental Contaminants. Boca Raton, FL: CRC Press Inc., 1985. , p. 45] **QC REVIEWED**
SPECTRAL PROPERTIES	IR: 6030 (Coblentz Society Spectral Collection) [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985. V2 39] **QC REVIEWED**
SPECTRAL PROPERTIES	UV: 256 (Sadtler Research Laboratories Spectral Collection) [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985. V2 39] **QC REVIEWED**

Examination: The aforementioned medical examinations should be repeated on an annual basis. /Napthalene/ [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication , p. 1] **PEER REVIEWED**

HUMAN TOXICITY VALUES HD

POPULATIONS AT SPECIAL RISK

Pregnant women may be especially susceptible to exposure effects associated with coal tar pitch volatiles. /Coal tar pitch volatiles/ [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication , p. 1] **PEER REVIEWED**

POPULATIONS AT SPECIAL RISK

Persons with existing skin disorders may be more susceptible to the effects of /coal tar pitch volatiles/. /Coal tar pitch volatiles/ [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication , p. 1] **PEER REVIEWED**

IARC SUMMARY AND EVALUATION

No data are available in humans. Inadequate evidence of carcinogenicity in animals. OVERALL EVALUATION: Group 3: The agent is not classifiable as to its carcinogenicity to humans. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-1985. (Multivolume work). S7 69 (1987)] **QC REVIEWED**

ABSORPTION, DISTRIBUTION AND EXCRETION

RADIOACTIVITY ACCUMULATION BY COALFISH ADMINISTERED 15.8 UG 9-(14)C-LABELED COALFISH, RADIOACTIVITY WAS GREATER IN LIVER THAN IN GALLBLADDER OR MUSCLE FOLLOWING INTRAGASTRIC ADMIN OF 15.8 UG. MAX ACCUM OCCURRED FROM 10-24 HR AFTER DOSING & APPROX 72% WAS PRESENT IN LIVER AFTER 17 HR. IN GALLBLADDER HIGHEST LEVEL OCCURRED 24-48 HR AFTER ADMIN. [SOLBAKKEN JE ET AL; BULL ENVIRON CONTAM TOXICOL 23 (1-2): 100-3 (1979)] **PEER REVIEWED**

ABSORPTION, DISTRIBUTION AND EXCRETION

FOLLOWING INTRAGASTRIC ADMIN IN NORWAY LOBSTER OF (14)C-LABELED PHENANTHRENE, HIGHEST AMT OF RADIOACTIVITY WAS FOUND IN HEPATOPANCREAS SYSTEM & MUSCLE. IN ALL TISSUES, EXCEPT INTESTINE, HIGHEST LEVELS WERE MEASURED 1 DAY AFTER DOSING, AFTER 28 DAYS ONLY MINUTE AMT REMAINED IN TISSUES. THE LOW CONTENT OF RADIOACTIVITY IN STOMACH & INTESTINE 1 DAY AFTER ADMINISTRATION INDICATED THAT MOST OF IT WAS ABSORBED FROM INTESTINE. NORWAY LOBSTER ACCUM RADIOACTIVITY AT HIGH RATE & IS ABLE TO ELIMINATE MOST OF RADIOACTIVITY WITHIN A FEW WK AFTER A SINGLE DOSE. [PALMORK KH, SOLBAKKEN JE; BULL ENVIRON CONTAM TOXICOL 25 (4): 668-71 (1980)] **PEER REVIEWED**

ABSORPTION, DISTRIBUTION AND EXCRETION

Polynuclear aromatic hydrocarbons are highly soluble in adipose tissue and lipids. /Polynuclear aromatic hydrocarbons/ [Sittig, M. Handbook of Toxic And Hazardous Chemicals. Park Ridge, NJ: Noyes Data Corporation, 1981. , p. 564] **PEER REVIEWED**

ABSORPTION, DISTRIBUTION AND EXCRETION

Polynuclear aromatic hydrocarbons (PAH), some of which are potent carcinogens, are common environmental pollutants. The transport processes for these hydrophobic compounds into cells and between intracellular membranes are diverse and are not well understood. A

common mechanism of transport is by spontaneous desorption and transfer through the aqueous phase. From the partitioning parameters, ... the rate limiting step involves solvation of the transfer species in the interfacial water at the phospholipid surface. Transfer of 10 PAH ... out of phosphatidylcholine vesicles has been examined. ... Results show that the molecular volume of the PAH is a rate-determing factor. Morever, high performance liquid chromatography (HPLC) data confirms the hypothesis that the rate of transfer is correlated with the size of the molecule and with the partitioning of the molecule between a polar and hydrocarbon phase. The kinetics and characteristics of the spontaneous transfer of carcinogens are likely to have a major impact on the competitive processes of PAH metabolism within cells. [Plant AL et al; Chem-biol Interact 44 (3): 237-46 (1983)] **PEER REVIEWED**

METABOLISM/METABOLITES

PHENANTHRENE YIELDS TRANS-9,10-DIHYDRO-9,10-DIHYDROXYPHENANTHRENE IN RAT & RABBIT: BOYLAND, E ET AL, BIOCHEM J, 84, 571 (1962); BOYLAND E & WOLF, G, BIOCHEM J, 47, 64 (1950); & IN RAT: BOYLAND E, & WOLF G; BIOCHEM J 42 32P (1948). /FROM TABLE/ [Goodwin, B.L. Handbook of Intermediary Metabolism of Aromatic Compounds. New York: Wiley, 1976. P-4] **PEER REVIEWED**

METABOLISM/METABOLITES

PHENANTHRENE YIELDS TRANS-1,2-DIHYDRO-1,2-DIHYDROXYPHENANTHRENE, TRANS-3,4-DIHYDRO-3,4-DIHYDROXYPHENANTHRENE, AND S-(9,10-DIHYDRO-9-HYDROXYPHENANTHR-10-YL) GLUTATHIONE IN RABBIT & IN RAT; BOYLAND E, AND SIMS P; BIOCHEM J 84 571 (1962). /FROM TABLE/ [Goodwin, B.L. Handbook of Intermediary Metabolism of Aromatic Compounds. New York: Wiley, 1976. P-4] **PEER REVIEWED**

METABOLISM/METABOLITES

PHENANTHRENE YIELDS 1-HYDROXY-, 2-HYDROXY-, 3-HYDROXY-, & 4-HYDROXYPHENANTHRENE IN RAT & IN RABBIT: BOYLAND E ET AL; BIOCHEM J 84: 571 (1962); SIMS P; BIOCHEM J 84: 558 (1962). /FROM TABLE/ [Goodwin, B.L. Handbook of Intermediary Metabolism of Aromatic Compounds. New York: Wiley, 1976. P-4] **PEER REVIEWED**

METABOLISM/METABOLITES

PHENANTHRENE YIELDS 9-HYDROXYPHENANTHRENE IN RAT & RABBIT: SIMS P; BIOCHEM J 84: 558 (1962); & PHENANTHRENE-9,10-OXIDE; GROVER PL, HEWER A, & SIMS P; FEBS LETTERS 18: 76 (1971). /FROM TABLE/ [Goodwin, B.L. Handbook of Intermediary Metabolism of Aromatic Compounds. New York: Wiley, 1976. P-4] **PEER REVIEWED**

METABOLISM/METABOLITES

METABOLITES 48 HR AFTER INTRAGASTRIC ADMIN OF 75 MG/KG TO COALFISH WERE ALL 5 OF POSSIBLE MONOHYDROXY DERIV &
TRANS-PHENANTHRENE-1,2-DIHYDRODIOL &
TRANS-PHENANTHRENE-9,10-DIHYDRODIOL. TRANS-PHENANTHRENE-1,2-DIHYDRODIOL WAS EXCRETED AS GLUCURONIDE &/OR SULFATE CONJUGATE. [SOLBAKKEN JE ET AL; ACTA PHARMACOL TOXICOL 46 (2): 127-32 (1980)] **PEER REVIEWED**

METABOLISM/METABOLITES

The metabolism of (14)C-phenanthrene in vitro by untreated, sodium phenobarbital (PhB) and 3-methylcholanthrene pre-treated rat, guinea pig, and mouse hepatic microsomes has been studied. The major metabolite, except with microsomes from 3-methylcholanthrene pre-treated guinea pigs, was
trans-9,10-dihydro-9,10-dihydroxyphenanthrene. In the case of 3-methylcholanthrene pre-treated guinea pig microsomes, the

34 (1): 67-74 (1986)] **PEER REVIEWED**

INTERACTIONS ND

ENVIRONMENTAL FATE/EXPOSURE SUMMARY

Release of phenanthrene (PHEN) most likely results from the incomplete combustion of a variety of organic compounds including wood and fossil fuels. Release to the soil will likely result in biodegradation. Volatilization is not expected to be significant. Phenanthrene is expected to bind strongly to soil and not leach extensively to groundwater. When released to water, adsorption of PHEN to suspended sediments is expected to remove most of the compound from solution. Photolysis is expected to occur near the water surface and biodegradation of phenanthrene in the water column is expected. Oxidation, volatilization and bioconcentration are not expected to be significant. Phenanthrene released to the atmosphere is expected to rapidly adsorb to particulate matter. Phenanthrene adsorbed on fly ash has been shown to photolyze rapidly (half-life 49 hr) and Phenanthrene adsorbed on particulate matter will be subject to wet and dry deposition. Vapor phase phenanthrene will react with photochemically gener ated, atmospheric hydroxyl radicals with an estimated half-life of 1.67 days. PHEN is a contaminant in air, water, sediment, soil, fish and other aquatic organisms and food. Human exposure results primarily from ingestion of food contaminated with PHEN. (SRC) [CITATION] **PEER REVIEWED**

