UNITED STATES DISTRICT COURT
DISTRICT OF RHODE ISLAND

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District of Rhode Island

UNITED STATES OF AMERICA and STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS,	
Plaintiffs,	
v.	Civil Action No.
TOWN OF SOUTH KINGSTOWN, R.I.,	
and	
TOWN OF NARRAGANSETT, R.I.,	
Defendants.	

COMPLAINT

The United States of America ("United States"), by authority of the Attorney General of the United States and on behalf of the Administrator of the United States Environmental Protection Agency ("EPA"), and the State of Rhode Island and Providence Plantations ("State"), by authority of and on behalf of the Director of the Rhode Island Department of Environmental Management ("RIDEM"), alleges as follows:

STATEMENT OF THE CASE

1. This is a civil action brought pursuant to Sections 106 and 107 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended ("CERCLA"), 42 U.S.C. §§ 9606 and 9607, and R.I.G.L. Chapters 23-18.9, 23-19.1, and 23-19.14. By this action, the United States and the

SDMS DocID 41363

State seek to recover costs which they have incurred and will incur to respond to the releases or threatened releases of hazardous substances at or from the Rose Hill Regional Landfill Superfund Site in South Kingstown, Washington County, Rhode Island (the "Rose Hill Landfill Site" or the "Site"). The United States and the State also seeks injunctive relief requiring the implementation of EPA's December 20, 1999 Record of Decision ("ROD") relating to the Rose Hill Landfill Site.

JURISDICTION AND VENUE

2. This Court has jurisdiction over the subject matter of this action pursuant to Sections 106(a), 107(a) and 113(b) of CERCLA, 42 U.S.C. §§ 9606(a), 9607(a) and 9613(b), and 28 U.S.C. §§ 1331 and 1345.

3. Pursuant to Sections 106 and 113(b) of CERCLA, 42 U.S.C. §§ 9606 and 9613(b), and 28 U.S.C. § 1391(b), venue is proper in this district because the releases or threatened releases of hazardous substances that give rise to the claims occurred in this district.

DEFENDANTS

4. Defendant Town of South Kingstown, R.I., is a municipality located in Rhode Island, which has an office at 180 High Street, Wakefield, R.I. 02879.

5. Defendant Town of Narragansett, R.I., is a municipality located in Rhode Island, which has an office at 25 Fifth Avenue, Narragansett, R.I. 02882.

6. Each of the defendants is a "person" as defined in Section 101(21) of CERCLA, 42 U.S.C. § 9601(21).

7. Defendants Town of South Kingstown and Town of Narragansett owned or operated the Rose Hill Landfill Site during a time period when CERCLA hazardous substances were disposed of at the Site.

FACTUAL BACKGROUND

8. The Rose Hill Landfill Site is located in the Village of Peace Dale, in the Town of South Kingstown, in Rhode Island. The Site lies about five miles inland from Narragansett Bay and two miles north of Wakefield, Rhode Island. The Site is bordered by Rose Hill Road to the west, the Saugatucket River to the east, and residential private property to the north and south.

9. In 1967, the Town of South Kingstown began operation of the Solid Waste Area landfill at the Site. In 1973, the Town of Narragansett entered into an agreement with the Town of South Kingstown for joint use and operation of the landfill. In approximately 1977, the Towns began operation of the Bulky Waste Area landfill at the Site. Landfill operations at the Solid Waste Area ceased in approximately 1982, and landfill operations at the Bulky Waste Area ceased in approximately 1983. During the time period when the Towns operated the Rose Hill landfill facilities, municipal refuse and industrial refuse were disposed of at the Site. Among the refuse disposed of at the Site were wastes containing CERCLA hazardous substances.

10. In 1989, following preliminary assessments and site investigations, EPA listed the Rose Hill Landfill Site on the National Priorities List, 40 C.F.R. Part 300, Appendix B, which is a list of hazardous waste sites nationwide that pose the greatest threat to public health, public welfare, or the environment. The National Priorities List is established pursuant to Section 105(a) of CERCLA, 42 U.S.C. § 9605(a).

11. Pursuant to its authority under Section 104 of CERCLA, 42 U.S.C. § 9604, during the 1990s EPA conducted a Remedial Investigation and Feasibility Study (the "RI/FS") for the Site. The RI/FS identified risks to human health from exposure to and inhalation of landfill gas and ingestion of contaminated groundwater and risks to the ecology of the Saugatucket River and Mitchell Brook from leachate production.

12. On December 20, 1999, EPA issued a Record of Decision for the First Operable Unit -- Source Control (the "ROD") for the Site, which was concurred in by RIDEM. The source control remedy for the Site consists of consolidation of the Bulky Waste Area landfill materials onto the Solid Waste Area landfill, leachate collection and management, construction of a multi-layer hazardous waste cap over the Solid Waste Area landfill and consolidated Bulky Waste Area materials, landfill gas collection and management, institutional controls, and operation, maintenance and monitoring.

13. The Rose Hill Landfill Site is a "facility" within the meaning of Section 101(9) of CERCLA, 42 U.S.C. § 9601(9).

14. There have been and continue to be "releases" and "threatened releases" of "hazardous substances" within the meaning of Sections 101(14), (22), and 107(a) of CERCLA, 42 U.S.C. §§ 9601(14), (22), and 9607(a), into the environment at and from the Rose Hill Landfill Site. CERCLA hazardous substances that have been released at and from the Rose Hill Landfill site include, but are not limited to, benzene, dichloroethene, tetrachloroethane, vinyl chloride, copper, lead, and manganese.

FIRST CLAIM FOR RELIEF

15. The statements and allegations set forth in paragraphs 1 through 14 are realleged and incorporated herein by reference.

16. As a result of the release or threatened release of hazardous substances at and from the Site, the United States has incurred "response costs" as defined in Sections 101(25) and 107(a) of CERCLA, 42 U.S.C. §§ 9601(25) and 9607(a), for actions taken in response to the release or threatened release of hazardous substances at and from the Rose Hill Landfill Site. The United States will continue to incur response costs in connection with the Site.

17. The response actions taken by the United States and the resulting response costs incurred by the United States in connection with the Rose Hill Landfill Site were not inconsistent

with the National Contingency Plan ("NCP") applicable at the time the response actions were taken.

18. Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), provides, in pertinent part:

> (1) the owner and operator of a vessel or a facility,
>
> (2) any person who at the time of disposal of any hazardous substance owned or operated any facility at which such hazardous substances were disposed of,
>
> (3) any person who by contract, agreement, or otherwise arranged for disposal or treatment, or arranged with a transporter for transport for disposal or treatment, of hazardous substances owned or possessed by such person, by any other party or entity, at any facility. . . owned or operated by another party or entity and containing such hazardous substances, and
>
> (4) any person who accepts or accepted any hazardous substances for transport to disposal or treatment facilities, . . . or sites selected by such person, from which there is a release, or a threatened release which causes the incurrence of response costs, of a hazardous substance, shall be liable for--
>
> > (A) all costs of removal or remedial action incurred by the United States Government or a State . . . not inconsistent with the national contingency plan . . . .

19. Each of the defendants Town of South Kingstown, R.I., and Town of Narragansett, R.I., is a person who, at the time of disposal of hazardous substances thereon, owned or operated the Rose Hill Landfill Site, which is a facility within the meaning of Section 101(9) of CERCLA, 42 U.S.C. § 9601(9). Each of the defendants is therefore liable under Section 107(a)(2) of CERCLA, 42 U.S.C. § 9607(a)(2), for response costs incurred and to be

incurred by the United States in connection with the Rose Hill Landfill Site.

20. Pursuant to Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), Defendants Town of South Kingstown, R.I., and Town of Narragansett, R.I., are jointly and severally liable to the United States for the response costs the United States has incurred in the past and will incur in the future relating to the Rose Hill Landfill Site.

SECOND CLAIM FOR RELIEF

21. The statements and allegations set forth in paragraphs 1 through 20 are realleged and incorporated herein by reference.

22. Section 106(a) of CERCLA, 42 U.S.C. § 9606(a), provides in pertinent part:

> [W]hen the President determines that there may be an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance from a facility, he may . . . secure such relief as may be necessary to abate such danger or threat . . . .

23. The President, through his delegate, the Director, Office of Site Remediation and Restoration of EPA Region I, determined that there are actual or threatened releases of hazardous substances from the Rose Hill Landfill Site which may present an imminent and substantial endangerment to public health, welfare, or the environment.

24. Section 106(a) of CERCLA, 42 U.S.C. § 9606(a), authorizes the United States to bring an action to secure such

relief as may be necessary to abate the danger or threat at the Site. The remedial actions selected by EPA in the December 20, 1999 ROD are necessary to abate the danger or threat at the Site.

25. Pursuant to Section 106(a) of CERCLA, 42 U.S.C. § 9606(a), the defendants are liable to the United States to abate the danger or threat at the Site.

THIRD CLAIM FOR RELIEF

26. The statements and allegations set forth in paragraphs 1 through 25 are realleged and incorporated herein by reference.

27. As a result of the release or threatened release of hazardous substances or hazardous materials within the meaning of Section 101(25) of CERCLA, 42 U.S.C. § 9601(25), and R.I.G.L. 23-19.14-3, at and from the Rose Hill Landfill Site, the State has incurred costs of response that are recoverable under Section 107(a) of CERCLA, 42 U.S.C. §§ 9601(25) and 9607(a), and R.I.G.L. Chapters 23-18.9, 23-19.1, and 23-19.14, for actions taken in response to the release or threatened release of hazardous substances or hazardous materials at and from the Site. The State will continue to incur costs of response in connection with the Site.

28. The response actions taken by the State and the resulting costs of response incurred by the State in connection with the Rose Hill Landfill Site were not inconsistent with the National Contingency Plan ("NCP") applicable at the time the response actions were taken.

29. Pursuant to Section 107(a) of CERCLA, 42 U.S.C.

§ 9607(a), and R.I.G.L. Chapter 23-19.14-6, any person who at the time of disposal of any hazardous substance or hazardous material owned or operated the facility or the site is liable for the costs of response action relating to the facility or site incurred and to be incurred by the State.

30. Since each of the defendants Town of South Kingstown, R.I., and Town of Narragansett, R.I., is a person who owned or operated the Rose Hill Landfill Site at a time of disposal of hazardous substances thereon, each is liable to the State for the costs of response incurred and to be incurred by the State relating to the Site pursuant to Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), and R.I.G.L. Chapters 23-18.9, 23-19.1, and 23-19.14.

31. Pursuant to Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), and R.I.G.L. Chapters 23-18.9, 23-19.1, and 23-19.14, Defendants Town of South Kingstown, R.I., and Town of Narragansett, R.I., are jointly and severally liable to the State for the costs of response the State has incurred in the past and will incur in the future relating to the Rose Hill Landfill Site.

FOURTH CLAIM FOR RELIEF

32. The statements and allegations set forth in paragraphs 1 through 31 are realleged and incorporated herein by reference.

33. Pursuant to R.I.G.L. Chapters 23-18.9, 23-19.1, and 23-19.14, with respect to a site which contains hazardous substances or hazardous materials, such as hazardous wastes, which present a hazard to the public health and safety or to the environment, the

Director of RIDEM is authorized to bring an action for injunctive relief to require the owner or operator of the site or the custodian of the wastes to take steps necessary to abate the conditions which constitute the hazard.

34. As a result of the disposal of hazardous substances or hazardous materials, such as hazardous wastes, at the Rose Hill Landfill Site, there are conditions at the Site which present a hazard to public health and safety or the environment. The remedial actions selected in the December 20, 1999 ROD, which was concurred in by RIDEM, are necessary to abate conditions which constitute a hazard at the Site.

35. Defendants Town of South Kingstown, R.I., and Town of Narragansett, R.I. are the owners or operators of the Rose Hill Landfill Site or the custodians of the wastes at the Site. Pursuant to R.I.G.L. Chapters 23-18.9, 23-19.1, and 23-19.14, the defendants are liable to the State for injunctive relief to abate the conditions which constitute a hazard at the Site.

PRAYER FOR RELIEF

WHEREFORE, Plaintiffs, the United States of America and the State of Rhode Island and Providence Plantations, prays that this Court:

1. Enjoin the defendants, jointly and severally, to implement the response actions selected in the December 20, 1999 Record of Decision for the Site;

2. Order the defendants to reimburse the United States, jointly and severally, for the response costs incurred by the United States in connection with the Site, plus interest;

3. Order the defendants to reimburse the State, jointly and severally, for the response costs incurred by the State in connection with the Site, plus interest;

4. Award to the United States its costs and fees in this action;

5. Award to the State its costs and fees in this action; and

6. Grant such other and further relief as the Court deems appropriate.

Respectfully submitted,

FOR THE UNITED STATES:

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United States Department of Justice

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UNITED STATES DISTRICT COURT
DISTRICT OF RHODE ISLAND

UNITED STATES OF AMERICA and STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS,	)	
Plaintiffs,	)	
v.	)	CIVIL ACTION NO.
TOWN OF SOUTH KINGSTOWN, R.I., and TOWN OF NARRAGANSETT, R.I.	)	
Defendants.	)	

CERTIFICATE OF SERVICE

I hereby certify that I have this 19th day of December, 2002, caused to be mailed, first-class, postage prepaid, a copy of the Complaint and the Notice of Lodging of Consent Decree and of Defendants' Waiver of Service, with accompanying Consent Decree, to the counsel and representatives for the defendants, as well as to counsel for the State, at the following addresses:

Gerald J. Petros
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Stephen A. Alfred
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Jeffry Ceasrine, P.E.
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Michael P. Iannotti
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50 Kennedy Plaza
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UNITED STATES DISTRICT COURT
DISTRICT OF RHODE ISLAND

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Property of U.S. District Court
District of Rhode Island

UNITED STATES OF AMERICA and STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS,	)	
Plaintiffs,	)	
v.	)	CIVIL ACTION NO.
TOWN OF SOUTH KINGSTOWN, R.I., and TOWN OF NARRAGANSETT, R.I.	)	
Defendants.	)	

NOTICE OF LODGING OF CONSENT DECREE
AND OF DEFENDANTS' WAIVER OF SERVICE

Plaintiff, the United States of America, notifies the Court that it is herewith lodging the Consent Decree, which consent decree resolves the claims of the United States and the State of Rhode Island against the Towns of South Kingstown and Narragansett for past response costs and for the implementation of the source control remedy ("Operable Unit One") at the Rose Hill Landfill Superfund Site ("Site") in South Kingstown, R.I. The United States' claims are under Sections 106 and 107 of the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA"), 42 U.S.C. §§ 9606, 9607, and the State's claims are under Section 107 of CERCLA, 42 U.S.C. § 9607, and R.I.G.L. Chapters 23-18.9, 23-19.1, and 23-19.14. Both the United States' and the State's claims concerning the Site are set forth in the complaint against the defendants in the above-captioned action, United States and State of Rhode Island v. Town of South Kingstown and Town of Narragansett, filed concomitantly with this notice of lodging.

The Consent Decree is being lodged in this case pending solicitation and consideration of public comments, as required by 28 C.F.R. § 50.7 and consistent with R.I.G.L. § 23-19.14-11. In accordance with Department of Justice policy, 28 C.F.R. § 50.7, and 42 U.S.C. § 9622(d), the Department of Justice will publish in the Federal Register a notice that this Consent Decree has been lodged with the Court. The notice will solicit public comments on the Consent Decree for a period of thirty (30) days from the date of publication. After the close of the comment period, the United States will evaluate any comments received and will advise the Court as to whether the United States requests that the Consent Decree be entered.

However, because opportunities for public comment are required, the United States respectfully requests that the Court take no action with respect to the lodged Consent Decree until the United States requests entry or otherwise advises the Court.

In the Consent Decree, at page 76, each of the defendants waives service of process in accordance with Rule 4 of the Federal Rules of Civil Procedure in regard to the Complaint filed concomitantly with the lodging of this Consent Decree.

Respectfully submitted,

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Deputy Chief, Environmental Enforcement Section
Environment and Natural Resources Division
U.S. Department of Justice

Margaret Curran
United States Attorney

By: Elizabeth Yu
Elizabeth Yu
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By: _____ for

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Dated: December 19, 2002

OF COUNSEL:

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UNITED STATES DISTRICT COURT
DISTRICT OF RHODE ISLAND

UNITED STATES OF AMERICA and STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS,	)	
Plaintiffs,	)	
v.	)	CIVIL ACTION NO.
TOWN OF SOUTH KINGSTOWN, R.I., and TOWN OF NARRAGANSETT, R.I.	)	
Defendants.	)	

CERTIFICATE OF SERVICE

I hereby certify that I have this 19th day of December, 2002, caused to be mailed, first-class, postage prepaid, a copy of the Complaint and the Notice of Lodging of Consent Decree and of Defendants' Waiver of Service, with accompanying Consent Decree, to the counsel and representatives for the defendants, as well as to counsel for the State, at the following addresses:

Gerald J. Petros
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Department of Environmental Management
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Assistant United States Attorney
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Fleet Center
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ROSE HILL REGIONAL LANDFILL SUPERFUND SITE
SOUTH KINGSTOWN, RHODE ISLAND

TOWN OF SOUTH KINGSTOWN, R.I.

AND

TOWN OF NARRAGANSETT, R.I.

SETTLING PARTIES

UNITED STATES DISTRICT COURT
DISTRICT OF RHODE ISLAND
CIVIL ACTION NO.

CONSENT DECREE
UNDER CERCLA SECTIONS 106 AND 107

TABLE OF CONTENTS

I. BACKGROUND 1

II. JURISDICTION 3

III. PARTIES BOUND 3

IV. DEFINITIONS 4

V. STATEMENT OF PURPOSE 12

VI. ESCROW OBLIGATIONS 13

VII. PAYMENT REGARDING UNITED STATES' RESPONSE COSTS 14

VIII. DISBURSEMENT OF SPECIAL ACCOUNT FUNDS 20

IX. FEDERAL NATURAL RESOURCE DAMAGES SETTLEMENT 21

X. STATE NATURAL RESOURCE DAMAGES SETTLEMENT 22

XI. PERFORMANCE OF THE OPERABLE UNIT 1 SOURCE CONTROL REMEDY 23

XII. QUALITY ASSURANCE, SAMPLING, AND DATA ANALYSIS 32

XIII. REPORTING REQUIREMENTS 36

XIV. EMERGENCY RESPONSE 38

XV . DISPUTE RESOLUTION BETWEEN UNITED STATES AND STATE 39

XVI. WORK TO BE PERFORMED BY SETTLING DEFENDANTS 41

XVII. SETTLING DEFENDANTS' REIMBURSEMENT TO STATE 45

XVIII. FAILURE TO COMPLY WITH REQUIREMENTS OF CONSENT DECREE 49

XIX. COVENANT NOT TO SUE BY PLAINTIFFS 55

XX. RESERVATION OF RIGHTS BY PLAINTIFFS 56

XXI. COVENANT NOT TO SUE BY SETTLING DEFENDANTS 59

XXII. EFFECT OF SETTLEMENT/CONTRIBUTION PROTECTION 61

XXIII. ACCESS AND INSTITUTIONAL CONTROLS 62

XXIV. ACCESS TO INFORMATION 68

XXV. RETENTION OF RECORDS 69

XXVI. NOTICES AND SUBMISSIONS 71

XXVII. COMMUNITY RELATIONS 73

XXVIII. MODIFICATION 73

XXIX. RETENTION OF JURISDICTION 74

XXX. INTEGRATION/APPENDICES 74

XXXI. LODGING AND OPPORTUNITY FOR PUBLIC COMMENT 75

XXXII. EFFECTIVE DATE 76

XXXIV. SIGNATORIES/SERVICE 76

LIST OF APPENDICES

"Appendix A" List of Settling Defendants.
"Appendix B" Map of Rose Hill Regional Landfill Site.
"Appendix C" Escrow Agreement.
"Appendix D" Record of Decision for the Operable Unit 1 Source Control Remedy.
"Appendix E" Cooperative Agreement for the OU1 Remedial Design, including the OU1 Remedial Design Scope of Work.
"Appendix F" OU1 Remedial Action Statement of Work.
"Appendix G" Draft access and institutional control instrument.
"Appendix H" Guidelines for Reuse Plan and Assessment.
"Appendix I" Description and site plan for the Frisella property.

EXHIBIT LIST

"Exhibit 1" Illustration of Methodology for Cost Sharing Arrangement between the State and the Settling Defendants

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF RHODE ISLAND

UNITED STATES OF AMERICA	)	
and	)	
THE STATE OF RHODE ISLAND	)	
Plaintiffs,	)	
v.	)	Civil Action No. _____
THE TOWN OF SOUTH KINGSTOWN, R.I.	)	Judge _____
and	)	
THE TOWN OF NARRAGANSETT, R.I.	)	
Defendants.	)	

CONSENT DECREE

I. BACKGROUND

A. The United States of America ("United States"), on behalf of the Administrator of the United States Environmental Protection Agency ("EPA"), filed a complaint against the defendants in this matter pursuant to Sections 106 and 107 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. §§ 9606 and 9607, as amended ("CERCLA"), seeking injunctive relief and reimbursement of response costs incurred or to be incurred for response actions taken or to be taken for Operable Unit 1 at or in connection with the release or threatened release of hazardous substances at the Rose Hill Regional Landfill

Superfund Site in South Kingstown, Washington County, Rhode Island ("the Site"). The Operable Unit 1 source control remedy was selected by EPA in the Record of Decision for the Rose Hill Landfill Site, dated December 20, 1999.

B. The State of Rhode Island and Providence Plantations (the "State") also filed a complaint against the defendants in this Court alleging that the defendants are liable to the State under Section 107 of CERCLA, 42 U.S.C. § 9607, and R.I.G.L. Chapter 23-18.9 and 23-19.1. The State in its complaint seeks injunctive relief and reimbursement of response costs incurred or to be incurred for response actions taken or to be taken for Operable Unit 1 at or in connection with the release or threatened release of hazardous substances at the Rose Hill Regional Landfill.

C. In accordance with Section 122(j) of CERCLA, 42 U.S.C. § 9622(j), EPA notified the Department of the Interior and the Department of Commerce - National Oceanographic and Atmospheric Administration on August 10, 2000 of negotiations with Settling Defendants regarding the release of hazardous substances that may have resulted in injury to the natural resources under federal trusteeship and encouraged the Trustee(s) to participate in the negotiation of this Consent Decree.

D. The defendants that have entered into this Consent Decree ("Settling Defendants") do not admit any liability to Plaintiffs arising out of the transactions or occurrences alleged in the complaints.

E. The United States, the State, and Settling Defendants contemplate that the State shall implement the remedial design, remedial action, and operation and maintenance of the Operable Unit 1 Source Control Remedy at the Rose Hill Regional Landfill, and that Settling Defendants shall make payments and perform various items of work pertaining to Operable Unit 1 as

provided herein;

F. The United States, the State, and Settling Defendants agree, and this Court by entering this Consent Decree finds, that this Consent Decree has been negotiated by the Parties in good faith, that settlement of this matter will avoid prolonged and complicated litigation between the Parties, and that this Consent Decree is fair, reasonable, and in the public interest.

THEREFORE, with the consent of the Parties to this Decree, it is ORDERED, ADJUDGED AND DECREED:

II. JURISDICTION

1. This Court has jurisdiction over the subject matter of this action pursuant to 28 U.S.C. §§ 1331 and 1345 and 42 U.S.C. §§ 9606, 9607 and 9613(b) and also has personal jurisdiction over Settling Defendants. Settling Defendants consent to and shall not challenge entry of this Consent Decree or this Court's jurisdiction to enter and enforce this Consent Decree.

III. PARTIES BOUND

2. a. This Consent Decree is binding upon the United States and the State and upon Settling Defendants and their successors and assigns. Any change in ownership or corporate or other legal status, including but not limited to, any transfer of assets or real or personal property, shall in no way alter the status or responsibilities of the Settling Defendants under this Consent Decree.

b. The State and Settling Defendants shall provide a copy of this Consent Decree to each contractor hired to perform the Work required by this Consent Decree and to each person representing any Settling Defendant or the State with respect to the Site or the Work and shall condition all contracts entered into hereunder upon the performance of the Work in

conformity with the terms of the Consent Decree. The State or its contractors and Settling Defendants or their contractors shall provide written notice of the Consent Decree to all subcontractors hired to perform any portion of the Work required by this Consent Decree. The State and Settling Defendants shall nonetheless be responsible for ensuring that their contractors and subcontractors perform the Work contemplated herein in accordance with this Consent Decree.

IV. DEFINITIONS

3. Unless otherwise expressly provided herein, terms used in this Consent Decree which are defined in CERCLA or in regulations promulgated under CERCLA shall have the meaning assigned to them in CERCLA or in such regulations. Whenever terms listed below are used in this Consent Decree or in any appendix attached hereto, the following definitions shall apply:

a. "Additional U.S. RD/RA Response Costs" shall mean any costs, including direct and indirect costs, that EPA incurs and pays at or in connection with the Site for Operable Unit 1 remedial design/remedial action activities that exceed $8,500,000 (fifty percent of the estimated cost of Operable Unit 1 remedial design/remedial action activities at the Site).

b. "Arbitrator," for purposes of Sections XVI, XVII and XXII (Paragraph 75) of the Consent Decree, shall mean the RIDEM Administrative Adjudication Division hearing officer.

c. "CERCLA" shall mean the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9601, et seq.

d. "Consent Decree" shall mean this Consent Decree and all appendices attached hereto. In the event of conflict between this Consent Decree and any appendix, this Consent

Decree shall control.

e. "Cooperative Agreement" shall mean the Cooperative Agreement, Rose Hill Regional Landfill Superfund Site, dated September 25, 2001, for the remedial design for the Operable Unit 1 Source Control Remedy, a copy of which, including the Remedial Design Scope of Work, is attached as Appendix E.

f. "Day" shall mean a calendar day. In computing any period of time under this Consent Decree, where the last day would fall on a Saturday, Sunday, or federal holiday, the period shall run until the close of business of the next working day.

g. "DOI" shall mean the United States Department of the Interior and any successor departments, agencies or instrumentalities of the United States.

h. "DOJ" shall mean the United States Department of Justice and any successor departments, agencies or instrumentalities of the United States.

i. "Effective date" of this Consent Decree shall mean the date on which it is entered by the Court.

j. "EPA" shall mean the United States Environmental Protection Agency and any successor departments, agencies or instrumentalities of the United States.

k. "EPA Hazardous Substance Superfund" shall mean the Hazardous Substance Superfund established by the Internal Revenue Code, 26 U.S.C. § 9507.

l. "Expected Life" means the period of time the cap remains in place and the period of time necessary for all monitoring and/or other measures to achieve and maintain cleanup goals established in the ROD.

m. "Federal Natural Resource Trustees" shall mean the National Oceanic and

Atmospheric Administration (NOAA) of the United States Department of Commerce and the United States Department of the Interior (DOI) and any successor departments, agencies or instrumentalities of the United States.

n. "Final Approval of the Consent Decree," for purposes of Paragraph 6 and Paragraph 11 of the Consent Decree, shall mean the earliest date on which all of the following have occurred: (1) the Decree has been lodged with the Court and noticed in the Federal Register, and the period for submission of public comments has expired; (2) the Court has approved and entered the Decree as a judgment; and (3) the time for appeal from that judgment has expired without the filing of an appeal, or the judgment has been upheld on appeal and either the time for further appeal has expired without the filing of a further appeal or no further appeal is allowed.

o. "Future Response Costs" shall mean all costs, including but not limited to direct and indirect costs, that the United States incurs at or in connection with the Site for Operable Unit 1, beginning October 1, 2000, except for any Additional U.S. RD/RA Response Costs. Future Response Costs shall also include all Interim Response Costs and all Interest on the Past Costs that has accrued during the period from October 1, 2000, to the date of entry of this Consent Decree.

p. "Interim Response Costs" shall mean all costs, including direct and indirect costs, (a) paid by the United States in connection with the Site between October 1, 2000, and the effective date of this Consent Decree, or (b) incurred prior to the effective date of this Consent Decree but paid after that date.

q. "Interest" shall mean interest at the rate specified for interest on investments of

the EPA Hazardous Substance Superfund established by 26 U.S.C. § 9507, compounded annually on October 1 of each year, in accordance with 42 U.S.C. § 9607(a). The applicable rate of interest shall be the rate in effect at the time the interest accrues. The rate of interest is subject to change on October 1 of each year.

r. "Municipal sewage sludge" shall mean any solid, semi-solid, or liquid residue removed during the treatment of municipal waste water or domestic sewage, and may include residue removed, all or in part, during the treatment of wastewater from manufacturing or processing operations, provided that such residue has essentially the same characteristics as residue removed during the treatment of domestic sewage.

s. "Municipal solid waste" shall mean household waste and solid waste collected from non-residential sources that is essentially the same as household waste. While the composition of such wastes may vary considerably, municipal solid waste generally is composed of large volumes of non-hazardous substances (e.g., yard waste, food waste, and glass) and can contain small amounts of other wastes as typically may be accepted in RCRA Subtitle D landfills.

t. "Natural Resource Damages" shall mean damages for injury to, destruction of, or loss of natural resources as defined in 42 U.S.C. § 101(16) and includes the costs of natural resource damage assessment and restoration actions.

u. "NOAA" shall mean the National Oceanic and Atmospheric Administration of the United States Department of Commerce, and any successor departments, agencies, or instrumentalities of the United States.

v. "Operable Unit 1" or "Operable Unit 1 Source Control Remedy" shall mean

all work that is to be performed to implement the Record of Decision for the First Operable Unit–Source Control at the Site, signed by the Director of the Office of Site Remediation and Restoration, EPA New England, on December 20, 1999. Operable Unit 1, the first operable unit of a phased approach to cleanup of the Site, generally includes source control through excavation, consolidation and capping of the waste, treatment of the landfill gas, institutional controls, and monitoring and data collection which will inform the future decision regarding management of the migration of contaminants to ground and surface waters. The Operable Unit 1 Source Control Remedy includes, without limitation, remedial design, remedial action, and operation and maintenance of the remedy.

w. "Operation and Maintenance" or "O&M" shall mean all activities necessary to implement the ROD after the Remedial Action has been constructed and determined to be Operational and Functional in accordance with the Remedial Action Statement of Work, including all activities required to maintain the effectiveness of the Operable Unit 1 Source Control Remedy, which are to be performed in accordance with the Operation and Maintenance Plan, Demonstration of Compliance Plan, and Long Term Monitoring Plan to be developed pursuant to this Consent Decree and the Remedial Action Statement of Work attached as Appendix F. Operation and Maintenance shall include groundwater monitoring, leachate collection (if any), and landfill gas collection and monitoring after the response actions constructed are deemed Operational and Functional by the State, with concurrence by EPA.

x. "Operational and Functional" shall have the meaning provided for under 40 C.F.R. § 300.435(f)(2).

y. "Paragraph" shall mean a portion of this Consent Decree identified by an

Arabic numeral or an upper or lower case letter.

z. "Parties" shall mean the United States, the State, and Settling Defendants.

aa. "Past Response Costs" shall mean all costs, including but not limited to direct and indirect costs, that the United States has paid at or in connection with the Site through September 30, 2000, plus accrued Interest on all such costs through such date.

ab. "Performance Standards" shall mean the cleanup standards and other measures of achievement of the goals of the Response Action set forth in the Record of Decision and Section IV of the Remedial Design Scope of Work.

ac. "Plaintiffs" shall mean the United States and the State of Rhode Island.

ad. "RCRA" shall mean the Solid Waste Disposal Act, 42 U.S.C. § 6901, et seq. (also known as the Resource Conservation and Recovery Act).

ae. "Record of Decision" or "ROD" shall mean the Operable Unit 1 Record of Decision for the Rose Hill Regional Landfill Superfund Site signed by EPA on December 20, 1999.

af. "Reimbursable Costs," for purposes of Section XVII of the Consent Decree, shall mean costs incurred by the State for performance of Operable Unit 1, including (1) all third party costs for design, construction, oversight, materials and other Site Work; and (2) RIDEM staff time, including payroll and fringe benefits, plus a markup at the indirect rate applied to State costs that is agreed to between EPA and the State in cooperative agreements under CERCLA. Reimbursable Costs do not include (i) any costs paid for or reimbursed by the United States; (ii) any other indirect costs the State may incur or pay; (iii) any past costs; or (iv) Natural Resource Damages. For purposes of the definition of "Reimbursable Costs," the term "third party" refers

to all persons, including but not limited to contractors hired by the State, other than the parties to this Consent Decree.

ag. "Remedial Action" shall mean those activities, except for Remedial Design and Operation and Maintenance, to be undertaken to implement the ROD, which are to be performed in accordance with the final plans and specifications developed during the Remedial Design, the Remedial Action Statement of Work ("RA SOW") attached hereto as Appendix F, and the Remedial Action Work Plans developed thereunder. Remedial Action shall include groundwater monitoring, leachate collection, and gas collection and monitoring until the response actions constructed are determined to be Operational and Functional.

ah. "Remedial Action Work Plan" shall mean the document developed pursuant to Paragraph 19 of this Consent Decree and the Remedial Action Statement of Work, and any amendments thereto.

ai. "Remedial Design" shall mean those activities to be undertaken to develop the final plans and specifications for the Remedial Action specified in the ROD, which are to be performed pursuant to the Remedial Design Work Plan under the terms and conditions of the Rose Hill Regional Landfill Cooperative Agreement attached hereto as Appendix E, including its remedial design Scope of Work ("Remedial Design Scope of Work" or "RD SOW") . The Remedial Design shall include groundwater monitoring during the Remedial Design.

aj. "Remedial Design Work Plan" shall mean the document developed pursuant to Paragraph 15 of this Consent Decree and the Remedial Design Scope of Work.

ak. "Response Action" shall mean those actions implemented or to be implemented pursuant to CERCLA at the Rose Hill Regional Landfill Superfund Site under the

first operable unit Record of Decision for the Rose Hill Regional Landfill Superfund Site signed on December 20, 1999.

al. "RIDEM" shall mean the Rhode Island Department of Environmental Management, and any successor agencies, departments, or instrumentalities of the State of Rhode Island.

am. "Rose Hill Regional Landfill Special Account" shall mean the special account established at the Site by EPA pursuant to Section 122(b)(3) of CERCLA, 42 U.S.C. §9622(b)(3), and this Consent Decree.

an. "Section" shall mean a portion of this Consent Decree identified by a Roman numeral.

ao. "Settling Defendants" shall mean the Town of South Kingstown, Rhode Island and the Town of Narragansett, Rhode Island and are listed on Appendix A.

ap. "State Natural Resources Trustee" shall mean the Director of RIDEM, or his or her designee.

aq. "Site" shall mean the Rose Hill Regional Landfill Superfund Site, encompassing approximately 70 acres, bordered by Rose Hill Road on the west, the Saugatucket River on the east, and residential private property to the north and south in the Town of South Kingstown, Washington County, State of Rhode Island, and generally shown on the map included in Appendix B.

ar. "State" shall mean the State of Rhode Island and Providence Plantations.

as. "State Future Response Costs" shall mean all costs, including but not limited to direct and indirect costs that the State incurs and pays at or in connection with the Site after

September 30, 2000, for response actions for Operable Unit 1, but State Future Response Costs do not include amounts paid or reimbursed to the State by EPA.

at. "United States" shall mean the United States of America, including its departments, agencies and instrumentalities.

au. "Waste Material" shall mean (1) any "hazardous substance" under Section 101(14) of CERCLA, 42 U.S.C. § 9601(14); (2) any pollutant or contaminant under Section 101(33), 42 U.S.C. § 9601(33); (3) any "solid waste" under Section 1004(27) of RCRA, 42 U.S.C. § 6903(27); and (4) any "hazardous material" under Rhode Island General Laws, Chapter 23, Section 19.14-3.

av. "Work" shall mean all work required to implement the Operable Unit 1 Source Control Remedy, including remedial design, remedial action, and operation and maintenance activities.

V. STATEMENT OF PURPOSE

4. By entering into this Consent Decree, the mutual objective of the Parties is to provide for the implementation of the Operable Unit 1 Source Control Remedy and to resolve certain claims of the United States and the State against Settling Defendants, as outlined in the Covenant Not to Sue by Plaintiffs, by allowing Settling Defendants to make an up-front cash payment and a commitment to make future payments and provide in-kind services, as provided in Sections VI, VII, IX, X, XVI and XVII herein, to address their liability for Past Response Costs, Future Response Costs, State Future Response Costs, Additional U.S. RD/RA Response Costs, and Natural Resource Damages, subject to the reservations of rights included in Section XX (Reservation of Rights by Plaintiffs).

VI. ESCROW OBLIGATIONS

5. a. Prior to or within ten (10) business days after their signing of this Decree, Settling Defendants shall establish an escrow account (the Escrow) bearing interest on commercially reasonable terms in a federally chartered bank in Massachusetts, Rhode Island, or New York with assets of over $100 million (the Escrow Agent), and Settling Defendants shall cause to be paid into the Escrow the amount of $ 4,000,000, plus Interest at a rate of 3.35 percent on $4,000,000 between March 31, 2002 and the date of payment into the Escrow. The Escrow Agreement between Settling Defendants and the Escrow Agent shall provide that the Escrow Agent shall submit to the jurisdiction and venue of the United States District Court for the District of Rhode Island in connection with any litigation relating to the Escrow or the Escrow agreement. A copy of the Escrow Agreement is attached as Appendix C. Settling Defendants shall provide written notification to EPA and DOJ of the creation and funding of the Escrow within seven days after the payment has been made at the addresses listed in Section XXVI (Notices and Submissions).

b. All funds paid into the Escrow by Settling Defendants shall remain in the Escrow and may not be withdrawn by any person, except to make the payments required by Paragraph 6 or unless one of the following events occurs: (1) the United States or the State of Rhode Island withdraws its consent to entry of the Decree after the Decree has been lodged, pursuant to Paragraph 96; or (2) a final judicial determination is made that the Decree will not be approved and entered. If any of (1), (2) or (3) above occurs, all sums in the Escrow shall be returned to Settling Defendants. Any risk of loss of funds paid into Escrow shall be borne by Settling Defendants.

c. All interest accrued in the Escrow shall be paid to Plaintiff United States in accordance with Paragraph 6 at the time the principal payments under those paragraphs are made. Settling Defendants will be responsible for all fees, taxes, costs and charges of the Escrow, and those amounts will not be deducted from the principal or accrued interest of the escrow account to Plaintiff United States.

VII. PAYMENT REGARDING UNITED STATES' RESPONSE COSTS

6. a. Within ten (10) business days after receipt of notice of Final Approval of the Consent Decree, Settling Defendants shall cause the full amount paid into the Escrow under Paragraph 5 and all accrued interest thereon through the date of payment to be disbursed from the Escrow to the Rose Hill Regional Landfill Special Account within the EPA Hazardous Substance Superfund for Past Response Costs and Future Response Costs.

b. Payment of the amount required to be disbursed under Paragraph 6.a. shall be made by FedWire Electronic Funds Transfer ("EFT") to the U.S. Department of Justice account in accordance with current EFT procedures, referencing USAO File Number 2002V00176, EPA New England Region and Site Spill ID Number 10A5, and DOJ Case Number 90-11-3-06627. Payment shall be made in accordance with instructions provided to Settling Defendants by the Financial Litigation Unit of the U.S. Attorney's Office in the District of Rhode Island following lodging of the Consent Decree. Any payments received by the Department of Justice after 4:00 p.m. Eastern Time (Standard or Daylight Savings Time, as applicable) shall be credited on the next business day.

c. At the time of payment, Settling Defendants shall send notice that payment has been made to EPA and DOJ in accordance with Section XXVI (Notices and Submissions).

7. The total amount to be paid pursuant to Paragraph 6 shall be deposited in the Rose Hill Regional Landfill Special Account within the EPA Hazardous Substance Superfund to be retained and used to conduct or finance response actions at or in connection with the Site, or to be transferred by EPA to the EPA Hazardous Substance Superfund.

8. Payment of Portion of Additional U.S. Response Costs. Settling Defendants shall reimburse the EPA for 30% of any Additional U.S. RD/RA Response Costs incurred not inconsistent with the National Contingency Plan. If Additional U.S. RD/RA Response Costs are incurred, EPA will send Settling Defendants one or more bills requiring payment of Settling Defendants' percentage, accompanied by an EPA-prepared cost summary, which includes direct and indirect costs incurred by EPA and its contractors. Settling Defendants shall make all payments within 30 days of receipt of each bill requiring payment, except as otherwise provided in Paragraph 9 (Resolution of Disputes Concerning Payment of Portion of Additional U.S. Response Costs). Payment to EPA shall be made by Settling Defendants by certified check or checks or cashiers' check or checks payable to "EPA Hazardous Substance Superfund." The check, or a letter accompanying the check, shall reference the name and address of the party(ies) making payment, Rose Hill Regional Landfill Superfund Site, EPA New England Region and Site Spill ID Number 10A5, USAO File Number 2002V00176, and DOJ Case Number 90-11-3-06627, and shall be sent to:

Region 1
U.S. Environmental Protection Agency
Attn: Hazardous Substance Superfund Accounting
P.O. Box 360197M
Pittsburgh, PA 15251

At the time of each payment to EPA, Settling Defendants shall send notice that such payment has

been made to EPA and DOJ in accordance with Section XXVI (Notices and Submissions). Payment(s) to EPA pursuant to this Paragraph shall be deposited in the Rose Hill Regional Landfill Special Account within the EPA Hazardous Substance Superfund to be retained and used to conduct or finance response actions at or in connection with the Site, or to be transferred by EPA to the EPA Hazardous Substance Superfund.

9. Resolution of Disputes Concerning Payment of Portion of Additional U.S. Response Costs.

a. Use of Dispute Resolution. The dispute resolution procedures set forth in this Paragraph shall be the exclusive mechanism for resolving disputes regarding Settling Defendants' obligation to reimburse EPA for 30% of Additional U.S. RD/RA Response Costs. The dispute resolution procedures in this Paragraph are limited to disputes regarding recovery of Additional U.S. RD/RA Response Costs.

b. Standard. Settling Defendants may only contest payment of Additional U.S. RD/RA Response Costs if they determine that EPA has made an accounting error, or if they allege that a cost item that is included represents costs that are inconsistent with the National Contingency Plan.

c. Notice. Any objection to the payment of Additional U.S. RD/RA Response Costs shall be made in writing by Settling Defendants within 30 days of receipt of the bill requiring the payment and must be sent to EPA and DOJ pursuant to Section XXVI (Notices and Submissions). Any such objection (hereinafter referred to as the "Notice of Objection") shall specifically identify the contested Additional U.S. RD/RA Response Costs and the basis for objection.

d. Payment of Undisputed Amounts. In the event of an objection to some but not all Additional U.S. RD/RA Response Costs billed, Settling Defendants shall, within 30 days of receipt of the bill requiring payment, pay all uncontested amounts to EPA in accordance with the instructions in Paragraph 8.

e. Escrow for Disputed Amounts. Within 30 days of receipt of the bill requiring payment, Settling Defendants shall establish an interest-bearing escrow account in a federally chartered bank in Rhode Island, Massachusetts, or New York with assets of over $100 million, bearing interest at a commercially reasonable rate, and remit to that escrow account funds equivalent to the amount of the contested portion of the Additional U.S. RD/RA Response Costsbilled. Settling Defendants shall send to EPA and DOJ a copy of the correspondence that establishes and funds the escrow account, including, but not limited to, information containing the identity of the bank and bank account under which the escrow account is established as well as a bank statement showing the initial balance of the escrow account.

f. Informal Dispute Resolution.

i. Any dispute with respect to Additional U.S. RD/RA Response Costs shall in the first instance be the subject of informal negotiations between EPA and Settling Defendants. The period for informal negotiations shall not exceed 20 days from EPA's receipt of the Notice of Objection, unless such time limit is modified by written agreement of EPA and Settling Defendants. If the dispute is resolved by informal negotiations, the agreement shall be reduced to writing, which, upon signature by EPA and Settling Defendants, shall be incorporated into and become an enforceable part of this Consent Decree. Within 10 days of the execution of the agreement, Settling Defendants shall pay to EPA from the escrow account any amount owed

to EPA pursuant to the written agreement, plus all interest on such amount that has accrued between the date that payment was due under Paragraph 8 (Payment of Portion of U.S. Additional Response Costs) through the date of payment.

g. Formal Dispute Resolution.

i. Initiation. If the dispute as to Additional U.S. RD/RA Response Costs is not resolved by informal dispute resolution, the position advanced by EPA shall be considered binding unless Settling Defendants, within 10 days after the conclusion of the informal dispute resolution period, commence formal dispute resolution by serving on the United States a Notice of Formal Dispute Resolution along with a written Statement of Position on the matter in dispute, which shall include, but not be limited to, any factual data, analysis or opinion supporting that position and any supporting documentation relied upon by Settling Defendants.

ii. Within 30 days after receipt of Settling Defendants Statement of Position, EPA shall serve on Settling Defendants its Statement of Position, including but not limited to, any factual data, analysis, or opinion supporting that position and all supporting documentation relied upon by EPA. Within 10 days after receipt of EPA's Statement of Position, Settling Defendants may submit a Reply.

iii. Administrative Record. Formal dispute resolution for disputes pertaining to payment of Additional U.S. RD/RA Response Costs shall be on the administrative record. EPA shall maintain an administrative record of the dispute, which shall include the disputed bill and cost summary sent by EPA to Settling Defendants, the Notice of Objection served by Settling Defendants, the Notice of Formal Dispute Resolution, the Statements of Position, including supporting documentation, and Settling Defendants' Reply, if any, submitted

pursuant to this Paragraph.

iv. Final Decision. The Director of the Office of Site Remediation and Restoration, EPA New England Region, will issue a final administrative decision resolving the dispute based upon the administrative record. This decision shall be binding upon Settling Defendants, subject only to the right to seek judicial review pursuant to Subparagraph 9.h. below.

h. Judicial Review of Final Administrative Decision.

i. Any administrative decision made by EPA in regard to Additional U.S. RD/RA Response Costs, shall be reviewable by this Court, provided that a motion for judicial review of the decision is filed by Settling Defendants with the Court and then served on all Parties within 10 days of receipt of EPA's decision. The motion shall include a description of the matter in dispute, the efforts made by the parties to resolve it, and the relief requested. The United States may file a response to Settling Defendants' motion.

ii. In proceeding on any dispute governed by this Paragraph, Settling Defendants shall have the burden of demonstrating that the decision of the Director of the Office Site Restoration and Remediation, EPA New England Region was arbitrary and capricious or otherwise not in accordance with law. Judicial review of EPA's decision shall be on the administrative record compiled pursuant to Subparagraph 9.g.iii.

iii. If EPA prevails in the dispute, within 5 days of resolution of the dispute, Settling Defendants shall pay the amount due under the final decision plus all interest that has accrued between the date the payment was initially due under Paragraph 8 (Payment of Portion of Additional Response Costs) through the date of payment. Payment shall be made from the escrow account in accordance with the instructions in Paragraph 8. Any amounts

remaining in the escrow account after payment to EPA shall be disbursed to Settling Defendants.

iv. The invocation of formal dispute resolution procedures under this Section shall not extend, postpone or affect in any way any obligation of Settling Defendants not directly in dispute, unless EPA or the Court agrees otherwise.

VIII. DISBURSEMENT OF SPECIAL ACCOUNT FUNDS

10. Subject to the terms and conditions set forth in this Section, EPA agrees to make the funds in the Rose Hill Regional Landfill Special Account available for disbursement to the State for performance of Remedial Action activities under this Consent Decree. EPA shall disburse such funds to the State in accordance with the procedures and milestones for phased disbursement set forth in this Section.

a. Timing, Amount and Method of Disbursing Funds From the Rose Hill Regional Landfill Special Account. Disbursements to the State from the Rose Hill Regional Landfill Special Account shall be made in accordance with 40 C.F.R. Chapter 1, Subchapter B, through the federally established Automated Standard Application for Payments (ASAP) system, in accordance with the requirements and policies governing that program. In addition, the State agrees to the following conditions:

i. The State shall submit an Interim Financial Status Report annually within 30 days of the close of the State's fiscal year. A final Financial Status Report shall be submitted no later than 90 days after the completion of the Remedial Action.

ii. Cash draw downs shall be made only as actually needed for disbursements to perform the Remedial Action activities for Operable Unit One and shall be made by site and action code, as applicable. Over the course of a year, such cash draw downs

shall amount to approximately fifty percent of the costs of such activities.

iii. The State shall provide timely reporting of cash disbursements and balances as required by the EPA Automated Clearinghouse (ACH) User's Manual.

iv. The State will impose the same standards of time and reporting on contractors and subcontractors performing the Work as is required of the State under this paragraph.

v. In the event of any dispute between the EPA and the State as to the amount to be disbursed from the Rose Hill Regional Landfill Special Account for any reimbursement request by the State, the dispute shall be resolved in accordance with Section XV.

b. Balance of Special Account Funds. If any funds remain in the Rose Hill Regional Landfill Special Account after the Remedial Action activities are constructed and determined to be Operational and Functional, EPA may transfer such funds to the Hazardous Substance Superfund. Any such transfer shall not be subject to challenge pursuant to the dispute resolution provisions of this Consent Decree or in any other forum.

IX. FEDERAL NATURAL RESOURCE DAMAGES SETTLEMENT

11. a. Within ten (10) business days of notice of the Final Approval of the Consent Decree, Settling Defendants shall make a payment of $117,000 to NOAA for the purpose of funding the implementation and monitoring of fish passage restoration projects on the Saugatucket River, a payment of $5,000 to NOAA for reimbursement of past NOAA natural resource damage assessment costs, and a payment of $3,000 to DOI for reimbursement of past DOI natural resource damage assessment costs.

b. The payments of $117,000 and $5,000, for a total payment of $122,000, to NOAA

shall be made by certified check, payable to DOC/NOAA/NOS/OR&R, accompanied by a letter stating that the payment is for NOAA CPRD, Rose Hill case, and sent to: Kathy Salter, NOAA DARRF Manager, NOAA/NOS/OR&R, 1305 East West Highway, Building #4, Silver Spring, MD 20910. Settling Defendants shall send notice that such payment has been made to the persons listed in Section XXVI (Notices and Submissions) for NOAA, DOI, and DOJ, with a copy of the check.

c. The payment of $3,000 to DOI shall be made by FedWire Electronics Funds Transfer to the U.S. Department of Justice account in accordance with electronic funds transfer procedures, referencing U.S.A.O. file number 2002V00176, DOJ case number 90-11-2-06627, and NRDAR Account Number 14X5198, in accordance with instructions provided to Settling Defendants by the Financial Litigation Unit of the U.S. Attorney's Office in the District of Rhode Island following lodging of the Consent Decree. Any payments received by the Department of Justice after 4:00 p.m. Eastern Time (Standard or Daylight Savings Time, as applicable) shall be credited on the next business day. Settling Defendants shall send notice that such payment has been made to the persons listed in Section XXVI (Notices and Submissions) for DOI, NOAA, and DOJ. Notice to DOI that such payment has been made shall also be sent to: Bruce Nesslage, Restoration Fund Manager, DOI NRDAR Program, Mail Stop 4449, 1849 C St. NW, Washington, D.C. 20240 and shall reference Accounting Number 14X5198 (NRDAR) and state that the payment is for reimbursement of past natural resource damage assessment costs with respect to the Rose Hill Regional Landfill Site, situated in the Town of South Kingstown, R.I. and is being paid by the Town of South Kingstown, R.I., and the Town of Narragansett, R.I.

X. STATE NATURAL RESOURCE DAMAGES SETTLEMENT

12. As settlement of the State's claims for Natural Resource Damages caused by the release

or threatened release of hazardous substances at the Rose Hill Regional Landfill Superfund Site and pursuant to the State's authority under R.I.G.L. Chapter 23-19.1 and 23-19.14-6, the Settling Defendants shall repair or reconstruct two dams in South Kingstown, Rhode Island as set forth below:

a. On or before December 31, 2003, the Settling Defendants shall complete the repair or replacement of the Indian Run Reservoir Dam in South Kingstown, Rhode Island.

b. The repair or replacement of the Indian Run Reservoir Dam shall be completed in accordance with the design plans that were reviewed by the RIDEM Office of Water Resources, Insignificant Alteration Permit No. 01-0197, in September 2001.

c. On or before December 31, 2006, the Settling Defendants shall complete the repair or replacement of the Asa Pond Dam in South Kingstown, Rhode Island.

d. The repair or replacement of the Asa Pond Dam shall be completed in accordance with the design plans that were reviewed by the RIDEM Office of Water Resources, Insignificant Alteration Permit No. 01-0198, in September 2001.

The estimated cost of the Indian Run Reservoir Dam project is $298,000 for construction, permitting and engineering. The estimated cost of the Asa Pond Dam project is $417,000 for construction, permitting and engineering.

XI. PERFORMANCE OF THE OPERABLE UNIT 1 SOURCE CONTROL REMEDY

13. The State agrees that it will assume the lead responsibility for performance of the Remedial Design and the Remedial Action for Operable Unit 1 and will assure performance of the Operation and Maintenance actions for Operable Unit 1. The State also agrees to oversee the Work to

be Performed by Settling Defendants pursuant to Section XVI of this Consent Decree.

Remedial Design.

14. The State has assumed the lead responsibility for development of the Remedial Design, in accordance with a Cooperative Agreement dated September 25, 2001 by and between the State and EPA (the "Cooperative Agreement"), a copy of which is attached hereto as Appendix E and incorporated herein by reference. In accordance therewith, the State has selected a Supervising Contractor. The State shall perform the Remedial Design in accordance with the ROD, the Cooperative Agreement, including the Remedial Design Scope of Work (the "RD SOW") attached to and incorporated in the Cooperative Agreement, and the Remedial Design Work Plan developed in accordance therewith. Within seven (7) days after the date of lodging of this Consent Decree, the State shall advertise, or have advertised, for a formal response to a Request for Proposal ("RFP") for selecting a Design Contractor to implement the Remedial Design. Within 120 days after the date of lodging of this Consent Decree, after reasonable opportunity for EPA review and comment, the State shall select or have selected a Design Contractor to conduct the Remedial Design.

15. Within 45 days after the State's selection of a Design Contractor, the State, through its Design Contractor, shall submit to EPA and RIDEM a work plan for the design of the Remedial Action at the Site ("Remedial Design Work Plan" or "RD Work Plan"). The Remedial Design Work Plan shall provide for design of the remedy set forth in the ROD, in accordance with the Remedial Design SOW attached in Appendix E and for achievement of the Performance Standards and all other requirements set forth in the ROD, this Consent Decree and the Remedial Design SOW. Upon its approval or modification by RIDEM, after reasonable opportunity for review and comment by EPA, the Remedial Design Work Plan shall be incorporated into and become enforceable under this

Consent Decree. Within 45 days after the State's selection of a Remedial Design Contractor, the State, through its Remedial Design Contractor, shall submit to EPA and RIDEM a Health and Safety Plan for field design activities which conforms to the applicable Occupational Safety and Health Administration and EPA requirements including, but not limited to, 29 C.F.R. § 1910.120.

16. The Remedial Design Work Plan shall include plans and schedules for implementation of all remedial design and pre-design tasks identified in the Remedial Design SOW, including, but not limited to, plans and schedules for completion of the following items: (1) design sampling and analysis plan (including, but not limited to, a Remedial Design Quality Assurance Project Plan (RD QAPP) in accordance with Section XII (Quality Assurance, Sampling and Data Analysis)); (2) a Construction Quality Assurance Plan; (3) a Pre-design Work Plan; (4) a preliminary design submittal; (5) an intermediate (30%) design submittal; (6) a pre-final (90%) submittal, and (7) a final (100%) design submittal; and may also include a treatability study. These plans and design submittals shall be subject to approval or modification by RIDEM, after review and comment by EPA. The 100% Remedial Design shall also be subject to concurrence by EPA.

17. In accordance with the Cooperative Agreement, upon approval or modification of the Remedial Design Work Plan by RIDEM, after a reasonable opportunity for review and comment by EPA, and after submittal by the Remedial Design Contractor of the Health and Safety Plan for all field activities to EPA and RIDEM, the State shall implement the Remedial Design Work Plan. The State, through its Remedial Design Contractor, shall submit to EPA and the RIDEM Project Coordinator all plans, submittals and other deliverables required under the approved Remedial Design Work Plan in accordance with the approved schedule.

Remedial Action.

18. The State shall perform the Remedial Action in accordance with the ROD, the approved 100% Remedial Design, and the Remedial Action Statement of Work (the "RA SOW") attached to this Consent Decree as Appendix F and incorporated herein by reference, and in accordance with the Remedial Action Work Plan developed in accordance therewith. Within 30 days after completion of the 90% Remedial Design, the State shall select a Supervising Contractor for the Remedial Action, after a reasonable opportunity for EPA review and comment and concurrence. Within 15 days after approval of the 100% Remedial Design, the State shall advertise, or have advertised, for a formal response to a Request for Proposal ("RFP") for selecting a Construction Contractor to implement the Remedial Action. Within 100 days after approval of the 100% Remedial Design, the State shall select a Construction Contractor to implement the Remedial Action, after reasonable opportunity for EPA review and comment and concurrence. Within 135 days after approval of the 100% Remedial Design, the State shall commence performance of the Remedial Action.

19. Within 135 days after the State's approval or modification of the final design submittal, the State, through its Construction Contractor, shall submit to EPA and RIDEM a work plan for the performance of the Remedial Action at the Site ("Remedial Action Work Plan"). The Remedial Action Work Plan shall provide for construction and implementation of the remedy set forth in the ROD and achievement of the Performance Standards, in accordance with this Consent Decree, the ROD, the Remedial Action SOW, and the design plans and specifications developed in accordance with the Remedial Design Work Plan and approved by the State. Upon its approval or modification by the State, after reasonable opportunity for EPA review and comment, the Remedial Action Work Plan shall be incorporated into and become enforceable under this Consent Decree. At the same time

as the Remedial Action Work Plan is submitted, the State, through its Construction Contractor, shall submit to EPA and RIDEM a Health and Safety Plan for field activities required by the Remedial Action Work Plan which conforms to the applicable Occupational Safety and Health Administration and EPA requirements including, but not limited to, 29 C.F.R. § 1910.120.

20. The Remedial Action Work Plan shall include the following: (1) schedule for completion of the Remedial Action; (2) schedule for developing and submitting other required Remedial Action plans; (3) groundwater monitoring plan; (4) methods for satisfying permitting requirements; (5) methodology for implementation of the Operation and Maintenance Plan; (6) methodology for implementation of the Contingency Plan; (7) tentative formulation of the Remedial Action team; (8) construction quality control plan (by constructor); and (9) procedures and plans for the decontamination of equipment and the disposal of contaminated materials. The Remedial Action Work Plan also shall include the methodology for implementation of the Construction Quality Assurance Plan and a schedule for implementation of all Remedial Action tasks identified in the final design submittal and shall identify the initial formulation of the States's Remedial Action Project Team.

21. Upon approval of the Remedial Action Work Plan by the RIDEM, after a reasonable opportunity for EPA review and comment, the State shall implement the activities required under the Remedial Action Work Plan in accordance with the approved schedule. The State, through its Construction Contractor, shall submit to EPA and RIDEM all plans, submittals, or other deliverables required under the approved Remedial Action Work Plan in accordance with the approved schedule.

22. Following completion of construction of Remedial Action components, the State shall implement the OU1 Operation and Maintenance activities, through its personnel and/or contractors

and/or by arrangement with Settling Defendants, in accordance with the ROD and the Operation and Maintenance Plan developed in accordance with the RA SOW.

23. The State shall continue to implement the Operable Unit 1 Source Control Remedy until the Performance Standards are achieved and for so long thereafter as is otherwise required under this Consent Decree.

General State Responsibilities

24. The State shall be responsible for 50% of the total cost of the OU1 Source Control Remedy, as set forth in the Record of Decision, until such time that the Remedy is determined to be "Operational and Functional" by the EPA and the State. The State shall receive reimbursement of 30% of such costs, in monetary payments and/or as in-kind services from Settling Defendants in accordance with Section XVII of this Consent Decree.

25. The State shall be responsible for 100% of the cost of the Operation and Maintenance of the implemented Remedial Action for the Expected Life of the Remedial Action and assure the implementation of the Operation and Maintenance activities. The State shall receive reimbursement of 30% of O&M costs, in monetary payments and/or as in-kind services, from Settling Defendants in accordance with Section XVII of this Consent Decree.

26. During the implementation of the Operable Unit 1 Source Control Remedy, the State and, as to any work they perform pursuant to Section XVI of this Consent Decree, Settling Defendants shall satisfy applicable Federal, State, and local requirements necessary for implementing activities addressed in this Consent Decree, in conformance with 40 C.F.R. § 35.6105, including the requirements specified in Section XII (Quality Assurance, Sampling, and Data Analysis) and within this Paragraph. The State and, as to any work they perform pursuant to Section XVI of this Consent

Decree, Settling Defendants shall also comply with all applicable and relevant and appropriate requirements of all Federal and State environmental laws, as set forth in the ROD and the RD SOW and RA SOW. The State shall post a sign at the Site that will include appropriate contacts for obtaining information on activities being conducted at the Site and for reporting suspected criminal activities. The State shall ensure that the Site is properly posted and secured throughout the duration of the Operable Unit 1 work. The State shall assure that, before field work is started, its contractors develop site-specific health and safety plan(s) in accordance with OSHA 29 C.F.R. 1910.120, which shall be submitted to EPA for review and concurrence. The State, in coordination with Settling Defendants, shall develop a re-use plan and assessment as further described in Appendix H to this Consent Decree.

27. It shall be the sole responsibility of the State to secure any necessary Federal, State and local permits pertaining to off-Site treatment, storage, or disposition of hazardous substances from the Site or any other permits that are necessary to complete satisfactorily the Response Action described in the ROD and the RD SOW and RA SOW, except it shall also be the responsibility of Settling Defendants to assure that the State is provided with any such permits that are within their control. If the State acquires property rights or participation therein related to this Site or Consent Decree, the State assures that the requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, 42 U.S.C. section 4601-4655, and the EPA regulation promulgated thereunder, 49 C.F.R. Part 24, if applicable, shall be observed. No property acquisitions shall be made by the State in relation to the Site response actions without prior EPA concurrence.

28. If the Remedial Design, the Remedial Action, or Operation and Maintenance results in any off-site storage, destruction, treatment, or disposal of hazardous waste, in accordance with

CERCLA §§ 104(c)(3)(B) and 121(d)(3) and 40 C.F.R. § 300.510(d), the State hereby provides its assurance on the availability of a hazardous waste disposal facility that is in compliance with CERCLA § 121(d)(3) and is acceptable to EPA.

29. By entering into this Consent Decree, the State hereby assures EPA of the availability of hazardous waste treatment or disposal facilities within and/or outside the State that comply with Subtitle C of the Solid Waste Disposal Act and that have adequate capacity for the destruction, treatment, or secure disposition of all hazardous wastes generated within the State during the 20-year period following the date of this Consent Decree, pursuant to CERCLA §§104(c)(3) and (c)(9), 42 U.S.C. §§ 9604(c)(3) and (c)(9), and 40 C.F.R. § 300.510(e).

30. a. Prior to any off-Site shipment of Waste Material from the Site to an out-of-state waste management facility, the State, through its personnel, through its contractors, and/or through Settling Defendants for applicable work performed pursuant to Section XVI of this Consent Decree, shall provide written notification to the appropriate state environmental official in the receiving facility's state and to the EPA Project Manager of such shipment of Waste Material. However, this notification requirement shall not apply to any off-Site shipments when the total volume of all such shipments will not exceed 10 cubic yards.

(1) The State shall include in the written notification the following information, where available: (1) the name and location of the facility to which the Waste Material is to be shipped; (2) the type and quantity of the Waste Material to be shipped; (3) the expected schedule for the shipment of the Waste Material; and (4) the method of transportation. The State shall notify the state in which the planned receiving facility is located of major changes in the shipment plan, such as a decision to ship the Waste Material to another facility within the same state, or to a facility in

another state.

(2) The identity of the receiving facility and state will be determined by the State following the award of the contract for Remedial Action construction. The State shall provide the information required by this Paragraph 30.a as soon as practicable after the award of the contract and before the Waste Material is actually shipped.

b. Before shipping any hazardous substances, pollutants, or contaminants from the Site to an off-site location, the State shall obtain EPA's certification that the proposed receiving facility is operating in compliance with the requirements of CERCLA Section 121(d)(3) and 40 C.F.R. 300.440. The State shall only send hazardous substances, pollutants, or contaminants from the Site to an off-site facility that complies with the requirements of the statutory provision and regulations cited in the preceding sentence.

31. The EPA and the State anticipate that hazardous substances may have to be stored on-site prior to ultimate treatment or disposal of these hazardous substances. The costs of such storage during the period of Operation and Maintenance (e.g., security, monitoring and analysis, etc.) shall be paid by the State.

32. In accordance with Section XXIII of this Consent Decree, Settling Defendants shall provide to the State and EPA and their representatives and contractors access, including all right(s)-of-way and easement(s), to property owned or controlled by any of the Settling Defendants and to the property known as the "Frisella property," necessary to complete the response actions. Settling Defendants shall use best efforts to acquire title to the "Frisella property," which is described in Appendix I, attached hereto and incorporated herein by reference. To the extent such access is not provided to the State and EPA by Settling Defendants, the State shall assist Settling Defendants to

obtain such access. Any easement or other property acquisition shall comply with provisions of 49 CFR Part 24. Access to the Site by EPA and State employees, or their assigns, shall be granted at all reasonable times.

33. In performing the Site remedy, the State agrees to allow Settling Defendants to review and comment on any of the State's remedial design and remedial action submittals. The State shall in good faith consider and, when the State and EPA determines reasonable and consistent with the requirements of the ROD, Consent Decree, the RD SOW, the RA SOW, and work plans developed thereunder, the State may incorporate Settling Defendants' comments and suggestions into the various decisions the State makes in the RD/RA process. To the extent permitted under State purchasing guidelines, the State will specifically consider input from Settling Defendants in the selection of all outside contractors.

XII. QUALITY ASSURANCE, SAMPLING, AND DATA ANALYSIS

34. a. The State shall comply with quality assurance requirements described in 40 CFR 31.45. Any other quality assurance plans required shall be submitted to EPA before the applicable field work. The State has developed and shall implement an ongoing quality system (quality assurance program). The State has documented this quality system in a Quality Management Plan (QMP) in accordance with "EPA Requirements for Quality Management Plans" (QA/R-2, 11-99), which has been approved by EPA.

b. The State, through its personnel, through its contractors, and/or through Settling Defendants for applicable work performed pursuant to Section XVI of this Consent Decree, shall use quality assurance, quality control, and chain of custody procedures for all treatability, design, compliance and monitoring samples in accordance with "EPA Requirements for Quality Assurance

Project Plans (QA/R5)" (EPA/240/B-01/003, March 2001), "Guidance for Quality Assurance Project Plans (QA/G-5)" (EPA/600/R-98/018, February 1998), and subsequent amendments to such guidelines upon notification by EPA to the State of such amendment. Amended guidelines shall apply only to procedures conducted after such notification.

c. Forty-five days prior to the commencement of any monitoring project under this Consent Decree, the State, through its personnel, through its contractors, and/or through Settling Defendants for applicable work performed pursuant to Section XVI of this Consent Decree, shall submit to EPA, at the address stated in Section XXVI (Notices and Submissions), with a copy to the Regional Quality Assurance Manager, U.S. Environmental Protection Agency, 11 Technology Drive, North Chelmsford, MA 01863-2431, for review and comment, a Quality Assurance Project Plan ("QAPP") that is consistent with the Remedial Design and Remedial Action SOWs, the NCP, and applicable guidance documents.

d. If relevant to the proceeding, the Parties agree that validated sampling data generated in accordance with the QAPP(s) and reviewed and approved by EPA shall be admissible as evidence, without objection, in any proceeding under this Decree.

e. The State shall ensure that EPA personnel and their authorized representatives are allowed access at reasonable times to all laboratories utilized by the State, through its personnel, through its contractors, and/or through Settling Defendants for applicable work performed pursuant to Section XVI of this Consent Decree, in implementing this Consent Decree. In addition, the State, through its personnel, through its contractors, and/or through Settling Defendants for applicable work performed pursuant to Section XVI of this Consent Decree, shall ensure that such laboratories shall analyze all samples submitted by EPA pursuant to the QAPP for quality assurance monitoring.

35. a. The State, through its personnel, through its contractors, and/or through Settling Defendants for applicable work performed pursuant to Section XVI of this Consent Decree, shall insure that the laboratories they utilize for the analysis of samples taken pursuant to this Decree perform all analyses according to accepted EPA methods and the Region I, EPA-New England Compendium of Quality Assurance Project Plan Requirements and Guidance, October 1999, and the national QAPP requirements specified in "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations", EPA QA/R-5, October 1998, or most recent revision, and the "EPA Quality Manual for Environmental Programs", 5360, July 1998. Accepted EPA methods consist of those methods which are documented in the "Contract Lab Program Statement of Work for Inorganic Analysis" and the "Contract Lab Program Statement of Work for Organic Analysis," dated February 1988, and any amendments made thereto during the course of the implementation of this Decree; however, upon approval by EPA, the State may use other analytical methods which are as stringent as or more stringent than the CLP-approved methods. The State, through its personnel, through its contractors, and/or through Settling Defendants for applicable work performed pursuant to Section XVI of this Consent Decree, shall ensure that all laboratories it uses for analysis of samples taken pursuant to this Consent Decree participate in an EPA or EPA-equivalent QA/QC program. The State, through its personnel, through its contractors, and/or through Settling Defendants for applicable work performed pursuant to Section XVI of this Consent Decree, shall only use laboratories that have a documented Quality System which complies with ANSI/ASQC E4-1994, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs," (American National Standard, January 5, 1995), and "EPA Requirements for Quality Management Plans (QA/R-2)," (EPA/240/B-01/002, March 2001) or equivalent documentation as

determined by EPA. EPA may consider laboratories accredited under the National Environmental Laboratory Accreditation Program (NELAP) as meeting the Quality System requirements.

b. The State, through its personnel, through its contractors, and/or through Settling Defendants for applicable work performed pursuant to Section XVI of this Consent Decree, shall ensure that all field methodologies utilized in collecting samples for subsequent analysis pursuant to this Decree will be conducted in accordance with the procedures set forth in the QAPP approved by EPA.

36. Upon request, the State, through its personnel, through its contractors, and/or through Settling Defendants for applicable work performed pursuant to Section XVI of this Consent Decree, shall allow split or duplicate samples to be taken by EPA or its authorized representatives. The State, through its personnel, through its contractors, and/or through Settling Defendants for applicable work performed pursuant to Section XVI of this Consent Decree, shall notify EPA not less than 28 days in advance of any sample collection activity unless shorter notice is agreed to by EPA. In addition, EPA shall have the right to take any additional samples that EPA deems appropriate. Upon request, EPA shall allow the State to take split or duplicate samples of any samples it takes as part of its evaluation of the State's implementation of the Work.

37. The State shall assure that all groundwater sampling performed for Operable Unit 1 work shall be conducted using low-flow methods. Any split samples shall be obtained as described in Section 104(e)(4)(B) of CERCLA, as amended.

38. The State, through its personnel, its contractors, and/or through Settling Defendants, shall submit to EPA a copy of the results of all sampling and/or tests or other data obtained or generated by or on behalf of State with respect to the Site and/or the implementation of this Consent Decree unless

EPA agrees otherwise.

39. Notwithstanding any provision of this Consent Decree, the United States and the State hereby retain all of their information gathering and inspection authorities and rights, including enforcement actions related thereto, under CERCLA, RCRA and any other applicable statutes or regulations.