NATURAL OCCURRING SOURCES

... Occurs in fossil fuels. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-1985. (Multivolume work). V32 420 (1983)] **PEER REVIEWED**

NATURAL OCCURRING SOURCES

Kuwait crude oil: 26 ppm; South Louisiania crude oil: 70 ppm. [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. , p. 970] **PEER REVIEWED**

NATURAL OCCURRING SOURCES

/Phenanthrene is a component of/ shale oil. [DOE; Identification and Toxicity of Fractionated-Shale-Oil Components 17pp Report No. DOE/EV/10404-TI (1982)] **PEER REVIEWED**

ARTIFICIAL SOURCES

Phenanthrene (PHEN) is a product of incomplete combustion of organic materials and so has been detected in sidestream cigarette smoke, mainstream smoke of marijuana cigarettes, gasoline engine exhaust and charcoal broiled steaks(1). PHEN has also been detected in used motor oil (157.85 mg/kg), crude oils (>128.7 mg/kg), and lubricating fuels (>7.09 mg/kg)(1). Diesel and gasoline exhaust contained 6.4 and 2.1 ug/cu m PHEN, respectively(2). Combined residues of PHEN and anthracene were 155,000 and 76,500 ppb dry weight in crude oil and soot samples, respectively(3). Phenanthrene was detected but not quantified in diesel exhaust(4). [(1) IARC; Polynuclear Aromatic Compounds Part 1. 32: 419-30 (1983) (2) Kerkhoff MJ et al; Environ Sci Technol 19: 695-99 (1985) (3) Sporstot S et al; Environ Sci Technol 17: 282-86 (1983) (4) Daisey JM et al; J Air Pollut Control Assoc 36: 17-33 (1986)] **PEER REVIEWED**

ENVIRONMENTAL FATE

TERRESTRIAL FATE: The phenanthrene (PHEN) content of dried sludge added to soil decreased by 98.8% after 1280 days(1). The loss of PHEN was attributed to biodegradation and unidentified abiotic processes(1). The PHEN content of secondary wastewater decreased by 80-90% following percolation through treatment basins(2). The residence time in the basins was 8 hr(2). When wastewater containing 0.05-100 ug/l polycylic aromatic hydrocarbons (PAH) and pretreated by oil separation was applied to grass covered soil at 4300 gallons per day/acre, water samples taken in November from downgradient wells contained 13-61 ng/l PHEN(3). PAH's were non-detectable in July well water samples(3). The wells were located an unspecified distance from the application site(3). Migration of PHEN through the soil is indicated by this study and, therefore, PHEN may leach to groundwater. Because of the high measured Koc value of PHEN (22,909), however, it is suggested that leaching of PHEN to groundwater should be limited in most circumstances(SRC). [(1) Bossert I et al; Appl Environ Microbiol 48: 463-7 (1984) (2) Bouwer EJ et al; Water Res 18: 463-72 (1984) (3) Middleton AC; Basic Life Sci 28: 137-49 (1984)] **PEER REVIEWED**

ENVIRONMENTAL FATE

AQUATIC FATE: Introduction of creosote into the Hershey River in Michigan resulted in phenanthrene (PHEN) concentrations as high as 352 ng/g sediment (wet weight) > 3 km downstream from the source(1). Partitioning of PHEN to sediment is generally expected whenever PHEN is released to water. Biodegradation of PHEN by water- and sediment-dwelling bacteria is expected. Volatilization of PHEN can also occur, but is not expected to be significant due to the anticipated adsorption to sediments(SRC). Bioconcentration of PHEN is not expected to be significant since the compound will probably be easily metabolized via microsomal oxidase in fish(SRC). Photolysis and photooxidation of dissolved PHEN may occur (estimated half-life 8.4 hr). These processes, however, are expected to be severely attenuated, if not eliminated entirely, by the anticipated adsorption of PHEN to particulate matter and sediments(SRC). [(1) Black JJ; Arch Environ Contam Toxicol 11: 161-6 (1982)] **PEER REVIEWED**

ENVIRONMENTAL FATE

ATMOSPHERIC FATE: The half-life for the reaction of vapor phase phenanthrene (PHEN) with photochemically generated hydroxyl radicals in the atmosphere was estimated to be 1.67 days(1) but this process is expected to be considerably slower for particle-adsorbed PHEN. Photolysis of PHEN adsorbed to fly ash has been shown to occur (half-life 49 hr) and any vapor phase PHEN may also photolyze directly since it absorbs irradiation above 290 nm. Wet and dry deposition of PHEN-adsorbed on particulates is expected(SRC). [(1) GEMS; Graphical Exposure Modeling System. Fate of Atmospheric Pollutants (FAP) Data Base. Office of Toxic Substances. USEPA (1986)] **PEER REVIEWED**

ENVIRONMENTAL FATE

AQUATIC FATE: ... Empirical evidence suggests that phenanthrene ... will be adsorbed onto suspended particulates and biota and that their transport will be determined by the hydrogeologic conditions of the aquatic system. That portion dissolved in the water column may undergo direct photolysis. [Callahan, M.A., M.W. Slimak, N.W. Gabel, et al. Water-Related Environmental Fate of 129 Priority Pollutants. Volume I. EPA-440/4 79-029a. Washington, DC: U.S. 96-1] **PEER REVIEWED**

BIODEGRADATION

Biodegradation of phenanthrene (PHEN) in water samples taken from several sites in the Center Hill Reservoir in Tennessee incubated at 25 deg C for 28 days was 55.52% (Feb), 65.86 to 90.25% (Mar), 80.39% to 91.75% (Apr), 79.76% to 85.76% (Jun), 49.58% to 58.84% (Aug), 67.61% to 78.46% (Sept), and 92.26% to 94.60% (Dec)(1). PHEN added to water samples from two Center Hill Reservoir sites incubated at 25 deg C was 90.12 and 86.70, 90.36 and 95.04, 94.02 and 93.55, 94.81 and 90.84% degraded after 1, 2, 3, and 4 weeks, respectively(1). When PHEN was added to Center Hill Reservoir water at 100 ug/l, the compound was 0, 66.4, 60.08, and 43.9% degraded following incubation at 25 deg C for 1, 2, 5, and 7 days respectively(1). PHEN added at 1000 ug/l was 2.3%, 13.5%, 39.6%, 22.8%, and 46.1% degraded after 1, 2, 3, 4, and 5 days of incubation at 25 deg C, respectively(1). Maximum biodegradation occurred at 25 and 37 deg C when PHEN was added to Center Hill Reservoir samples at 100 and 1000 ug/l, respectively(1). [(1) Saylor GS, Sherrill TW; Bacterial Degradation of Coal Conversion By-Products (polycyclic aromatic hydrocarbons) in Aquatic Environments. p.90 USNTIS PB 83-187161 (1981)] **PEER REVIEWED**

BIODEGRADATION

To investigate the mineralization rate of phenanthrene (PHEN) in aquatic sediments, the kinetics of mineralization of PHEN by bacteria in sediment slurries were determined(1). Incubation with sediments for 6 and 60 days yielded constants of 6.6X10-5 to 1.1X10-5 1/hr, respectively, and biodegradation half-lives of 437.5 and 2625 days, respectively(1). Microcosms consisting of natural sediments and sterilized pond water in 1 L Erlenmeyer flasks were prepared. The dependence of mineralization rates upon incubation temperature was determined for untreated microcosms and those treated with synthetic oil (SO) at 0.01% in the slurry. The sediments in the microcosms were acclimated prior to addition of PHEN, which was added at 1 ug/g sediment. The optimal temperatures were 15 and 23 deg C for the untreated and SO treated sediments, respectively; mineralization rates of the SO treated sediments were higher than the untreated sediments at all temperatures(1). The rate of mineralization was inversely dependent upon the weight/volume sediment slurry composition(1). When natural and sterilized sediments were inoculated with Beijerinckia sp., biodegradation rates of PHEN were higher than in uninoculated natural sediments(1). [(1) Saylor GS, Sherrill TW; Bacterial Degradation of Coal Conversion By-Products (polycyclic aromatic hydrocarbons) in Aquatic Environments. p.90 USNTIS PB 83-187161 (1981)] **PEER REVIEWED**

BIODEGRADATION

Bacteria were obtained from Eastern Bay in the Chesapeake Bay(1). Incubation of bacteria from Colgate Creek in Eastern Bay and Colgate Creek water resulted in 63.4% and 50.2% phenanthrene (PHEN) degradation respectively(1). Incubation of Eastern Bay bacteria in Colgate Creek and Eastern Bay water resulted in 85.0% and 92.4% PHEN degradation, respectively(1). The greater percentage of PHEN degradation observed in the Colgate Creek sediment bacteria was said to reflect the higher degree of organic pollution to which the bacteria were exposed(1). Phenanthrene incubated in Rhode Island water at 25 ug/l degraded with half-lives of 11000, 180, and 79 days at 2, 8, and 18 deg C, respectively(2). PHEN incubated in water from South Carolina degradaed

with half-lives 210, 19, 24, and 36 days at temperatures of 8,27,28 and 27 deg C, respectively(2). The biodegradation half-lives of PHEN in water obtained from the Gulf of Thailand and Chao Phraya River were 35 and 37 days, respectively(3). [(1) Walker JD, Colwell RR; Prog Water Technol 7: 783-91 (1975) (2) Lee RF, Ryan C; Can J Fish Aquat Sci 40: 86-94 (1983) (3) Hungspreuge M et al; Marine Pollut Bull 15: 213-28 (1984)] **PEER REVIEWED**

BIODEGRADATION

The half-life of phenanthrene (PHEN) applied to soil at 2.1 ug/g soil and incubated at 15-25 deg C was 26 days(1). The half-life when applied at 25,000 ug/g soil and incubated at > 25 deg C was 2.5 days(1). [(1) Sims RC, Overcash MR; Res Rev 88: 1-68 (1983)] **PEER REVIEWED**

ABIOTIC DEGRADATION

After 5 hr and 10 hr irradiation of phenanthrene (PHEN) with a 250 W, high pressure mercury lamp, 43% and 64.1% of the initial amount of PHEN remained in seawater(1). The direct photolysis half-life of PHEN in water was estimated to be 8.4 hr(2). Sunlight intensity in both estimations was assumed to be that of a clear day at latitude 40 degrees N at midday in midsummer and it was assumed that the chemical was near the surface of the water and fully exposed to the sunlight(2). The half-life for the reaction of polycylic aromatic hydrocarbons (PAH) with RO2 radicals is about 21,917 years, so the oxidation of PHEN by these radicals is not expected to be a major fate process(3). The rate constants for the reaction of PHEN with ozone at pH values of 1 and 7 are 1.33X10+4 and 1.57X10+4 cu dm 1/mol 1/s at 25 deg C(4). Assuming a tropospheric ozone concentration of 2X10-9 M in clean air, the half-life of PHEN in the atmosphere was estimated to be 6 hr(4). [(1) Nagata S, Kondo G; pp 617-20 in Proc 1977 Oil Spill Conf (1977) (2) Zepp RG, Schlotzhauer PF; pp 141-58 in Polynuclear Aromatic Hydrocarbons Jones PW, Leber P eds Ann Arbor Sci Publ Inc, Ann Arbor MI (1979) (3) Callahan MA et al; Water-Related Environmental Fate of 129 Priority Pollutants Vol II p 96-16 USEPA-440/4-79-029b (1979) (4) Butkovic V et al; Environ Sci Technol 17: 546-8 (1983)] **PEER REVIEWED**

ABIOTIC DEGRADATION

Adsorption of PHEN to fly ash is rapid and irreversible at concentrations of < 30 ug/g fly ash(1). PHEN is expected, therefore, to be largely adsorbed to atmospheric particulates. The direct photolysis half-life of PHEN adsorbed to fly ash irradiated at > 300 nm is 49 hr(2). Since photolysis of PAH is attenuated by adsorption to particulates(3), any PHEN in the vapor phase is expected to photolyze faster. [(1) Eiceman GA, Vandiver VJ; Atmos Environ 17: 461-5 (1983) (2) Behymer TD, Hites RA; Environ Sci Technol 19: 1004-6 (1985) (3) Korfmacher WA et al; Environ Sci Technol 14: 1094-9 (1980)] **PEER REVIEWED**

BIOCONCENTRATION

ANALYSES OF SOFT TISSUES OF 3 SPECIES OF UNIONIDAE MUSSELS (LAMPSILLIS RADIATA, ELLIPTIO COMPLANATUS & ANODONATA GRANDIS) FROM NORTHERN LAKE GEORGE SHOWED THESE ORGANISMS CONCENTRATED PHENANTHRENE. IT WAS DETECTED IN SOME BUT NOT ALL OF THE MUSSEL SAMPLES. [HEIT M ET AL; ENVIRON SCI TECHNOL 14 (4): 465-8 (1980)] **PEER REVIEWED**

BIOCONCENTRATION

The measured log octanol/water partition coefficient of phenanthrene (PHEN) is 4.57(1). A Kow of this magnitude suggests significant bioconcentration should occur in aquatic organisms(SRC). By the action of microsomal oxidase, however, fish are capable of rapidly metabolizing polycylic aromatic hydrocarbons(2). PHEN is expected to be similiarly degraded in fish, and therefore, may not bioconcentrate significantly(SRC). [(1) Karickhoff SW; Chemosphere 10: 833-46 (1981) (2) Santodonato J et al; Health and Ecological Assessment of Polynuclear Aromatic Hydrocarbons; Lee SD, Grant L eds; Pathotox Publ Park Forest South IL (1981)] **PEER REVIEWED**

BIOCONCENTRATION

... Some marine organisms have no detectable aryl hydrocarbons hydroxylase enzyme systems, namely: phytoplankton, certain zooplankton, mussels (Mytilus edulis), scallops (Placopecten sp), and snails (Litternia littorea). ... Those organisms which lack a metabolic detoxification enzyme system, tend to accumulate polycyclic aromatic hydrocarbons. /Polycyclic aromatic hydrocarbons/ [Malins DC; Ann NY Acad Sci 298: 482-96 (1977) as cited in: Health and Welfare Canada; Polycyclic Aromatic Hydrocarbons p.37 (1979) Report No. 80-EHD-50] **PEER REVIEWED**

BIOCONCENTRATION

POLYCYCLIC AROMATIC HYDROCARBONS (PAH) WERE ANALYZED IN SURFACIAL SEDIMENTS & BENTHIC ORGANISMS IN SOUTHEASTERN LAKE ERIE, NEAR A LARGE COAL-FIRED POWER PLANT. SEDIMENT CONCN (530-770 PPB PAH) WERE RELATIVELY HOMOGENOUS THROUGHOUT MOST OF THE 150 SQUARE KM AREA, ALTHOUGH RIVER & NEARSHORE CONCENTRATIONS REACHED 4 PPM. OLIGOCHAETE WORMS DID NOT BIOCONCENTRATE (ON WET WT BASIS) ANY OF THE PAH. CHIRONOMIDE MIDGES COLLECTED 1 KM OFFSHORE EXHIBITED BIOCONCENTRATION OF 5 PAH ONE OF WHICH WAS PYRENE. FURTHER OFFSHORE, THESE APPARENT BIOCONCENTRATIONS DISAPPEARED, WITH MIDGES AT NEAR EQUILIBRIUM WITH SEDIMENTS. /Polycyclic aromatic hydrocarbons/ [EADIE BJ ET AL; CHEMOSPHERE 11 (2): 185-92 (1982)] **PEER REVIEWED**

SOIL ADSORPTION/MOBILITY

The log soil-sorption coefficient (Koc) of phenanthrene (PHEN) in coarse silt fractions from sediments from Doe Run and Hickory Hill, Georgia, is 4.36(1). A log Koc of this magnitude suggests that PHEN will be strongly adsorbed to the soil and is not, therefore, expected to leach extensively(SRC). [(1) Karickhoff SW et al; Water Res 13: 241-8 (1979)] **PEER REVIEWED**

VOLATILIZATION FROM WATER/SOIL

Using a water solubility of 1.29 mg/l and a vapor pressure of 6.80X10-4 mm Hg(1), a Henry's Law constant of 1.24X10-4 atm cu m/mol at 25 deg C was estimated(2). The half-life values for the volatilization of phenanthrene (PHEN) from streams, rivers and lakes were estimated from these parameters(2). The wind velocity was assumed to be 3 m/sec, the current velocities of the streams, rivers and lakes, 2, 1 and 0.01 m/sec, respectively, the depths of the lakes 50 m and that of the streams and rivers 1 m. The half-life values were 9.4 hr, 13.15 hr and 4696.13 hr (195.7 day) for the streams, rivers and lakes, respectively. These values apply strictly to dissolved PHEN. Any process which limits the amount of dissolved PHEN, such as adsorption to sediments or biota, will increase these half-lives. Volatilization from water and soil is not expected to be significant, since most of the PHEN is expected to

be adsorbed(SRC). [(1) Sims RC, Overcash MR; Res Rev 88: 1-68 (1983) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods Environmental Behavior of Organic Compounds. McGraw-Hill NY p 15-11, 15-21 (1982)] **PEER REVIEWED**

WATER CONCENTRATIONS

... Has been identified in ... surface water (0.1300 ng/l); tap water (3.1-90 ng/l); waste water (780 ug/l) ... [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-1985. (Multivolume work). V32 421 (1983)] **PEER REVIEWED**

WATER CONCENTRATIONS

SURFACE WATER: Raw water - various US sites, 6-20 ng/l(1); Lake Quinsinamond, MA, Glen Ellyn, IL, Little Rock, AR, Bellevue, WA, and Eugene, OR - 12% pos, 0.3-10 ug/l(2). Five percent of 865 water samples had a median PHEN concentration of < 10.000 ug/l (STORET Database)(3). Great Britain (Tamar Estuary) - 8.8 ng/l(4). Tsukuba Japan - 0.34 ng/l(5). PHEN was detected but not quantified in Lakes Ontario, Erie, Michigan and Superior(6) and combined PHEN/anthracene residues were detected but not quantified in Mississippi River water(7) and in the Rhine and Maas Rivers in the Netherlands(8). [(1) Sorrell RK et al; Environ Intern 4: 245-54 (1980) (2) Cole RH et al; J Water Pollut Control Fed 56: 898-908 (1984) (3) Staples CA et al; Environ Toxicol Chem 4: 131-42 (1985) (4) Readman JW et al; Estuarine Coastal Shelf Sci 14: 369-89 (1982) (5) Shiraishi H et al; Environ Sci Technol 19: 585-9 (1985) (6) Great Lakes Quality Board; Report to the Great Lakes Water Quality Board, Windsor, Ontario, Canada (1983) (7) Overton EB et al; Chemosphere 9: 629-33 (1980) (8) Meijers AP, Van Der Leer RC; Water Res 10: 597-604 (1976)] **PEER REVIEWED**