XIII. REPORTING REQUIREMENTS

40. In addition to any other requirement of this Consent Decree, the State shall submit to EPA two copies of written quarterly progress reports that: (a) describe the actions which have been taken toward achieving compliance with this Consent Decree during the previous quarter; (b) include a summary of all results of sampling and tests and all other data received or generated by the State or its contractors or agents in the previous quarter; (c) identify all work plans, plans and other deliverables required by this Consent Decree completed and submitted during the previous quarter; (d) describe all actions, including, but not limited to, data collection and implementation of work plans, which are scheduled for the next six months and provide other information relating to the progress of construction; (e) include information regarding percentage of completion, unresolved delays encountered or anticipated that may affect the future schedule for implementation of the work, and a description of efforts made to mitigate those delays or anticipated delays; (f) include any modifications to the work plans or other schedules that the State has approved or is considering; and (g) describe all activities undertaken in support of the Community Relations Plan during the previous quarter and those to be undertaken in the next six months. The State shall submit these progress reports to EPA by the twentieth day of the month following each quarter after the lodging of this Consent Decree until the Operable Unit 1 Source Control Remedy is completed. If requested by EPA,

the State shall also provide briefings for EPA to discuss the progress of the Work.

41. The State, through its contractors, shall also provide copies of its contractors' monthly progress reports to EPA on a monthly basis.

42. The State shall notify EPA of any change in the schedule described in the quarterly progress report for the performance of any activity, including, but not limited to, data collection and implementation of work plans, no later than seven days prior to the performance of the activity.

43. Upon the occurrence of any event during performance of the Work that the State is required to report pursuant to Section 103 of CERCLA or Section 304 of the Emergency Planning and Community Right-to-know Act (EPCRA), the State shall within 24 hours of the onset of such event orally notify the EPA Project Manager or the Alternate EPA Project Manager (in the event of the unavailability of the EPA Project Manager), or, in the event that neither the EPA Project Manager or Alternate EPA Project Manager is available, the Emergency Response Section, Region I, United States Environmental Protection Agency. These reporting requirements are in addition to the reporting required by CERCLA Section 103 or EPCRA Section 304.

44. Within 20 days of the onset of such an event, the State shall furnish to EPA a written report, signed by the State's Project Coordinator, setting forth the events which occurred and the measures taken, and to be taken, in response thereto. Within 30 days of the conclusion of such an event, the State shall submit a report setting forth all actions taken in response thereto.

45. The State, through its personnel, through its contractors, and/or through Settling Defendants for work performed pursuant to Section XVI of this Consent Decree, shall submit two copies of all plans, reports, and data required by the SOW, the Remedial Design Work Plan, the Remedial Action Work Plan, or any other approved plans or deliverables to EPA in accordance with

the schedules set forth in such plans. Upon request by EPA, the State, through its personnel, through its contractors, and/or through Settling Defendants for any work performed pursuant to Paragraph XVI of this Consent Decree, shall submit in electronic form all portions of any report or other deliverable the State is required to submit pursuant to the provisions of this Consent Decree.

XIV. EMERGENCY RESPONSE

46. In the event of any action or occurrence during the performance of the Work which causes or threatens a release of Waste Material from the Site that constitutes an emergency situation or may present an immediate threat to public health or welfare or the environment, the State shall, subject to the following Paragraph, immediately take all appropriate action to prevent, abate, or minimize such release or threat of release, and shall immediately notify the EPA's Project Manager, or, if the Project Manager is unavailable, EPA's Alternate Project Manager. If neither of these persons is available, Settling Defendants shall notify the Emergency Response Section, Region I, United States Environmental Protection Agency. The State shall take such actions in consultation with EPA's Project Manager or other available authorized EPA officer and in accordance with all applicable provisions of the Health and Safety Plans, the Contingency Plans, and any other applicable plans or documents developed pursuant to the RD and RA SOWs.

47. Nothing in the preceding Paragraph or in this Consent Decree shall be deemed to limit any authority of the United States or the State a) to take all appropriate action to protect human health and the environment or to prevent, abate, respond to, or minimize an actual or threatened release of Waste Material on, at, or from the Site, or b) to direct or order such action, or seek an order from the Court, to protect human health and the environment or to prevent, abate, respond to, or minimize an actual or threatened release of Waste Material on, at, or from the Site, subject to Section XIX

(Covenants Not to Sue by Plaintiffs).

XV. DISPUTE RESOLUTION BETWEEN UNITED STATES AND STATE

48. In the event of a disagreement between United States and the State regarding performance of the response actions required under this Consent Decree and or any other issue under this Consent Decree, unless otherwise provided, the following dispute resolution procedures shall be followed:

a. Either the United States, through the EPA, or the State, through RIDEM, may initiate this dispute resolution process by providing written notice to the other party's Project Managers/Coordinator, identifying the matter(s) in dispute and requesting that this process be initiated. In the event of such notice, the parties will attempt to resolve the disagreement(s) through informal discussions at the staff level (i.e., between the EPA Project Managers and the RIDEM Project Coordinator), within five (5) working days after receipt of such notice.

b. If the discussion referred to in the preceding paragraph is unsuccessful, the EPA Project Managers and the RIDEM Project Coordinator will immediately obtain the assistance of their respective immediate supervisors, and with such assistance shall attempt to resolve the disagreement(s) within 10 working days of receipt of notice of the dispute.

c. If the immediate supervisors are unable to resolve the dispute within the 10 working day period, the disagreement(s) will be referred to RIDEM's Chief of the Office of Waste Management and EPA Region I's Director of the Office of Site Remediation and Restoration (jointly, the Directors). Upon such referral, which shall be made within 10 working days of the end of the dispute resolution period in subparagraph b, the United States and the State shall each submit to the other a written summary of the matter in dispute and a statement of their position on that matter (Statement of Position), including any data, analysis, or opinion supporting that position and all

supporting documentation relied upon.

d. Within 10 working days of referral by the immediate supervisors, the Directors shall confer and attempt to resolve the dispute. If after the 10 working day period there is no resolution, the EPA shall compile an administrative record consisting of all documents submitted by either party pursuant to the preceding subparagraph c. Based upon that record, EPA's Office of Site Remediation and Restoration Director (EPA's Director) will issue a written decision and will send the decision to RIDEM's Chief of the Office of Waste Management within 30 working days.

e. The State may file a petition with the Court seeking expedited review of the dispute within 20 days after receipt of the decision of the EPA's Director. If the State does not file a petition, the decision of the EPA's Director shall be final, and the State shall proceed accordingly. The United States may file a petition with the Court seeking enforcement of the requirements of this Consent Decree.

f. The United States and the State agree that the Court's review of the dispute shall be resolved in accordance with applicable law. Where such dispute challenges an EPA action or determination that, under applicable principles of administrative law, is to be upheld unless it is "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law," that standard shall be applied in the dispute resolution proceeding before the Court. Nothing in this Consent Decree shall be construed to allow any dispute or judicial review regarding the ROD's provisions.

g. Time periods for the resolution of disputes between the United States and the State concerning this Consent Decree may be extended or shortened by mutual agreement of the United States and the State. The United States and the State agree to use their best efforts to resolve all disputes at the earliest possible time and lowest management level, taking into consideration the

primary objective of protecting the public health, welfare, safety and the environment.

XVI. WORK TO BE PERFORMED BY SETTLING DEFENDANTS

49. Settling Defendants shall perform, in accordance with the requirements of the ROD and the RA SOW, at least the following Work in connection with the implementation of the OU1 Source Control Remedy at the Site:

- Obtain the institutional controls as required under Section XXIII of this Consent Decree, including the controls needed to implement and maintain the Operable Unit 1 Source Control Remedy at the Site, ensure non-interference with the remedial measures to be performed at the Site, and ensure placement of easements or restrictions to prevent land uses that would adversely affect the protectiveness of the remedial measures to be performed at the Site.
- Conduct community relation activities in cooperation with RIDEM and EPA as required under Section XXVII to keep the public informed about key developments at the Site.
- Following completion of construction of the cap at the Site, conduct routine inspection and monitoring of the cap and the fence periodically and provide for mowing of the grassed areas covering the cap, as needed, but, at a minimum, twice a year.
- Perform regular maintenance to the surface of the landfill cap as needed to address soil erosion resulting from rain, snow, wind, and other natural forces.
- Regrade areas of the storm drainage system where water is ponding to promote positive drainage.

- Maintain the storm drainage system and repair as soon as possible any damage to the storm water control structures due to subsidence, settlement, or erosion.
- Fill and compact any potholes or ruts that develop in the site access roads or access ramp within the designated specifications.
- Reseed and/or replant areas where vegetation has not been properly established, damaged turf areas and bare spots in the cap and areas of the Site which have been or will be impacted by Remedial Investigation, Remedial Design, and/or Remedial Action activities.
- Remove tree limbs or other debris that fall on the landfill surface and address any subsidence or settlement features that appear on the landfill surface or which may affect adequate drainage.
- Inspect gas vents and repair broken or damaged gas vents as soon as possible.
- Inspect groundwater monitoring wells and notify RIDEM and EPA of any damage to groundwater monitoring wells.
- Inspect perimeter fence and attached signs and replace or repair as needed.
- Inspect cover and perimeter plantings, drainage conduit and swales, subsidence/settlement features, and severe storm event damage, and replace or repair damaged elements as needed.

50. Following completion of construction of the cap at the Site, the Settling Defendants shall conduct routine inspection and monitoring of the items specified in the previous Paragraph (and the following two Paragraphs to the extent applicable) at least four times each year after the cap is deemed Operational and Functional, as well as inspections after severe storms. The frequency of the

routine inspections may be reduced to semi-annually after the first year if requested in writing by the Settling Defendants and approved by the State. Approximately three months in advance thereof, the State, with coordination from the Settling Defendants, will notify EPA of the date that 75% of the actual construction of the cap is expected to be completed, and the Settling Defendants shall submit an Operation and Maintenance Plan for the activities specified in the previous Paragraph (and the following two Paragraphs to the extent applicable), by that projected date to the State and to EPA, for review and approval or modification by the State, after reasonable opportunity for EPA to review and concur. The Settling Defendants shall inform EPA and the State of the results of the inspection, monitoring, maintenance, and repair work by sending a notice to the addressees in Section XXVI.

51. a. After the response actions that have been constructed have been determined to be Operational and Functional by the State, with EPA concurrence, if the Settling Defendants seek to perform groundwater monitoring requirements and/or landfill gas monitoring requirements and the State approves, with EPA concurrence, the Settling Defendants shall perform specified groundwater monitoring requirements and/or landfill gas monitoring requirements in accordance with the current Project Operations Plan and submit monitoring reports to EPA and the State. The State shall remain responsible to the United States for assurance that all groundwater monitoring requirements and landfill gas monitoring requirements are fully performed.

b. After the response actions that have been constructed have been determined to be Operational and Functional by the State, with EPA concurrence, if the Settling Defendants seek to replace or repair any groundwater monitoring wells that are noted during inspections to be damaged or otherwise not in working order and the State approves, with EPA concurrence, the Settling Defendants shall replace and repair the specified groundwater monitoring wells.

c. The Settling Defendants may also propose to perform other items that form part of the Remedial Action or Operation and Maintenance work and, if the State approves, with EPA concurrence, such proposals, the Settling Defendants shall perform those items of the Remedial Action or Operation and Maintenance work in accordance with all applicable plans and requirements.

52. a. As part of any proposals to perform Work under Paragraph 51.a., b., or c. above, the Settling Defendants shall fully state how the Work would be performed and the amount of the credit under Section XVII of the Consent Decree that the Settling Defendants would request for each item of Work proposed.

b. The State shall remain responsible to the United States to ensure that all items of the Work are fully performed, including the Work the Settling Defendants are required to perform pursuant to Paragraphs 49-51 of this Consent Decree.

53. a. Settling Defendants and the State shall, in consultation with EPA, prepare a Reuse Plan and Reuse Assessment for the Site. In the preparation of the Reuse Plan and Reuse Assessment, Settling Defendants and the State will consider the Guidelines for Reuse Plan and Reuse Assessment set forth in Appendix H, attached hereto. Settling Defendants and the State agree that they will use their best efforts to find a beneficial reuse for the Site. Any beneficial reuse selected for the Site will be subject to mutual agreement by the Settling Defendants and the State. If the Settling Defendants and the State implement a beneficial reuse that results in an income stream, they will agree on an allocation of any net income that recognizes (1) the Settling Defendants' ownership of the Site and (2) the respective amounts contributed by the Settling Defendants and the State to clean up the Site. Settling Defendants and the State will also consider non-income generating reuses for the Site, such as parks and playing fields.

b. Settling Defendants shall continue annual reporting concerning the landfill gas monitoring and alarm operation and maintenance at residential properties adjacent to the Site, in accordance with RCRA order # I-93-1055, until such time as the State, with concurrence from EPA, determines that the potential for off-site migration of landfill gases no longer poses a threat to human health or the environment or, if an alternate monitoring system is selected and approved by RIDEM and EPA that does not include monitoring at these properties, until such time as the alternate monitoring system becomes operative.

54. In the event of a dispute concerning performance of the Work required under this Section XVI, the procedures specified in Section XV (Dispute Resolution between the United States and the State) above shall be followed, except that, for disputes concerning the performance of the Work required under Section XVI only, the references to"the State" in Section XV shall be read as "the Settling Defendants and/or the State" and the references to the "Chief, Office of Waste Management" (for the State) shall be read as the "Chief, Office of Waste Management (for the State) and/or the Town Manager(s) (for the Settling Defendants)."

XVII. SETTLING DEFENDANTS' REIMBURSEMENT TO STATE

55. The Settling Defendants shall reimburse the State for 30 percent of the Reimbursable Costs the State incurs during the implementation of the Operable Unit 1 Source Control Remedy. That reimbursement by the Settling Defendants shall occur as follows:

a. **Annual Determination of State Reimbursable Costs**. On or after August 1 of each year during the implementation of the Operable Unit 1 Source Control Remedy, the State will deliver to the Settling Defendants an itemized written statement of Reimbursable Costs incurred by the State during the previous fiscal year (July 1 to June 30), along with the supporting bills, invoices

and similar statements that support each item of cost. The State will certify in writing and under oath the accuracy of this written statement. The Settling Defendants may within 30 days request additional information that relates to any of the costs identified by the State. The Settling Defendants may contest any of these costs by filing on or before September 15 a written statement explaining why the Settling Defendants contest a particular cost item or why the Settling Defendants need further information, which the State has either failed or refused to provide. If the Settling Defendants and the State cannot resolve any such contest by October 15, the matter will be determined by binding arbitration conducted by the Arbitrator. The State's Reimbursable Costs become final (1) if not challenged by the Settling Defendants, on or before September 15 or (2) if challenged, as agreed to by the Settling Defendants and the State or as determined by the Arbitrator to be fair or required as a result of applicable State purchasing processes and requirements. The State shall provide EPA with copies of the itemized statements of Reimbursable Costs, with attached documentation, required by this Section XVII at the same time they are provided to Settling Defendants, as well as a copy of the results of the resolution of any disputes between Settling Defendants and the State pursuant to this paragraph.

b. **Payment of Reimbursable Costs**. The Settling Defendants shall pay 30% of Reimbursable Costs by first making annual payments beginning in January following the third full year after the date of the Pre-final Inspection, as described in Section II.G. of the RA SOW, but in no event later than June 30, 2012. The methodology for the cost sharing arrangement between the State and the Settling Defendants is set forth on Exhibit 1 for illustrative purposes using present cost estimates for the Operable Unit 1 Source Control Remedy. The Settling Defendants and the State agree that as these costs change they will adjust the Town payments so that the relative proportion and timing of the costs borne by the Settling Defendants and the State remain approximately the same as

in the Exhibit 1 illustration. The Settling Defendants and the State agree that at some time in the future, the estimated value of the remaining O&M work at the Site may be equal to the total estimated value of the Settling Defendants' expected remaining payments to the State. On Exhibit 1 this is projected to occur in year 2022. When that occurs, if approved by the State, with concurrence by EPA, the Settling Defendants will accept responsibility for completing the O&M work and shall perform that work in full satisfaction of their obligations to make any further payments to the State for Operable Unit 1 pursuant to this Consent Decree. The State shall remain responsible to the United States for assurance that all of the remaining O&M work is fully performed in accordance with the ROD, RA SOW and plans developed thereunder, and the Consent Decree. If unexpected costs occur after the Settling Defendants assume responsibility for the O&M work, the Settling Defendants and the State agree to share those costs on a 30% - 70% basis consistent with this agreement. Any dispute regarding values, estimates, or costs will be decided by the Arbitrator at the request of one of the parties.

56. Payment to the State shall be made by Settling Defendants by certified or cashier's check(s) payable to "General Treasurer" (for deposit in the Environmental Response Fund), and shall be sent to the Office of the Director, Rhode Island Department of Environmental Management, 235 Promenade Street, Providence, Rhode Island 02908. At the time of each payment to the State, Settling Defendants shall send notice that payment has been made to the State in accordance with Section XXVI (Notices and Submissions).

57. a. The State will permit the Settling Defendants to pay at least a portion of the Settling Defendants' share of Reimbursable Costs through in kind services, provided that the in kind services are properly performed. The in-kind services shall include the response activities the Town is

required to perform pursuant to Paragraph 49 above, except as provided in Paragraph 57.b., and may include, without limitation, the response activities that the Town may be performing pursuant to Paragraph 51 above. The Settling Defendants will deliver to the State an itemized written statement of costs incurred by the Settling Defendants for in-kind services performed pursuant to this Decree during the previous fiscal year (July 1 to July 30), along with the supporting bills, invoices and similar statements that support each item of cost. The Settling Defendants will certify in writing and under oath the accuracy of this written statement. The State may within 30 days request additional information that relates to any of the costs identified by the Settling Defendants. The State may contest any of these costs by filing within 30 days of receipt of the Town's written statement or, if requested, within 30 days of receipt of the additional information, a written statement explaining why the State contests a particular cost item or why the State needs further information, which the Settling Defendants have either failed or refused to provide. If the Settling Defendants and the State cannot resolve any such contest within 30 days, the matter will be determined by binding arbitration conducted by the Arbitrator. The Settling Defendants' in-kind services costs become final (1) if not timely challenged by the State or (2) if challenged, as agreed to by the Settling Defendants and the State or as determined by the Arbitrator to be correct and consistent with the ROD. The value of the Settling Defendants' in-kind services will include applicable costs associated with services performed with Town personnel (including salary, fringe benefits, and a markup at the same indirect rate as is applied to State costs that is agreed to between EPA and the State in cooperative agreements under CERCLA) and/or approved or agreed upon equipment costs. Any dispute will be resolved by the Arbitrator in the manner described in Paragraph 57.a. Any in-kind services performed by the Settling Defendants prior to the first annual payment will be credited against the initial annual

payment, and any succeeding annual payments, until the credit is exhausted. Thereafter, the value of in-kind services will be credited against the annual payment for the fiscal year in which the services are rendered. The Settling Defendants will provide the State with information requested by the State concerning any in-kind services proposed or rendered by the Settling Defendants.

b. Although the costs incurred by the Settling Defendants to obtain title to and/or provide access and institutional controls on the Frisella property pursuant to this Consent Decree may exceed $60,000, only such costs up to $30,000 shall be eligible for credit under Paragraph 57.a. of this Consent Decree. Any such costs incurred by the Towns and/or the State shall not be considered Remedial Action costs for purposes of Paragraph 10 of this Consent Decree. In the event that it is necessary for EPA to incur costs to obtain access to and/or institutional controls on the Frisella property, the Towns shall reimburse EPA for such costs, in accordance with the procedures in Paragraph 6.

XVIII. FAILURE TO COMPLY WITH REQUIREMENTS OF CONSENT DECREE

58. Interest on Late Payments. If Settling Defendants fail to make any payment under Paragraphs 5, 6, 8, 9, 11, and 55 by the required due date, Interest shall continue to accrue on the unpaid balance through the date of payment.

59. Stipulated Penalty.

a. If any amounts due under Paragraphs 5, 6, 8, 9, 11, and 55 are not paid by the required due date, Settling Defendants shall be in violation of this Consent Decree and shall pay, as a stipulated penalty, in addition to the interest required by Paragraph 58, for days 1 through 30, $500 per violation per day that such payment is late and, for every additional day thereafter, $1,000 per violation per day that such payment is late. Stipulated penalties for failure to comply with Paragraphs

5, 6, 8, 9, and 11 shall be paid 100% to the United States, and stipulated penalties for failure to comply with payment requirements of Paragraph 55 shall be paid 100% to the State.

b. If the Settling Defendants fail to comply with any of the requirements of Section X (State Natural Resource Damages Settlement), Section XVI (Work to be Performed by Settling Defendants), Section XXIII (Access and Institutional Controls), and Section XXVII (Community Relations), Settling Defendants shall be in violation of this Consent Decree and shall pay, as a stipulated penalty, for days 1 through 30, $500 per violation per day and, for every additional day thereafter, $1,000 per violation per day. Except for stipulated penalties for failure to comply with Section X, any such stipulated penalties shall be paid 50% to the United States and 50% to the State. Stipulated penalties for failure to comply with Section X shall be paid 100% to the State.

c. Stipulated penalties owed to the EPA are due and payable within 30 days of the date of the demand for payment of the penalties by EPA. All payments to EPA under this Paragraph shall be identified as "stipulated penalties" and shall be made by certified or cashier's check made payable to "EPA Hazardous Substance Superfund." The check, or a letter accompanying the check, shall reference the name and address of the party(ies) making payment, Rose Hill Regional Landfill Superfund Site, EPA New England Region and Site Spill ID Number 10A5, USAO File Number 2002V00176, and DOJ Case Number 90-11-3-06627, and shall be sent to:

Region 1
U.S. Environmental Protection Agency
Attn: Hazardous Substance Superfund Accounting
P.O. Box 360197M
Pittsburgh, PA 15251

At the time of each payment, Settling Defendants shall send notice that such payment has been made to EPA and DOJ in accordance with Section XXVI (Notices and Submissions).

d. Stipulated penalties owed to NOAA are due and payable within 30 days of the date of the demand for payment of the penalties by NOAA. All payments to NOAA under this Paragraph shall be identified as "stipulated penalties" and shall be made by certified or cashier's check made payable to DOC/NOAA/NOS/OR&R, accompanied by a letter stating that the payment is for NOAA CPRD, Rose Hill case, and sent to: Kathy Salter, NOAA DARRF Manager, NOAA/NOS/OR&R, 1305 East West Highway, Building #4, Silver Spring, MD 20910. At the time of such payment, Settling Defendants shall send notice that such payment has been made to NOAA and DOJ in accordance with Section XXVI (Notices and Submissions).

e. Stipulated penalties owed to DOI are due and payable within 30 days of the date of the demand for payment of the penalties by DOI. All payments to DOI under this Paragraph shall be identified as "stipulated penalties" and shall be made in the same manner as set forth in Paragraph 11.c. Settling Defendants shall send notice that such payment has been made to the persons listed in Section XXVI (Notices and Submissions) for DOI and DOJ.

f. Stipulated penalties owed to the State are due and payable within 30 days of the date of the demand for payment of the penalties by the State. All payments to the State under this Paragraph shall be identified as "stipulated penalties" and shall be made by certified or cashier's check made payable to "General Treasurer" (for deposit in the Environmental Response Fund), and shall be sent to the Office of the Director, RIDEM, 235 Promenade Street, Providence, Rhode Island 02908. At the time of each payment, Settling Defendants shall send a notice that such payment has been made to the State in accordance with Section XXVI (Notices and Submissions). The State shall retain and use any amount(s) paid pursuant to Paragraph 59.f. to conduct or finance response actions for Operable Unit 1 at or in connection with the Site.

g. Penalties shall accrue as provided in this Paragraph regardless of whether EPA, NOAA, DOI, or the State has notified Settling Defendants of the violation or made a demand for payment, but need only be paid upon demand. All penalties shall begin to accrue on the day after payment is due and shall continue to accrue through the date of payment. Nothing herein shall prevent the simultaneous accrual of separate penalties for separate violations of this Consent Decree.

h. This dispute resolution provision shall apply to any disputes concerning demands for stipulated penalties.

i. Any dispute concerning a demand for stipulated penalties shall in the first instance be the subject of informal negotiations between the parties to the dispute. The period for informal negotiations shall not exceed 20 days from the time the dispute arises, unless it is modified by written agreement of the parties to the dispute.

ii. In the event that the parties to the dispute cannot resolve the dispute by informal negotiations, then the position advanced by EPA, NOAA, DOI, or the State, with respect to a stipulated penalties demand by EPA, NOAA, DOI, or the State, respectively, shall be considered binding unless, within 30 days after the conclusion of the informal negotiation period, Settling Defendants invoke the formal dispute resolution procedures of this Subparagraph by serving on the party making the demand for stipulated penalties a written Statement of Position on the matter in dispute, including, but not limited to, any factual data, analysis or opinion supporting that position and any supporting documentation relied upon by the Settling Defendants.

iii. Within 30 days after receipt of Settling Defendants' Statement of Position, the party making the demand for stipulated penalties will serve on Settling Defendants its

Statement of Position, including, but not limited to, any factual data, analysis, or opinion supporting that position and all supporting documentation relied upon by that party. Within 14 days after receipt of that Statement of Position, Settling Defendants may submit a Reply.

iv. An administrative record of the dispute shall be maintained by the party making the demand for stipulated penalties and shall contain all statements of position and supporting documentation. EPA Region I's Director of the Office of Site Remediation and Restoration, RIDEM's Chief of the Office of Waste Management, or persons designated by NOAA or DOI, shall issue a final administrative decision on any stipulated penalties demand made by EPA, RIDEM, NOAA, or DOI, respectively. The final administrative decision shall be binding on Settling Defendants unless, within 10 days of receipt of the decision, Settling Defendants file with the Court and serve on the party making the demand a motion for judicial review of the decision. The party making the demand may file a response to Settling Defendants' motion.

v. The parties agree that the Court's review of the dispute shall be resolved in accordance with applicable law. Where the dispute challenges a Federal or State agency determination that, under applicable principles of administrative law, is to be upheld unless it is "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law," that standard shall be applied in the dispute resolution proceeding before the Court.

vi. The invocation of dispute resolution procedures under this Subparagraph shall not extend, postpone or affect in any way any obligation of Settling Defendants under this Consent Decree, nor shall payment of penalties alter in any way Settling Defendants' obligation to complete any Work required of the Settling Defendants under the Consent

Decree. Penalties shall continue to accrue during any dispute resolution period, but need not be paid until the following:

A. If the dispute is resolved by agreement or by a final administrative decision that is not appealed to this Court, accrued penalties determined to be owing shall be paid within 30 days of the agreement or the receipt of the final administrative decision.

B. If the dispute is appealed to this Court and the party demanding the stipulated penalties prevails in whole or in part, Settling Defendants shall pay all accrued penalties determined by the Court to be owed within 60 days of receipt of the Court's decision or order, except as provided in Subparagraph c below;

C. If the District Court's decision is appealed by any party, Settling Defendants shall pay all accrued penalties determined by the District Court to be owing into an interest-bearing escrow account within 60 days of receipt of the Court's decision or order. Penalties shall be paid into this account as they continue to accrue, at least every 60 days. Within 15 days of receipt of the final appellate court decision, the escrow agent shall pay the balance of the account to the party making the stipulated penalties demand or to Settling Defendants to the extent they prevail.

D. If Settling Defendants fail to pay stipulated penalties when due, the party making the stipulated penalties demand may institute proceedings to collect the stipulated penalties, as well as Interest.

60. If the United States or the State brings an action to enforce this Consent Decree against the Settling Defendants and the United States or the State prevails, Settling Defendants shall

reimburse the United States and the State for all costs of such action, including but not limited to costs of attorney time.

61. Payments made under this Section shall be in addition to any other remedies or sanctions available to Plaintiffs by virtue of Settling Defendants' failure to comply with the requirements of this Consent Decree.

62. The obligations of Settling Defendants to pay amounts owed the United States under this Consent Decree and to perform the Work the Settling Defendants are to perform under this Consent Decree are joint and several. In the event of the failure of any one of the Settling Defendants to make the payments required under this Consent Decree and/or perform the Work the Settling Defendants are to perform under the Consent Decree, the remaining Settling Defendant shall be responsible for such payments and/or performance.

63. Notwithstanding any other provision of this Section, the United States may, in its unreviewable discretion, waive payment of any portion of the stipulated penalties that have accrued pursuant to this Consent Decree. Payment of stipulated penalties shall not excuse Settling Defendants from payment as required by Section VII, Section IX, and Section XVII or from performance of any other requirements of this Consent Decree.

XIX. COVENANT NOT TO SUE BY PLAINTIFFS

64. a. Covenant Not to Sue by United States. Except as specifically provided in Section IX (Reservation of Rights by United States), the United States covenants not to sue or to take administrative action against Settling Defendants pursuant to Sections 106 and 107(a) of CERCLA, 42 U.S.C. §§ 9606 and 9607(a), for payment of Past Response Costs, Future Response Costs, Additional U.S. RD/RA Response Costs, and Natural Resource Damages. This covenant not to sue

shall take effect upon receipt by EPA, NOAA, and DOI of all payments required by Paragraph 6 of Section VII (Payment Regarding United States Response Costs) and Paragraph 11 of Section IX (Federal Natural Resource Damages Settlement) and any amount due under Section XVIII in regard to noncompliance with or delay in compliance with the requirements of Paragraph 6 and/or Paragraph 11. This covenant not to sue is conditioned upon the satisfactory performance by Settling Defendants of their obligations under this Consent Decree. This covenant not to sue extends only to Settling Defendants and does not extend to any other person.

b. Covenant Not to Sue by the State. Except as specifically provided in Section XX (Reservation of Rights by Plaintiffs), the State covenants not to sue or to take administrative action against Settling Defendants pursuant to Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), and R.I.G.L. Chapters 23-18.9 and 23-19.1, for payment of State Future Response Costs and Natural Resource Damages. This covenant not to sue shall take effect upon receipt by the State of all payments required by Paragraph 55 of Section XVII (Settling Defendants' Reimbursement to State) and any amount due under Section XVIII (Failure to Comply with Consent Decree). This covenant not to sue is conditioned upon the satisfactory performance by Settling Defendants of their obligations under this Consent Decree. This covenant not to sue extends only to Settling Defendants and does not extend to any other person.

XX. RESERVATION OF RIGHTS BY PLAINTIFFS

65. General Reservations of Rights by United States. The United States reserves, and this Consent Decree is without prejudice to, all rights against Settling Defendants with respect to all matters not expressly included within the Covenant Not to Sue by United States in Paragraph 64.a. Notwithstanding any other provision of this Consent Decree, the United States reserves all rights against Settling Defendants with respect to:

a. liability for failure of Settling Defendants to meet a requirement of this Agreement;

b. criminal liability;

c. liability for response costs and injunctive relief or administrative order enforcement under Sections 106 and 107 of CERCLA, 42 U.S.C. §§ 9606 and 9607, for response actions that are not within the definition of Operable Unit 1;

d. liability for costs incurred or to be incurred by the United States that are not within the definition of Past Response Costs, Future Response Costs, and Additional U.S. RD/RA Response Costs;

e. liability for the transportation, treatment, storage, or disposal, or the arrangement for the transportation, treatment, storage, or disposal, of a hazardous substance or a solid waste at or in connection with the Site, after signature of this Consent Decree by Settling Parties, other than as provided in the ROD or otherwise ordered by EPA; and

f. liability arising from the past, present, or future disposal, release or threat of release of a hazardous substance, pollutant, or contaminant outside of the Site.

66. Federal Reservations Concerning Natural Resource Injury. Notwithstanding any other provision of this Decree, the United States, on behalf of the Federal Natural Resource Trustees, reserve the right to institute proceedings against Settling Defendants in this action or in a new action seeking recovery of Natural Resource Damages, based on (1) conditions with respect to the Site, unknown to the United States at the date of lodging of this Consent Decree, that result in releases or threatened releases of hazardous substances that contribute to injury to, destruction of, or loss of Natural Resources, or (2) information received by the United States after the date of lodging of the Consent Decree which, together with other relevant information, indicates that there is injury to,

destruction of, or loss of Natural Resources of a type that was unknown, or of a magnitude greater than was known, to the United States at the date of lodging of this Consent Decree.

67. General Reservation of Rights by the State. The State reserves, and this Consent Decree is without prejudice to, all rights against Settling Defendants with respect to all matters not expressly included within the Covenant Not to Sue by Plaintiffs in Paragraph 64.b. Notwithstanding any other provision of this Consent Decree, the State reserves all rights against Settling Defendants with respect to:

a. liability for failure of Settling Defendants to meet a requirement of this Agreement;

b. criminal liability;

c. liability for response costs and injunctive relief or administrative order enforcement under Section 107 of CERCLA, 42 U.S.C. § 9607, and R.I.G.L. Chapters 23-18.9 and 23-19.1 for response actions that are not within the definition of Operable Unit 1;

d. liability for costs incurred or to be incurred by the State that are not within the definition of State Future Response Costs;

e. liability for the transportation, treatment, storage, or disposal, or the arrangement for the transportation, treatment, storage, or disposal, of a hazardous substance or a solid waste at or in connection with the Site, after signature of this Consent Decree by Settling Parties, other than as provided in the ROD or otherwise ordered by EPA; and

f. liability arising from the past, present, or future disposal, release or threat of release of a hazardous substance, pollutant, or contaminant outside of the Site.

68. State Reservations Concerning Natural Resource Injury. Notwithstanding any other provision of this Decree, the State in its capacity as Natural Resource Trustee, reserves the right to

institute proceedings against Settling Defendants in this action or in a new action seeking recovery of Natural Resource Damages, based on (1) conditions with respect to the Site, unknown to the State at the date of lodging of this Consent Decree, that result in releases or threatened releases of hazardous substances that contribute to injury to, destruction of, or loss of Natural Resources, or (2) information received by the State after the date of lodging of the Consent Decree which, together with other relevant information, indicates that there is injury to, destruction of, or loss of Natural Resources of a type that was unknown, or of a magnitude greater than was known, to the State at the date of lodging of this Consent Decree.

XXI. COVENANT NOT TO SUE BY SETTLING DEFENDANTS

69. Settling Defendants covenant not to sue and agree not to assert any claims or causes of action against the United States or the State, or their contractors or employees, with respect to Past Response Costs, Future Response Costs, State Future Response Costs, Additional U.S. RD/RA Response Costs, Operable Unit 1, Natural Resource Damages, or this Consent Decree, including but not limited to:

a. any direct or indirect claim for reimbursement from the Hazardous Substance Superfund based on Sections 106(b)(2), 107, 111, 112, or 113 of CERCLA, 42 U.S.C. §§ 9606(b)(2), 9607, 9611, 9612, or 9613, or any other provision of law;

b. any claim arising out of Operable Unit 1 or out of the response actions for which the Past Response Costs, Future Response Costs, State Future Response Costs, and Additional U.S. RD/RA Response Costs were or will be incurred; and

c. any claim against the United States and/or the State pursuant to Sections 107 and 113 of CERCLA, 42 U.S.C. §§ 9607 and 9613, relating to Past Response Costs, Future Response

Costs, State Future Response Costs, Additional U.S. RD/RA Response Costs, or Natural Resource Damages.

70. Nothing in this Consent Decree shall be deemed to constitute approval or preauthorization of a claim within the meaning of Section 111 of CERCLA, 42 U.S.C. § 9611, or 40 C.F.R. 300.700(d).

71. Settling Defendants agree not to assert any claims and to waive all claims or causes of action that they may have for all matters relating to the Site, including for contribution, against any person where the person's liability to Settling Defendants with respect to the Site is based solely on having arranged for disposal or treatment, or for transport for disposal or treatment, of hazardous substances at the Site, or having accepted for transport for disposal or treatment of hazardous substances at the Site, if

a. any materials contributed by such person to the Site constituting Municipal Solid Waste (MSW) or Municipal Sewage Sludge (MSS) did not exceed 0.2% of the total volume of waste at the Site; and

b. any materials contributed by such person to the Site containing hazardous substances, but not constituting MSW or MSS, did not exceed the greater of (i) 0.002% of the total volume of waste at the Site, or (ii) 110 gallons of liquid materials or 200 pounds of solid materials. This waiver shall not apply to any claim or cause of action against any person meeting the above criteria if EPA has determined that the materials contributed to the Site by such person contributed or could contribute significantly to the costs of response at the Site. This waiver also shall not apply with respect to any defense, claim, or cause of action that a Settling Defendant may have against any person if such person asserts a claim or cause of action relating to the Site against such Settling

Defendant.