WATER CONCENTRATIONS

DRINKING WATER: Athens, GA - 24-90 ng/l(1). Tsukuba, Japan - 0.45-1.41 ng/l(2). Combined phenathrene (PHEN) and anthracene residues were as follows: New York - public water system wells, 39 wells tested, 17.9% pos, 21.0 ppb max(3); Great Lakes (various locations) - 0.6-1269 ng/l(4); Japan - tap water, 0.7 ng/l (5) and 1.7 ppb(6). PHEN was detected but not quantified in drinking water from an unspecified location(7). [(1) Thruston AD Jr; J Chromat Sci 16: 254-9 (1978) (2) Sharaishi H et al; Environ Sci Technol 19: 585-9 (1985) (3) Council on Environmental Quality; 11th Annual Report (1980) (4) Williams DT et al; Chemosphere 11: 263-76 (1982) (5) Akiyama T et al; J UOEH 2: 285-300 (1980) (6) Shinohara R et al; Water Res 15: 535-42 (1981) (7) Kool HJ et al; Crit Rev Env Control 12: 307-57 (1982)] **PEER REVIEWED**

WATER CONCENTRATIONS

GROUNDWATER: Pensacola, FL - 0.76 and 0.78 mg/l at 12 and 6 m depths, respectively, and at 18 m, 0.07 mg/l (different site than above)(1). Phenanthrene was detected but not quantified in groundwater in Minnesota(2). [(1) Goerlitz DF et al; Environ Sci Technol 19: 955-61 (1985) (2) Rostad CE et al; Chemosphere 14: 1023-36 (1985)] **PEER REVIEWED**

WATER CONCENTRATIONS

RAIN/SNOW: Portland, OR - 61-130 ng/l, 90.1 ng avg(1). Oregon Graduate Center (southeast of Portland, OR) - 3.1-51 ng/l, 24 ng/l; Portland, OR - 62-280 ng/l, 140 ng/l avg(2). Netherlands - 30-133 ng/l(3). Combined phenanthrene (PHEN)/anthracene residues in Portland, OR were 1.3-10.0 ng/l in particulates, 4.1 ng/l avg and 0.08-0.93 ng/cu m

OTHER ENVIRONMENTAL CONCENTRATIONS

Sidestream cigarette smoke - 6.0-8.5 ug/100 cigarettes, mainstream marijuana smoke - 8.9 ug/100 cigarettes (1). Sewage influent in Japan contained 400 ng/l phenanthrene/anthracene (2). [(1) IARC; Polynuclear Aromatic Compounds Part 1, Chemical, Environmental and Experimental Data 32: 419-30 (1983) (2) Akiyama T et al; J UOEH 2: 285-300 (1980)] **PEER REVIEWED**

OTHER ENVIRONMENTAL CONCENTRATIONS

Phenanthrene ... has been identified in ... used motor oil (157.85 mg/kg) ... [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-1985. (Multivolume work). V32 421 (1983)] **PEER REVIEWED**

OTHER ENVIRONMENTAL CONCENTRATIONS

Coke oven emissions: 163.5-2,828.5 ug/g of sample; coal tar pitch fumes: 36.4 weight % (phenanthrene and/or anthracene). [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. , p. 971] **PEER REVIEWED**

OTHER ENVIRONMENTAL CONCENTRATIONS

Phenanthrene /concn/ in gasoline (high octane): 20.5 mg/l; gasoline: 15.7 mg/l. [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. , p. 970] **PEER REVIEWED**

OTHER ENVIRONMENTAL CONCENTRATIONS

Exhaust condensate of gasoline engine: 2.3-2.9 mg/l gasoline consumed. [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. , p. 970] **PEER REVIEWED**

OTHER ENVIRONMENTAL CONCENTRATIONS

The loading of phenanthrene (PHEN) in metric tons per year to each of the Great Lakes were estimated to be: Lake Superior - 4.8; Lake Michigan - 3.4; Lake Huron - 3.5; Lake Erie - 1.5; Lake Ontario - 1.1(1). Inputs of PHEN to the Narragansett Bay watershed in kg/yr were as follows: residential - 1.7; commercial - 2.1; industrial - 32.4; and highway - 32.8(2). [(1) Eisenreich SJ et al; Environ Sci Technol 15: 30-8 (1981) (2) Hoffman EJ et al; Environ Sci Technol 18: 580-7(1984)] **PEER REVIEWED**

PROBABLE ROUTES OF HUMAN EXPOSURE

Human exposure to phenanthrene occurs primarily through the smoking of tobacco, inhalation of polluted air or by ingestion of food or water contaminated by combustion effluents. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-1985. (Multivolume work). V32 426 (1983)] **QC REVIEWED**

PROBABLE ROUTES OF HUMAN EXPOSURE

Human exposure to phenanthrene (PHEN) most likely results from the ingestion of food, especially broiled and smoked food, containing the compound(1). Exposure may also result from the inhalation of air contaminated by PHEN as a result of incomplete combustion of fossil and other fuels and from use of tobacco containing products. (SRC) [(1) Santodonato J et al; Health and Ecological Assessment of Polynuclear Aromatic Hydrocarbons Lee SD, Grant L eds Pathotox Publ Park Forest South Il (1981)] **QC REVIEWED**

PROBABLE ROUTES OF HUMAN EXPOSURE

Coal tar pitch volatiles ... may contact the eyes. /Coal tar pitch volatiles/ [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication , p. 1] **QC REVIEWED**

AVERAGE DAILY INTAKE

AIR INTAKE: 7 ng/day/man(1). (assume 0.01-10 ng/cu m) 0.2-200 ng. WATER INTAKE: (assume 24-90 ng/l) 48-180 ng; FOOD INTAKE: insufficient data(SRC). [(1) Matsumoto H, Kashimoto T; Bull Environ Contam Toxicol 34: 17-23 (1985)] **PEER REVIEWED**

PROBABLE EXPOSURES

Air samples obtained from various locations within a primary aluminum smelting plant and a prebaked aluminum reduction plant in Norway were as follows: Smelting plant - above baking ovens, 0.28-1.24 mg/g particulates, not detected-16.0 ug/cu m gaseous; above anode compression, 0.84 mg/g particulates, 134 ug/cu m gaseous(1). Personal monitoring data of particulates in the plant were as follows: Coke packer - 1.70 ug/cu m; pitch bin worker - 22.7 ug/cu m; operator - 0.35 ug/cu m(1). Aluminum reduction plant - various locations, not detected-2.4 mg/g particulates, 1.91-446.0 ug/cu m gaseous(1). Personal monitoring data of particulates in the plant were as follows. Pin Puller - 36.2-60.4 ug/cu m(1). [(1) Bjorseth A et al; Scand J Work Environ Health 4: 212-23 (1978)] **PEER REVIEWED**

PROBABLE EXPOSURES

POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONTENT IN AIR OF 10 FERROUS & NONFERROUS FOUNDRIES WAS STUDIED. CERTAIN OCCUPATIONS REPORTED TO HAVE A HIGH RISK OF LUNG CANCER, SUCH AS MOLDERS, CASTERS & CRANE MEN, WERE ASSOCIATED WITH HIGH CONCENTRATIONS OF PAH EXPRESSED AS PERCENTAGE OF TOTAL SUSPENDED PARTICULATE. THIS RESULT WAS NOT STATISTICALLY SIGNIFICANT. /PAH/ [VERMA DK ET AL; ANN OCCUP HYG 25 (1): 17-26 (1982)] **PEER REVIEWED**

PROBABLE EXPOSURES

GLASS CAPILLARY GAS CHROMATOGRAPHY SHOWED THAT WORKERS IN COKE PLANT WERE EXPOSED TO 5 TO 1000 MG POLYCYCLIC AROMATIC HYDROCARBONS (PAH)/CU M AIR (INCL ACENAPHTHYLENE). PARTICULATE MATTER CONTAINS 98% RESPIRABLE PAH. [BJOERSETH A ET AL; SCAND J WORK, ENVIRON HEALTH 4 (3): 224 (1978)] **PEER REVIEWED**

PROBABLE EXPOSURES

Samples taken around battery tops in a Norwegian coke plant were as follows. Stationary sampling - Spring 1976, 28.8-42.8 mg/g, 41.2 mg/g avg particulates, 6.7-67 ug/cu m, 35 ug/cu m avg gaseous; Fall 1976, 9-17.36 mg/g, 14.38 mg/g avg particulates, 55-276 ug/cu m, 119 ug/cu m gaseous. Mobile sampling - Spring 1976, 0.3-0.33 mg/g particulates, not detected-3.95 ug/cu m gaseous; Fall 1976, 1.95-8.24 mg/g particulates, 71.39-72.82 ug/cu m gaseous. Personal monitoring data of particulates in the plant were as follows. Spring 1976 - Larry car operators, 0.25-1.24 mg/g; Coke car operators, not detected-0.021 mg/g; Jamb cleaner, 0.13-0.56 mg/g; Door cleaner, not detected-0.12 mg/g; Push car operator, not detected-0.11 mg/g; Wharfman, 0.34 mg/g(1). Fall 1976- Lorry car operator 0.34-1.0 mg/g; Coke car operator, 0.11 mg/g; Jamb cleaner, 0.89 mg/g; Door cleaner, 0.14-0.18 mg/g; Push car operator, 0.11-0.145 mg/g; Sweeper, 0.75 mg/g; Quench car operator, 0.16 mg/g(1). [(1) Bjorseth A et al; Scand J Work Environ Health 4: 224-36 (1978)] **PEER REVIEWED**

PROBABLE EXPOSURES

Workers ... exposed to coal tar, mineral oil, and petroleum waxes. /Polynuclear aromatic hydrocarbons/ [USEPA; Ambient Water Quality Criteria Doc: Polynuclear Aromatic Hydrocarbons (Draft) p.C-37 (1980)] **PEER REVIEWED**