XXII. EFFECT OF SETTLEMENT/CONTRIBUTION PROTECTION

72. Except as provided in Paragraph 71, nothing in this Consent Decree shall be construed to create any rights in, or grant any cause of action to, any person not a Party to this Consent Decree. The preceding sentence shall not be construed to waive or nullify any rights that any person not a signatory to this Decree may have under applicable law. Except as provided in Paragraph 71, each of the Parties expressly reserves any and all rights (including, but not limited to, any right to contribution), defenses, claims, demands, and causes of action which each Party may have with respect to any matter, transaction, or occurrence relating in any way to the Site against any person not a Party hereto.

73. The Parties agree, and by entering this Consent Decree this Court finds, that Settling Defendants are entitled, as of the effective date of this Consent Decree, to protection from contribution actions or claims as provided by Section 113(f)(2) of CERCLA, 42 U.S.C. § 9613(f)(2), for "matters addressed" in this Consent Decree. The "matters addressed" in this Consent Decree are Past Response Costs, Future Response Costs, State Future Response Costs, Additional U.S. RD/RA Response Costs, Federal Natural Resource Damages, subject to the reservation in Paragraph 66, and State Natural Resource Damages, subject to the reservations in Paragraph 68.

74. Each Settling Defendant agrees that, with respect to any suit or claim for contribution brought by it for matters related to this Consent Decree, it will notify EPA and DOJ and the State in writing no later than 60 days prior to the initiation of such suit or claim. Each Settling Defendant also agrees that, with respect to any suit or claim for contribution brought against it for matters related to this Consent Decree, it will notify EPA and DOJ and the State in writing within 10 days of service of

the complaint or claim upon it. In addition, each Settling Defendant shall notify EPA and DOJ and the State within 10 days of service or receipt of any Motion for Summary Judgment, and within 10 days of receipt of any order from a court setting a case for trial, for matters related to this Consent Decree.

75. If the Settling Defendants or the State pursue a contribution claim or other action against a person not party to this Consent Decree to recover Site costs, they will inform each other and offer a participation agreement that involves an equitable sharing of costs and of any net recovery. If the other party declines to participate, the prosecuting party shall pay all of the expenses and keep any recovery. Any dispute regarding the participation agreement will be resolved by the Arbitrator. The United States reserves all of its rights against persons who are not parties to this Consent Decree, and this Paragraph shall in no way affect any rights of the United States.

76. In any subsequent administrative or judicial proceeding initiated by the United States or the State for injunctive relief, recovery of response costs, or other relief relating to the Site, Settling Defendants shall not assert, and may not maintain, any defense or claim based upon the principles of waiver, res judicata, collateral estoppel, issue preclusion, claim-splitting, or other defenses based upon any contention that the claims raised by the United States or the State in the subsequent proceeding were or should have been brought in the instant case; provided, however, that nothing in this Paragraph affects the enforceability of the Covenants Not to Sue by Plaintiffs set forth in Section XIX.

XXIII. ACCESS AND INSTITUTIONAL CONTROLS

77. If the Site, or any other property where access and/or land/water use restrictions are needed to implement response activities at the Site, is owned or controlled by any of the Settling

Defendants, such Settling Defendants shall:

a. commencing on the date of lodging of this Consent Decree, provide the United States, the State, and their representatives, including EPA, RIDEM, and their contractors, with access at all reasonable times to the Site, or such other property, for the purpose of conducting any response activity related to the Site, including but not limited to, the following activities:

1. Monitoring, investigation, removal, remedial or other activities at the Site;

2. Verifying any data or information submitted to the United States or the State;

3. Conducting investigations relating to contamination at or near the Site;

4. Obtaining samples;

5. Assessing the need for, planning, or implementing additional response actions at or near the Site;

6. Inspecting and copying records, operating logs, contracts, or other documents maintained or generated by Settling Defendants or their agents, consistent with Section XXIV (Access to Information);

7. Assessing Settling Defendants' compliance with this Consent Decree;

8. Determining whether the Site or other property is being used in a manner that is prohibited or restricted, or that may need to be prohibited or restricted, by or pursuant to this Consent Decree;

9. Conducting operation and maintenance activities; and

10. Conducting 5-year reviews.

b. commencing on the date of lodging of this Consent Decree, refrain from using the Site, or any other property, in any manner that would interfere with or adversely affect the integrity or

protectiveness of the remedial measures to be implemented at or in connection with the Site or that would result in the use, extraction, or consumption of ground water or surface water at the Site or that would result in the disturbance of the surface or subsurface of the land, other than for the purpose of conducting response activities at the Site; and

c. execute and record in the Town Clerk's Office, Town of South Kingstown, Washington County, State of Rhode Island, an easement, running with the land, that (i) grants a right of access for the purpose of conducting response activities, operation and maintenance, and 5-year reviews at the Site, and (ii) grants the right to enforce the land/water use restrictions referred to in Paragraph 77.b. of this Consent Decree and the Record of Decision for Operable Unit 1, or other restrictions that EPA determines are necessary to implement, ensure non-interference with, or ensure the protectiveness of the remedial measures to be performed at the Site. Such Settling Defendant(s) shall grant the access rights and the rights to enforce the land/water use restrictions to one or more of the following persons, as determined by EPA: (i) the United States, on behalf of EPA, and its representatives, and (ii) the State and its representatives. Such Settling Defendant(s) shall, within 45 days of entry of this Consent Decree, submit to EPA and the State for review and approval with respect to such property:

1. a draft easement, in substantially the form attached hereto as Appendix G, that is enforceable under the laws of the State of Rhode Island, free and clear of all prior liens and encumbrances (except as approved by EPA), and acceptable under the Attorney General's Title Regulations promulgated pursuant to 40 U.S.C. § 255; and

2. current title commitment or report prepared in accordance with the U.S. Department of Justice Title Standards 2001 (the "Standards"). Within 15 days of EPA's approval and acceptance

of the easement, such Settling Defendants shall update the title search and, if it is determined that nothing has occurred since the effective date of the commitment or report to affect the title adversely, record the easement with the Town Clerk, Town of South Kingstown, Washington County, Rhode Island. Within 30 days of recording the easement, such Settling Defendants shall provide EPA with final title evidence acceptable under the Standards, and a certified copy of the original recorded easement showing the clerk's recording stamps.

78. If the Site, or any other property where access and/or land/water use restrictions are needed to implement this Consent Decree, is owned or controlled by persons other than any of the Settling Defendants, Settling Defendants shall use best efforts to secure from such persons:

a. an agreement to provide access thereto for Settling Defendants, as well as for the United States on behalf of EPA, and the State, as well as their representatives (including contractors), for the purpose of conducting any activity related to this Consent Decree including, but not limited to, those activities listed in Paragraph 77.a of this Consent Decree;

b. an agreement, enforceable by the Settling Defendants, the State, and, if requested by the United States, the United States, to abide by the obligations and restrictions established by Paragraph 77 of this Consent Decree, or that are otherwise necessary to implement, ensure non-interference with, or ensure the protectiveness of the remedial measures to be performed pursuant to this Consent Decree; and

c. at EPA's request, the execution and recordation in the Town Clerk's Office, Town of South Kingstown, Washington County, State of Rhode Island, of an easement, running with the land, that (i) grants a right of access for the purpose of conducting any activity related to this Consent Decree including, but not limited to, those activities listed in Paragraph 77.a of this Consent Decree,

and (ii) grants the right to enforce the land/water use restrictions referred to in Paragraph 77.b of this Consent Decree and the Record of Decision for Operable Unit 1, or other restrictions that EPA determines are necessary to implement, ensure non-interference with, or ensure the protectiveness of the remedial measures to be performed pursuant to this Consent Decree. The access rights and/or rights to enforce land/water use restrictions shall be granted to one or more of the following persons, as determined by EPA: (i) the United States, on behalf of EPA, and its representatives, (ii) the State and its representatives, (iii) the Settling Defendants and their representatives, and/or (iv) other appropriate grantees. Within 45 days of EPA's request, Settling Defendants shall submit to EPA and the State for review and approval with respect to such property:

1. a draft easement, in substantially the form attached hereto as Appendix G, that is enforceable under the laws of the State of Rhode Island, free and clear of all prior liens and encumbrances (except as approved by EPA), and acceptable under the Attorney General's Title Regulations promulgated pursuant to 40 U.S.C. § 255; and

2. a current title commitment or report prepared in accordance with the U.S. Department of Justice Title Standards 2001 (the "Standards"). Within 15 days of EPA's approval and acceptance of the easement, Settling Defendants shall update the title search and, if it is determined that nothing has occurred since the effective date of the commitment or report to affect the title adversely, the easement shall be recorded with the Town Clerk, Town of South Kingstown, Washington County, Rhode Island. Within 30 days of the recording of the easement, Settling Defendants shall provide EPA with final title evidence acceptable under the Standards, and a certified copy of the original recorded easement showing the clerk's recording stamps.

79. For purposes of Paragraph 78 of this Consent Decree, "best efforts" includes the payment

of reasonable sums of money in consideration of access, access easements, land/water use restrictions, and/or restrictive easements. If any access or land/water use restriction agreements required by Paragraphs 78.a or 78.b of this Consent Decree are not obtained within 45 days of EPA's request, or any access easements or restrictive easements required by Paragraph 78.c of this Consent Decree are not submitted to EPA in draft form within 45 days of EPA's request, Settling Defendants shall promptly notify the United States in writing, and shall include in that notification a summary of the steps that Settling Defendants have taken to attempt to comply with Paragraph 78 of this Consent Decree. The State shall assist the Settling Defendants, and the United States may, as it deems appropriate, assist Settling Defendants and/or the State, in obtaining access or land/water use restrictions, either in the form of contractual agreements or in the form of easements running with the land. Settling Defendants shall reimburse the United States or the State, as applicable, in accordance with the procedures in Paragraph 6 of Section VII (Payment Regarding United States' Response Costs) or Paragraph 56 of Section XVII (Settling Defendants' Reimbursement to the State), for all costs incurred, directly or indirectly, by the United States or the State, as applicable, in obtaining such access and/or land/water use restrictions including, but not limited to, the cost of attorney time and the amount of monetary consideration paid or just compensation. The State agrees, pursuant to Section 104(j) of CERCLA, to accept title to any and all real property relating to the Site or the Consent Decree transferred to it by the United States.

80. If EPA determines that land/water use restrictions in the form of state or local laws, regulations, ordinances or other governmental controls are needed to implement response activities at the Site, ensure the integrity and protectiveness thereof, or ensure non-interference therewith, Settling Defendants shall cooperate with EPA's and the State's efforts to secure such governmental controls.

81. Notwithstanding any provision of this Consent Decree, the United States and the State retain all of their access authorities and rights, as well as all of their rights to require land/water use restrictions, including enforcement authorities related thereto, under CERCLA, RCRA, and any other applicable statute or regulations.

XXIV. ACCESS TO INFORMATION

82. Settling Defendants shall provide to EPA and the State, upon request, copies of all documents and information within their possession or control or that of their contractors or agents relating to activities at the Site or to the implementation of this Consent Decree, including, but not limited to, sampling, analysis, chain of custody records, manifests, trucking logs, receipts, reports, sample traffic routing, correspondence, or other documents or information related to the Site.

83. Confidential Business Information and Privileged Documents.

a. Settling Defendants may assert business confidentiality claims covering part or all of the documents or information submitted to Plaintiffs under this Consent Decree to the extent permitted by and in accordance with Section 104(e)(7) of CERCLA, 42 U.S.C. §9604(e)(7), and 40 C.F.R. 2.203(b). Documents or information determined to be confidential by EPA will be accorded the protection specified in 40 C.F.R. Part 2, Subpart B. If no claim of confidentiality accompanies documents or information when they are submitted to EPA and the State, or if EPA has notified Settling Defendants that the documents or information are not confidential under the standards of Section 104(e)(7) of CERCLA, the public may be given access to such documents or information without further notice to Settling Defendants.

b. Settling Defendants may assert that certain documents or information are privileged under the attorney-client privilege or any other privilege recognized by federal law. If Settling

Defendants assert such a privilege in lieu of providing documents or information, they shall provide Plaintiffs with the following: 1) the title of the document or information; 2) the date of the document or information; 3) the name and title of the author of the document or information; 4) the name and title of each addressee and recipient; 5) a description of the subject of the document or information; and 6) the privilege asserted. However, no documents or information created or generated pursuant to the requirements of this or any other consent decree with the United States shall be withheld on the grounds that they are privileged. If a claim of privilege applies only to a portion of a document or information, the document or information shall be provided to Plaintiffs in redacted form to mask the privileged information only. Settling Defendants shall retain all documents or information that they claim to be privileged until the United States has had a reasonable opportunity to dispute the privilege claim and any such dispute has been resolved in the Settling Defendants' favor.

84. No claim of confidentiality shall be made with respect to any data, including but not limited to, all sampling, analytical, monitoring, hydrogeologic, scientific, chemical, or engineering data, or any other documents or information evidencing conditions at or around the Site.

XXV. RETENTION OF RECORDS

85. Until 10 years after the entry of this Consent Decree, each Settling Defendant shall preserve and retain all documents or information now in its possession or control, or which come into its possession or control, that relate in any manner to response actions taken at the Site or the liability of any person for response actions or response costs at or in connection with the Site, regardless of any corporate retention policy to the contrary.

86. After the conclusion of the document retention period in the preceding paragraph, Settling Defendants shall notify EPA and the State at least 90 days prior to the destruction of any such

documents or information, and, upon request by EPA or the State, Settling Defendants shall deliver any such documents or information to EPA or the State. Settling Defendants may assert that certain documents or information are privileged under the attorney-client privilege or any other privilege recognized by federal law. If Settling Defendants assert such a privilege, they shall provide Plaintiffs with the following: 1) the title of the document or information; 2) the date of the document or information; 3) the name and title of the author of the document or information; 4) the name and title of each addressee and recipient; 5) a description of the subject of the document or information; and 6) the privilege asserted. However, no documents or information created or generated pursuant to the requirements of this or any other consent decree with the United States shall be withheld on the grounds that they are privileged. If a claim of privilege applies only to a portion of a document or information, the document or information shall be provided to Plaintiffs in redacted form to mask the privileged portion only. Settling Defendants shall retain all documents or information that they claim to be privileged until the United States has had a reasonable opportunity to dispute the privilege claim and any such dispute has been resolved in the Settling Defendants' favor.

87. By signing this Consent Decree, each Settling Defendant certifies individually that, to the best of its knowledge and belief, it has:

a. conducted a thorough, comprehensive, good faith search for documents or information, and has fully and accurately disclosed to EPA, all documents or information currently in its possession, or in the possession of its officers, directors, employees, contractors or agents, which relates in any way to the ownership, operation or control of the Site, or to the ownership, possession, generation, treatment, transportation, storage or disposal of a hazardous substance, pollutant or contaminant at or in connection with the Site;

b. not altered, mutilated, discarded, destroyed or otherwise disposed of any documents or information relating to its potential liability regarding the Site, after notification of potential liability or the filing of a suit against the Settling Defendant regarding the Site; and

c. fully complied with any and all EPA requests for information regarding the Site pursuant to Sections 104(e) and 122(e) of CERCLA, 42 U.S.C. §§ 9604(e) and 9622(e).

XXVI. NOTICES AND SUBMISSIONS

88. Whenever, under the terms of this Consent Decree, notice is required to be given or a document is required to be sent by one party to another, it shall be directed to the individuals at the addresses specified below, unless those individuals or their successors give notice of a change to the other Parties in writing. Written notice as specified herein shall constitute complete satisfaction of any written notice requirement of the Consent Decree with respect to the United States, the State, and Settling Defendants, respectively.

As to the United States:

the addressees and addresses for DOJ, EPA, NOAA, and DOI below

As to DOJ:

Chief, Environmental Enforcement Section
Environment and Natural Resources Division
U.S. Department of Justice (DJ # 90-11-3-06627)
P.O. Box 7611
Washington, D.C. 20044-7611

Michael P. Iannotti
Assistant United States Attorney
District of Rhode Island
Fleet Center
50 Kennedy Plaza
Providence, RI 02903

As to EPA:

David J. Newton, EPA Project Manager
Office of Site Remediation and Restoration
United States Environmental Protection Agency
New England Region (HBO)
One Congress Street, Suite 1100
Boston, MA 02114-2023

Regional Financial Manager
Office of Finance and Cost Recovery
United States Environmental Protection Agency
New England Region (MFC)
One Congress Street, Suite 1100
Boston, MA 02114-2023

As to NOAA:

Gwendolyn A. Wilkie
United States Department of Commerce
National Oceanic and Atmospheric Administration
Office of General Counsel, Natural Resources Division
Gloucester, MA 01930-2298

As to DOI:

Mark Barash
U.S. Department of the Interior
Office of the Solicitor
One Gateway Center, Suite 612
Newton Corner, MA 02158

As to the State:

Gary Jablonski, State Project Coordinator
RI Department of Environmental Management
Office of Waste Management
235 Promenade Street
Providence, RI 02908

As to Settling Defendants:

Town Manager
Town of South Kingstown
180 High Street
Wakefield, RI 02879

Town Manager
Town of Narragansett
25 Fifth Avenue
Narragansett, RI 02882-0777

XXVII. COMMUNITY RELATIONS

89. Settling Defendants shall cooperate with and provide support to the community relations efforts of EPA and the State relating to Operable Unit 1, including the provision of information regarding the Operable Unit 1 Work to the public. As requested by EPA and the State, Settling Defendants shall participate in the preparation of such information for dissemination to the public and in public meetings which may be held or sponsored by EPA and the State to explain activities at or relating to the Site. This support may include (i) the provision of presentations, logistical support, visual aids and equipment, (ii) publication and copying of fact sheets or updates, (iii) assistance in placing EPA and State public notices in print, and (iv) assistance in development of a Community Relations Plan.

XXVIII. MODIFICATION

90. Schedules specified in this Consent Decree for completion of the Work may be modified by agreement of EPA and the State. All such modifications shall be made in writing.

91. No material modifications shall be made to the Remedial Design SOW or the Remedial Action SOW without written notification to and written approval of the United States, the State, and the Court, if such modifications fundamentally alter the basic features of the selected remedy within

the meaning of 40 C.F.R. 300.435(c)(2)(B)(ii). Modifications to the RD SOW or the RA SOW that do not materially alter that document, or material modifications to the SOW that do not fundamentally alter the basic features of the selected remedy within the meaning of 40 C.F.R.300.435(c)(2)(B)(ii), may be made by written agreement between the EPA and the State.

92. Nothing in this Decree shall be deemed to alter the Court's power to enforce, supervise or approve modifications to this Consent Decree.

XXIX. RETENTION OF JURISDICTION

93. This Court shall retain jurisdiction over this matter over both the subject matter of this Consent Decree and the Parties to this Consent Decree for the purpose of interpretation of the Consent Decree, or to effectuate or enforce compliance with its terms, or to resolve disputes in accordance with the dispute resolution provisions of the Consent Decree.

XXX. INTEGRATION/APPENDICES

94. The following appendices are attached to and incorporated into this Consent Decree:

"Appendix A" is the List of Settling Defendants.

"Appendix B" is the Map of Rose Hill Regional Landfill Site.

"Appendix C" is the Escrow Agreement.

"Appendix D" is the Record of Decision for the Operable Unit 1 Source Control Remedy.

"Appendix E" is the Cooperative Agreement for the OU1 Remedial Design, including the OU1 Remedial Design Scope of Work.

"Appendix F" is the OU1 Remedial Action Statement of Work.

"Appendix G" is the draft access and institutional control instrument.

"Appendix H" is the Guidelines for Reuse Plan and Assessment.

"Appendix I" is the description and site plan for the Frisella property.

95. This Consent Decree and its appendices constitute the final, complete and exclusive agreement and understanding among the Parties with respect to the settlement embodied in this Consent Decree. The Parties acknowledge that there are no representations, agreements or understandings relating to the settlement other than those expressly contained in this Consent Decree.

XXXI. LODGING AND OPPORTUNITY FOR PUBLIC COMMENT

96. This Consent Decree shall be lodged with the Court for a period of not less than 30 days for public notice and comment. The United States reserves the right to withdraw or withhold its consent if the comments regarding the Consent Decree disclose facts or considerations which indicate that this Consent Decree is inappropriate, improper, or inadequate. The State may withdraw or withhold its consent to the entry of this Consent Decree if comments received disclose facts or considerations which show that the Consent Decree violates state law. The United States reserves the right to challenge in court the State withdrawal from the Consent Decree, including the right to argue that the requirements of state law have been waived, pre-empted or otherwise rendered inapplicable by federal law. The State reserves the right to oppose the United States' position taken in opposition to the proposed withdrawal. In addition, in the event of the United States' withdrawal from this Consent Decree, the State reserves its right to withdraw from this Consent Decree. Settling Defendants consent to the entry of this Consent Decree without further notice.

97. If for any reason this Court should decline to approve this Consent Decree in the form presented, this agreement is voidable at the sole discretion of any party and the terms of the agreement may not be used as evidence in any litigation between the Parties.

XXXII. EFFECTIVE DATE

98. The effective date of this Consent Decree shall be the date upon which it is entered by the Court.

XXXIV. SIGNATORIES/SERVICE

99. Each undersigned representative of a Settling Defendant to this Consent Decree, the Assistant Attorney General for the Environment and Natural Resources Division of the United States Department of Justice and the Commissioner of the Department of Environmental Management of the State of Rhode Island certifies that he or she is authorized to enter into the terms and conditions of this Consent Decree and to execute and bind legally the Settling Defendants, the United States, and the State of Rhode Island, respectively, to this document.

100. Each Settling Defendant hereby agrees not to oppose entry of this Consent Decree by this Court or to challenge any provision of this Consent Decree, unless the United States has notified Settling Defendants in writing that it no longer supports entry of the Consent Decree.

101. Each Settling Defendant shall identify, on the attached signature page, the name and address of an agent who is authorized to accept service of process by mail on behalf of that Party with respect to all matters arising under or relating to this Consent Decree. Settling Defendants hereby agree to accept service in that manner and to waive the formal service requirements set forth in Rule 4 of the Federal Rules of Civil Procedure and any applicable local rules of this Court, including but not limited to, service of a summons.

SO ORDERED THIS ___ DAY OF _____.

_____

United States District Judge

THE UNDERSIGNED PARTIES enter into this Consent Decree in the matter of United States and State of Rhode Island v. Town of South Kingstown, R.I. and Town of Narragansett, R.I., relating to the Rose Hill Regional Landfill Superfund Site.

FOR THE UNITED STATES OF AMERICA

Date: 11-29-02

Thomas L. Sansonetti
Assistant Attorney General
Environment and Natural Resources Division
U.S. Department of Justice

Date: 11/15/02

Henry S. Friedman
Senior Attorney
Environmental Enforcement Section
Environment and Natural Resources Division
U.S. Department of Justice
P.O. Box 7611
Washington, DC 20044-7611

Margaret Curran
United States Attorney

Date: 12-19-02 By:

Michael D. Iannotti
Assistant United States Attorney
District of Rhode Island
Fleet Center
50 Kennedy Plaza
Providence, RI 02903

Date: 9-30-02

Robert W. Varney
Regional Administrator
Region I
U.S. Environmental Protection Agency
One Congress Street, Suite 1100
Boston, MA 02114-2023

Date: 9/30/02

Amelia Welt Katzen
Senior Enforcement Counsel
Region I
U.S. Environmental Protection Agency
One Congress Street, Suite 1100
Boston, MA 02114-2023

THE UNDERSIGNED PARTY enters into this Consent Decree in the matter of United States and State of Rhode Island v. Town of South Kingstown, R.I. and Town of Narragansett, R.I. , relating to the Rose Hill Regional Landfill Superfund Site.

FOR THE STATE OF RHODE ISLAND

Date: 9/30/02

Jan Reitsma
Director
Department of Environmental Management
235 Promenade Street
Providence, Rhode Island 02908

THE UNDERSIGNED PARTY enters into this Consent Decree in the matter of United States and State of Rhode Island v. Town of South Kingstown, R.I. and Town of Narragansett, R.I., relating to the Rose Hill Regional Landfill Superfund Site.

FOR DEFENDANT TOWN OF SOUTH KINGSTOWN, R.I.

Date: 10/16/2002

Name: Stephen A. Alfred
Title: Town Manager
Address: 180 High Street
Wakefield, RI 02879

Agent Authorized to Accept Service on Behalf of Above-signed Party:

Name: Stephen A. Alfred

Title: Town Manager

Address: 180 High Street
Wakefield, RI 02879

THE UNDERSIGNED PARTY enters into this Consent Decree in the matter of United States and State of Rhode Island v. Town of South Kingstown, R.I. and Town of Narragansett, R.I., relating to the Rose Hill Regional Landfill Superfund Site.

FOR DEFENDANT TOWN OF NARRAGANSETT, R.I.

Date: 10.09.02

Name: Maurice J. Loontjens, Jr.
Title: Town Manager
Address: Town of Narragansett
25 Fifth Avenue
Narragansett, RI 02882

Town Council Authorized October 7, 2002
Agenda Item 2002-10-335

Agent Authorized to Accept Service on Behalf of Above-signed Party:

Name: Jeffry Ceasrine, P.E.

Title: Town Engineer

Address: Town of Narragansett
25 Fifth Avenue
Narragansett, RI 02882

UNITED STATES DISTRICT COURT
DISTRICT OF RHODE ISLAND

UNITED STATES OF AMERICA and STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS,	)	
Plaintiffs,	)	
v.	)	CIVIL ACTION NO.
TOWN OF SOUTH KINGSTOWN, R.I., and TOWN OF NARRAGANSETT, R.I.	)	
Defendants.	)	

CERTIFICATE OF SERVICE

I hereby certify that I have this 19th day of December, 2002, caused to be mailed, first-class, postage prepaid, a copy of the Complaint and the Notice of Lodging of Consent Decree and of Defendants' Waiver of Service, with accompanying Consent Decree, to the counsel and representatives for the defendants, as well as to counsel for the State, at the following addresses:

Gerald J. Petros
Hinckley, Allen & Snyder LLP
1500 Fleet Center
Providence, Rhode Island 02903-2393

Stephen A. Alfred
Town Manager
Town of South Kingstown
180 High Street
Wakefield, RI 02879

Jeffry Ceasrine, P.E.
Town Engineer
Town of Narragansett
25 Fifth Avenue
Narragansett, RI 02882

John Langlois
Senior Legal Counsel
Department of Environmental Management
State of Rhode Island
235 Promenade Street
Providence, RI 02908

Michael P. Iannotti
Assistant United States Attorney
District of Rhode Island
Fleet Center
50 Kennedy Plaza
Providence, RI 02903
(401) 528-5477

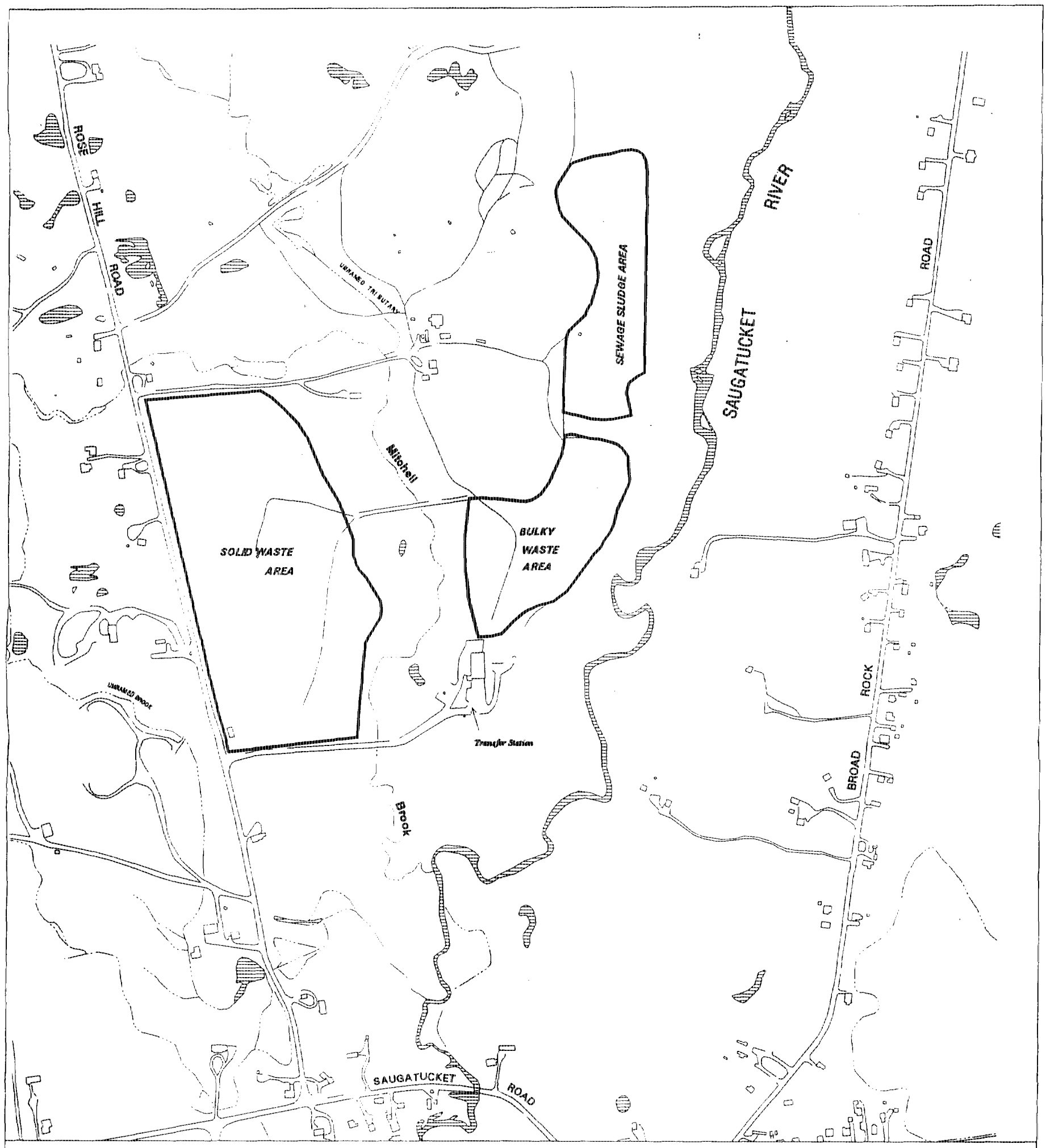
APPENDIX A

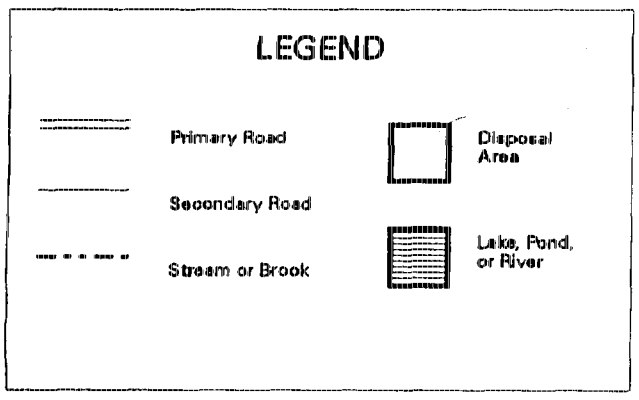
LIST OF SETTLING DEFENDANTS

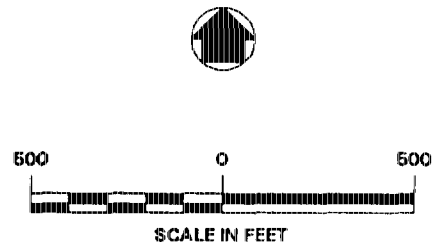
Town of South Kingstown, RI
Town of Narragansett, RI

APPENDIX B

MAP OF ROSE HILL REGIONAL LANDFILL SUPERFUND SITE







APPENDIX B

Map of

ROSE HILL REGIONAL LANDFILL SITE

ROSE HILL REGIONAL LANDFILL SITE

SOUTH KINGSTOWN, RI

FSTUDY1.WAT(SEPT. 1996)

METCALF & EDDY

APPENDIX C

ESCROW AGREEMENT

SOVEREIGN BANK
ESCROW DEPOSIT ACCOUNT SERVICE

MASTER ACCOUNT AGREEMENT

This Agreement made this 25th day of June, 2002 by and between Sovereign Bank ("Bank") with its principal office located at 1130 Berkshire Boulevard, Wyomissing, PA 19610 and Town of South Kingstown ("Customer") whose principal office is located at 180 High Street, Wakfield, RI . Customer and Bank agree as follows:

1. By executing this Agreement, Customer authorizes the Bank to receive and act on written, facsimile (fax) or telephone instructions from Customer's Authorized Representative(s) listed below. Customer agrees that the Bank will act on instructions only if Customer's Authorized Representative provides the Authorization Code listed below.

2. Customer agrees to indemnify the Bank for any costs, losses or liabilities that the Bank may incur as a result of any claim or wrongful transfer of Customer's funds if the Bank acts on it reasonable belief that it was authorized to do so.

Name on Master Account: TOWN OF SOUTH KINGSTOWN AF
S KINGSTOWN & NARR EPA ESCROW ACCOUNT BENEF

Master Account #: 95570004317 Tax Ident (TIN): 05-6000519

Disbursement Account #: Same Authorization Code: N/A call Governmnet Banking at 877-506-9352

Telephone #: 401-789-9331 X 206 Fax # 401-792-9646

Rate 1.74% Landlord/Tenant(Interest Split) Yes ☐ No ☒
If yes,

Name of Authorized Representatives:

Alan R Lord

3. This Agreement may be canceled by Customer at any time by written notice to the Bank at the address listed above. This Agreement also may be canceled by the Bank with thirty (30) days written notice to Customer. Customer's notice of cancellation shall be effective only for transactions initiated after the Bank's receipt of the notice and after the Bank has a reasonable time to act on a notice of cancellation.

4. Customer represents and warrants that the entering into this Agreement is authorized by Customer, and Customer agrees to supply to Bank corporate resolutions or such other documents evidencing such authorization as may reasonably be required.

5. This Agreement shall be subject to such administrative rules as Bank may establish and disseminate from time to time governing these services such as time limits by which requests for transfers may be received, specific telephone numbers for various types of transfer requests, and other rules.

CUSTOMER AUTHORIZATION
Signed: [signature]
Name: Alan R. Lord
Title: Finance Director

SOVEREIGN BANK - Branch #
Signed: John Conte
Name: JOHN CONTE
Title: SR. VICE PRESIDENT
RT ☐

Copy - Community Banking Office Copy - Customer

ADDENDUM

THE ESCROW AGENT SHALL SUBMIT TO THE JURISDICTION AND VENUE OF THE UNITED STATES DISTRICT COURT OF RHODE ISLAND IN CONNECTION WITH ANY LITIGATION ARISING OUT OF THE ESCROW AGREEMENT.

Ver2: escrow.dot
1/6/00

SOVEREIGN BANK

John Conte
JOHN CONTE, SR VICE PRESIDENT

APPENDIX D

RECORD OF DECISION FOR THE OPERABLE UNIT 1 SOURCE CONTROL REMEDY

U.S. ENVIRONMENTAL PROTECTION AGENCY
Region I, New England

RECORD OF DECISION
First Operable Unit--Source Control

ROSE HILL REGIONAL LANDFILL SUPERFUND SITE
SOUTH KINGSTOWN, RHODE ISLAND
EPA ID # RID980521025

December, 1999

DECLARATION

ROSE HILL REGIONAL LANDFILL SUPERFUND SITE
SOUTH KINGSTOWN, RHODE ISLAND
EPA ID # RID980521025

STATEMENT OF BASIS AND PURPOSE

This decision document presents the Selected Remedy for the Rose Hill Regional Landfill Superfund Site, in South Kingstown, Rhode Island, which was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Contingency Plan (NCP). This decision document represents the first operable unit of a phased approach to remediate the environmental contamination caused by the Site. The first operable unit is a source control remedy which is intended to prevent or minimize the continued release of hazardous substances, pollutants or contaminants to the environment. The first operable unit will collect data to assess the effectiveness of the source control remedy, assess the need for taking any further response actions under a second operable unit, and assist the State with TMDL predictions for Site-related contaminant concentrations affecting local water bodies. Management of the migration of contaminants to surface or ground water will be based on data obtained from monitoring conducted under the first operable unit and any additional studies that are deemed necessary to further assess Site impacts, characterize the extent of contamination, and assess the need to develop and evaluate alternatives for future actions.

This decision is based on the Administrative Record which has been developed in accordance with Section 113(k) of CERCLA and which is available for public review at the South Kingstown Public Library in Peace Dale, Rhode Island and at the USEPA Region I -New England, Office of Site Remediation and Restoration Records Center in Boston, Massachusetts. The Administrative Record Index identifies each of the items comprising the Administrative Record upon which the selection of the remedial action is based. The Administrative Record Index is Appendix B of this Record of Decision (ROD).

The Rhode Island Department of Environmental Management has reviewed the various alternatives and has indicated its support for the selected remedy. The State has also reviewed the Remedial Investigation, Risk Assessment and Feasibility Study to determine if the selected remedy is in compliance with applicable or relevant and appropriate State Environmental laws and regulations. The State of Rhode Island concurs with the selected remedy for the Rose Hill Regional Landfill Superfund Site.

ASSESSMENT OF THE SITE

The response action selected in this ROD is necessary to protect the public health, welfare, or the

environment. The human health and ecological risk assessments identified unacceptable risks posed by actual or threatened releases of hazardous substances from this Site which if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment. Groundwater (through the use of institutional controls), air (through the collection and treatment of landfill gas) and leachate (through excavation and consolidation) are the media of focus for this operable unit response.

DESCRIPTION OF THE SELECTED REMEDY

The Selected Remedy is Alternative 4B, modified to take into account its role as the first operable unit of a phased approach to remediate the environmental contamination caused by the Site. The Selected Remedy consists of the following activities:

- **Alternative 4B:** *Consolidation of the Bulky Waste Area onto the Solid Waste Area, Containment, Leachate Collection and Treatment (during consolidation), and Landfill Gas Treatment (Solid Waste Area)*

  1. Excavate and consolidate the Bulky Waste Area landfill materials onto the Solid Waste Area landfill;

  2. Collect and effectively manage leachate and waters collected from runoff and de-watering operations during the excavation of the Bulky Waste Area ;

  3. Construct a multi-layer hazardous waste cap using innovative and cost efficient cover materials, as may be appropriate and as further defined in design, over the extent of the Solid Waste Area landfill and consolidated Bulky Waste Area materials;

  4. Inspect and monitor the integrity and performance of the landfill cap over time;

  5. Assess, control, collect, and treat landfill gas emissions by an active internal and perimeter gas collection system and thermal treatment of such gasses through the use of an enclosed flare and continue monitoring landfill gas concentrations to assess the need to modify the landfill gas collection treatment system as necessary;

  6. Implement access restrictions and Institutional Controls (land title restrictions including, but not limited to, easements and restrictive covenants) on land use and the use of, or hydraulic alteration of, groundwater where Preliminary Remediation Goals (PRGs) (based on MCLs, MCLGs) and/or other health based standards are exceeded.

  7. Install a chain link fence and/or other physical barriers where necessary to prevent

Site access, injury and/or exposure;

8. Long-term monitoring of surface water, groundwater, air and leachate emergence;

9. Perform operation and maintenance activities throughout the life of the remedy;

10. Conduct statutory five year reviews as required.

Estimated Time for Design and Construction:	*2 years*
Estimated Time of Operation:	*<15 years for LFG; >30 years GW/Leachate*
Estimated Capital Cost:	*$11,360,000*
*Estimated Operations and Maintenance Costs (**net present worth**):*	*$6,680,000*
*Estimated Total Cost (**net present worth**):*	*$18,040,000*

STATUTORY DETERMINATIONS

The remedial action selected for implementation at the Rose Hill Regional Landfill Superfund Site is consistent with CERCLA and the NCP. The Selected Remedy is protective of human health and the environment, attains ARARs and is cost effective. The Selected Remedy partially satisfies the statutory preference for treatment which permanently and significantly reduces the mobility, toxicity or volume of hazardous substances as a principal element and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. The remedy uses treatment to address landfill gas emissions and includes excavation of the Bulky Waste Area to reduce mobility of hazardous substances. Consistent with EPA's presumptive remedy for municipal landfills, capping of the consolidated Bulky and Solid Waste Areas was selected given the volume of material and the cost to treat such volume.

Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a review will be conducted within five years after initiation of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

ROD DATA CERTIFICATION CHECKLIST

See attached ROD data certification checklist.

AUTHORIZING SIGNATURE

12/20/99
Date

Patricia L. Meaney, Director
Office of Site Remediation and Restoration
EPA - New England

ROSE HILL REGIONAL LANDFILL
SUPERFUND SITE ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this Record of Decision. Additional information can be found in the Administrative Record file of this Site.

- Chemicals of concern and their respective concentrations.
- Baseline risk represented by the chemicals of concern.
- Cleanup levels established for chemicals of concern and the basis for these levels.*
- How source materials constituting principal threats are addressed.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of ground water used in the baseline risk assessment and ROD.
- Potential land and ground-water use that will be available at the site as a result of the Selected Remedy.
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.
- Key factor(s) that led to selecting the remedy (i.e., describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision).

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*NOTE: The selected remedy is a source control remedy which is intended to prevent or minimize the continued release of hazardous substances, pollutants or contaminants to the environment. This decision is also the first operable unit remedy of a phased clean up approach. As such, no cleanup levels are established under this remedy; instead the remedy will meet the performance standards set out in the ROD. The first operable unit remedy will meet all ARARs including those for Site air emissions, landfill closure, and process water discharge or reinjection. Management of the migration of contaminants from the Site will be addressed in a future decision document, based upon data obtained from monitoring conducted under the first operable unit, and any additional studies that are deemed necessary to further assess Site impacts, characterize the extent of contamination, and to assess the need to develop and evaluate alternatives for future actions.

RECORD OF DECISION
First Operable Unit--Source Control

ROSE HILL REGIONAL LANDFILL SUPERFUND SITE
SOUTH KINGSTOWN, RHODE ISLAND
EPA ID # RID980521025

Table of Contents

I. SITE NAME, LOCATION AND DESCRIPTION 1

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES 2
- A. Land Use 2
- B. Response Activity 5
- C. Enforcement History 11

III. COMMUNITY PARTICIPATION 12

IV. SCOPE AND ROLE OF THE FIRST OPERABLE UNIT RESPONSE ACTION 13

V. SUMMARY OF SITE CHARACTERISTICS 14
- A. Soil 17
- B. Groundwater 31
- C. Surface Water 34
- D. Sediment 39
- E. Leachate 45
- F. Landfill Gas 48
- G. Contaminant Fate and Transport 52

VI. CURRENT AND FUTURE SITE AND RESOURCE USES 53
- A. Current Land Use 53
- B. Future Land Use 54
- C. Current and Future Surface Water Use 54
- D. Current and Future Groundwater Use 54

VII. SUMMARY OF SITE RISKS 55
- A. Human Health Risk Assessment 56
- B. Ecological Risk Assessment 59

VIII. REMEDIAL OBJECTIVES AND DEVELOPMENT AND SCREENING OF ALTERNATIVES 65
- A. Statutory Requirements/Response Objectives 65
- B. Technology and Alternative Development and Screening 66

IX. DESCRIPTION OF ALTERNATIVES 67

X. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES 70

XI. THE SELECTED REMEDY 86

XII. STATUTORY DETERMINATIONS 89
A. The Selected Remedy is Protective of Human Health and the Environment 89
B. The Selected Remedy Attains ARARs 90
C. The Selected Remedial Action is Cost-Effective 92
D. The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable 93
E. The Selected Remedy Satisfies the Preference for Treatment Which Permanently and Significantly Reduces the Toxicity, Mobility or Volume of the Hazardous Substances as a Principal Element. 93

XIII DOCUMENTATION OF SIGNIFICANT CHANGES 94

XIV. STATE ROLE 95

APPENDICES . . . . . A through E

I. SITE NAME, LOCATION AND DESCRIPTION

The Rose Hill Regional Landfill Superfund Site (the Site) is located within the town of South Kingstown, Rhode Island, in the village of Peace Dale (Figure 1) within Washington County. It lies about 5 miles inland from Narragansett Bay and 2 miles north of Wakefield, Rhode Island. The Site is bordered by Rose Hill Road to the west, the Saugatucket River to the east, and residential private property to the north and south. Remedial response activities including this Remedial Investigation and Feasibility Study were conducted under a United States Environmental Protection Agency (EPA) lead with the State of Rhode Island Department of Environmental Management (RIDEM) remaining active throughout as the support agency.

The Site is located in an abandoned sand and gravel quarry and encompasses approximately 70 acres. As shown in Figure 1, the Site consists of three separate and inactive disposal areas or landfills, referred to herein as the Solid Waste Area (SWA), the Bulky Waste Area (BWA), and the Sewage Sludge Area (SSA). An active transfer station, south of the disposal areas, is also located on the Site (Figure 2).

Two primary surface water bodies flow through the Site: Saugatucket River and Mitchell Brook. An unnamed brook, west of the Site, flows into the Saugatucket River and an unnamed tributary, in the northern portion of the Site, flows into Mitchell Brook. The Saugatucket River is classified by the State of Rhode Island as a Class B water body that is suitable for fishing and swimming. Wetland and flood plain habitats are also found adjacent to the disposal areas and are subject to runoff and contamination from the disposal areas. An open excavated area approximately 400 feet north of the disposal areas is currently used for target and skeet shooting. Approximately 200 feet west of the disposal areas, sand and gravel operators excavate sand, gravel and loam for resale to the public.

Groundwater is used within a 3-mile radius of the Site for the following purposes:

- Private residential supplies (no alternate supply available)
- Municipal public water supply

Residents in South Kingstown obtain water from both public and private wells. Private wells within a 3-mile radius of the Site consist of overburden or bedrock wells. Three supply wells for the University of Rhode Island are located 2.7 miles northwest of the Site. Two municipal supply wells for the Kingston District are located 2.9 miles northwest of the Site. The University and the District utilize each other's systems as water supply back-up.

II SITE HISTORY AND ENFORCEMENT ACTIVITIES

A. Land Use

Prior to 1941, the Site was used for agriculture. Sand and gravel excavation operations were conducted at the Site from at least 1948 through 1963. The Rose Hill Site began operation as a landfill in 1967 in the area previously used for sand and gravel excavation. The landfill was operated by the Town of South Kingstown under a state permit from RIDEM which was renewable annually. For approximately 16 years, it received domestic and industrial wastes from residents and industries in South Kingstown and Narragansett. In October 1983, the landfill reached its state-permitted maximum capacity and active landfilling operations ceased. For the past fifty years, the Site owner has conducted organized small game hunts, the boarding, breeding, training, and showing of hunting dogs, skeet and target shooting, and stocking and periodic release of small game birds throughout the Site.

Facility Operations and Waste Disposal Practices. Table 1 provides a chronology of activities affecting the landfill operations.

Landfills in the three disposal areas (the Solid Waste, Bulky Waste, and Sewage Sludge Areas), began operations in 1967, 1978, and 1977, respectively. The Solid Waste Area landfill was closed in 1982 and the Bulky Waste and Sewage Sludge Area landfills were closed in 1983. During 1983, a transfer station for municipal refuse was located south of the Bulky Waste Area. The transfer station is currently active. At the station, refuse is unloaded from collection trucks and transferred to vehicles that transport it off site to the Johnston landfill. Figure 1 shows the three disposal areas and the transfer station at the Site.

Waste handling procedures for the Rose Hill Regional Landfill were set by state regulations and town ordinance. The waste handling practices conducted at the landfill consisted of the disposal of municipal refuse and industrial refuse including the disposal of industrial wastes. Through its investigation, EPA has acquired some information regarding the disposal and approximate location of these industrial wastes but the exact quantity and location(s) of hazardous substances disposed of on the Site throughout the landfill's operation are predominantly unknown. Information regarding the total volume of solid waste placed in the landfill is available through studies conducted for the Town of South Kingstown by C.E. Maguire.

In 1967, when activity at the landfill officially commenced, a court order prohibited the disposal of combustibles at Rose Hill. In 1978, the order was amended to allow the disposal of combustibles in the Bulky Waste Area. In 1979, the State of Rhode Island ordered cities and towns to establish facilities for the collection of waste oil. It is reported that a waste oil collection facility at the Rose Hill Site was established during this time.

A known waste handling problem concerns the disposal of liquid waste from the Peacedale Processing Company, specifically a urethane adhesive. A letter dated January 8, 1970, transmitted from an engineer of the State Division of Solid Waste Management to the South Kingstown Director of Public Works, put into writing an agreement on the disposal method for liquid waste from the Peacedale Processing Company. The two authorities came to an understanding that the drummed waste would be disposed of daily by dumping it onto other wastes that had been deposited each day. The purpose of this was to take advantage of the absorptive characteristics of the waste materials as the urethane adhesive was disposed.

A year later, on March 16, 1971, correspondence sent from the same state office notified the South Kingstown Town Manager that liquid waste from Peacedale Processing was being improperly disposed of at the Rose Hill Solid Waste landfill. The communication reiterated that the liquid waste should be spread over the surface of the landfill to allow it to be absorbed by the fill, if acceptance of such waste were to continue.

In 1979, a resident observed and reported to RIDEM the dumping of a number of barrels, with the lids intact, on the Solid Waste landfill slope within a few feet of Rose Hill Road. The truck transporting these drums on this occasion was reported to be labeled "Peacedale Processing." The resident further reported at least one barrel was labeled "slop glue." The drums were buried intact with the exception of one. One of these barrels was also observed to be at least part liquid. RIDEM investigated this report and found a drum labeled "DALTOSLEX 535" and "DRANO 21." Daltoslex is a polyurethane fabric coating dissolved in trichloroethylene (TCE), dimethyl formamide (*N,N*-DMF), and cellosolve solvent. Cellosolve is the trademark for mono- and dialkyl ethers of ethylene glycol and their derivatives (Sax and Lewis 1987). Analysis of samples collected from these drums identified hexane, 2-butanone (MEK), TCE, and toluene as components of the liquid. All of these chemicals are widely used industrial solvents. Dimethyl formamide and cellosolve cannot be detected by the common methods used to analyze for volatile organic compounds.

On December 6, 1979, the State Division of Solid Waste Management wrote to Kenyon Piece Dyeworks (a subsidiary of Peacedale Processing) to confirm an analysis of the waste adhesive procured from the Peacedale plant on November 19, 1979. The analysis revealed that the sample contained trichloroethylene at 29,000 parts per billion (ppb), toluene at 400 ppb, and tetrachloroethylene at 4 ppb. An analysis of the waste itself revealed that it contained trichloroethylene in the amount of 0.35%. Based upon the analyses, the waste adhesive produced at the plant was deemed not hazardous [as a solid], as defined by Rhode Island regulations, and could be disposed of at any licensed solid waste management facility. The State added that the waste adhesive was to be in a solid form when taken to the landfill and exposed to the air for at least a week prior to its disposal. Within the same time frame, Kenyon Piece Dyeworks notified the State that the company had suspended shipment of the above-mentioned waste adhesive to the Rose Hill landfill pending further investigation of its environmental reactivity.

Peacedale Processing notified the United States Environmental Protection Agency (EPA), Region I, in 1981 that the company had disposed of laminating adhesive at the Rose Hill Landfill from 1971 to 1979. Although other volatile organics, inorganics, and phthalate compounds have been detected at the Site study area, little is known about the disposal practices associated with these contaminants.

Landfill Disposal Areas. The Solid Waste Area (SWA) operated from 1967 until 1982. The exact depth of deposited solid waste materials is unknown but estimated during studies conducted for the Town of South Kingstown to be to bedrock in some places. Refuse was also reportedly deposited in areas above, below, and at the water table. Areal photographs of the disposal area compiled June 1991 by EPA's Environmental Monitoring Systems Laboratory indicate that the sand and gravel pit was filled in with refuse material starting in the southern portion and progressing north. By 1988, waste materials were present throughout the pit, and all remnants of the original sand and gravel pit were gone. Several possible leachate seeps (rust-colored staining as evidenced in November 5, 1988 photography) are observed in the northern, eastern and southern portions of the disposal area. The thickness of solid waste deposited throughout the landfill prior to 1977 is unknown. However it was estimated that from 1977 to 1982 between 10 and 14 feet of solid waste were deposited. Upon closure, the SWA was reported to have been covered with 0.5 to 2 feet of sandy soil and subsoil. Recent information indicates that only a portion of this area may have been properly covered. Natural vegetation is observed throughout most of this Area; however some spotty, less vegetated sites and occasional exposed debris is apparent where lesser amounts of cover materials were used or subsequently were eroded.

The Sewage Sludge Area (SSA) is located in the northeast section of the Site, between Mitchell Brook and the Saugatucket River. This area operated from 1977 to 1983. Its predominant use was to receive sludge from the South Kingstown wastewater treatment plant. The sludge was deposited in trenches. Aerial photographs taken in 1981 show that the northern section of a large north-to-south-orientated trench, running the entire length of this area, as well as two smaller trenches in the northern section, already contained sludge material. Three unfilled trenches were also visible at that time. The depth of each excavation and the number of trenches are unknown. Reported problems with the high moisture content of the sludge prompted the Town of South Kingstown to initiate the hauling of the sludge to the Johnston landfill. Vegetative cover in this area is less prevalent here than in the Solid Waste Area. In a letter dated July 15, 1993 from RIDEM, Division of Water Resources to the Utilities Director of the Town of South Kingstown, the Department writes: " This Department is thus in a position to confirm that this site has been properly closed, poses no threat to public health as long as the area is not excavated...", and "We [the Department] also take this opportunity to close Order of Approval No. 490 issued for the sludge disposal area."

The Bulky Waste Area (BWA), understood by reference and inference from historic Town records to have been used primarily for the disposal of large "bulky" materials such as appliances, tree stumps, and other debris, is an 11-acre area located east of the SWA and southwest of the

SSA (Figure 1). This area is approximately 200 feet east of Mitchell Brook and 250 feet west of the Saugatucket River. Disposal of materials in this Area began in 1978. Solid waste was also reportedly disposed of in the period between closure of the Solid Waste Area and construction of the transfer station (May 1982 through October 1983). Recent investigative information presented to EPA by the Town of South Kingstown in 1999 offers additional evidence that the BWA is comprised of a far greater amount of municipal solid waste than had been previously reported (see the April 1999 GZA report, in Section 11.10 of Administrative Record). Vegetation, primarily grasses overlying natural fill materials, provides a natural cover for this area.

Property Ownership. Edward L. Frisella, Sr. (deceased) and Pearl F. Frisella are owners of record of the property within which the landfill facility is located. The gravel quarry area, located adjacent to and north of the landfill, is owned by the Estate of Edward L. Frisella, Sr. In 1967, the Town of South Kingstown entered into a lease with Mr. Frisella for the operation of a Solid Waste landfill. After the establishment of the landfill, in February 1973, the Town of Narragansett entered into an agreement with the Town of South Kingstown for joint use and operation of the landfill. In 1977, Edward L. Frisella, Sr., and the Town of South Kingstown reached an agreement upon the continued use of the property as a landfill facility. This amendment to the lease provided additional land for expansion of the landfill facility (i.e., the Sewage Sludge and Bulky Waste Areas). In 1982, the Town of South Kingstown purchased 15.03 acres from Mr. Frisella for the location of the town's transfer station.

B. Response Activity

Several supporting studies have been conducted from 1975 through1994 at the Rose Hill Site prior to and during the Remedial Investigation and Feasibility Study (RI/FS). These studies have generated reports and maps concerning the Rose Hill Landfill Site. The studies are documented in the Administrative Record Index (Appendix E of this document) and many are summarized and/or referenced in either or both of the Remedial Investigation (May, 1994) and Feasibility Study (November, 1998) Reports.

Preliminary Assessment/Site Inspection. The Preliminary Assessment Report for the Rose Hill Regional Landfill Site was completed in January, 1983 followed by a Site Inspection Report completed in September, 1985. The Site was proposed for inclusion on the National Priority List (NPL) on June 24, 1988. Upon review of the Site Investigation and comments received from the proposed listing, EPA chose to conduct an Expanded Site Investigation to further characterize the Site in anticipation of final NPL listing. This effort consisted of more detailed inspection, sampling and surveying of the Site and a final report was submitted in January 1989. On October 4, 1989, the Site qualified for a final listing on the NPL.

In 1985, the Town of South Kingstown provided a municipal water line extension to adjacent residences located on Rose Hill Road and those dwellings abutting the immediate northern portion of the Site. The municipal water line extends as far north as the Site owner's driveway

(across from 349 Rose Hill Road and marked by a terminal hydrant). Hookups to the waterline were voluntary. One resident who initially refused the service was subsequently provided municipal water. By 1989, water service was provided to Broad Rock Road. Generally, residences along Rose Hill Road directly west and south of the Site use municipal water. A number of residences on Saugatucket Road and Broad Rock Road are not connected to municipal water and continue to use private wells, as do residents north of the Site on Rose Hill Road.

Removal Action. The Remedial Investigation (RI) and Feasibility Study (FS), conducted by EPA, began in 1990 with field work commencing in the Spring of 1991. In June 1991, Metcalf and Eddy (M&E), as EPA's remedial response contractor for performance of the RI/FS, installed permanent soil gas sampling wells on the three landfill disposal areas and along the perimeter of the Site. Initial results of sampling from the soil gas wells indicated the presence of explosive levels of combustible gases in the vicinity of residential dwellings abutting the landfill. As a result of M&E's soil gas results, the EPA Remedial Project Manager requested assistance from the EPA Emergency Planning and Response Branch (EPRB) to perform a removal assessment of nearby residential dwellings to ensure that the structures were free of migrating gases. The following paragraphs discuss the removal response actions conducted by EPA and a summary of the resultant conclusions. A complete history of this work, monitoring results, and reports on the removal be found in Section 2 of the Administrative Record under Removal Response.

On November 8, 1991 personnel from the United States Environmental Protection Agency Emergency Planning and Response Branch (EPRB), Waste Management Division (WMD; now known as the Office of Site Remediation and Response (OSRR)), the South Kingstown Fire Department and Technical Assistance Team (TAT) monitored 12 dwellings in proximity to the Solid Waste Area landfill for the presence of combustible gases. The results of this survey indicated that the dwellings were free of detectable concentrations of combustible gases. These results are found in a document entitled: *Methane Gas Investigation for Rose Hill Landfill, South Kingstown, Rhode Island, December 1991,* prepared by TAT.

In December 1991, the Agency for Toxic Substances and Disease Registry (ATSDR) issued a health evaluation based on analytical data generated by M&E as well as the residential survey performed in November 1991. At that time, ATSDR stated "..the data did not indicate any public health concerns, but EPA should continue periodic monitoring of the houses". As a result, EPRB requested that TAT monitor the residential dwellings on a monthly basis for the next four months. From December 1991 through March 1992, TAT monitored eight residential basements for combustible gases in ambient air using an organic vapor analyzer (OVA), a combustible gas indicator (CGI), and a photoionization detector (PID). During this time, OVA readings above background levels were observed in several residential basements, with the residential basement at 220 Rose Hill Road containing concentrations significantly above the background level (240-1,000 units). PID readings in this residential basement were not above the background readings, indicating that the gas was methane, a common landfill by-product, which is detected by the OVA but not the PID.

In July 1992, ATSDR issued another health consultation based on the monthly monitoring data and a sample collected from a soil gas well located along the foundation of 220 Rose Hill Road. Methane was detected at 18,000 parts per million (ppm) at this soil gas well.

ATSDR recommended that "a methane monitor/alarm be installed in the residence which had the 37% lower explosive level (LEL) at its external foundation". ATSDR recommended that periodic monitoring be performed on other residences.

In July 1992, EPA requested that TAT begin a biweekly monitoring program designed to monitor residential basements and the soil gas wells (installed by M&E) using a CGI, an OVA equipped with a charcoal filter (to eliminate all organic compounds except methane, ethane, and propane), and a PID (to verify that the gases detected with the OVA were methane). From July through September 1992, elevated levels of gases were detected in soil gas wells, but no significant concentration of gases were detected in any of the residential basements, including 220 Rose Hill Road. A summary of the residential basement sampling and the soil gas well sampling performed by TAT from December 1991 through September 1992 can be found in the report entitled: *Air Monitoring Data Tables, Rose Hill Regional Landfill Site, South Kingstown, Rhode Island, December 1991 - September 1992,* prepared by TAT.

On September 2,1992, EPA and TAT collected soil gas samples in Summa canisters at three soil gas wells and submitted the samples to the EPA New England Regional Laboratory (NERL) for VOC analyses. The results of the Summa samples indicated the presence of vinyl chloride in soil gas well LFGR-8 at a concentration of 4,000 ppm. The remaining two Summa samples contained other VOCs at low levels but no vinyl chloride. The presence of vinyl chloride in soil gas well LFGR-8 was verified by TAT on September 16, 1992, using a vinyl chloride Drager Chemical Detector Tube.

In October 1992, ATSDR issued another health consultation based on the September 2, 1992 Summa canister sampling results. ATSDR stated, "The presence of high levels of vinyl chloride in soil gas (4000 ppm) would justify additional characterization to determine the extent (if any) of the contaminant migration from the landfill. Additional air monitoring should include ambient air, both from the landfill property and the adjacent residential area."

On October 14, 1992, EPA Deputy Regional Administrator Paul Keough signed an Action Memorandum for Regional Administrator Julie Belaga, authorizing $1,920,000 to mitigate the threat to public health or to the environment resulting from the actual or potential exposure to nearby human populations from the migration of the landfill gases.

On October 19-20, 1992, an air and soil gas sampling survey was conducted by personnel from EPRB, the EPA Environmental Response Team (ERT), the Roy F. Weston, Inc. Response Engineering and Analytical Contract (REAC) Team and TAT. Based on the results obtained from this survey, REAC prepared two reports. The first report, entitled: *Final Emission Modeling*

Report, Rose Hill Regional Landfill, South Kingstown, Rhode Island, December 1992, estimated that the landfill would generate 800 megagrams per year (Mg/year) of methane for the next few years, and also generate 7 Mg/year of nonmethane organic compounds (NMOC). The second REAC report, entitled: *Final Air Quality Modeling Report, Rose Hill Regional Landfill, South Kingstown, Rhode Island, December 1992,* estimated that the residences around the landfill would be exposed to an average 10.7 parts per billion, volume to volume (ppb/v) vinyl chloride. Since these were models, actual data were needed to verify the estimates. Therefore two additional surveys were scheduled for the Site by EPA. In January 1993, EPRB issued a work assignment to M&E to prepare a report evaluating options for an expedited response action to mitigate the subsurface migration of landfill gases toward the residential dwellings.

The first survey was conducted by EPRB and TAT from February through March 1993, when the Site was covered by snow, and the subsurface migration of landfill gases was thought to be at the annual maximum. This survey found that only one residential dwelling (220 Rose Hill Road) had significant concentrations of methane (up to 2500 ppm) and vinyl chloride (up to 22 ppb/v). Based on the vinyl chloride result, ATSDR stated that an increased cancer risk may exist if the exposure of these levels of vinyl chloride was greater than 1.45 years. Based on the maximum vinyl chloride concentration (1.78 ppb/v) found in the other residential basements sampled and the outside ambient air, ATSDR stated that no adverse health affects were expected to occur (for the same interval of time). A summary of the results of the survey can be found in the report entitled: *Rose Hill Regional Landfill Site, Indoor Residential Air Survey Results, South Kingstown, Rhode Island, February 1993 - March 1993,* prepared by TAT.

The second survey was conducted by ERT and REAC from May 24-28, 1993, when the surface of the landfill was permeable, and the vertical migration of the gases through the surface of the landfill was thought to be at the annual maximum. Based on the results from this survey, REAC predicted the residences around the landfill would be exposed to an average 0.008 ppb/v vinyl chloride. A summary of the results can be found in the reports entitled: *Observed Ambient Air Impact Report, Rose Hill Regional Landfill, South Kingstown, Rhode Island, July 1993* and *Air Quality Modeling Final Report, Rose Hill Regional Landfill, South Kingstown, Rhode Island, August 1993,* both prepared by REAC.

The report recommended the installation of a landfill gas mitigation system consisting of a series of perimeter gas extraction wells, a gas collection system and an enclosed flare to burn the off-gases. M&E estimated the capital cost of this action at $3,770,000 and a yearly Operation and Maintenance cost of $350,000. Based upon sampling results and cost benefit analyses, an interim response action consisting of landfill gas sensors equipped with alarms for three residences and a landfill gas ventilation system for one dwelling was recommended by EPRB. A unilateral order was issued to the Town of South Kingstown in March 1993 with the above mentioned requirements (see Enforcement History below). A week later, EPRB approved the Town's Work Plan in response to the issued order requiring gas sensors, alarms, and one ventilation system to be installed at the residents' properties. By May 1993, the Town placed gas sensors and alarms at

two residences and initiated discussions with the property owner of 220 Rose Hill Road about installing a ventilation system or, alternatively, razing the dwelling. The March 1993 M&E report was used extensively as support documentation for the Feasibility Study and the remedial (long-term) response action.

On April 12, 1993, ATSDR issued a health evaluation for the samples collected in February and March 1993. ATSDR concluded that the exposure to a concentration of 21 ppb vinyl chloride at 220 Rose Hill Road may result in an increased cancer risk if the exposure were to exceed 1.45 years. ATSDR recommended that actions be taken at this residential property to prevent long term exposure. ATSDR reviewed the vinyl chloride data for the other residential dwellings and the ambient air sample results collected in February and March of the same year and concluded that "no significant risk is expected as a result of exposure to this level of vinyl chloride (a concentration range reported from non-detect to 0.99 ppb at the other residential dwellings) within the time frame that remedial action is expected to be in place (approximately 10 years)".

In June 1993, the Town of South Kingstown by agreement with the property owner and under order by EPA razed the building located at 220 Rose Hill Road and prohibited any future housing on the property.

Shortly after ERT and REAC submitted their July 1993 report entitled *Observed Ambient Air Impact Report* and the August 1993 *Air Quality Modeling Final Report* for samples gathered from May 24-28, 1993 from the residences and at the landfill, ATSDR prepared a health consult for EPA which concluded: "The maximum detected vinyl chloride [and benzene] concentration (1.6 ppb [23.4 ppb for benzene]) is below levels shown to produce adverse, non-carcinogenic health effects in animals or humans. However, long term exposure to this concentration of vinyl chloride [and benzene] in air could cause an increased risk of cancer". The health consult also contained the following recommendation: "Implement appropriate remedial actions to reduce risks associated with chronic exposure to benzene and vinyl chloride in air."

The final reports also indicated a possible "upwind" (westerly) source for these contaminants, in addition to the Rose Hill Landfill. Based on subsequent peer review of the report and additional RI data, this conclusion is thought to be erroneous. No substantiated documentation on the use, storage or disposal of any hazardous substances, including but not limited to, benzene or vinyl chloride, are known to exist with respect to the properties along Rose Hill Road and adjacent to the landfill. The report indicated that the wind velocity and direction was quite variable and at times calm. The PAL dispersion model used for this study cannot readily predict concentrations under these conditions. Therefore, the model may seriously under-predict the concentration for vinyl chloride when compared to concentrations as measured at the residential receptors. This suggests that the model results have substantial uncertainty for vinyl chloride (and for other compounds). The possible reasons for under-predicting contaminant concentrations are: 1) emission is underestimated, 2) dispersion is overestimated, and 3) that the conceptual model may be inadequate. For example, emissions may be underestimated if the flux chambers do not

represent the actual flux of landfill gas across the entire landfill surface or if laboratory recovery of vinyl chloride was low; dispersion may be overestimated if the PAL model does not adequately account for near-calm conditions; the conceptual model may be inadequate if landfill gas migrates below the ground surface to the vicinity of residential receptors. Benzene is a fairly ubiquitous contaminant and, although found to be present at the landfill, was not found in substantial concentrations in samples of landfill gas. It may be reasonable therefore to suspect that off-site sources may contribute to the recorded measurements of benzene. However, vinyl chloride was found in substantial concentrations in landfill gas. This compound is not ubiquitous and is known to be a substantial degradation byproduct of chlorinated compounds found in quantity at the landfill. Since both ambient measurement results and modeled concentrations are subject to significant uncertainty, it is entirely speculative to attribute vinyl chloride at receptor locations adjacent to the Rose Hill Landfill to unknown off-site sources. The continued remedial work, including but not limited to the RI, FS, and the human health risk assessment, also took these factors into account and more advanced modeling concepts were sought in support of the continued remedial response.

In early 1994, the Town installed a bentonite clay dam around the town water line feeding the resident at 278 Rose Hill Road to prevent landfill gases from entering the residence. The Town also moved the sensor from against the outside basement wall to inside the basement to record methane concentrations inside the dwelling. The Town continues to maintain the equipment and submit data reports to EPA.

Preliminary Natural Resource Survey. On June 24 1994, the National Oceanic and Atmospheric Administration (NOAA) submitted a Preliminary Natural Resource Survey (PNRS) for the Site. The findings presented in the PNRS are based upon results documented in the EPA RI report and in a preliminary screening study entitled *An Evaluation of Saugatucket Pond Sediment, South Kingstown, Rhode Island, Final Report* (NOAA, 1994). These latter reports can be found in their entirety in Section 16 of the Administrative Record.

The findings of the PNRS indicate that the Rose Hill Regional Landfill Site is located in the Saugatucket River basin, adjacent to the Saugatucket River and Mitchell Brook, a tributary to the river. Fish passage facilities have been installed on the Saugatucket River to allow for upstream migration of anadromous fish species. The river now provides significant spawning and nursery habitat for alewife and blueback herring. Contamination from the Rose Hill Landfill may pose a threat to natural resources, including NOAA trust resources utilizing Mitchell Brook, the Saugatucket River, and Saugatucket Pond. The primary pathways of contaminant migration from the Site are groundwater discharge and surface water runoff. Iron and several trace elements were detected at elevated concentrations in surface water and sediment during the RI. The leachate seeps located on the perimeter of both the Bulky Waste and Solid Waste Areas appear to be a source of contamination to surface water bodies. A floc sample collected from Mitchell Brook contained substantial amounts of iron. In addition, iron was present at high concentrations in sediment collected as far downstream as Saugatucket Pond. Flocculent material that accumulates

near the Site may be a source of iron in sediments of the pond. Results suggest that sediment and floc transported from the vicinity of the Site contains concentrations of iron and possibly other trace element contaminants that may adversely effect blueback herring and alewife inhabiting Saugatucket Pond during sensitive life stages. While the results of the PNRS and sediment study were not unequivocal, they provided sufficient evidence to justify further study and analysis of the relationship between Site releases and adverse biological responses downstream in Saugatucket Pond.

C. Enforcement History

In April and June of 1989, EPA sent general notice letters to eight Potentially Responsible Parties (PRPs). EPA met with the PRPs in June 1989 and in June 1990, EPA sent out special notice letters to the PRPs to undertake an RI/FS. After failed attempts at negotiations, EPA requested and received funding from the Superfund trust fund to begin the RI/FS at Rose Hill.

Actual field work for the Remedial Investigation (RI) began in the Spring of 1991. Shortly after the initiation of the RI, it became apparent that the Site owner's continued use of the property (including, hunting, sport and target shooting, dog training, and other related activities) presented an unreasonable and unacceptable risk to EPA and its contractors and placed operational restrictions upon EPA in conducting the necessary field activities. On August 21, 1991, EPA issued an Administrative Order for Property Access to the property owner. An amendment to the Administrative Order for Property Access was issued on March 27, 1992 which allowed the limited use of a ten acre parcel for his business-related activities.

In March 1989, the Agency received notice of a bankruptcy proceeding and filed a proof of claim seeking reimbursement of response costs against Coated Sales and its wholly-owned subsidiary, Kenyon Industries, Inc. The Coated Sales bankruptcy proceeding involved six related corporate entities. EPA had claims against two of them, Coated Sales, Inc. ("CSI"), and Kenyon Industries, Inc. ("Kenyon"), a Rhode Island corporation and subsidiary of CSI. The bankruptcy proceeding presented EPA with its only opportunity to resolve its claims for response costs under CERCLA against CSI and Kenyon, corporate affiliates of Peacedale Processing Company, Inc., a known hazardous waste generator at the Site. In June 1994, the case was settled with EPA recovering a portion of its response costs.