BODY BURDENS

Semi-quantitative analyses revealed phenanthrene in atherosclerotic aortas at 8-10 ng/g anthracene equivalents(1). [(1) Ferrario JB et al; Arch Environ Contam Toxicol 14: 529-34 (1985)] **PEER REVIEWED**

WATER STANDARDS

Toxic pollutant designated pursuant to section 307(a)(1) of the Clean Water Act and is subject to effluent limitations. /Polynuclear aromatic hydrocarbons/ [40 CFR 401.15 (7/1/87)] **PEER REVIEWED**

WATER STANDARDS

For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms, ... therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 1x10-5, 1x10-6, and 1x10-7. The corresponding criteria /for ambient water/ are 28.0 ng/l, 2.8 ng/l, and 0.28 ng/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 311.0 ng/l, 31.1 ng/l, and 3.11 ng/l respectively. /Polynuclear aromatic hydrocarbons based on benzo(a)pyrene as the model PAH/ [USEPA; Ambient Water Quality Criteria Doc: Polynuclear Aromatic Hydrocarbons p.C-121 (1980)] **PEER REVIEWED**

WATER STANDARDS

The attempt to develop a drinking water criterion for polynuclear aromatic hydrocarbons (PAH) as a class is hindered by several gaps in the scientific data base: (1) The PAH class is composed of numerous compounds having diverse biological effects and varying carcinogenic potential. A "representative" PAH mixture, has not been defined. (2) The common practice of using data derived from studies with benzo(a)pyrene to make generalizations concerning the effects of environmental PAH may not be scientifically sound. (3) No chronic animal toxicity studies involving oral exposure to PAH mixtures exist. (4) No direct human data concerning the effects of exposure to defined PAH mixtures exist. /Polynuclear aromatic hydrocarbons/ [USEPA; Ambient Water Quality Criteria Doc: Polynuclear Aromatic Hydrocarbons (Draft) p.C-118 (1980)] **PEER REVIEWED**

ATMOSPHERIC STANDARDS ND

SOIL STANDARDS ND

NAME OF SUBSTANCE	FLUORANTHENE
SYNONYMS	1,2-(1,8-NAPHTHYLENE)BENZENE **PEER REVIEWED**
SYNONYMS	1,2-BENZACENAPHTHENE **PEER REVIEWED**
SYNONYMS	BENZENE, 1,2-(1,8-NAPHTHALENEDIYL)- **PEER REVIEWED**
SYNONYMS	BENZENE, 1,2-(1,8-NAPHTHYLENE)- **QC REVIEWED**
SYNONYMS	BENZO(JK)FLUORENE **PEER REVIEWED**
SYNONYMS	IDRYL **PEER REVIEWED**
MOLECULAR FORMULA	C16-H10 **PEER REVIEWED**

MAJOR USES

CONSTITUENT OF COAL TAR & PETROLEUM DERIVED ASPHALT USED AS LINING MATERIAL TO PROTECT INTERIOR OF STEEL & DUCTILE-IRON POTABLE WATER PIPES AND STORAGE TANKS [National Research Council. Drinking Water & Health, Volume 4. Washington, DC: National Academy Press, 1981. , p. 74] **PEER REVIEWED**

MAJOR USES

RESEARCH CHEMICAL [SRI] **PEER REVIEWED**

CONSUMPTION PATTERNS	ND
COLOR/FORM	COLORED NEEDLES [Sax, N.I. and R.J. Lewis, Sr. (eds.). Hawley's Condensed Chemical Dictionary. 11th ed. New York: Van Nostrand Reinhold Co., 1987. , p. 529] **PEER REVIEWED**
COLOR/FORM	PALE YELLOW NEEDLES OR PLATES FROM ALCOHOL [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989. C-276] **PEER REVIEWED**
ODOR	ND
TASTE	ND
BOILING POINT	ABOUT 375 DEG C [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989. C-276] **PEER REVIEWED**
MELTING POINT	111 DEG C [Weast, R.C. (ed.). Handbook of Chemistry and Physics. 60th ed. Boca Raton, Florida: CRC Press Inc., 1979. C-306] **PEER REVIEWED**
MOLECULAR WEIGHT	202.26 [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989. C-276] **PEER REVIEWED**
CORROSIVITY	ND
CRITICAL TEMPERATURE & PRESSURE	ND
DENSITY/SPECIFIC GRAVITY	1.252 AT 0 DEG C/4 DEG C [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989. C-276] **PEER REVIEWED**
DISSOCIATION CONSTANTS	ND
HEAT OF COMBUSTION	ND
HEAT OF VAPORIZATION	ND
OCTANOL/WATER PARTITION COEFFICIENT	Log Kow= 4.90 [USEPA; Ambient Water Quality Criteria Doc: Polynuclear Aromatic Hydrocarbons p.C-19 (1980)] **PEER REVIEWED**
PH	ND

SOLUBILITIES	SOL IN ALCOHOL, ETHER, BENZENE, ACETIC ACID [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989. C-276] **PEER REVIEWED**
SOLUBILITIES	Sol: in seawater at 22 deg C: 0.1 + or - 0.06 ppm, 0.120 mg/l at 24 deg C (99% purity). [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. , p. 671] **PEER REVIEWED**
SOLUBILITIES	/Fluoranthene/ has a high molecular weight and its relative non-polarity makes this cmpd very insoluble in water. [USEPA; Ambient Water Quality Criteria Doc: Fluoranthene p.C-1 (1980)] **PEER REVIEWED**
SOLUBILITIES	Virtually insoluble (0.20-0.26 mg/l) in water [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-1985. (Multivolume work). V32 356 (1983)] **PEER REVIEWED**
SOLUBILITIES	Sol in carbon disulfide, chloroform [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-1985. (Multivolume work). V32 356 (1983)] **PEER REVIEWED**
SOLUBILITIES	Soluble in >10% Et2O [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985. , p. 635] **PEER REVIEWED**
SPECTRAL PROPERTIES	MAX ABSORPTION (CYCLOHEXANE): 237 NM (LOG E= 4.75), 254 NM (LOG E= 4.22), 263 NM (LOG E= 4.18), 277 NM (LOG E= 4.41), 288 NM (LOG E= 4.73) [Weast, R.C. (ed.). Handbook of Chemistry and Physics. 60th ed. Boca Raton, Florida: CRC Press Inc., 1979. C-306] **QC REVIEWED**
SPECTRAL PROPERTIES	SADTLER REFERENCE NUMBER: 901 (IR, PRISM) [Weast, R.C. (ed.). Handbook of Chemistry and Physics. 60th ed. Boca Raton, Florida: CRC Press Inc., 1979. C-306] **PEER REVIEWED**
SPECTRAL PROPERTIES	IR: 180 (Sadtler Research Laboratories IR Grating Collection) [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985. V1 635] **PEER REVIEWED**
SPECTRAL PROPERTIES	UV: 281 (Sadtler Research Laboratories Spectral Collection) [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985. V1 635] **PEER REVIEWED**

HEENT
- Ingestion of greater than 5% solution may result in oral burns. The affected area generally turns white and is without pain but may become necrotic several days later. Eye exposure may result in severe burns.

CARDIOVASCULAR
- Tachycardia, hypotension, supraventricular, and ventricular arrhythmias may be noted.

RESPIRATORY
- Tachypnea, pulmonary edema, and respiratory arrest may occur.

NEUROLOGIC
- CNS excitation including seizures followed by CNS depression (coma) may be noted.

GASTROINTESTINAL
- Nausea, vomiting, and diarrhea may be noted.

HEPATIC
- Hepatic injury may be noted in 3 to 5 days.

TEMPERATURE REGULATION
- Intense diaphoresis (sweating) may be noted.

HEMATOLOGIC
- Methemoglobinemia may occur following exposure to some phenols, most notably dinitrophenol or hydroquinone. Deep venous thrombosis has been reported following injection of phenol.

DERMATOLOGIC
- Skin ulcerations may be noted.

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o LABORATORY :

- Obtain CBC, electrolytes, and urinalysis.

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o TREATMENT OVERVIEW :

ORAL EXPOSURE
- DILUTION: May enhance absorption of phenol, and should be avoided.
- ACTIVATED CHARCOAL: May be preferable to ipecac-induced emesis due to the potential rpaid onset of seizures or coma and to the irritant effects of phenol.
- GASTRIC LAVAGE: May be indicated if performed soon after ingestion, or in patients who are comatose or at risk of convulsing. After control of any seizures present, perform gastric lavage. Protect airway by placement in Trendelenburg and left lateral decubitus position or by cuffed endotracheal intubation. Lavage return should approximate fluid given.

- o ACTIVATED CHARCOAL/CATHARTIC: Administer charcoal slurry, aqueous or mixed with saline cathartic or sorbitol. Usual charcoal dose: 30 to 100 g in adults and 15 to 30 g in children (1 to 2 g/kg in infants). Administer one dose of a cathartic, mixed with charcoal or given separately. See Section 5.3.1. for doses.
- o ORAL ADMINISTRATION of castor oil, 30 to 60 mL, may slow absorption of phenol from the stomach, but no clinical documentation for efficacy has been reported.
- o SEIZURES: Administer diazepam IV bolus (DOSE: ADULT: 5 to 10 mg initially which may be repeated every 15 minutes PRN up to 30 mg. CHILD: 0.25 to 0.4 mg/kg/dose up to 10 mg/dose). If seizures cannot be controlled or recur, administer phenytoin or phenobarbital.
- o MONITOR EKG, and kidney and liver function tests.
- o METHEMOGLOBINEMIA: Administer 1 to 2 mg/kg of 1% methylene blue slowly IV if the patient is cyanotic and symptomatic, or the methemoglobin level is greater than 30% in an asymptomatic patient. Additional doses may be required.