On March 26, 1993, as an enforcement component to the Removal Action, EPA issued a Unilateral Administrative Order (RCRA Docket 1-93-1055) (the Order), directing the Towns of Narragansett and South Kingstown to install methane gas sensors/alarms outside the foundations and in the basements of 278 Rose Hill Road and 349 Rose Hill Road. The Order also directed the Towns to install a methane gas ventilation system and a gas sensor/alarm in the basement of 220 Rose Hill Road. As an alternative to the second directive, the Towns relocated the residents of 220 Rose Hill Road and razed the building on June 4, 1993. The alarms at 278 and 349 Rose Hill Road were installed on May 18, 1993. A summary of the alarm installation activities can be

found in the report entitled: *Completion of Work Report for Environmental Protection Agency, Administrative Order 1-93-1055, February 9, 1994,* prepared by Geological Field Services (the Town of South Kingstown's consultant). The Town is required to perform maintenance and monitoring activities and report a summary of the collected data to EPA annually.

Further information regarding the above described enforcement activities be found in Section 10 of the Administrative Record.

III. COMMUNITY PARTICIPATION

Throughout the Site's history, community concern and involvement has been moderate. EPA has kept the community and other interested parties apprized of the Site activities through informational meetings, fact sheets, press releases and public meetings.

In June 1991, EPA released a community relations plan which outlined a program to address community concerns and keep citizens informed about and involved in activities during remedial activities. On June 18, 1991, EPA held an informational meeting in South Kingstown, RI to describe the plans for the Remedial Investigation and Feasibility Study. On June 23, 1994, EPA held an open house in South Kingstown, RI to discuss the results of the Remedial Investigation.

During the removal activities, meetings were held with the residents of Rose Hill Road on January 20 and April 29, 1993 to inform the residents of monitoring results, ongoing work and proposed actions.

EPA published a notice and brief analysis of the FS and Proposed Plan in the Providence Journal on January 29, 1999 and made the plan available to the public at South Kingstown Public Library. On February 1, 1999, EPA made the Administrative Record available for public review at EPA's offices in Boston and at South Kingstown Public Library.

On February 2, 1999, EPA held an informational meeting to discuss the results of the Remedial Investigation and the cleanup alternatives presented in the Feasibility Study and to present the Agency's Proposed Plan. Also during this meeting, the Agency answered questions from the public. A joint letter from the Towns of South Kingstown and Narragansett was received on January 27, 1999 which contained a formal request to extend the 30 day public comment period by sixty days. In response to this request, the Agency held a 90-day public comment period from February 3 to May 3, 1999 to accept public comment on the alternatives presented in the Feasibility Study and the Proposed Plan and on any other documents previously released to the public. On February 18, 1999, the Agency held a public hearing to discuss the Proposed Plan and to accept any oral comments. A transcript of the hearing, the comments, and the Agency's response to comments are included in Appendix C (Responsiveness Summary) of this ROD.

Throughout the time in which the RI/FS was conducted, EPA solicited views from the Site owner, neighboring property owners, the State, the Town, and local citizen groups on the current and reasonably anticipated future land uses, and current and potential future groundwater use and value within the Site boundary and in adjacent areas. Section VI of this ROD contains a brief summary of that information.

IV. SCOPE AND ROLE OF THE FIRST OPERABLE UNIT RESPONSE ACTION

The Feasibility Study (FS) analyzed source control and management of migration alternatives for the Site. Upon extensive review and consideration of new information and comments presented during the public comment, EPA believes that additional data is needed to properly assess and evaluate management of migration options for groundwater and its impact on surface water after the source control remedy is implemented. Instituting a well designed source control remedy at the present time will minimize the migration of contaminants to groundwater. Accordingly, a more cost effective and potentially less extensive management of migration remedy can be realized through a phased approach.

The selected remedy is the first operable unit of a phased approach to remediate the environmental contamination caused by the Site. The first operable unit is a source control remedy which is intended to prevent or minimize the continued release of hazardous substances, pollutants or contaminants to the environment. Source control alternatives rely on the prevention of exposure for the protection of human health and the environment.

The first operable unit will control the sources of contamination at the Site by limiting percolation and infiltration from precipitation through waste materials thereby controlling an otherwise continued release of hazardous substances to the air and ground water. The first operable unit remedy will minimize the further migration of hazardous substances, pollutants and contaminants to groundwater and surface water. Future management of the migration of contaminants to surface and ground water will be based on data obtained from the first operable unit monitoring and any additional studies that are deemed necessary in order to further assess Site impacts, characterize the extent of contamination, and assess the need to develop and evaluate alternatives for future actions, should it be found necessary to do so.

The first operable unit remedy consists of the following components: Consolidate the Bulky Waste Area landfill onto the Solid Waste Area landfill; collect and manage leachate and waters collected from runoff and de-watering operations during the excavation and consolidation of the Bulky Waste Area; apply a protective cover (hazardous waste cap) to the Solid Waste Area landfill; assess, collect and treat landfill gases via an enclosed flare; inspect and monitor the integrity and performance of the cap over time; monitor groundwater, surface water, leachate emergence, and landfill gas emissions over the duration of the remedial action; implement deed restrictions (in form of easements and covenants) on groundwater and land use and prevent access onto the portions of the Site where remediation activities warrant this restriction; provide data to

assess the need for taking any further response actions after the cap is in place and functional; operation and maintenance of the remedy; and plan for and conduct statutory five-year reviews to ensure protectiveness. Site monitoring will furnish data to assess the effectiveness of the source control remedy and assist the State with TMDL predictions for Site-related contaminant concentrations affecting local water bodies. The Sewage Sludge Area meets minimal State requirements for sewage sludge landfill closure, and poses no significant health threat as closed. The source control remedy includes continued monitoring of this area.

The exposure to and inhalation of landfill gas and the exposure to and ingestion of contaminated groundwater are principle threats to human health posed by the Site. Leachate production poses an ecological threat to the Saugatucket River and Mitchell Brook. Consolidating and capping the landfill wastes coupled with controlling landfill gas emissions will minimize these threats by containing and treating these contaminants on-site. Once the sources are consolidated, the role of the landfill cap is to 1) effectively contain the source, 2) contain and control landfill gas emissions, 3) minimize any further migration of contaminants from the source to the groundwater, and 4) minimize the migration of the contaminated groundwater plume. Ecological risks associated with leachates reaching and impacting nearby surface water bodies are also substantially reduced through 1) removing one source in immediate proximity to the Saugatucket River, 2) consolidating the source areas to one location away from the Saugatucket River, and 3) effectively containing the combined source area, using a multi-layer hazardous waste cap. Long-term environmental monitoring coupled with deed restrictions to prevent the use of, or hydraulic alteration of, groundwater throughout the Site will ensure that the selected remedy remains protective of human health and the environment. Further assessment of the groundwater and surface water impacts as a component of the long-term environmental monitoring will be conducted after the cap is in place and functional to ensure remedy integrity and protectiveness and to support any future remedial actions that may be necessary in response to those risks posed by the Site.

V. SUMMARY OF SITE CHARACTERISTICS

Sections 1.2, 1.3 and 1.4 of the Feasibility Study (FS) contain background information including an overview of the Remedial Investigation (RI). The significant findings of the RI are summarized below. The RI/FS support documentation can be found in the Administrative Record under Section 3.0 and 4.0, respectively.

The Site study area is situated in the southwest corner of Rhode Island about five miles inland from Narragansett Bay, approximately two miles north of Wakefield, Rhode Island and located within Peace Dale; a small village of the Town of South Kingstown. The topography of the area is typical for coastal lowlands of the northeastern United States, generally flat with gently rolling hills. Elevations range from 50 to 260 feet above mean sea level with slopes of generally less than three percent.

Several geologic features that impact the movement of groundwater across the Site were identified. The behavior of groundwater in the bedrock was found to be influenced by bedrock topography, with recharge and discharge occurring at bedrock high and low areas, respectively. The predominant flow of groundwater in bedrock is to the southeast along regional fractures. Weathered and fractured bedrock (Scituate Gneiss, USGS 1956) south and west of the Solid Waste Area appears to facilitate interconnection of the overburden and bedrock flow systems.

The three major constituents of the overburden are ablation till, glacial lacustrine deposits, and glacial outwash sediments. The till and glacial outwash permit unconfined groundwater flow in a south-southeast direction. Although the groundwater flow is predominantly to the south-southeast, mounding of groundwater in the northwest corner of the Solid Waste Area may facilitate radial flow to the north, east, and west. Lacustrine deposits, encountered in the south-southeastern portion of the Site, act as a confining layer between the till and outwash. A combination of the rise in the surface elevation of the bedrock and the presence of thick lacustrine deposits along the Saugatucket River plays a significant role in the increased horizontal gradient and strong upward gradients observed south of the Bulky Waste Area.

Due to the composition and condition of existing cover materials, infiltration of precipitation through these materials is expected to be high. Groundwater interactions with the Saugatucket River and Mitchell Brook most likely play an important role in the transport of contaminants. The Saugatucket River was observed to gain water from the shallow and deep overburden and the bedrock flow systems along the western side of the river. Mitchell Brook was observed to lose water to groundwater in its upper reaches and gain groundwater in its lower reaches.

Significant ecological habitats within the Site include the Saugatucket River and Mitchell Brook, their associated tributaries and forested wetlands, and the adjacent forested and old field upland habitats. Rare plant species known to occur within the Site include a species of state interest, tickseed sunflower *(Bidens coronata)*, and a species of state concern, bloodroot *(Sanguinaria canadensis)*. A probable sighting of an avian species of state concern, red-bellied woodpecker *(Melanerpes carolinus)*, also occurred within the Site. Two avian species of state interest, glossy ibis *(Plegadis falcinellus)* and great egret *(Casmerodius albus)*, were also observed within the Site. However, the state designation applies only to breeding sites for these two species, and suitable breeding habitat does not exist within the Site, except possibly along the Saugatucket River.

As indicated by a single, reconnaissance-level survey, the Site is utilized by a variety of terrestrial species. Avian species observed on the Site were generally typical of those expected based upon geographical location, habitat present, and surrounding land uses. The extensive running of dogs and hunting on the Site have influenced the use of the Site by mammalian species. Reptiles and amphibians utilizing the Site are likely to be confined largely to terrestrial species, as Mitchell Brook does not appear to support large numbers of these organisms or other prey species, such as fish. However, the Saugatucket River likely supports a more diverse assemblage of wildlife and

aquatic species.

The macroinvertebrate species composition in the sediments of the Saugatucket River appears to be affected by the disposal areas. The species composition (in terms of the relative abundance of dominant organisms) adjacent to the disposal areas appears to be different from the species composition in upstream and downstream locations. The area adjacent to the Bulky Waste Area has the most contaminated sediments and pollution-tolerant taxa did occur in relatively high numbers in the sediments compared to the taxa in sediments in upstream and downstream locations.

Organisms in the water column of the Saugatucket River also appear to be more directly influenced by the disposal areas and leachate seeps. Total densities of organisms in the water column downstream of the disposal areas and leachate seeps are significantly lower than at upstream locations. The occurrence of pollution-sensitive invertebrate taxa in the water column also decreased from upstream to downstream locations. There also appears to be a scarcity of fish in this section of the river, where resident and migratory fish would be expected to occur.

The benthic macroinvertebrate community in Mitchell Brook does not appear to be as diverse as that of the Saugatucket River. In general, the macroinvertebrates in Mitchell Brook sediments and surface waters showed a pattern of decreasing densities from upstream to downstream locations. Species density and diversity were especially low adjacent to the disposal areas. Additionally, the occurrence of pollution-sensitive species decreased from upstream to downstream locations. In the Brook, as in the Saugatucket River, few fish were observed.

Historical sampling data gathered in support of the Preliminary Assessment and Site Investigation indicated the presence of contaminants in groundwater, landfill leachate, surface water, and sediments within the vicinity of the Site. The contamination information was summarized in the Preliminary Health Assessment written by ATSDR in 1990 and presented as follows:

- Historical contaminant concentrations in ground water collected from on-site wells were variable.

- Surface water quality data from Mitchell Brook collected in 1982 revealed the presence of 1,1,1-trichloroethane (2 ppb), methylene chloride (1 ppb), 1,2-dichloroethylene (11 ppb), 1,1-dichloroethane (1 ppb), and toluene (2 ppb).

- Off-site residential wells have also intermittently revealed the presence of contaminants reportedly attributable to the Site. These contaminants included trans-1,2-dichloroethylene (27 ppb), trichloroethylene (6 ppb), di-n-butyl phthalate (20 ppb), and diethyl phthalate (20 ppb).

- In leachate, primarily from the Solid Waste Landfill, 1,1-dichloroethylene (5 ppb), trans-1,2-dichloroethylene (10 ppb), cis-1,2 dichloroethylene (2,260 ppb), benzene (15 ppb), toluene (385 ppb), ethylbenzene (35 ppb), and m-xylene (50 ppb) were reported.

- Surface water and soil samples collected in November 1987 and March 1988 revealed several volatile and extractable organic compounds; however, sampling and analytical problems precluded further use of this data.

Based upon, and in response to, the preliminary studies, the RI field work was initiated in 1991 and completed in 1994. Chemical data for surface soil, subsurface soil, groundwater, surface water, sediment, leachate, and landfill gas derived from the RI field investigation are presented below. The nature and extent of contamination in the Site study area was evaluated using analytical data generated during the RI field investigation. The results of the field investigation and information on the historical activities associated with the Site study area were used to provide an understanding of contamination and Site condition. A chronology of the RI field investigation activities is found in Table 2. To more effectively present the analytical data for the Site, sampling locations are grouped according to geographical location, disposal area or water body. Table 3 presents, by media, the different groupings used in this section.

A. Soil

Thirteen surface soil samples (SS-01 to SS-13), from 0 to 6 inches in depth, were collected in September/October 1991. In April 1992, 11 additional samples (SS-14 to SS-24) were collected from depths of 0 to 12 inches.

Three background locations (SS-01, SS-02, and SS-14) were selected and sampled. Three samples were located on the Sewage Sludge Area (SS-11, SS-12, and SS-15), three on the Bulky Waste Area (SS-09, SS-10, and SS-24), six on the Solid Waste Area (SS-03, SS-04, SS-05, SS-13, SS-16, and SS-17), and nine in non-disposal areas (SS-06, SS-07, SS-08, SS-18, SS-19, SS-20, SS-21, SS-22, and SS-23). Surface soil sampling locations are shown in Figure 3. Samples were analyzed for the following parameters:

- Volatile organics
- Semivolatile organics
- Pesticides and PCBs
- Metals
- Cyanide
- Total combustible organics (TCO; September 1991 only)
- Grain size (September 1991 only)

In addition, fourteen subsurface soil samples were collected from seven soil borings (two from each boring). Each of the borings was advanced to a depth of 20 feet. One background boring, BH-05, was drilled. Four borings were advanced in the Sewage Sludge Area (BH-01 through 04), one boring was advanced in the Bulky Waste Area (BH-06), and one was advanced in the Solid Waste Area (BH-07). Two samples from each boring were also analyzed for the above listed parameters. The analytes detected in surface soils are presented in Tables 4 and 5. The analytes detected in subsurface soils are presented in Table 6.

Surface Soil Results Summary. The presence of organic compounds in the surface soils were largely related to location (proximity to waste disposal areas). Volatile organics were the most prevalent organic compounds detected, and chlorinated and aromatic compounds and ketones were detected most frequently and in the highest concentrations. Refuse and landfill gas were the primary sources of volatile organics in surface soil. Elevated iron concentrations were found in samples near leachate seeps, and elevated lead was found throughout the Site.

Background Results. Three background samples (SS-01, SS-02, and SS-14) were collected north of the disposal areas. The locations selected were in areas that are upgradient of disposal areas and appear undisturbed by landfill operations. Samples were collected from topsoil materials and did not exhibit any signs of recent disturbance. As a result, the samples collected are considered to be representative of background conditions for surface soil.

Five organic compounds were detected infrequently at concentrations below sample quantitation limits in the background samples. Acetone was detected at 480 µg/kg in SS-14. Two phthalates, diethylphthalate and butylbenzylphthalate, were each detected at SS-02 (31 µg/kg) and SS-01 (41 µg/kg), respectively. Phthalates are widely distributed in residential as well as commercial areas because they are components in many plastics, pesticides, hydraulic oils, and lubricants. Since much of the Site study area has been used for multiple purposes, such as farming and residential use, the detection of phthalates was not unexpected.

Two polycyclic aromatic hydrocarbons (PAHs), fluoranthene (25 µg/kg) and pyrene (29 µg/kg), were also detected in SS-01, which is located approximately 20 feet away from a dirt road, and are most likely attributable to vehicular activities. Four pesticides were found in SS-01 and SS-14 at concentrations ranging from 0.6 to 1.2 µg/kg: 4,4'-DDT, 4,4'-DDE, aldrin, and endrin ketone. This family of chlorinated pesticides has been regularly used for insect control in both residential and agricultural applications from the early 1900s to the 1980s. The concentrations detected are most likely residual pesticides that were applied in the past to areas in or surrounding the Site study area. PCBs were not found in any of the background samples.

With the exception of sodium, major-metal ions (aluminum, iron, calcium, magnesium, and potassium) were detected in the three background samples at concentrations higher than those for other metals. Aluminum ranged from 12,200 to 16,600 mg/kg, iron ranged from 12,300 to 18,100 mg/kg, and basic cations (calcium, magnesium, and potassium) ranged from 213 to

1,360 mg/kg. Sodium was not reported as discussed in section 2.6. Other metals detected in the background samples include barium (15.4 to 37.8 mg/kg) and 12 heavy metals:

arsenic	2.1 to 2.8 mg/kg
chromium	11.2 to 17.5 mg/kg
cobalt	3 to 3.6 mg/kg
copper	3.5 to 5.3 mg/kg
lead	11.1 to 30.1 mg/kg
manganese	82 to 267 mg/kg
mercury	0.17 mg/kg
nickel	4.1 to 5.5 mg/kg
thallium	0.28 mg/kg
vanadium	16 to 25.7 mg/kg
zinc	21 to 30.1 mg/kg

These metals are present in other soil samples in the eastern United States and Rhode Island, with the exception of thallium, which was not analyzed for, and beryllium, which was not detected in the literature samples. Barium, beryllium, chromium, cobalt, copper, lead, manganese, mercury, vanadium, and zinc were also found in background subsurface soil samples collected in the Site study area. Aluminum, lead, and mercury were found at concentrations within the ranges listed for the eastern United States and at concentrations less than those reported in the Rhode Island sample. Lead and beryllium were found at concentrations above those reported for the Rhode Island sample but within the range reported for the eastern United States. Since metals are naturally occurring in soils and can vary within a small area, it was not possible to determine the significance of differences between literature values and concentrations detected in these samples. However, lead concentrations may be elevated throughout the Site study area because of bullets (or pellets, shot) used in the shooting of game birds, skeet shooting, and target practice, in recent years.

Cyanide was not detected in any of the background samples. The organic content of the samples was measured as 6.8 and 7.5% at SS-01 and SS-02, respectively, which indicate low organic content in the soils.

Sewage Sludge Area Results. Surface soil samples were collected at three locations (SS-11, SS-12, and SS-15) in the Sewage Sludge Area. Topsoil/fill material was encountered at thicknesses of 2 to 5 feet (based on boring activities) in several locations in the Sewage Sludge Area. The origin and thickness of fill overlying the Sewage Sludge Area is not entirely known. The fill is reportedly from a combination of off-site sources and sand and gravel excavated from areas north of the disposal areas (Figure 4). There was no evidence of sludge material in any of the surface soil samples. In addition, vegetation was not present in the immediate vicinity of SS-11.

The analytes detected are presented in Tables 4 and 5. Figures 5 and 6 present a summary of the organic compounds detected.

A few organic compounds, including several volatile and semivolatile organics and pesticides, were identified in two of the surface soil samples (SS-11 and SS-12), but were not detected in SS-15 (Tables 4 and 5). PCBs were not detected in any of the samples.

Acetone was detected in SS-11 (23 µg/kg) and SS-12 (14 µg/kg), and 2-butanone (MEK) was detected in SS-12 (4 µg/kg). Diethylphthalate was also detected at a concentration less than sample quantitation limits (29 µg/kg) in SS-12. A similar concentration was found in a background surface soil sample. Tetrachloroethene and pyrene were detected in SS-11 at concentrations below sample quantitation limits (2 µg/kg and 26 µg/kg, respectively). Pyrene was also detected in the background surface soil.

In addition, 4-chloroaniline, dieldrin, and *alpha*-chlordane were detected in SS-11 at 490, 4.5, and 3.7 µg/kg, respectively. The source of these compounds is not clear. The immediate area from which SS-11 was collected is characterized by the absence of vegetation. While there was no physical evidence of sludge material at this location, similar compounds were detected in subsurface media investigated in this area. *alpha*-Chlordane was detected from 2 to 8 feet in BH-01, located in the southern portion of the disposal area, and 4-chloroaniline was also found in groundwater from MW-II, in the central portion of the Sewage Sludge Area. Both the boring and well are in contact with sludge material.

If present in buried sludge, limited partitioning of pesticides from the sludge material upwards into the cover material would be expected because of strong adsorption and low volatility characteristics of pesticides in soils. Dieldrin is a photo- and biodegradation product of aldrin, which was found in background surface soil. In addition, chloroanilines are formed from the degradation of some pesticides and can be produced during wastewater treatment. For these reasons, these compounds may be attributed to the underlying sludge material. However, 4-chloroaniline is also used in agricultural chemicals.

Of the 20 metals detected in surface soil samples, major-metal ions (aluminum, iron, calcium, magnesium, and potassium) were detected in each of the samples and at higher concentrations than those for other metals. Concentrations ranged from 3,450 to 6,740 mg/kg for aluminum, from 7,190 to 10,400 mg/kg for iron, and from 263 to 1,300 mg/kg for basic cations. Sodium would also be expected to be detected, but was not reported, as described in section 2.6.2. Besides major-metal ions, barium, lead (2.6 to 11.8 mg/kg), manganese (96.4 to 135 mg/kg), and zinc (19.9 to 56.5 mg/kg) were detected in the three surface soil samples. Other heavy metals, consisting of arsenic (0.52 to 0.86 mg/kg), chromium (5.3 to 9.8 mg/kg), cobalt (3 to 3.6 mg/kg), and nickel (3.9 to 5.4 mg/kg), were found in SS-11 and SS-12 (both were collected in September/October 1991 from depths of 0 to 6 inches), while copper (9.9 to 99.3 mg/kg) and vanadium (12 mg/kg) were detected at SS-11 and SS-15, which was collected in April 1992 from

depths of 0 to 12 inches. Antimony, mercury, and silver were detected in SS-11 at 78.8, 0.28, and 1.6 mg/kg, respectively. Thallium (0.25 mg/kg) was found in SS-12. Beryllium (0.4 mg/kg) was detected at SS-15. Generally, more heavy metals and higher metal concentrations were measured in SS-11 relative to the other two samples.

With the exception of antimony, all of the metals detected in these surface soil samples were also found in background surface soils. In comparison to the largest metal concentrations detected in background samples, concentrations were less than two times greater than background for barium, manganese, and zinc, but were as much as 20 times greater for copper. Copper was the only metal that was significantly higher in concentration in the Sewage Sludge Area than in the background samples. All of the other metals detected in the surface soil samples were within or below the range detected in the background samples.

Cyanide was not detected in any of the samples. The organic content of the samples was measured at 0.9 and 2.8% in SS-12 and SS-11, respectively.

Bulky Waste Area Results. Three surface soil samples (SS-09, SS-10, and SS-24) were collected from the Bulky Waste Area. The sample located at SS-09 was selected because of the detection of elevated volatile organics in landfill gas at this location. The other sample locations were chosen to characterize the area. During installation of landfill settlement platforms, 2 to 4 feet of fill was encountered at ground surface in this area, whereas refuse was found at ground surface at the eastern perimeter during boring activities (BH-06). This indicates that fill/soil material does not continuously cover the area.

The surface soil samples collected consisted predominantly of topsoil and sand or sand/gravel material. Refuse was not visible, although organic vapors and methane (CH_4) were measured during sampling. Vegetative cover in the area generally consisted of tall grass (section 3.4 of the RI).

Organic compounds were detected at SS-09 and SS-10 but were not detected at SS-24. The types of organic compounds found included chlorinated and aromatic volatiles, ketones, and one phthalate. Acetone, MEK, and PCE were the only compounds detected at concentrations above sample quantitation limits. Pesticides and PCBs were not detected in any of the samples.

Two ketones, acetone (45,000 µg/kg) and MEK (1,400 µg/kg), were detected at SS-09. Acetone was also detected at SS-10 (37 µg/kg). Acetone is commonly found in municipal and industrial landfills from the disposal of solvents or industrial materials, and MEK was identified in industrial waste disposed of in the Solid Waste Area. In addition, production of acetone during degradation processes results in releases to subsurface media.

Chlorinated organics detected at SS-09 include PCE (24 µg/kg) as well as 1,2-DCE, chloroform, and TCE at concentrations less than the sample quantitation limit (8, 2, and 2 µg/kg, respectively).

Tetrachloroethene was also found at SS-10 (3 µg/kg). Three aromatic volatiles consisting of toluene, ethylbenzene, and xylene were also detected at concentrations up to 10 µg/kg at SS-09. Butylbenzylphthalate, which was also found in background surface soil, was detected in SS-10 at a concentration less than the sample quantitation limit (120 µg/kg). These organic compounds are known to have been disposed of during landfill operations, and are typically found in municipal wastes.

Of the 13 metals detected in the surface soil samples, major-metal ions (aluminum, iron, calcium, magnesium, and potassium) were detected at the highest concentrations in all of the samples. Aluminum ranged from 6,500 to 8,940 mg/kg, iron from 9,240 to 11,650 mg/kg and basic cations from 442 to 1,270 mg/kg. Sodium was also detected at similar concentrations, but was not reported. Barium (14.4 to 16.5 mg/kg), manganese (105 to 154 mg/kg), lead (4.3 to 5.6 mg/kg), vanadium (10.2 to 15 mg/kg), and zinc (19.3 to 36 mg/kg) were also found at all three locations. In addition, beryllium and copper (0.52 and 5.6 mg/kg, respectively) were detected at SS-24. Arsenic, chromium, cobalt, and nickel were detected at concentrations from 1.05 to 9.8 mg/kg at SS-09 and SS-10. All of these metals were also found in background surface soil. Concentrations measured in the three bulky waste samples were near (less than two times greater) or within the range found in background surface soil. Cyanide was not detected in any of the surface soil samples. The organic content of the samples ranged from 1.9 to 2.9%.

Solid Waste Area Results. Six surface soil samples were collected from the Solid Waste Area. Surface soil sampling points SS-03, SS-04, and SS-05 were located to evaluate areas where volatile organics were detected in landfill gas. Locations for SS-16 and SS-17 were chosen to further characterize the area, and SS-13 was located near exposed glue-like waste.

During walkovers of the Solid Waste Area many places of exposed refuse were observed. Many of these areas are located near the perimeters of the disposal area, although other exposed areas are also within the boundaries of the disposal area. Two of the samples (SS-03 and SS-05) were collected in areas where there was little topsoil or fill material, and outcrops of exposed refuse occurred. Elevated levels of organic vapors were measured during excavation of these samples. The sample collected at SS-03 consisted of sandy soil intermixed with decomposing refuse and spongy glue-like waste material, while the sample collected at SS-05 was composed of topsoil and refuse. At SS-04, 3 inches of brown weathered sand underlain by a darkly stained sand was sampled. Elevated readings were detected at this location with the FID but not the PID. Similar measurements were made at SS-13, where organic-enriched topsoil, sand, and spongy glue-like waste were collected. A chunk of this waste removed from near SS-13 was analyzed and found to consist of methyl methacrylate, a component of laminants and adhesives (section 4.1 of the RI). Again elevated FID readings were measured, although no PID readings occurred at this location. The other two samples (SS-16 and SS-17) were collected from locations where topsoil and vegetative cover were present. These samples consisted of compacted sand and silt intermixed with pebbles and organic-enriched soil, respectively. There was no visible evidence of refuse in these samples.

Similar findings were also noted during boring and excavation (installation of landfill settlement platforms) activities, as fill material at the ground surface ranged in thickness from 0 to 1.5 feet. In addition, grey or dark-stained soil that was similar to the material collected at SS-04 was also noted at about 0.5 feet below the ground surface at several locations.

The types of volatile organics detected in the surface soils consisted of chlorinated and aromatic volatiles and ketones. Semivolatile organics found include PAHs and phthalates. Pesticides were also detected. PCBs were not detected in any of the samples.

Volatile organics were detected in all of the surface soil samples except at SS-17. Eight of the volatile organics (including 1,1-DCA, 1,2-DCE, toluene, ethylbenzene, xylenes, acetone, and MEK) were generally found in higher concentrations and more often than other volatile organics. Other volatile organics (including PCE, 1,1,1-TCA, 1,1-DCE, chloroform, benzene, 4-methyl-2-pentanone (MIBK), and 2-hexanone were found at concentrations less than sample quantitation limits. Vinyl chloride was also detected.

The majority of chlorinated volatiles were detected in SS-03 and SS-13. Total concentrations at SS-13 were 2,700 µg/kg and at SS-03 were 1,000 µg/kg. As previously mentioned, these samples were collected near refuse and glue-like waste. Chlorinated volatiles were also detected in SS-05 and SS-04. These locations were also sampled near refuse or in discolored fill, respectively. Tetrachloroethene was detected at concentrations below sample quantitation limits (2 to 5 µg/kg) in SS-03, SS-04, and SS-13. 1,1,1-Trichloroethane was also found at 8 µg/kg in SS-03. 1,2-Dichloroethene was found at the highest concentrations in SS-03 (970 µg/kg) and SS-13 (2,400 µg/kg). 1,1-Dichloroethane was also detected in SS-03 (25 µg/kg), while 1,1-DCE was detected in SS-13 (4 µg/kg). Vinyl chloride was also detected at SS-13 (250 µg/kg) and at SS-03 (4 µg/kg). Dichlorinated volatiles and vinyl chloride are common degradation products. In addition, up to 3 µg/kg of chloroform was found at SS-05 and SS-03.

Aromatic volatiles consisting of benzene, toluene, ethylbenzene, and xylenes (BTEX compounds) were present at three of the surface soil samples (SS-03, SS-04, and SS-13). Toluene (58 to 110 µg/kg), ethylbenzene (11 to 21 µg/kg), and xylenes (20 to 84 µg/kg) were found in all three samples. In addition, benzene was detected at 6 µg/kg in SS-03 and SS-13. The highest total BTEX concentrations (220 µg/kg) occurred at SS-13.

The ketones detected in surface soils in this area include acetone, MEK, 2-hexanone, and MIBK. Ketones were detected more often and in the highest total concentrations at SS-04 (160,000 µg/kg), and were also found in SS-03, SS-05, SS-13, and SS-16 at concentrations ranging from 24 to 4,000 µg/kg. Acetone was detected at an elevated concentration (160,000 µg/kg) in SS-04. Acetone concentrations at other locations were lower (75 µg/kg in SS-05 to 4,000 µg/kg in SS-16). 2-Butanone was detected in SS-03, SS-04, and SS-13. 2-Hexanone and MIBK were each detected once at SS-04 at concentrations below sample quantitation limits (3 and 6 µg/kg, respectively).

Isopropanol (IPA) was also detected as a tentatively identified compound (TIC) in SS-04 at a relatively high estimated concentration. Since this was an isolated occurrence at elevated concentrations, it is not suspected of being an artifact from field procedures. In addition, IPA was potentially disposed of in the Solid Waste Area (Kenyon Piece Dyeworks 1979). The other volatile organics are all commonly found in municipal waste, and some of these compounds (MEK, PCE, TCE, and toluene) were components of industrial wastes deposited in this area.

Phthalates and PAHs were detected in several samples at concentrations below sample quantitation limits. Butylbenzylphthalate (41 µg/kg) was detected at SS-03, and diethylphthalate (29 µg/kg) was detected at SS-13. Similar concentrations were also detected in background samples. Ten different PAHs were each detected in SS-04, SS-05, and SS-17 at concentrations ranging from 19 to 170 µg/kg. Two of the PAHs, pyrene (38 µg/kg) and fluoranthene (33 µg/kg), were also detected in SS-13. The detection of PAHs in surface soils in urban areas is common. Debris from fires or ash from boilers or fireplaces may contain PAHs. In the past, used oils were typically applied to the surface of dirt roads or the shoulders of paved roads to reduce airborne dust. Also, fuel oil, asphalt, tar, or heavier fractions of petroleum products contain PAHs, which can be released to the environment either directly or by combustion (i.e., automobile fumes). These PAHs may also be attributed to wastes disposed of in the Solid Waste Area.

The DDT family of pesticides was detected at SS-04, SS-13, SS-16, and SS-17. Except for 4,4'-DDE, concentrations were less than sample quantitation limits. 4,4'-DDT was detected at SS-04 (4.7 µg/kg) and SS-17 (0.9 µg/kg). 4,4'-DDD was detected at SS-13 (5.2 µg/kg) and SS-16 (0.24 µg/kg), and 4,4'-DDE was detected at SS-13 (7.6 µg/kg) and SS-17 (0.33 µg/kg). 4,4'-DDE and 4,4'-DDT were also detected in background surface soil samples. The concentrations found in the Solid Waste Area, however, were generally greater than those in the background samples. The disposal of insecticides, rodenticides, or herbicides in municipal solid waste landfills was not regulated until the mid-1980s. Until then, these chemicals were regularly disposed of by the public. Hence, it is likely that these contaminants would be present in the Site study area.

Major-metals ions (aluminum, iron, calcium, magnesium, and potassium) were detected at concentrations greater than other metals. Sodium was also detected at similar concentrations, but was qualified as nondetected. Barium (15.5 to 20.3 mg/kg), manganese (92.1 to 138 mg/kg), and four heavy metals (copper, lead, vanadium, and zinc at concentrations ranging from 5.4 to 253 mg/kg) were also detected in all of the samples. Arsenic, chromium, copper, and nickel were detected at concentrations from 0.81 to 12.8 mg/kg in the four samples collected from 0 to 6 inches (SS-03, SS-04, SS-05, and SS-13). In addition, beryllium was found at SS-16 and SS-17, while silver was detected at SS-03 and SS-13, and thallium was found at SS-03. Except for silver, all of the metals detected in the Solid Waste Area were also found in background surface soil. The highest concentrations tended to occur at SS-13 or SS-03. Of the metals detected, copper concentrations were as much as 50 times greater than found in background surface soils. However, based on the available data, no statistical difference was evident between the metal concentrations, including copper, and concentrations in background surface soil

(Appendix D of the RI).

Cyanide was not reported in any of the surface soil samples. The organic content of the soil ranged from 2.3 to 9.4%.

Non-disposal Areas Results. Nine sampling locations were selected outside of the disposal area boundaries. Two surface soil samples, SS-07 and SS-08, were collected on residential property to evaluate volatile organics detected in soil gas. Samples collected from these locations consisted of roots and organic-enriched soil with sand. Organic vapors were measured at SS-07. Locations for SS-18, north of the Solid Waste Area, and SS-22 and SS-23, between the Bulky Waste Area and Saugatucket River, were positioned near leachate outbreaks. Samples from these locations were characterized by dark organic matter intermixed with sand, silt, and roots. An orange leachate outbreak was observed about 3 feet from SS-23. Surface soil samples SS-19 and SS-20 were collected south of the Solid Waste Area, in a wooded area near Mitchell Brook. Samples consisted of decomposing organic matter intermixed with sand and silt. In an open area, approximately 150 feet south of the Transfer Station Road, SS-06 was collected. SS-21 was collected in a low-lying drainage area next to the eastern perimeter of the Solid Waste Area. The sample was collected from a 4-by-25-foot area with little to no vegetation and orange-stained sand that was presumed to be a dried-up leachate seep since a drainage swale was identified near this location (Figure 7). Orange-stained sandy soil was collected at this location.

Volatile organics (chlorinated and aromatic volatiles and ketones) were detected at five locations. Chlorinated volatiles were detected at concentrations below sample quantitation limits in three locations. Tetrachloroethene was found at 4 µg/kg in SS-08, while 1,1-DCA and 1,2-DCE were found in SS-07 at 2 (field duplicate only) and 6 µg/kg, respectively. SS-07 was collected near an area where leachate seeps were observed in past years by the residents and elevated volatile organic concentrations were measured in landfill gas a few feet away. Chloroform was detected in SS-06 (2 µg/kg), which is less than 100 feet from where landfill gas was detected. Concentrations of BTEX compounds ranged from 2 to 12 µg/kg. Ethylbenzene, toluene, and xylene were detected at SS-22, and toluene was found at SS-23. These compounds were also detected in a nearby leachate seep (section 4.2.3 of the RI). Acetone and MEK were found in SS-06, SS-07 (in field duplicate), SS-08, and SS-22 at concentrations ranging from 15 to 4,400 µg/kg and 23 to 33 µg/kg, respectively. Volatile organics were not detected at three locations: SS-19, SS-20, and SS-21.

Diethylphthalate (27 to 42 µg/kg) was detected in SS-20 and SS-22 at concentrations similar to those found in background surface soil. Ten individual PAHs, at concentrations ranging from 31 to 100 µg/kg, were detected at SS-07. While individual concentrations were below sample quantitation limits, total concentrations equaled 560 µg/kg. At this location, these compounds have likely resulted from runoff from Rose Hill Road, approximately 10 feet away. Several PAHs were also found in background surface soil at similar concentrations.

Other PAHs were detected in SS-08, SS-22, and SS-23 at concentrations ranging from 23 to 120 µg/kg. Two pesticides, 4,4'-DDT (0.38 to 5.2 µg/kg) and 4,4'-DDE (0.38 to 11 µg/kg), were found in SS-07, SS-18, SS-22, and SS-23. Endrin ketone was found at a concentration of 2.3 µg/kg in SS-08. These pesticides were also found in background surface soil, although at lower concentrations. PCBs were not detected in any of the samples. SS-22 and SS-23 are located downslope and downgradient of the Bulky Waste Area, near large leachate outbreaks. SS-18 is located downslope of the Solid Waste Area, and SS-08 is located on residential property.

Major-metal ions (aluminum, iron, calcium, magnesium, and potassium), barium (3.1 to 3.5 mg/kg), lead (2.8 to 6.3 mg/kg) manganese (12.9 to 6,120 mg/kg), vanadium (3.2 to 27.2 mg/kg), and zinc (10.3 to 37.4 mg/kg) were detected in each of the samples. Other metals detected include beryllium (0.37 to 0.88 mg/kg), arsenic (3.1 to 3.5 mg/kg), chromium (3.2 to 13.9 mg/kg), cobalt (3.8 to 12.8 mg/kg), copper (2.8 to 6.3 mg/kg), mercury (0.2 to 4.1 mg/kg), nickel (6.2 to 10 mg/kg), and selenium (5.9 mg/kg). Concentrations of major-metal ions were larger than those of the other metals detected: aluminum was 1,740 to 14,400 mg/kg, iron was 4,090 to 149,000 mg/kg, and basic cations were 106 to 1,710 mg/kg. The number of metals as well as concentrations tended to be higher in surface soil collected near leachate seeps (SS-18, SS-22, and SS-23). In particular, iron concentrations (15,100 to 149,000 mg/kg) at these locations were elevated in relation to background surface soil. Elevated iron concentrations were also found at SS-21 (40,500 mg/kg), collected from a large area of orange-stained soil to the east of the Solid Waste Area, presumed to be a dried-up leachate seep or drainage area.

Cyanide was not detected in any of the surface soil samples. The organic content of soils analyzed for TCO ranged from 3.2 to 12.6%.

Subsurface Soils Results Summary. Within the disposal areas, seven soil boring locations, including one background, four located in the Sewage Sludge Area, and one each in the Bulky and Solid Waste Areas, were drilled to collect subsurface soils. Fourteen samples were collected from the seven borings (two from each boring). The chemicals detected included typical municipal and industrial wastes: ketones, toluene, PAHs, phthalates, phenols, pesticides, and dichlorobenzenes. These compounds were similar to the types of compounds detected in surface soils and landfill gas. Although several metals were detected, most were not significantly elevated compared to background soils. Buried waste provides an active source for the release of contaminants to subsurface soils.

Background Results. The background boring, BH-05, was located in a wooded area just northwest of the Sewage Sludge Area. Trees in the area appear to be at least 20 to 30 years old. In addition, aerial photographs taken from 1941 to 1988 (United States Environmental Protection Agency1987a, 1991a) indicate that excavation has not occurred and that this location has remained largely undisturbed during landfill operations. Glacial outwash was present throughout the boring. For these reasons, the samples collected from BH-05 are considered to be representative of background conditions in subsurface soils.

Volatile organics, pesticides, and PCBs were not identified in either of the samples from BH-05. The only semivolatile organics detected in samples from this boring were two phthalates, at concentrations less than sample quantitation limits. Di-n-butylphthalate was detected at 62 µg/kg from 0 to 2 feet, and di-n-octylphthalate was detected at 19 µg/kg from 10 to 16 feet but was not detected in the field duplicate for this sample.

Major-metal ions (aluminum, iron, magnesium, and potassium) were detected in both samples at concentrations that were higher than those for other metals. Concentrations ranged from 3,955 to 11,800 mg/kg for aluminum, from 6,415 to 12,800 mg/kg for iron, and from 415 to 1,350 mg/kg for magnesium and potassium. Calcium and sodium were also detected, but were not reported because of qualifications during validation. Beryllium (0.47 to 0.59 mg/kg) and seven heavy metals including chromium (3.8 to 9.2 mg/kg), cobalt (3.1 to 5.4 mg/kg), copper (3.4 to 3.5 mg/kg), lead (2.6 to 12.6 mg/kg), manganese (125 to 148 mg/kg), vanadium (6.2 to 19.3 mg/kg), and zinc (12.1 to 20 mg/kg) were also detected in each of the samples. In addition, barium (19.1 mg/kg) and mercury (0.15 mg/kg) were each detected in only one sample. All of these metals were also detected in background surface soils. With the exception of beryllium and cobalt, which were as much as two times greater, concentrations of the metals detected were within the range found in background surface soil. Aluminum concentrations were higher than those reported for soils in the eastern United States, but were lower than those reported for Rhode Island (Table 7).

Cyanide was not detected in either of the background subsurface soils. An organic content of 0.7% was measured in BH-01 (10 to 16 feet). The grain-size distribution shows that the outwash material is predominately composed of sand (51.1%), with some silt and small quantities of clay and gravel present (39.4, 3.1, and 6.5%, respectively).

Sewage Sludge Area Results. Four borings (BH-01 to BH-04) were advanced in the Sewage Sludge Area. Soil borings BH-01, BH-03, and BH-04 were located to evaluate minor landfill gas readings, while BH-02 was advanced to help define the western perimeter of the disposal area boundary. Between 2 and 6 feet of topsoil and fill material were encountered at the top of each borehole. At BH-02 and BH-04, the remainder of the borehole consisted of glacial outwash material. Although no odors, staining, or sludge material were observed in these borings, organic vapors were measured in BH-04. Sludge material and sewage odors were evident during advancement at BH-01 and BH-03. Elevated organic vapor levels were also measured in these borings.

The analytes detected are summarized in Table 6. The organic compounds detected are shown on Figure 8. Volatile organics, phenols, phthalates, and pesticides were detected in several subsurface soil samples. PCBs were not found in any of the samples.

No volatile organics were detected in the shallow sample at BH-03 (2 to 4 feet) or in either of the samples collected at BH-02 and BH-04. Sludge material and sewage odors were observed in the

samples in which volatile organics were found. Toluene was detected in one sample, BH-03 (16 to 20 feet). Acetone and MEK were each found in samples from BH-01 (2 to 8 feet and 10 to 16 feet) and in BH-03 (16 to 20 feet). Concentrations ranged from 84 to 740 µg/kg for acetone and 73 to 340 µg/kg for MEK. Acetone was also found in landfill gas at a depth of 12 feet in this area (section 4.2.8). The highest concentrations for both these chemicals occurred in BH-01 (2 to 8 feet).

Phenol, PAHs, and phthalates were found in BH-01, BH-02, and BH-03. One PAH, 2-methylnaphthalene was detected at 27 and 140 µg/kg in the two samples from BH-01 (0 to 8 feet and 8 to 10 feet, respectively). Likewise, 4-methylphenol (2,200 and 5,600 µg/kg) was found in the two samples from BH-01 (2 to 8 feet and 8 to 10 feet), respectively. Phenol (240 µg/kg) was also detected in the shallow sample (2 to 8 feet). Concentrations of these compounds tended to be higher in the sample from 2 to 8 feet than in the deeper sample from 8 to 10 feet. Another phenol, 2-methylphenol (700 µg/kg), was detected from 16 to 20 feet at BH-03.

Phthalates, which are ubiquitous in the environment, were found in all of the borings in this area and in background subsurface soil. Two phthalates were detected at concentrations less than the sample quantitation limit. Di-n-butylphthalate was detected at concentrations ranging from 40 to 120 µg/kg in four samples: BH-02 (8 to 10 and 16 to 18 feet), BH-03 (16 to 20 feet), and BH-04 (8 to 10 feet). Di-n-octylphthalate was detected in BH-02 (16 to 18 feet) and BH-03 (16 to 20 feet) at concentrations of 26 to 86 µg/kg, respectively. Although BH-02 and BH-04 were composed of glacial outwash, it is likely that the material was disturbed because of the extensive excavation throughout the disposal area.

Two chlordane pesticides (*alpha* at 6.2 mg/kg and *gamma* at 7.5 mg/kg) were detected in one sample, BH-01 (2 to 8 feet). *alpha*-Chlordane was also detected in surface soil and is typically found in Sewage Sludge Landfills.

Of the 15 metals detected in the subsurface soils in this area, major-metal ions (aluminum, iron, magnesium, and potassium) were detected at the highest concentrations (367 to 8,635 mg/kg). Aluminum concentrations ranged from 3,705 to 6,000 mg/kg, iron ranged from 3,400 to 8,635 mg/kg, and magnesium and potassium ranged from 367 to 1,700 mg/kg. Beryllium (0.35 to 0.71 mg/kg) and six heavy metals, including chromium (1.6 to 8.9 mg/kg), cobalt (1 to 6.3 mg/kg), copper (4.2 to 79.2 mg/kg), lead (2.3 to 8.8 mg/kg), vanadium (5.7 to 11.4 mg/kg), and zinc (16.5 to 188 mg/kg), were reported in at least seven of the samples (Table 4-8). Barium (10.1 to 54.3 mg/kg), antimony (5.4 to 16.8 mg/kg), manganese (106 to 213 mg/kg), and mercury (0.13 to 0.47 mg/kg) were detected less often.

Generally, the highest concentrations were found in one of the two samples from BH-01. Except for antimony, all of the metals detected were also found in background surface soils. Most of the metal concentrations were near (less than two times greater) or within the range detected in background subsurface soils. Barium and manganese were as much as two to three times higher,

while zinc was as much as nine times higher, and copper was as much as 20 times higher than the concentration detected in background surface soil.

As shown in Table 8, elevated metal concentrations typically occur in sewage sludge landfills. The highest metal concentrations tended to occur in samples collected from BH-01 and BH-03, where sludge was observed. Even though large differences in concentrations were evident for some metals, none of the differences were found to be significantly higher for samples associated with sludge material from this area in comparison to background subsurface soil (Appendix D of the RI).

Cyanide was not detected in any of the samples. The organic content in samples from BH-01 (2 to 8 feet) and BH-03 (16 to 20 feet) was 3.0 and 0.5%, respectively. Grain-size distribution for these samples shows that sand is the predominant fraction (61.4 to 79.9%), with some silt (14.1 to 29.4%), and only small percentages of gravel and clay (5.5 to 6.8% and 0.4 to 2.3%, respectively).

Bulky Waste Area Results. One soil boring (BH-06) was located in the Bulky Waste Area. During drilling, a large amount of refuse was encountered from 0 to 6 feet, which was underlain by glacial outwash from 6 to 20 feet. The types of refuse identified included nylons, paper, bottles, wire, and black organic (decomposed) material. Two samples were collected: one from 2 to 4 feet and a second from 6 to 10 feet.

One volatile organic (acetone) and one pesticide (4,4'DDE) were detected at this boring. No semivolatile organics or PCBs were found at either of the depths. A summary of the organic compounds is presented in Figure 8.

Acetone was detected at concentrations of 350 and 48 µg/kg at 2 to 4 feet and 6 to 10 feet, respectively. This compound was also found in landfill gas at other portions of this disposal area. 4,4'-DDE was detected at 4.6 µg/kg in the 2-to-4-foot sample. The detection of this pesticide is most likely attributed to the materials disposed of in the Bulky Waste Area, although 4,4'-DDE was also found in background surface soil at a lower concentration.

Major-metal ions (aluminum, iron, magnesium, and potassium) were detected in both samples at the highest concentrations (401 to 9,530 mg/kg). Barium, beryllium, and seven heavy metals [chromium (3 to 6.3 mg/kg), cobalt (3.5 mg/kg), copper (3.3 to 4.1 mg/kg), lead (4.5 to 61.4 mg/kg), mercury (0.2 to 0.24 mg/kg), vanadium (6.7 to 11.3 mg/kg), and zinc (18.9 to 95.9 mg/kg)] were also detected in both samples. In addition, antimony was found at 6.0 mg/kg from 6 to 10 feet, and manganese was found at 116 mg/kg from 2 to 4 feet. Concentrations of individual metals were usually near or within the range detected in background samples. Concentrations of mercury were less than two times greater, and lead and zinc were as much as five times higher than those in the background. Even though some of these metal concentrations were elevated, it cannot be demonstrated that there is any significant difference between concentrations in these subsurface soil samples compared to those in background subsurface soil

(Appendix D of the RI).

Cyanide was not detected in either sample. The grain-size distribution and TCO analysis conducted on BH-06 (6 to 10 feet) indicate that sand (59.8%) was the largest fraction present, followed by silt (29.8%), gravel (8.8%), and clay (5.5%). An organic content of 1.0% was also measured.

Solid Waste Area Results. One soil boring (BH-07) was drilled at the southern end of the Solid Waste Area. A strong refuse odor was present during drilling activities, and organic vapors ranging from 30 to 300 ppm occurred. Assorted refuse, including household garbage, milk cartons, plastic, and paper, was encountered throughout the entire 20 feet of the boring. Both samples (4 to 8 feet and 14 to 18 feet) collected from this boring contained refuse material.

Volatile organics were not detected in either sample collected from BH-07 because of elevated detection limits that may have masked detectable concentrations. This was discussed in more detail in section 2.6.2 of the RI. However, semivolatile organics, pesticides, and PCBs were detected.

Even though volatile organics were not identified in subsurface soil, landfill gas (section 4.2.8 of the RI) and surface soil data indicate that aromatic and chlorinated volatiles were present in a large range of concentrations throughout most of the Solid Waste Area. Ketones were also identified in these media.

Semivolatile organics (PAHs, phthalates, dichlorobenzenes, and phenols) were found in the two samples collected at BH-07. Seven different PAHs (naphthalene, 2-methylnaphthalene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, and chrysene) were detected from 4 to 8 feet. Three PAHs (naphthalene, 2-methylnaphthalene, and phenanthrene) were also found in the sample collected from 14 to 18 feet. When detected, individual PAH concentrations were higher at the 14 to 18 foot depth.

Two dichlorobenzenes (1,2-dichlorobenzene and 1,4-dichlorobenzene) were found from 4 to 8 feet at 240 and 97 μg/kg, respectively. Two phenols, consisting of 2-methylphenol and 4-methylphenol, were detected from 4 to 8 feet at 260 μg/kg and from 14 to 18 feet at 4,000 μg/kg, respectively. Dichlorobenzenes and methylphenols (creosols) have many uses including uses as disinfectants, moth control agents, synthetic resins, and wood preservatives. A variety of mixtures containing methylphenols include degreasers and cutting oils. Dichlorobenzenes are also used in pesticides, waxes, and agricultural chemicals. Because of the various uses of these chemicals, municipal or industrial disposal to this area is probably the dominant source.

Five different phthalate compounds (diethylphthalate, di-n-butylphthalate, bis(2-ethylhexyl)phthalate, di-n-octylphthalate, and butylbenzylphthalate) were found in both

samples from BH-07 at concentrations ranging from 96 to 18,000 µg/kg. Total phthalate concentrations were generally higher in the sample collected from 14 to 18 feet (25,000 µg/kg) than in the sample collected from 4 to 8 feet (2,556 µg/kg). Given that phthalate concentrations were higher in the subsurface soil than in other soils in the study area, coupled with the types of refuse found, these phthalates may be attributed to the materials deposited in this disposal area.

Five pesticides detected from 14 to 18 feet included 4,4'-DDD (26 µg/kg), 4,4'-DDE (12 µg/kg), dieldrin (14 µg/kg), *alpha*-chlordane (17 µg/kg), and *gamma*-chlordane (15 µg/kg). Only 4,4'-DDE was found from 4 to 8 feet (12 µg/kg). Although these pesticides have been found in other surface and subsurface soils in the Site study area, it is likely that they are associated with the buried refuse in the Solid Waste Area.

Two PCB aroclors, 1242 and 1254, were detected in samples from BH-07. Aroclor-1242 was detected at 310 µg/kg in the sample collected from 14 to 18 feet, while aroclor-1254 was detected at 270 µg/kg in the sample collected from 4 to 8 feet. PCBs were also detected in monitoring wells MW-08-01, MW-08-02, and MW-05-01 (section 4.2.4 of the RI), although a different aroclor was identified. The primary use of PCBs is in capacitors and transformers. Aroclor-1242 was also used in light ballasts, and aroclor-1254 was also used in small appliances. Because disposal of PCBs was not regulated until 1978, it is possible that materials containing PCBs could have been disposed of during landfill operations.

In addition to the organic compounds, major-metal ions (aluminum, iron, magnesium, and potassium), barium (16 to 22.9 mg/kg), beryllium (0.39 to 0.7 mg/kg), chromium (5.5 mg/kg), cobalt (1.8 to 3.3 mg/kg), copper (7.4 to 18.9 mg/kg), lead (19.4 to 20.2 mg/kg), mercury (0.18 to 0.39 mg/kg), vanadium (5.5 to 9.3 mg/kg), and zinc (45.5 to 68.2 mg/kg) were detected in both the samples. Concentrations ranged from 3,620 to 5,250 mg/kg for aluminum, 4,800 to 7,540 mg/kg for iron, and 618 to 1,090 mg/kg for basic cations. Antimony was also detected from 4 to 8 feet (6 mg/kg). In comparison to background subsurface soil concentrations, mercury and lead concentrations were about two times greater, zinc was about three times greater, and copper was about five times greater. These differences, however, were not found to be statistically significant in relation to background surface soil. The sample analyzed for grain size and TCO was predominantly sand (60.7%) with 27.6% silt, 8.1% gravel, and 3.5% clay. The organic content of this sample was 3.8%.

B. Groundwater

Groundwater was collected from shallow and deep overburden and bedrock monitoring wells along with residential wells in the vicinity of the Site study area. Eight existing monitoring wells and nine residential wells were sampled during June 1991. M&E installed 28 additional monitoring wells from July to September 1991. These were selectively sampled along with existing monitoring wells and nine residential wells during September/October 1991, January/February 1992, and April 1992. Samples submitted during these four rounds of sampling

were analyzed for the following parameters:

- Volatile organics
- Semivolatile organics
- Water-soluble organics (only September/October 1991, January/February 1992, and April 1992)
- Pesticides and PCBs
- Metals (unfiltered and filtered)
- Cyanide
- Sulfide (only June 1991, September/October 1991, and January/February 1992)
- Ammonia (only April 1992)
- Total organic carbon (TOC)
- Biochemical oxygen demand (BOD)

Four wells sampled during this investigation were known to be in waste material in one of the disposal areas. Three of the wells are located in the Solid Waste Area (MW-14-01, OW-25, and OW-27); the fourth well, MW-02-01, is located in the Sewage Sludge Area. A fifth well, MW-V, appears to be located within the boundaries of the Bulky Waste Area; however, drilling logs for this well were not available to confirm this. For this reason, MW-V is not considered to be in waste material. All of the other monitoring wells were installed outside of the disposal area boundaries for further characterization of the potential migration contaminants and ground water flow paths.

Summary of Groundwater Findings. Numerous organic compounds were detected in the different groundwater flow zones. The types of compounds ranged from volatile organics to compounds that were less volatile and soluble (semivolatiles, pesticides, PCBs) to compounds that were more soluble (water-soluble organics). Of these compounds, volatile organics, primarily chlorinated and aromatic volatiles, were frequently and consistently detected in groundwater throughout the study period.

The aerial and vertical extent of volatile organics in groundwater is shown in Figures 9 and 10. More elevated concentrations generally occurred in the vicinity of the Solid Waste Area. Less elevated concentrations occurred in the vicinity of the Bulky Waste Area, and even lower concentrations occurred in the vicinity of the Sewage Sludge Area. The predominant groundwater flow direction through the Site study area is toward the south and southeast. Immediately downgradient of the Solid Waste Area, volatile organics were present in elevated concentrations. Further downgradient, and east of Mitchell Brook, concentrations tended to decrease. Volatile organics were still present, though at lower concentrations, south of the transfer station road. However, further south towards Saugatucket Road, volatile organics were not found in the residential well (Resident #6).

Volatile organics also occurred to the north of the Solid Waste Area as well as to the northeast in two residential wells. These compounds were also found to the west of Rose Hill Road near the northern portion of the Solid Waste Area, but not to the northwest in the vicinity of Resident #11. West of Rose Hill Road, near the southern portion of the Solid Waste Area, volatile organics were not found. To the north, volatile organics were found as far north as the north side of Mitchell Brook, but were not detected in the most northern residential well (Resident #1).

East of the Bulky Waste Area, concentrations decreased even more, and south of the Bulky Waste Area, one compound was found at a low concentration during only one sampling round.

In comparison to concentrations measured in wells located in the Solid Waste Area, volatile organic concentrations found in the Sewage Sludge Area were relatively low. East of the Sewage Sludge Area, volatiles were found at slightly higher concentrations, but this was not consistent.

East of the Saugatucket River, volatile organics were not detected in the lower overburden groundwater, but were found infrequently in residential wells at relatively low concentrations. The source of the volatiles in the residential wells, however, is not entirely clear.

Throughout the Site study area, the chlorinated volatiles detected most often and in the highest concentrations were 1,1-DCA (range of 1 to 220 ug/L), 1,2-DCE (3 to 730 ug/L), vinyl chloride (3 to 690 ug/L), and chloroethane (4 to 86 ug/L). In comparison, the lower concentrations of the more chlorinated volatiles (i.e., TCE, PCE, 1,1,1-TCA) suggests that degradation processes are active. While this is very likely because of degradation of landfill wastes, it is also possible that these compounds were disposed of in industrial and municipal wastes, given the elevated concentrations detected. These compounds are components of consumable products but are used in larger quantities as solvents in industrial applications. Aromatic volatiles, primarily BTEX compounds, were also found in most of the wells. Tables 9 through 16 summarize the chemicals detected in ground water.

Although prevalent, volatile concentrations appear to have decreased to some extent since landfill operations ceased. During previous studies, the highest concentrations were measured between 1981 and 1982 , and by 1984 concentrations had decreased by as much as several orders of magnitude. Concentrations detected during this investigation varied depending upon location within the Site study area. During RI, the highest concentrations detected for the organic compounds listed in the historical data set were generally well below the concentrations detected up to 1982, but in many wells, concentrations were higher than found in 1984.

Although variations in volatile organic concentrations occurred over the study period, specific trends were not evident with the available data. This is not unexpected, since the source of these compounds is wastes from within the disposal areas. Given the nature of landfills, with their heterogeneous deposits of wastes and decomposition and biological transformations, the types of and concentrations of compounds released to groundwater are expected to vary to some degree.

Since landfill operations stopped in 1983, the decreases that have occurred are likely related to the slower release of contaminants from source materials (landfill contents).

The detection of *N,N*-DMF in wells west of Rose Hill Road and north of Mitchell Brook confirms that movement of groundwater in these directions is occurring. This compound and acrylamide were also found in several wells directly in and immediately downgradient of the Solid Waste Area, where disposal of industrial wastes, primarily solvents and adhesive glue wastes, have been documented. An explanation for presence of *N,N*-DMF in Residence #8 during one sampling round is not apparent. However, the concentration detected was well below the method detection limit.

The predominant metals detected in groundwater, regardless of flow zone or location, were aluminum, iron, basic cations (calcium, magnesium, sodium, and potassium), barium, and manganese. For the most part, the more soluble forms of these metals were found in higher concentrations than insoluble forms. The types of metals and concentrations detected were similar between the shallow and deep overburden groundwater. Heavy metals found at least once in these flow zones include antimony, arsenic, cadmium, chromium, cobalt, copper, lead, nickel, mercury, vanadium, and zinc. Beryllium was also detected. The number of metals and concentrations were significantly lower in bedrock groundwater. In this flow zone, major-metal ions along with barium and manganese were typically the only metals detected. A few heavy metals (zinc, nickel, copper) were occasionally found.

In shallow overburden groundwater in and immediately downgradient of the Sewage Sludge Area, metals that exceeded concentrations compared to background wells were generally basic cations, iron, barium, and manganese. Occasionally other heavy metals (arsenic, lead, nickel, vanadium, and zinc) were found in higher concentrations than background. Elevated metal concentrations were also found downgradient of the Solid Waste Area, west of Mitchell Brook. However, none of these exceedances were found to be statistically significant based on the available data. In deep overburden groundwater, elevated concentrations and a larger number of heavy metals were exhibited by groundwater directly in and west of the Solid Waste Area.

In bedrock groundwater, significantly elevated concentrations of basic cations, aluminum, barium, and manganese were found in relation to background groundwater. In addition, a few heavy metals (chromium, nickel, vanadium, and zinc) that were not detected in background groundwater were found. In several residential wells (overburden and bedrock) particularly to the north and northeast of the Solid Waste Area, and east of the Saugatucket River, manganese was the metal that most often exceeded background concentrations.

C. Surface Water

Eighteen surface water locations were sampled during the study period. This includes surface water from Mitchell Brook, the Saugatucket River, the unnamed brook, and an unnamed tributary

to Mitchell Brook. The unnamed brook was sampled west of Rose Hill Road at SW-10. Located north of the disposal areas, SW-01 was sampled in an unnamed tributary that feeds into Mitchell Brook. Along Mitchell Brook, seven locations were sampled: SW-07, SW-09, SW-12, SW-13, SW-14, SW-15, and SW-16. In the Saugatucket River nine locations were sampled: SW-02, SW-03, SW-04, SW-05, SW-06, SW-08, SW-11, SW-17, and SW-18. Surface water sampling locations are shown in Figure 11. Surface water samples were analyzed for the following parameters:

- Volatile organics
- Semivolatile organics
- Water-soluble organics (only September/October 1991, January/February 1992 and April 1992)
- Pesticides and PCBs
- Metals (unfiltered and filtered)
- Cyanide
- Sulfide (only June 1991, September/October 1991, and January/February 1992)
- Ammonia (only April 1992 and May 1992)
- Total organic carbon (TOC)
- Biochemical oxygen demand (BOD)

Other water quality parameters measured during field activities include dissolved oxygen, conductivity, and pH.

The analytes detected in surface water are presented in Tables 17 through 21. A summary of the organic compounds and metals detected in surface water samples is presented in Figures 12 and 13.

Surface Water Results Summary. A few organic compounds were infrequently detected in low concentrations in the three surface water bodies: Mitchell Brook, the Saugatucket River, and the unnamed brook. Volatile organic compounds, primarily carbon disulfide and chlorinated and aromatic VOCs, were the major contaminants found. A few SVOCs and pesticides and a water-soluble organic, acrylamide, were also detected. Several surface water locations that were adjacent to leachate seeps and downgradient of the Solid Waste Area exhibited high metal concentrations.

Unnamed Brook. One location in the unnamed brook was sampled in June and September/October 1991 and January/February 1992 (Figure 11). The unnamed brook was not sampled during the other two rounds, April and May 1992. The sampling location (SW-10) is west of Rose Hill Road and southwest of the Solid Waste Area. An active sand and gravel operation is located directly upstream of this location.

The only organic compounds detected at this location during the study period were one volatile organic, carbon disulfide, at 6 μg/L in January/February 1992 and one pesticide, *gamma*-BHC, at

0.002 μg/L in September/October 1991. Both of these concentrations were less than sample quantitation limits. Semivolatile organics, water-soluble organics, and PCBs were not detected.

During the study period, major-metal ions as well as barium and manganese were generally the only metals detected. While concentrations of these metals varied slightly, a large fraction of the concentrations was associated with the more soluble forms of these metals. Aluminum was not detected in filtered samples and was reported once at 160 µg/L in unfiltered samples. In unfiltered samples, iron concentrations ranged from 5,140 to 6,160 µg/L, basic cation concentrations ranged from 2,060 to 11,100 µg/L, barium concentrations ranged from 24.9 to 31.6 µg/L, and manganese concentrations ranged from 905 to 1,690 mg/L. Concentrations in filtered samples ranged from 3,325 to 3,660 µg/L for iron, from 2,800 to 12,100 µg/L for basic cations, from 22.7 to 30.2 µg/L for barium, and from 789 to 1,740 µg/L for manganese. In addition, zinc was found in January/February 1992 at 17.2 μg/L in the unfiltered sample and at 14.9 μg/L in the filtered sample.

Cyanide was not detected, while sulfide was measured at 1.9 mg/L in June 1991. Total organic carbon and BOD were not detected. Conductivities ranged from 26 to 146 μmhos/cm, pH values ranged from 5.9 to 7.2, and DO ranged from not detected to 8.4 mg/L during the study period.

As discussed above, different pesticides (such as *gamma*-BHC) that are not necessarily related to the disposal areas were detected at low concentrations. This brook is not expected to be affected by the disposal areas, since it is upgradient and was found to be consistently losing water to groundwater during the study period. However, there is a strong likelihood that alterations of metal concentrations are occurring because of the disturbance from the nearby sand and gravel operations, which are still active. Weathering of newly exposed soil and bedrock would result in increased releases of metals (including iron and aluminum) that would enter the brook. This is important, since this brook runs through the sand and gravel operations upstream of the sampling location, and new cuts in the sand bank reveal visually apparent, iron rich sands of natural origin.

Mitchell Brook. Along Mitchell Brook, seven locations were sampled from June 1991 to May 1992. Six of the locations were sampled in June and September/October 1991 and include SW-07, SW-09, SW-12, SW-13, SW-14, and SW-15. In addition, SW-01, which is located on the unnamed tributary that feeds into Mitchell Brook upstream of the disposal areas, was sampled during these rounds. In May 1992, only SW-07, SW-09, SW-12, and a new location established as SW-16 were sampled. The location on the unnamed tributary (SW-01) was not sampled in May 1992.

No organic compounds were found in the background location (SW-01) on the unnamed tributary, yet a few organic compounds were detected infrequently and at low concentrations (usually less than 10 μg/L) in Mitchell Brook. Carbon disulfide was detected more frequently than other compounds at concentrations below 10 μg/L. All of the other compounds detected were found in only one location during one sampling round; and consist of chlorinated (1,2-DCE and

chloroethane) and aromatic (BTEX compounds and chlorobenzene) organics, and three phthalates [bis(2-ethylhexyl)phthalate, diethylphthalate, and di-n-butylphthalate]. In addition, acrylamide was found at 272 μg/L in SW-12. All of these compounds have also been found in different media in the vicinity of the disposal areas.

Most of the organic compounds were detected at SW-12, which is the most downstream location on Mitchell Brook, prior to its confluence with the Saugatucket River. The presence of organic compounds coincides with higher BOD levels measured at this location. In particular, acrylamide, which was also found in groundwater immediately downgradient of the Solid Waste Area and near Mitchell Brook (MW-04), was possibly disposed of with industrial waste, indicating that groundwater may be affecting water quality in this stream. Similarly, the compounds detected in SW-12 are similar to those found in MW-11, which is located near Mitchell Brook. Likewise, the xylene detected in SW-07 was similar to the types of aromatic volatiles (BTEX compounds) found at MW-11.

The predominant metals detected include major-metal ions, barium, and manganese. As shown in Figure 14, the highest concentrations of unfiltered metals were consistently found south of the transfer station road and downstream of the disposal areas, near SW-07, and increased near SW-12. This coincides with the extensive orange staining, precipitate, and floc covering of sediment in the brook south of the transfer station road. Insoluble forms of these metals were associated with these locations, whereas more soluble forms were dominant at upstream locations, north of the transfer station road. Conductivities also increased in a downstream direction. Concentrations of iron, manganese, basic cations, and conductivities were found to be significantly higher at these locations compared to the background location on the unnamed tributary. Metal concentrations and conductivity also increased, but were less pronounced, at SW-15. Other metals (zinc, antimony, copper, and lead) were occasionally found at lower concentrations in Mitchell Brook.

These trends, coupled with the organic compounds detected at SW-12, indicate that groundwater may be contributing to downgradient migration from the disposal areas to Mitchell Brook. Shallow and deep overburden groundwater exhibited elevated metal concentrations in the vicinity of the Solid Waste and Bulky Waste Areas. These flow zones discharged to Mitchell Brook throughout the study period. Overland flow to Mitchell Brook may also be occurring. The metals detected and concentrations varied over the study period, but there were no recognizable seasonal trends.

Saugatucket River. Nine locations were sampled in the Saugatucket River over five sampling rounds from June 1991 to May 1992. Six locations were sampled in June 1991: SW-02, SW-03, SW-04, SW-05, SW-06, and SW-08. Surface water location SW-11 was added in September/October 1991, and locations SW-17 and SW-18 were added in May 1992.

A few organic compounds were detected at low concentrations (less than 14 μg/L) in the surface water locations on Saugatucket River. Besides carbon disulfide, which was detected the most

frequently, xylene and pesticides (4,4'-DDD and methoxychlor) were each detected once during the study period. Coupled with DOs above 5 mg/L and BOD values near zero, there was no indication that the disposal areas were substantially contributing organics to this river during the study period.

On the other hand, increases in metal concentrations along the course of the river appear to be influenced by the disposal areas, especially the Bulky Waste Area. For the most part, major-metal ions, manganese, and barium were the primary metals detected consistently throughout the study period. The largest fraction of these metals appears to be in a more soluble form based on comparisons of unfiltered and filtered sample concentrations.
Of these, iron and manganese as well as conductivities were found to be significantly elevated in leachate along the eastern perimeter of the Bulky Waste Area and the banks of the Saugatucket River.

Figure 15 shows the trends from upstream to downstream for unfiltered metal concentrations along the Saugatucket River. For aluminum, there was no recognizable trend, as concentrations constantly increased and decreased between sampling locations. In contrast, iron and manganese concentrations gradually increased from the background location (SW-02) toward SW-03 and SW-04, which are primarily downgradient of the Sewage Sludge and Bulky Waste Areas, respectively. Concentrations for these metals peaked at SW-05, which is downgradient of several large leachate seeps that flow into the river at this point. Downstream concentrations then decreased to a level similar to that of SW-03 and SW-04, most likely because of dilution, and then remained near the same level or slightly increased again below the confluence of Mitchell Brook. Concentrations continued to increase beyond where the river approaches and flows past Saugatucket Road. These downstream increases are more pronounced for manganese and basic cations (calcium, magnesium, sodium, and potassium) than for iron and barium. Conductivities exhibit the same patterns. Differences were statistically confirmed for calcium, manganese, magnesium, sodium, and conductivity between several downstream locations and the background location.

Elevated concentrations of similar metals were also evident, although not significantly, in shallow overburden groundwater downgradient of each of the disposal areas. Since the predominant groundwater flow direction from the disposal areas (primarily the Sewage Sludge and Bulky Waste Area) is toward the Saugatucket River, groundwater discharges along with surface runoff (overland flow) to the river are likely mechanisms that contribute to the transport of these more soluble metals from those areas.

Differences in metal concentrations also occurred between sampling rounds. Metal concentrations in June 1991 were greater than in any other round. Iron and barium concentrations were about 20 times greater in June 1991 than in September 1991. Calcium, magnesium, sodium, and manganese were also four to six times greater in June 1991 than in September. This was particularly evident at SW-05. At this location, the higher concentrations during the June 1991 sampling round corresponded with low-flow conditions in combination with elevated metal concentrations from

leachate seeps. Throughout the rest of the study period, concentrations varied, but not as substantially. Many of the mechanisms that likely contribute to these variations depend on precipitation (i.e., leachate composition, groundwater discharge, surface water volume, surface runoff).