EYE EXPOSURE

- o DECONTAMINATION: Exposed eyes should be irrigated with copious amounts of tepid water for at least 15 minutes. If irritation, pain, swelling, lacrimation, or photophobia persist, the patient should probably be seen in a health care facility.

DERMAL EXPOSURE

- o Remove phenol with undiluted polyethylene glycol 300 to 400 prior to washing, if readily available. Wash exposed areas twice with deluge quantities of water. A physician may need to examine the exposed area if irritation or pain persist after the area is washed.

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o RANGE OF TOXICITY :

- o The minimal toxic dose of phenol and related compounds is not well established in the literature.
- o Acute ingestion of as little as 1 gram of pure phenol in adults has resulted in death. Toxicity may be noted at significantly lower doses.

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o REFERENCE : [Rumack BH & Spoerke DG: POISINDEX(R) Information System. Micromedex Inc., Denver, CO, 1990; CCIS CD-ROM Volume 66, edition exp November, 1990.] **PEER REVIEWED**

ANTIDOTE AND EMERGENCY TREATMENT ND

MEDICAL SURVEILLANCE

The following medical procedures should be made available to each employee who is exposed to coal tar pitch volatiles at potentially hazardous levels. 1) Initial medical examination: A complete history and physical examination: The purpose is to detect existing conditions that might place an exposed employee at greater risk, and to establish a baseline for future health monitoring. Examination of the oral cavity, respiratory tract, bladder, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders, for premalignant and malignant lesions, and evidence of hyperpigmentation or photosensitivity. Urinalysis: Coal tar pitch volatiles are associated with an excess of kidney and bladder cancer. A urinalysis should be obtained to include at a minimum, specific gravity, albumin, glucose, and a microscopic /examination/ of centrifuged sediment, as well as a test for red blood cells. ... /Coal tar pitch volatiles/ [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication , p. 1] **PEER REVIEWED**

MEDICAL SURVEILLANCE

1) Urinary cytology: Coal tar pitch volatiles are associated with an excess of kidney and bladder cancer. Employees having 5 or more years of exposure or who are 45 years of age or older should have a urinary cytology examination. 2) Coal tar pitch volatiles are associated with an excess of lung cancer. Employees having 10 or more years of exposure or who are 45 years of age or older should have a sputum cytology examination, a 14" x 17" chest roentgenogram, and periodic measure of FVC and FEV (1 sec). 3) Due to the possibility of benzene exposure associated with coal tar pitch volatiles, a complete blood count is considered necessary to search for leukemia and aplastic anemia. /Coal tar pitch volatiles/ [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication , p. 1] **PEER REVIEWED**

HUMAN TOXICITY VALUES ND

POPULATIONS AT SPECIAL RISK

Skin disease: Coal tar pitch volatiles are defatting agents and can cause dermatitis on prolonged exposure. Persons with existing skin disorders may be more susceptible to the effects of these agents. /Coal tar pitch volatiles/ [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication , p. 1] **PEER REVIEWED**

IARC SUMMARY AND EVALUATION

No data are available in humans. Inadequate evidence of carcinogenicity in animals. OVERALL EVALUATION: Group 3: The agent is not classifiable as to its carcinogenicity to humans. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-1985. (Multivolume work). S7 63 (1987)] **QC REVIEWED**

ABSORPTION, DISTRIBUTION AND EXCRETION

Fluoranthene has been found in human urine and feces. [USEPA; Ambient Water Quality Criteria Doc: Fluoranthene (Draft) p.C-2 (1980)] **PEER REVIEWED**

ABSORPTION, DISTRIBUTION AND EXCRETION

The demonstrated toxicity of fluoranthene by oral and dermal administration indicates that it can pass across epithelial membranes. The high lipid solubility of fluoranthene supports this observation. [Smyth HF et al; Am In Hyg Assoc J 23: 95 (1962) as cited in USEPA; Ambient Water Quality Criteria Doc: Fluoranthene (Draft) p.C-21 (1980)] **PEER REVIEWED**

ABSORPTION, DISTRIBUTION AND EXCRETION

Five normal adult volunteers without cutaneous disease applied 2% crude coal tar to the skin for 8 hr periods on 2 consecutive days. Blood extracts subjected to gas chromatography and mass spectrophotometry yielded evidence of absorption in all 5 volunteers. ... Fluoranthene was found in 4 of the volunteers. [Storer JJ et al; Arch Dermatol 120 (7): 874-7 (1984)] **PEER REVIEWED**

METABOLISM/METABOLITES

METABOLITES OF FLUORANTHENE ARE TRANS-2,3-DIHYDRODIHYDROXYFLUORANTHENE & TRANS-2,3-DIHYDRODIOL-1,10-BETA-EPOXYFLUORANTHENE. [BARFKNECHT TR ET AL; DEV TOXICOL ENVIRON SCI 10 (TOXICOL EFF EMISS DIESEL ENGINES): 277-94 (1982)] **PEER REVIEWED**

METABOLISM/METABOLITES

The metabolite of fluoranthene ... obtained upon incubation with liver homogenate from Aroclor pretreated rats ...
2,3-dihydro-2,3-dihydroxyfluoranthene. [Lavoie EJ et al; Carcinogenesis 3 (8): 841-6 (1982)] **PEER REVIEWED**

BIOLOGICAL HALF-LIFE

Half-life for depuration by Crassostrea virginica (oysters): 5 days from an oil treated enclosure. [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. , p. 674] **PEER REVIEWED**

MECHANISM OF ACTION ND

INTERACTIONS ND

ENVIRONMENTAL FATE/EXPOSURE SUMMARY

Fluoranthene's release into air and water is quite general since it is a universal product of combustion of organic matter and is present in fossil fuel products. Its release is greatest in areas of high anthropogenic activity. Both in air and water it is largely associated with particulate matter. When released into water, it will rapidly become adsorbed to sediment and particulate matter in the water column, and bioconcentrate into aquatic organisms. In fact, concentrations in shellfish such as clams and mussels are an excellent indicator of pollution in a localized area. In the unadsorbed state it will degrade by photolysis (half-life days to wk). It appears to be stable in sediment for decades or more. Because it is strongly adsorbed to soil, it should remain in the upper few centimeters of the soil. However, its detection in groundwater demonstrates that it can be transported there by some process(es). It should biodegrade in a few years in the presence of acclimated microorganisms. The fluoranthene released in the atmosphere will photodegrade in the free state (half-life 4-5 days). Aerosols and particulate matter containing sorbed fluoranthene is sufficiently stable to be transported long distances while being subject to gravitational settling and rainout. Photochemical smog situations enhance the degradation of both the sorbed molecule and the free vapor. Human exposure is from ambient air and ingesting food contaminated with products of combustion or prepared in such a manner

(smoking, charcoal broiling) as to generate polynuclear aromatic hydrocarbons. Exposure from drinking water is less common since water treatment such as filtration and chlorination removes fluoranthene. Distribution systems lined with coal tar or asphalt can sometimes contribute measurable amounts of fluoranthene to the drinking water. (SRC) [CITATION] **PEER REVIEWED**

NATURAL OCCURRING SOURCES

Crude oil, fossil fuels(1,2). Since fluoranthene is a product of incomplete combustion, there will be natural sources arising from volcanoes, forest fires, etc. (SRC) [(1) Verschueren K; Handbook of Environ Data on Organic Chemicals; 2nd ed Van Nostrand Reinhold New York pp.671-4 (1983)] **PEER REVIEWED**

ARTIFICIAL SOURCES

Fluoranthene occurs ubiquitously in products of incomplete combustion such as in exhaust gases from gasoline engines, stack gases from municipal incinerators, emissions from coal tar pitch, coal tar, coke ovens, burning coal, gasoil, gas(1). Sewage sludge, spills of motor oil, gasoline, and other petroleum products. Fluoranthenes/pyrenes are high relative to naphthalene in samples from combustion sources; the opposite is true for petroleum products(2). [(1) Verschueren K; Handbook of Environ Data on Organic Chemicals; 2nd ed Van Nostrand Reinhold New York pp.671-4 (1983) (2) Sporstol S et al; Environ Sci Technol 17: 282-6 (1983)] **PEER REVIEWED**

ARTIFICIAL SOURCES

/LABORATORY TESTS/ CONDUCTED ON STEEL PANELS COATED WITH COAL TAR /REVEALED THAT/ AFTER 1 WK OF STATIC TESTING, SEVERAL POLYCYCLIC AROMATIC HYDROCARBONS WERE FOUND IN LEACHATE SAMPLES. ... /FLUORANTHENE AMONG 6 OTHERS/ RANGED FROM 13 TO 56 UG/L. ... IN EPA LABORATORY, COAL-TAR-BASED COATINGS WERE TESTED ON GLASS PLATES WITH FLOWING TAP WATER. CONCN OF POLYCYCLIC AROMATIC HYDROCARBONS /WERE FOUND/ IN WATER AFTER 25 & 165 DAYS ... /INCL FLUORANTHENE AMONG 2 OTHERS/ AT 14000 TO 46000 NG/L ... /LEACHATE SAMPLES FROM/ PETROLEUM ASPHALT COATINGS ON DUCTILE-IRON PIPE...ANALYZED BY HPLC ... & GC/MS USING RECIRCULATION TEST SYSTEM & SAMPLING TIMES RANGING FROM 10 MIN TO 293 HR ... FLUORANTHENE WAS MEASURED AT 7 NG/L, THE HIGHEST CONCN FOR ANY SINGLE PAH COVERED BY WORLD HEALTH ORGANIZATION STANDARDS. ... /LEACHATES FROM/ CEMENT- & ASPHALT-LINED CAST-IRON PIPE /WERE TESTED/ USING NUMBER OF ANALYTICAL TECHNIQUES ... FLUORANTHENE (4-6 NG/L) ... /IDENTIFIED/ IN WATER THAT HAD BEEN IN CONTACT WITH ASPHALT LINING. [National Research Council. Drinking Water & Health, Volume 4. Washington, DC: National Academy Press, 1981. , p. 78] **PEER REVIEWED**

ARTIFICIAL SOURCES

... SAMPLES /WERE COLLECTED/ AT INLET & OUTLET OF 12000 GAL (45600-L) STORAGE TANK WHICH HAD A 5-YR OLD COMMERCIAL COAL-TAR LINING. ... INFLUENT & EFFLUENT CONCN IN UG/L ... FOR FLUORANTHENE WAS (0.003 & 0.081), RESPECTIVELY ... [National Research Council. Drinking Water & Health, Volume 4. Washington, DC: National Academy Press, 1981. , p. 88] **PEER REVIEWED**

ENVIRONMENTAL FATE

TERRESTRIAL FATE: Fluoranthene adsorbs strongly to soil and would be expected to remain in the upper layers of soil. However, it has been detected in groundwater samples which demonstrates that it can be transported there by some process(es). It slowly degrades in soil (half-life ca 5 mo to 2 yr). (SRC) [CITATION] **PEER REVIEWED**

ENVIRONMENTAL FATE

AQUATIC FATE: When fluoranthene is released into water it will partially sorb to sediment and particulate matter in the water column including phytoplankton, zooplankton and detrital particles(1). Photolysis should occur in the surface layers of water (half-life 21 hr in clear water, ca 200 hr in turbid water). When a crude oil dispersion was placed in the top of a water column in a controlled ecosystem in Saanich Inlet, Canada, the fluoranthene concn in the water column decreased exponentially, declining to half its initial concentration in 3-4 days. After 17 days, 10% of the fluoranthene was recovered in the sediment(1). In another study, fluoranthene concns in sediment core samples in an area near a ferro-smelter in Norway were approximately constant down to a depth of 6-8 cm below which it sharply declined(2). The depth of sediment can be correlated with the year it was desposited and a depth of 6-8 cm correspond to 1923 when when the smelter was installed(2). This suggests that little or no degradation occurred in the sediment(SRC). [(1) Lee RF et al; Environ Sci Technol 12: 832-8 (1978) (2) Bjorseth A et al; Sci Total Environ 13: 71-86 (1979)] **PEER REVIEWED**

ENVIRONMENTAL FATE

ATMOSPHERIC FATE: Fluoranthene released into the atmosphere exists as the free vapor as well as adsorbed to particulate matter. The unadsorbed chemical will photolyze as well as react with such molecules as ozone, nitrogen oxides and sulfur oxides. The half-life is approximately 4-5 days. The sorbed molecule is considerably more stable, traveling long distances under appropriate wind conditions. It will be subject to gravitational settling and rainout. The sorbed chemical, however, appears to degrade at about the same rate as the free chemical under photochemical smog conditions. (SRC) [CITATION] **PEER REVIEWED**

BIODEGRADATION

It has been shown that several bacterial strains isolated from the marine environment(1) and sewage(2) are capable of degrading fluoranthene. When crude oil enriched with fluoranthene was incubated with coastal sediment in a flowing seawater system, 1.9%-2.4% of the chemical was removed per week translating to a half-life of 143-182 days(3,4) or a degradation rate of 2 ng/g-soil per hour at a concn of 10 ug/g(3). Microbial degradation was more rapid in upper surfaces than in lower layers of sediment and greatest where the sediment grain size was largest(4). When percolated through a soil column in a mixture of polynuclear aromatic hydrocarbons (PAHs), fluoranthene degraded with a half-life of 44 days(3,5). When 7 applications of polynuclear aromatic hydrocarbons-containing oily sludge was amended to soil over a two year period and then monitored for an additional year and a half, the fluoranthene residue in the soil at the end of the 2 year ammendation period was decreased by 39% in the following year and a half(6). In the sludge ammendation experiment 4.7% of the applied fluoranthene remained after 3 1/2 years(6). Mixed results were reported in a static biodegradability test employing a domestic wastewater inoculum where 100% and 0% of the fluoranthene was degraded in four successive weekly subcultures at concn of 5 and 10 mg/l, respectively(7). In a pilot wastewater treatment plant, no fluoranthene was lost due to biodegradation(8). [(1) Soli G; Hydrocarbon-oxidizing bacteria and their possible use as controlling agents of oil pollution in the ocean;

NTIS AD-763 655. Naval Weapons Ctr China Lake CA (1973) (2) Patterson JW, Kodukala PS; Chem Eng Prog 77: 48-55 (1981) (3) Sims RC, Overcash MC; Res Rev 88: 1-68 (1983) (4) Gardner WS et al; Water Air Soil Pollut 11: 339-47 (1979) (5) Groenewegen D, Stolp H; Zentrablat Bakteriol Parasitenkd Infektionskr Hyg Abt 1: Orig Reike B 162: 225-32 (1976) (6) Bossert I et al; Appl Environ Microbiol 47: 763-7 (1984) (7) Tabak HH et al; J Water Pollut Control Fed 53: 1503-18 (1981) (8) Petrasek AC et al; J Water Pollut Control Fed 55: 1286-96 (1983)] **PEER REVIEWED**

ABIOTIC DEGRADATION

Fluoranthene absorbs solar radiation strongly and thereby can undergo direct photolysis(1,2). Polynuclear aromatic hydrocarbons also photodecompose in the atmosphere by reaction with ozone, other oxidants, nitrogen oxides, and sulfur oxides while singlet oxygen is considered to be the major oxidant species in water(2). Fluoranthene is found both in the free and adsorbed state in both the aqueous and atmospheric compartments and photodegradation is usually different in the sorbed state. No significant degradation was observed when fluoranthene vapor adsorbed on coal fly ash from the electrostatic precipitator of a power plant was irradiated for 3.3 hr using a xexon lamp(3). When filters containing pure fluoranthene were exposed to air and synthetic smog (1 hr exposure equivalent of 100 hr exposure to natural smog), 20 and 24% of the cmpd decomposed in air in 48 hr in darkness or light, respectively. 59% was lost in 1 hr when exposed to smog and light(4). When filters containing fluoranthene sorbed on combustion particules were exposed, 4% of the cmpd was lost in 48 hr in air and light while 59% was lost in 1 hr exposed to synthetic smog and light(4). Therefore it would appear that sorbed fluoranthene is less reactive than the free vapor in air but equally reactive in photochemical smog(4). It should be noted that sorption on certain types of surfaces (eg silica gel) greatly enhances photodecomposition(2). When particulate matter from air was analyzed immediately and after being stored in a sealed envelope, it was found that 37% and 92% of the flouranthene was lost in storage after 3 wks and 1 yr, respectively(2). Polynuclear aromatic hydrocarbons do not contain groups amenable to hydrolysis (2). [(1) IARC; Polynuclear Aromatic Compounds. Part I. Chemical environ and experimental data; 32: 355-7 (1983) (2) Sims RC, Overcash MR; Res Rev 88: 1-68 (1983) (3) Korfmacher WA et al; Environ Sci Technol 14: 1094-9 (1980) (4) Santodonato J et al; pp.77-176 in Health and Ecological Assessment of Polynuclear Aromatic Hydrocarbons; Pathotox Publ Inc Park Forest South NY (1980)] **PEER REVIEWED**

ABIOTIC DEGRADATION

In water, the half-life resulting from direct photolysis of flouranthene in near surface waters exposed to sunlight (latitude 4 deg N, midday, midsummer) is calculated to be 21 hr(1). If the water body is deep or turbid, the sunlight is attenuated. For example, in a well mixed body of water 5 m deep that contained sediment of 20 mg/l, the half-life is increased to 160 hr if one does not take partitioning to particulate matter into account and 200 hr if one does(1). Photolysis of polynuclear aromatic hydrocarbons in nonpolar organic solvents are typically 10-100 times less than in water(1). Sorption onto green and blue green algae photosensitizes the degradation of fluoranthene(2). In the presence of algae at a concn of 1-10 mg/l chlorophyll, the photodegradation rate is increased by a factor of 6.6-11(2). [(1) Zepp

RG, Schlotzhauer PF; pp. 141-58 in Polynuclear Aromatic Hydrocarbons; Ann Arbor Sci Publ Jones PW, Leber eds; Ann Arbor MI (1979) (2) Zepp RG, Schlotzhauer PF; Environ Sci Technol 17: 462-8 (1983)] **PEER REVIEWED**

BIOCONCENTRATION

In a 21 day bioconcentration test in a flow through tank, the log BCF in rainbow trout was 2.58(1). Fathead minnows - 28 day experiment in flow through tank log BCF 3.60 peak after 7 days; depuration occurs in 2 days(5). When oysters were suspended in oil treated enclosures contaminated with fluoranthene dissolved in Prudhoe crude oil, the log BCF was 4.09 after 2 days exposure(2). After the oysters were transferred to clean water, depuration half-life was 5 days(2). The log BCF for fish calculated from the log Kow (5.22(3)) is 3.74(4,SRC). [(1) Spehar RL et al; J Water Pollut Control Fed 52: 1703-74 (1980) (2) Lee RF et al; Environ Sci Technol 12: 832-38 (1978) (3) Mackay D et al; Chemosphere 9: 701-11 (1980) (4) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Environmental behavior of organic compounds; McGraw-Hill New York pp.5.1 to 5.30 (1982) (5) Carlson RM et al; Implications to the Aquatic Environ of Polynuclear Aromatic Hydrocarbons Liberated from Northern Great Plains Coal; USEPA-600/3-79-093 (1979)] **PEER REVIEWED**

SOIL ADSORPTION/MOBILITY

No specific data relating to fluoranthene's adsorption to soil or sediment could be found in the literature. However using its log octanol/water partition coefficient, 5.22(1), and using a regression equation for polycyclic hydrocarbons, one can calculate a Koc of 66,000(2,SRC). An adsorption constant of this magnitude indicates that fluoroanthene is immobile in soil(4). The importance of bottom sediment in removing fluoranthene was gauged by adding the chemical to water in the presence of bottom sediment. After 17 days 10% of the fluoranthene was recovered in the sediment(3). [(1) Mackay D et al; Chemosphere 9: 701-11 (1980) (2) Karickhoff SW; Chemosphere 10: 833-46 (1981) (3) Lee RF et al; Environ Sci Technol 12: 832-38 (1978) (4) Swann RL et al; Res Rev 80: 17-28 (1983)] **PEER REVIEWED**

VOLATILIZATION FROM WATER/SOIL

Volatilization of fluoranthene from water is not an important process(1). Less than 1% was volatilized in a pilot wastewater treatment plant(2). Volatilization from soil will also be unimportant because of its low vapor pressure(3) and strong adsorption to soil(1). [(1) Sims RC, Overcash MR; Res Rev 88: 1-68 (1983) (2) Petrasek AC et al; J Water Pollut control Fed 55: 1286-96 (1983) (3) USEPA; Treatability Manual pp.I.10.13-1 to I.10.13-5 USEPA-600/2-82-001A (1981) (4) Santodonato J et al; pp.77-176 in Health and Ecological Assessment of Polynuclear Aromatic Hydrocarbons; Pathotox Publisher Inc Park Forest South NY (1981)] **QC REVIEWED**

WATER CONCENTRATIONS

DRINKING WATER: Ottawa drinking water (Jan-Feb 1978) 0.55 and 1.9 ng/l(1). 18 USA cities - (finished water) not detected in 11 cities (detection limit 0.1-0 ng/l), 1-8.9 ng/l in 7 cities, 94.5 ng/l in Wheeling WV(2). Derwent England finished water 0.8 ng/l(2). Filtration, activated carbon treatment and chlorination remove considerable amounts of fluoranthene from drinking water. However distribution systems with asphalt or coal tar linings can contribute fluoranthene to the tap water. In one extreme case, Portland Oregon, the raw water had 4 ng/l

(1981) (2) Verschueren K; Handbook on Environ Data on Organic Chemicals; 2nd ed Van Nostrand Reinhold New York p.671-4 (1983)] **PEER REVIEWED**

OTHER ENVIRONMENTAL CONCENTRATIONS

CONCN OF PAH'S ARE MUCH LOWER IN ASPHALT LININGS THAN THEY ARE IN COAL TAR LININGS. ... ASPHALT PAINT /WAS ANALYZED/ FOR SEVERAL POLYCYCLIC AROMATIC HYDROCARBONS ... /FLUORANTHENE AMONG 8 OTHERS/ CONCN RANGING FROM 0.1 TO 10 UG/G. [National Research Council. Drinking Water & Health, Volume 4. Washington, DC: National Academy Press, 1981. , p. 75] **PEER REVIEWED**

PROBABLE ROUTES OF HUMAN EXPOSURE

Human exposure to fluoranthene is from air, food, and water contaminated with products of combustion, with food being the most important route of exposure. Contamination of water or seafood by oil or fossil fuel may be important in some situations but is less pervasive than the former. Concn are highest in areas of high anthropogenic activity(1,2). [(1) Hites RA et al; Adv Chem Ser 185(Pet Mar Environ): 289-311 (1980) (2) Santodonato J et al; pp.77-176 in Health and Ecological Assessment of Polynuclear Aromatic Hydrocarbons; Pathotox Publ Inc Park Forest South IL (1980)] **PEER REVIEWED**

AVERAGE DAILY INTAKE

AIR INTAKE: (Assume 0.1-10 ng/cu m) 2-200 ng; WATER INTAKE: (Assume 0-10 ng/l) 0-200 ng; FOOD INTAKE: 990 ng. (SRC) [CITATION] **PEER REVIEWED**

PROBABLE EXPOSURES

Fluoranthene is 8% of total polynuclear aromatic hydrocarbon (PAH) in work atmosphere in a foundry and 23-35% of total polynuclear aromatic hydrocarbons in the occupational atmosphere in aluminum coke, ferro-alloy and iron work industries(1). 3.2-14.6% of total polynuclear aromatic hydrocarbons in various areas of a solvent refined pilot plant(1). Norwegian primary aluminum smelting plant, complex fluoranthene: Anode plant, stationary monitoring: 1.0-23.1 ug/cu m particulates, 0.15-6.58 ug/cu m gaseous; Anode plant, personal sampling: 2.04-59.2 ug/cu m particulates with pitch bin workers having highest exposure; Prebake plant, stationary monitoring: 0.14-0.66 ug/cu m particulates, 0.88-13.4 ug/cu m gaseous; Prebake plant, personal sampling: 0.52-2.0 ug/cu m; Vertical pin Soderberg plant, stationary monitoring: 0.55-30.0 ug/cu m particulate, 14.1-162.0 ug/cu m gaseous; Vertical pin Soderberg plant personal sampling: 1.5-648.7 ug/cu m particulates with pin pullers having highest exposure(2). Coke plant-battery top, stationary monitoring: 45-427 ug/cu m particulates, 0-24 ug/cu m gaseous; coke plant, personal monitoring: 0.22-133.79 ug/cu m particulates, highest concentrations are in particulate size range <0.9-3 um(3). [(1) Gammage RB; pp.653-707 in Handbook of Polycyclic Aromatic Hydrocarbons; Bjorseth A ed; Marcel Dekker New York (1983) (2) Bjorseth A et al; Scand J Work Environ Health 4: 212-23 (1978) (3) Bjorseth A et al; Scand J Work Environ Health 4: 224-36 (1978)] **PEER REVIEWED**

PROBABLE EXPOSURES

COLUMN & THIN-LAYER CHROMATOGRAPHY FOLLOWED BY SPECTROFLUOROMETRY INDICATED THAT COMMERCIAL SAMPLES OF 4 SUNTAN OILS BASED ON MINERAL &/OR VEGETABLE OILS CONTAINED FLUORANTHENE. TOTAL POLYCYCLIC AROMATIC HYDROCARBON (PAH) CONTENT RANGED FROM 88.5 TO 188.7 NG/G. USERS OF SUNTAN OILS MAY BE EXPOSED TO LOW LEVELS OF POTENTIALLY HAZARDOUS POLYNUCLEAR AROMATIC HYDROCARBONS; HOWEVER, IN COMPARISON WITH MANY OTHER COSMETICS THAT ARE PRESUMABLY BASED ON SIMILAR OILS, SUNTAN OILS ARE ONLY USED INTERMITTENTLY & FOR RELATIVELY SHORT PERIODS. [MONARCA S ET AL; FOOD CHEM TOXICOL 20 (2): 183-87 (1982)] **PEER REVIEWED**

PROBABLE EXPOSURES

Exposure to fluoranthene will be considerably increased among tobacco smokers or those who are exposed to smokers in closed indoor environments. [Sittig, M. Handbook of Toxic and Hazardous Chemicals and Carcinogens, 1985. 2nd ed. Park Ridge, NJ: Noyes Data Corporation, 1985. , p. 454] **PEER REVIEWED**

BODY BURDENS

FLUORANTHENE WAS DETECTED IN SKIN LIPID OF 9 ROOFERS AT MEDIAN CONCN OF 1.2 NG/MG LIPID (RANGE: 0.3-8.9); TOTAL NG IN SAMPLE FROM 36 SQ CM AREA OF FOREHEAD, 2.7 MEDIAN (RANGE: 0.6 TO 36). [WOLFF MS ET AL; CHEMOSPHERE 11 (6): 595-9 (1982)] **PEER REVIEWED**

WATER STANDARDS

For the protection of human health from the toxic properties of fluoranthene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 42 ug/l. [USEPA; Ambient Water Quality Criteria Doc: Fluoranthene p.C-47 (1980)] **PEER REVIEWED**

WATER STANDARDS

For the protection of human health from the toxic properities of fluoranthene ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 54 ug/l. [USEPA; Ambient Water Quality Criteria Doc: Fluoranthene p.C-47 (1980)] **PEER REVIEWED**

WATER STANDARDS

Toxic pollutant designated pursuant to section 307(a)(1) of the Clean Water Act and is subject to effluent limitations. [40 CFR 401.15 (7/1/88)] **PEER REVIEWED**

ATMOSPHERIC STANDARDS ND

SOIL STANDARDS ND

MEMO

DATE: 2/28/91

TO: FILE

SUBJECT: I-40 INDUSTRIAL PARK.

Recommend for closeout.

- Initial real estate assessment found levels of asphalt-related compounds
- Not in an area of residential development so considered a risk-based assessment. considered SOC/Agreement.
- Next sampling showed BDL so. no longer a threat (so it appears at this time.

From: Steve Vein.

North Carolina Department of Environment, Health, and Natural Resources

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