Although the organic compounds detected in surface water in Mitchell Brook and the Saugatucket River were also found in other media in the Site study area, upstream to downstream trends were not exhibited since these compounds were seldom and inconsistently detected. However, the detection of acrylamide in Mitchell Brook, prior to its intersection with the Saugatucket River, indicates that transport of organic compounds in the Site study area is occurring at least this far south. More evident were the increases in metal concentrations in the Saugatucket River, near the large leachate seeps (along the eastern perimeter of the Bulky Waste Area), and in Mitchell Brook, south of the transfer station road. In particular, concentrations of iron, manganese, and other metals in these areas were found to be significantly elevated. Higher conductivities and the presence of orange floc were characteristic features in these areas. Below the confluence of Mitchell Brook and the Saugatucket River, metal concentrations decreased, although concentrations were higher than those found upgradient of the disposal areas.

D. Sediment

Eighteen sediment locations were sampled during the study period. This includes sediment from Mitchell Brook, the Saugatucket River, the unnamed brook, and an unnamed tributary to Mitchell Brook. The unnamed brook was sampled west of Rose Hill Road at SD-10. Located north of the disposal areas, SD-01, was sampled in an unnamed tributary that feeds into Mitchell Brook. Along Mitchell Brook seven locations were sampled: SD-07, SD-09, SD-12, SD-13, SD-14, SD-15, and SD-16. The Saugatucket River was sampled at nine locations: SD-02, SD-03, SD-04, SD-05, SD-06, SD-08, SD-11, SD-17, and SD-18. Sediment sampling locations are shown in Figure 11. Sediment sampling was conducted at the same time as surface water sampling. Sediment samples were analyzed for the following parameters:

- Volatile organics
- Semivolatile organics
- Pesticides and PCBs
- Metals
- Cyanide
- Sulfide (only June 1991 and September/October 1991)
- Ammonia (only May 1992)
- Total combustible organics (TCO)
- Grain size

The analytes detected in sediment are presented in Tables 22, 23, 24. A summary of the organic compounds and metals detected in sediment samples are presented in Figures 16 and 17. The

analytes detected in each of the different areas (Table 3) are discussed in the following sections.

4.2.7.1 Unnamed Brook. One location in the unnamed brook (SD-10) was sampled for sediments in June and September/October 1991. This location corresponds with SW-10, which was also sampled at the same time. The analytes detected during June 1991 and September/October 1991 are summarized in Table 22 and Figures 16 and 17.

During September/October 1991, one volatile organic, 4-methyl-2-pentanone, was detected at 3 μg/kg. Seven pesticides were detected at concentrations below sample quantitation limits (0.23 to 2.6 μg/kg): *delta*-BHC, 4,4'-DDE, 4,4'-DDT, methoxychlor, endosulfan II, dieldrin, and *gamma*-chlordane.

Of the metals detected, iron concentrations (113,000 mg/kg) were substantially elevated above the others. Aluminum, followed by manganese and calcium (3,210, 1,150, and 1,070 mg/kg, respectively), were the next abundant. Magnesium, sodium, and potassium concentrations ranged from 2 to 415 mg/kg. Barium (64.6 mg/kg) and four heavy metals (lead at 7.4 mg/kg, nickel at 3.0 mg/kg, vanadium at 15.2 mg/kg, and zinc at 236 mg/kg) were also detected.

Sulfide was measured at 25 mg/kg, while cyanide was not detected. The sediment consisted primarily of sand (67.7%) and was intermixed with finer silt (18.8%) and clay (10.4%) grains. The organic content was 4.7%. No organic compounds, including volatile organics, semivolatile organics, pesticides, and PCBs, were detected.

The detection of several different pesticides including *delta*-BHC in September/October 1991 in sediments coincides with the detection of *gamma*-BHC in the associated surface water sample. Since these sediments are predominantly sand with little organic material, the retention of organic compounds (if present) is expected to be limited. During this same time, substantial increases in lead concentrations and the detection of other heavy metals occurred in sediment, but were not evident in surface water. This suggests that sediment transport from upgradient sources is possibly occurring. As discussed earlier, there is no hydrogeologic indication that the disposal areas are affecting this brook, which is west of Rose Hill Road. However, as also discussed above, nearby sand and gravel operations are likely affecting metal concentrations in the brook.

Mitchell Brook. Seven locations were sampled on Mitchell Brook from June 1991 to May 1992. Six of the locations were sampled in June and September/October 1991: SD-07, SD-09, SD-12, SD-13, SD-14, and SD-15. In addition, SD-01, which is located on the unnamed tributary that feeds into Mitchell Brook and is upstream of the disposal areas, was sampled during these rounds. In May 1992 a new location established as SD-16 was sampled. The location at the unnamed tributary was not sampled in May 1992.

Two volatile organics were detected during the June 1991 sampling round at concentrations below sample quantitation limits. Xylenes were detected at SD-07 (8 μg/kg) and at SD-09 (7 μg/kg).

Trichloroethane (9 μg/kg) was detected at SD-09. Semivolatile organics, pesticides, and PCBs were not detected at any location sampled. Sulfide was detected at all locations and ranged from 3.7 to 34 mg/kg, whereas cyanide was not detected at any of the locations. Sand was the predominant size fraction (57.3 to 97%). Organic content ranged from 0.8 to 7.0%.

Five volatile organics, consisting of chlorinated and aromatic volatiles and ketones, were detected at one or two locations during the September/October 1991 round of sampling. These include chloroform at SD-15 (5 μg/kg), and PCE at SD-14 (3 μg/kg) and SD-09 (2 μg/kg). Benzene (1 μg/kg) was detected at SD-12. The highest concentrations were for ketones, as acetone was detected at SD-07 and SD-09 (190 μg/kg and 200 μg/kg, respectively). Also detected at SD-07 was MEK (46 μg/kg).Sulfide was detected only at SD-12 (850 mg/kg) during the September/October 1991 sampling round, and cyanide was not detected at any of the locations. Based on grain-size distributions, sand was the predominant fraction (51.2 to 97.3%), and organic content ranged from 0.8 to 7.6%.

Three semivolatile organics and two pesticides were detected at two locations during this sampling round. PCBs were not detected at any locations. Di-n-butylphthalate (650 μg/kg) was detected at SD-09. Two PAHs, fluoranthene and pyrene, were also detected at SD-09 (34 and 40 μg/kg, respectively). Pesticides found at this location include 4,4'-DDD (8.2 μg/kg) and 4,4'-DDE (4.9 μg/kg). The same PAHs and pesticides were found at SD-15: fluoranthene (34 μg/kg), pyrene (40 μg/kg), and 4,4'-DDE (1.6 μg/kg).

Ammonia was also detected at SD-12 (25.6 mg/kg) and SD-16 (4.36 mg/kg) during May 1992. Cyanide was not detected at any of the locations. The predominant grain size at the locations was sand (86.5 to 95.7%). Organic content ranged from 1.1 to 1.8%.

More types of organic compounds were detected in sediment in Mitchell Brook than in the associated surface water. Organic compounds were not found at the background location on the unnamed tributary (SD-01). Ketones (acetone and MEK) and chlorinated volatiles (TCE, PCE, 1,2-DCE, and chloroform) and BTEX compounds were the primary types of volatile organics. Found more often and in higher concentrations were PAHs, phthalates, and pesticides (4,4'-DDE, 4,4'-DDD, and *delta*-BHC), since these compounds are less soluble and more strongly adsorb to sediment and organic material. All of these compounds were also found in other media near the disposal areas. Surface runoff (overland flow) and groundwater discharges to the brook are evident. With the exception of PAHs, which were found in several locations near roads and other areas of vehicular activity, there were no recognizable patterns of distribution.

On the other hand, metals exhibited several trends, from upstream to downstream as shown in Figure 18. For the most part, concentrations were not found to be significantly elevated compared to the background location on the unnamed tributary. For example, concentrations for aluminum and lead were highest at the most upgradient location, SD-13, which is upstream of the northern portion of the Solid Waste Area. Concentrations steadily decreased toward SD-16 and then

increased at SD-07, which is south of the transfer station road, before decreasing a short distance downstream at SD-12. Barium exhibited a somewhat similar trend as aluminum and lead. On the other hand, iron and manganese concentrations were relatively similar along the length of brook from SD-13 to SD-09. Iron concentrations began to increase at SD-16. Iron concentrations continued to increase at SD-07, as did manganese. Lower concentrations for both these metals occurred further downstream at SD-12. Elevated concentrations south of the transfer station road correspond with elevated metal concentrations in surface water in this area as well as the presence of large amounts of orange floc and precipitate that cover the sediment.

Saugatucket River. Nine locations were sampled in the Saugatucket River from June 1991 to May 1992. Six locations were sampled in June 1991: SD-02, SD-03, SD-04, SD-05, SD-06, and SD-08. Sediment location SD-11 was added in September/October 1991, and locations SD-17 and SD-18 were added in May 1992.

Five volatile organics, consisting of chlorinated (TCE and 1,2-DCE) and aromatic volatiles (ethylbenzene and xylenes) and carbon disulfide, were detected at three locations during the June 1991 sampling round. Trichloroethene was detected at 7 μg/kg in SD-04 and increased downstream to 10 μg/kg at SD-06 and 150 μg/kg at SD-08, which is downstream of Saugatucket Road. Also detected at SD-08 was 1,2-DCE (5 μg/kg) and ethylbenzene and xylene (8 and 67 μg/kg, respectively). Xylene was also detected at 10 μg/kg in SD-03. Carbon disulfide was found at SD-08 (9 μg/kg). No volatile organics were detected at SD-02, the background location, or SD-05, which is downstream of SD-04.

Seven PAHs were detected at SD-08 (Table 22) at a total concentration of 1,410 μg/kg. This location is downstream of the Saugatucket Road. Another semivolatile organic, butylbenzylphthalate was detected at SD-06, also below the sample quantitation limit. Pesticides and PCBs were not detected.

Aluminum, iron, manganese, and barium were detected at all of the locations. At all of the downstream locations, concentrations of these metals were higher than in the background location, SD-02. Concentrations for aluminum ranged from 749 to 6,280 mg/kg. Iron ranged from 780 to 1,600 mg/kg, and barium and manganese ranged from 2.7 to 26.2 mg/kg and 13.5 to 193 mg/kg, respectively. Basic cation concentrations ranged from 115 to 1,270 mg/kg. The highest concentrations for these metals usually occurred at SD-04 and SD-05.

Also detected in downstream locations were arsenic (0.79 to 2.1 mg/kg) at SD-04, SD-05, and SD-08 and chromium (1.9 to 8.7 mg/kg) and cobalt (3.4 to 4.2 mg/kg) at SD-04, SD-05, and SD-06. Higher concentrations corresponded with SD-04 and SD-05. In addition, lead and zinc were detected at SD-06 (10.9 and 20.5 mg/kg, respectively), while selenium was found at SD-05 (2.1 mg/kg). Beryllium and nickel were detected at almost all locations at concentrations ranging from 0.4 to 2 mg/kg and 1.4 to 9.5 mg/kg, respectively. With the exception of beryllium and zinc, these metals were also detected at the background location, SW-02, at least once during the study

period.

Sulfide was detected in all locations while cyanide was not found at any. Sulfide ranged from 15 to 129 mg/kg and was highest at SD-06. At SD-04 and SD-05, sediments largely consisted of sand (37.7 and 54.5%, respectively) and silt (48.5 and 42.5%, respectively). At other locations, the percentage of silt decreased and sand increased. Organic content ranged from 1.0 to 14.7%.

Volatile organics were also detected during the September/October 1991 sampling round, but the compounds were somewhat different from those found in June 1991. Aromatic volatiles, ethylbenzene (3 μg/kg), and xylene (8 μg/kg) were found at SD-05. Acetone was detected at two locations: SD-03 (210 μg/kg) and SD-08 (215 μg/kg). Three other volatile organics were found at SD-08: MEK (28 μg/kg), PCE (4 μg/kg), and carbon disulfide (22 μg/kg). In addition, pyrene was detected in SD-03 at 39 μg/kg. Pesticides and PCBs were not detected at any of the locations.

During this sampling round, major-metal ions, manganese, and barium were detected at higher concentrations downstream of the background location. In the background location, SD-01, concentrations of aluminum were 8,650 mg/kg, iron were 1,500 mg/kg, basic cations were 350 to 373 mg/kg, and barium and manganese were 21.5 and 113 mg/kg, respectively. The iron concentration at SD-06 was 8,940 mg/kg, and iron and aluminum concentrations at SD-04 (6,780 and 16,400 mg/kg, respectively) and SD-05 (8,420 and 6,170 mg/kg, respectively) were more elevated than those at the other locations (1,260 to 3,080 and 1,020 to 2,590 mg/kg, respectively). Basic cation concentrations ranged from 242 to 2,560 mg/kg, barium ranged from 3.1 to 30.5 mg/kg, and manganese ranged from 41.1 to 422 mg/kg. Concentration ranges for these metals were slightly higher than ranges in June 1991.

Other metals detected include arsenic (0.43 to 1.2 mg/kg), (chromium 11.4 to 18.1 mg/kg), cobalt (1.9 to 6.5 mg/kg), lead 4.3 to 24.2 mg/kg), nickel (12.8 to 20 .5 mg/kg), selenium (0.37 to 1.3 mg/kg), vanadium (2 to 17.7 mg/kg), and zinc (43.6 to 49.8 mg/kg). Beryllium (2.3 mg/kg) was detected at SD-04. Four of these metals were also detected at SD-02: lead at 7.2 mg/kg, selenium at 0.52 mg/kg, and vanadium at 2 mg/kg. Higher concentrations of these metals were found in at least one location downstream.

Four PAHs (phenanthrene, anthracene, fluoranthene, and pyrene) were detected at a total concentration of 241 μg/kg in SD-11 during the May 1992 sampling round. Three pesticides were also detected in the sediments during this sampling round. The one detected most frequently was *delta*-BHC, which was found in all six of the downstream locations (0.46 to 1.3 μg/kg), but was not detected in the background location, SD-02. Detected at higher concentrations were 4,4'-DDE at 4.3 μg/kg and 4,4'-DDD at 8.0 μg/kg in SD-11, the location with PAHs. 4,4'-DDE was also detected at SD-18 at 1.2 μg/kg.

Major-metal ions were the predominant metals found during the May 1992 sampling round. Concentrations of aluminum were 836 to 1,860 mg/kg. The most elevated iron concentrations

detected during this round were at SD-05 (25,900 mg/kg) and SD-06 (12,500 mg/kg). Iron ranged from 885 to 25,900 mg/kg. Basic cation (258 to 555 mg/kg), barium (2.9 to 13.7 mg/kg), and manganese (22.6 to 200 mg/kg) concentrations were similar to those detected during June 1991. Chromium and lead were detected at all locations from 1.1 to 2.5 and 3.7 to 13.5 mg/kg, respectively. Arsenic (2 to 6.1 mg/kg), cobalt (0.91 to 1.4 mg/kg), and selenium (0.43 to 0.58 mg/kg) were also found, but less frequently (two to four locations). Nickel was detected in SD-06 at 4.7 mg/kg, while vanadium and zinc were detected at 3.4 and 11.2 mg/kg, respectively, in SD-05.

During the May 1992 sampling round, cyanide was not found at any locations. Ammonia was detected in three locations with the maximum at SD-05 at 3.17 mg/kg. Sand was the predominant size fraction (64.6 to 95.8%) in sediment at each location, and organic content continued to be relatively low (1.3 to 5.6%).

The types of organic compounds detected in Saugatucket River sediment were also detected in the disposal areas and other media during the study period and include chlorinated and aromatic volatiles, ketones, carbon disulfide, PAHs, and pesticides. Most notably, TCE was detected at several locations along the river. The less soluble organics, like PAHs and pesticides, as well as volatile organics were detected more often in sediments than in the associated surface water.

When detected, organic compounds were predominantly found at SD-08 and SD-11. Both of these locations are near Saugatucket Road and were sampled in areas where the river widens and current is slower. As a result, suspended sediment tends to settle out here. In June 1991, volatile organics were primarily found along with PAHs at SD-08, which is located downstream of Saugatucket Road. This suggests that organic compounds and metals detected in this section of the River are probably more related to the road than to other sources.

For the most part, all of the metals detected in sediment were also found in the background location during the study period. Iron and aluminum were the predominant metals. As shown on Figure 19, the concentrations were generally consistently higher at SD-04 and SD-5, and coincided with higher concentrations in surface water at these locations. Both are immediately downgradient of the large leachate seeps east of the Bulky Waste Area. Orange floc and precipitate covering the sediment in this area were also present. Concentrations for these metals were also elevated at SD-06, below the confluence of Mitchell Brook, although surface water concentrations at this location were not. Lead, on the other hand, was lower at these locations and in general did not exhibit any discernable pattern. In relation to background concentrations, concentrations of lead, barium, manganese, and iron were significantly elevated at most of the downstream locations (SD-04, SD-05, SD-06, SD-08, SD-11). Iron and manganese concentrations at SD-03 were also found to be significantly higher. As discussed above, elevated metal concentrations near Saugatucket Road (SD-08 and SD-11) can be attributed to the road.

All metals were generally at the highest concentrations in September/October 1991. This corresponds with higher concentrations in surface water during the same period and may be somewhat related to seasonal variations. Following drier summer periods, metal concentrations generally increased during lower flow periods, when groundwater discharge accounts for a larger portion of a stream's volume.

E. Leachate

During the study period, leachate seeps were observed around the Solid Waste and Bulky Waste Areas. Leachate was collected from six locations at which seeps were present. Five of the leachate seeps (LE-02 to LE-06) were located between the Bulky Waste Area and the Saugatucket River. The other seep (LE-01) was just north of the Solid Waste Area, near Mitchell Brook. Leachate locations are presented on Figure 20. Historically, leachate seeps have been identified at the disposal areas by aerial photographs (United States Environmental Protection Agency 1987a, 1991a). In the past, a resident has reportedly observed leachate seeps with sulfur odors and varying colors and quantities west of Rose Hill Road, near the northern portion of the Solid Waste Area. At the Bulky Waste Area, a trench filled with crushed stone was reportedly dug to drain water to the Saugatucket River (RIDEM 1992a). During the field investigation a crushed-stone trench running vertically along the eastern bank of the Bulky Waste Area toward the Saugatucket River was observed. In addition, colored leachate originating from the hill slope near the Bulky Waste Area has been observed.

All six leachate locations (LE-01 to LE-06) were sampled during June 1991. Three additional composite samples were collected from the seep at LE-05 during April 1992, to supplement ecological toxicity testing. Samples were analyzed for the following parameters:

- Volatile organics
- Semivolatile organics
- Water-soluble organics (April 1992 only)
- Pesticides and PCBs
- Metals (unfiltered and filtered)
- Cyanide
- Sulfide (June 1991 only)
- Ammonia (April 1992 only)
- Total organic carbon (TOC)
- Biochemical oxygen demand (BOD)

The analytes detected in leachate are presented in Tables 25 and 26. A summary of the organic compounds and metals detected in leachate samples is presented in Figures 21 and 22. The analytes detected in each of the different areas (Table 3) are discussed in the following sections.

Saugatucket River. Five leachate seeps (LE-02 through LE-06) were sampled along the western bank of the Saugatucket River. Several large outbreaks of leachate were obvious because of orange-colored puddles of water and orange-stained soil and vegetation. The size of the seeps varied, with LE-03, LE-05, and LE-06 comprising the largest areas. Large clumps of orange floc were also observed near the seeps. It was reported that gravel-filled trenches were embedded along the eastern perimeter of the Bulky Waste Area to facilitate drainage from this disposal area.

In the June 1991 sampling effort, chlorinated and aromatic volatiles were detected in three of the five leachates seeps near the Bulky Waste Area. Chlorinated volatiles, 1,1-DCA and chloroethane, were each found at LE-03, LE-04, and LE-05 at concentrations below sample quantitation limits (2 to 8 µg/L). Aromatic volatiles, toluene, and chlorobenzene were also detected in these samples, although toluene was the only chemical detected above sample quantitation limits (27 to 50 µg/L). The highest toluene concentration occurred at LE-03. Each of these leachate seeps was approximately 50 feet downgradient of the Bulky Waste Area and within a few feet of the Saugatucket River. Although volatile organic concentrations were relatively low in leachate, elevated concentrations of chlorinated and aromatic volatiles were found in landfill gas in the Bulky Waste Area. Similar types of volatile organics have also been detected in soil and groundwater downgradient of this disposal area.

Carbon disulfide was the only organic detected in LE-02 (3 µg/L), located south of LE-05 and the Bulky Waste Area. The most northern leachate sampling location, LE-06, had no detectable concentrations of volatile organics, yet bis(2-ethylhexyl)phthalate was detected at 230 µg/L. Organic compounds, at similar concentrations, were found periodically in surface water and sediment in the Saugatucket River during the study period.

Metals detected in the highest concentrations in unfiltered samples were the major-metal ions [aluminum (184 to 9,220 µg/L), iron (15,200 to 1,370,000 µg/L), calcium (10,000 to 59,000 µg/L), magnesium (2,420 to 16,100 µg/L), sodium (5,560 to 55,400 µg/L), and potassium (2,000 to 44,800 µg/L)]. Other metals detected in all of the samples consist of barium (22.2 to 2,120 µg/L) and manganese (2,490 to 14,700 µg/L). Cobalt (5.6 to 295 µg/L) was detected in four samples (LE-02, LE-04, LE-05, and LE-06). Vanadium (22.2 to 65.2 µg/L) and zinc (34.4 to 133 µg/L) were each found in two samples (LE-02 and LE-05, and LE-02 and LE-03, respectively). Beryllium and lead were detected in only one sample, LE-02, at 8.7 and 174 µg/L, respectively. Metals were usually detected more often and at higher concentrations at LE-02 than in any of the other unfiltered leachate samples. This sample was collected in an orange-stained muddy area along seismic line S-5.

Fewer metals were detected in filtered samples. Again major-metal ions were found in all samples in the highest concentrations. Barium and manganese were also detected, and cobalt was found at LE-04. Because of the smaller number of metals and the lower concentrations found in filtered samples, the largest fraction of the metals are likely adsorbed onto soil or other particles, are in a colloidal phase or floc, or are present in less soluble or insoluble forms.

Cyanide was detected in the most northern (LE-06) and the most southern (LE-02) leachate seeps at 41.7 and 36.1 µg/L, respectively. Sulfides were not found in any samples. Biochemical oxygen demand was measured in LE-06 and LE-02 at 7.5 and 51 mg/L, respectively. High BOD indicates organic contamination. The BOD measured in these samples is consistent with the levels of organics found.

In April 1992, the leachate seep at LE-05 was sampled on three consecutive days to supplement ecological toxicity testing. The analytes detected in April 1992 are summarized in Table 26. Water-soluble organics, pesticides, and PCBs were not detected at this location. Although slightly different sampling methods were used to collect samples during this round, analytical data between the two rounds were fairly similar and are therefore comparable.

The types of organic compounds detected during this sampling round were similar to those found at LE-05 in June 1991. Ethylbenzene (1 to 2 µg/L) was found on all three days and xylenes on two days (2 to 3 µg/L). Chloroethane and 1,2-DCE were each detected once at 2 and 1 µg/L, respectively. Naphthalene and diethylphthalate were each detected on all three days at concentrations ranging from 0.7 to 0.9 µg/L and 4 to 11 µg/L, respectively.

In unfiltered samples, major-metal ions consisting of aluminum (239 to 623 µg/L), iron (49,000 to 283,000 µg/L), calcium (16,700 to 23,000 µg/L), magnesium (5,710 to 7,220 µg/L), sodium (20,800 to 24,700 µg/L), and potassium (12,000 to 15,200 µg/L) were found, all three days, at concentrations elevated above other metals. Barium (97.4 to 293 µg/L) and manganese (1,490 to 2,410 µg/L) were also detected each day. Chromium, lead, mercury, and zinc were each detected once at 5, 10.5, 0.2, and 8.1 µg/L, respectively. In filtered samples, major-metal ions, barium, and manganese were also detected daily. Concentrations were generally highest on the second day of sampling. In addition, vanadium and cobalt were not detected during this sampling round, though they were found at this leachate location in June 1991.

Cyanide was not found. Ammonia was detected from 5.06 to 22.6 µg/L. Total organic carbon ranged from 30.9 to 49.9 mg/L, levels that were higher than in June 1991. Likewise, BOD values ranged from 1.5 to 4.2 mg/L, though BOD wasn't detected in June 1991. A pH of 6.5 and conductivity of 412 were recorded, and hardness varied between 65 and 87 mg/L $CaCO_3$. Differences in chemical composition of leachate from June 1991 to April 1992 are evident, but for the most part, these differences appeared to be minor. Chlorinated and aromatic volatiles and phthalates were detected in both sampling rounds, although the individual chemicals sometimes varied. Similar types of metals were generally found, and there was no noticeably consistent difference in concentrations. In contrast, the physical character of the seeps varied. In June 1991, large quantities of floc and water volume emerging from the seeps were evident in the Saugatucket River area. In April 1992, this was less evident. This could have resulted from changes in precipitation, as groundwater and surface water levels were higher in April 1992 than in June 1991.

Mitchell Brook. A small leachate seep, LE-01, located along the northern slope of the Solid Waste Area, was sampled in June 1991. Orange-staining of ground material was present at the sampling location.

Four chlorinated volatiles were detected: 1,2-DCE (44 µg/L), TCE (4 µg/L), and vinyl chloride (1 µg/L). Carbon disulfide was also detected at 12 µg/L. Semivolatile organics, pesticides, and PCBs were not found at LE-01.

In the unfiltered sample, all of the major-metal ions (aluminum, iron, calcium, magnesium, sodium, and potassium) were detected. Aluminum and iron concentrations were 60,500 and 133,000 µg/L. Basic cations ranged from 3,620 to 14,900 µg/L. Barium, beryllium (328 and 11.2 µg/L, respectively), and eight heavy metals were detected. Concentrations ranged from 3.7 to 49.8 µg/L for beryllium, arsenic, chromium, copper, nickel, and vanadium. For lead, manganese, and zinc, concentrations ranged from 150 to 814 µg/L. In the filtered samples, all major-metal ions except for aluminum were detected, as were barium and manganese. All of these metals, with the exception of arsenic, were found in groundwater from the shallow overburden background well. In comparison, concentrations were as much as three times greater for barium and beryllium, five times greater for aluminum, 10 times greater for iron, and 30 times greater for lead.

Ammonia, sulfide, cyanide, and BOD were not detected. Total organic content was measured at 8.4 mg/L. A conductivity of 100 µmhos/cm and a pH of 5.4 were measured.

Summary of Leachate Findings. As indicated by subsurface soil and landfill gas data, the Bulky Waste and Solid Waste Areas still serve as a viable source of organic compounds and metals. The same types of chlorinated and aromatic volatile organics were found at relatively low concentrations in leachate as in other media in the vicinity of the disposal areas. The leachate seeps were also characterized by large amounts of orange floc and stained ground cover, which is indicative of metals (i.e., iron), precipitating/coagulating such as iron hydroxide under oxidizing conditions. Concentrations of several metals, including barium, lead, manganese, and iron, were found to be significantly elevated in leachate in comparison to levels in the shallow overburden groundwater at the background well. This is important since surface water bodies (Mitchell Brook and Saugatucket River) are within a few feet of the seeps.

F. Landfill Gas

Landfill gas samples were collected from each of the disposal areas and from permanent off-site monitoring points in June and July 1991 as part of the Site reconnaissance activities. The off-site monitoring points were again measured in September 1991. Percent carbon dioxide (CO_2), methane (CH_4), oxygen (O_2), and percent of the lower explosive limit (LEL) were measured, and nearly all of the points were analyzed using a field GC equipped with a PID.

In December 1991, additional points were sampled offsite to define the areal extent of landfill gas migration and its proximity to adjacent residences. At this time, 16 additional permanent monitoring points were installed. Eight were located near homes, and eight were located along the furthest known extent of the landfill gas plume (Figure 23). Each of the eight points near adjacent homes and selected other permanent points were monitored monthly from January through April 1992. Approximately 24 of the 48 permanent points were measured during each of these monthly sampling rounds.

In May 1992, six points were sampled using SUMMA passivated canisters for laboratory analysis of volatile organics by method TO-14 (Figure 24). At the same time, impingers were used to collect and analyze samples for reduced sulfur, consisting of hydrogen sulfide and mercaptan sulfur in the landfill gas, using ASTM method D 2385-81. The impingers were analyzed in an on-site laboratory. Samples from these locations were also analyzed using the field GC. A detailed discussion of analytical methodologies, sample collection procedures, and data use is presented in section 2.5.8 of the RI report.

Sewage Sludge Area. Twenty-two points were sampled in the sewage sludge area in June 1991. These points were located using a 100-foot-by-100-foot grid and are shown on Figure 25. Many of the grid points were omitted because volatile organics were not detected in adjacent samples and concentrations of methane and carbon dioxide were much lower than in the other disposal areas. One point [SS(08+000)] was resampled in May 1992 for SUMMA canister and reduced sulfur analysis, as shown on Figure 26.

Carbon dioxide was the primary component of landfill gas throughout the Sewage Sludge Area. Methane was detected at one point SS(08+000) at a concentration above the LEL. The concentrations of these compounds, as discussed in the following sections, were much lower than were detected in other disposal areas. Carbon dioxide and methane in landfill gas result from the biological degradation of organic materials placed into a landfill. Digested sewage sludge disposed of in this area was previously degraded during primary and secondary treatment. This material would not be expected to consume as much oxygen or produce as much methane or carbon dioxide as untreated municipal waste.

The only volatile organic detected above the quantitation limit in either the field GC or the SUMMA canister analysis was acetone at SS(08+000). Volatile organic data for soil (sections 4.2.1 and 4.2.2 of the RI) from this area are consistent with this finding. Acetone was detected at two of the surface soil locations (SS-11 and SS-12) and in three of the subsurface soils (BH-01 from 4 to 6 feet and 8 to 10 feet; BH-03 from 18 to 20 feet). 2-Butanone was also detected in all of these samples except SS-11. Toluene was detected in one of the soil samples (BH-03 from 18 to 20-feet), and TCE was detected at a concentration below its sample quantitation limit in SS-11.

In addition to acetone, several other volatile organics (methylene chloride, ethylbenzene, *m,p*-xylene, *o*-xylene, 1,3,5-trimethylbenzene, and 1,2,4-trimethylbenzene) were detected in the SUMMA canister sample at concentrations below the sample quantitation limit.

Bulky Waste Area. Twenty-nine points, shown on Figure 25, were sampled in the Bulky Waste Area in July 1991. These were located using a 100-foot-by-100-foot grid. Many of the grid points were omitted because the landfill gas was found to contain similar concentrations of the same compounds from point to point. Two points [BW(04+100) and BW(05+500)] were resampled in May 1992 for volatile organics using a SUMMA canister and also for reduced sulfur analysis, as shown on Figure 26.

Carbon dioxide and methane concentrations were greater than 25% throughout most of the Bulky Waste Area and were measured as high as 49% for carbon dioxide and 57% for methane. Oxygen concentrations were generally depressed from ambient air concentrations to as low as 1%.

Volatile organics were present throughout the disposal area but had elevated concentrations at some hot spots such as BW(05+400), BW(05+500), BW(04+100) and BW(01+300). The relative concentrations of different volatile organic compounds in the landfill gas also varies. Toluene, *cis*-1,2-DCE, and TCE were the primary compounds detected during the field GC analysis.

Toluene had the highest concentration of any component identified during the analysis of SUMMA canister samples collected from BW(04+100) and BW(05+500). Other aromatic compounds were also detected in each of these samples.

Chlorinated compounds were present in greater quantities in BW(04+100) than in BW(05+500). Vinyl chloride and *cis*-1,2-DCE had the highest concentrations of the chlorinated compounds in BW(04+100). The compounds 1,1-DCA, chloroethane, *trans*-1,2-DCE, 1,1,1-TCA, methylene chloride, PCE and TCE were also detected.

In BW(04+100), the ketone MEK was detected in both of the SUMMA samples, while acetone was the only ketone detected.

Dichlorodifluoromethane was detected at a higher concentration in BW(05+500) than in BW(04+100). Trichlorofluoromethane was detected in both samples, while Freon 113 was only detected in BW(04+100).

Hydrogen sulfide was detected at both BW(04+100) and BW(05+500), while mercaptans were not detected at either point.

Solid Waste Area. Eighty-five points were sampled in the Solid Waste Area in June and July 1991. These points were located using a 100-foot-by-100-foot grid. The actual sampling locations are shown on Figure 25. Three points [SW(03+300), SW(11+500) and SW(13+300)] were

resampled in May 1992 for SUMMA canister and reduced sulfur analysis, as shown on Figure 26. Permeation of the landfill gas through the cover material of the Solid Waste Area was measured using two flux boxes installed in February 1992.

Carbon dioxide and methane concentration were greater than 35% throughout most of the Solid Waste Area and ranged as high as 62% for carbon dioxide and 60% for methane. Oxygen concentrations were generally depressed from ambient air concentration to as low as 1%.

Volatile organics were present throughout the disposal area but appear to have elevated concentrations at SW(11+500) and SW(13+200). The relative concentrations of different volatile organic compounds in the landfill gas also appear to vary. Toluene, *cis*-1,2-DCE, and TCE were the primary compounds detected during the field GC analysis. For the SUMMA canister data, *cis*-1,2-DCE had the highest concentration of any volatile organic in the Solid Waste Area. Vinyl chloride had the second highest concentration at SW(13+300) and SW(11+500). Chloromethane, chloroethane, 1,1-DCE, methylene chloride, *trans*-1,2-DCE, 1,1-DCA, 1,1,1-TCA, TCE, and PCE were all detected at these two points.

At SW(03+300), aromatic compounds were the primary volatile organics present in the SUMMA canisters. Although most of the same chlorinated compounds are present, the concentrations of toluene, ethylbenzene, *p*-xylene, and *o*-xylene are higher than those of any of the chlorinated compounds.

Of the Freon compounds, dichlorofluoromethane was present in all of the Solid Waste Area SUMMA canisters. Freon 114 and 113 and trichlorofluoromethane were present periodically.

2-Butanone was the only ketone detected, and it was present at a much lower concentration relative to other volatile organics.

Carbon disulfide was present in two of the four samples, and bromoform was found in only one of the four samples from the Solid Waste Area. These compounds were present at concentrations much less than those of other volatile compounds detected in these samples.

Reduced sulfur analysis indicated hydrogen sulfide results ranging from 1.0 to 6.3 mg/m^3. No mercaptan sulfur was detected.

Of the two flux boxes installed on the Solid Waste Area, FLUXEAST indicates that landfill gas is readily passing through the landfill cover material. Concentrations of methane, carbon dioxide, and volatile organic compounds appeared similar to concentrations of these compounds in landfill gas detected in the same area.

Delineation of Off-Site Landfill Gas Plume. In June and July 1991, 32 permanent landfill gas sampling points were installed around the perimeter of the Solid Waste Area. Nine points, spaced

at approximately 100-foot intervals, were placed at the north end of the Solid Waste Area along the driveway at the northern boundary. Eighteen points were placed along the west side of Rose Hill Road also at approximately 100-foot intervals. Five points were placed at the southern perimeter of the Solid Waste Area, just inside the fence that divides the Solid Waste Area from the transfer station road, again at approximately 100-foot intervals.

These sampling points are shown on Figure 27. Permanent sampling points along the driveway north of this disposal area are designated LFGF. Permanent sampling points west of the Solid Waste Area along Rose Hill Road are designated LFGR. Points south of the Solid Waste Area along the transfer station road are designated LFGT.

Sampling of the perimeter landfill gas monitoring points in July and September 1991 indicated that landfill gas was migrating from the Solid Waste Area to the north, west, and south. Elevated methane, carbon dioxide, and total volatile organics were identified at LFGF-03 to the north of the Site. *cis*-1,2-dichloroethene and vinyl chloride were the primary volatile components identified at this point. TCE, toluene, ethylbenzene, and xylenes were also identified.

The largest area of landfill gas migration was along the western perimeter of the Site. The highest landfill gas concentrations were at LFGR-08. Methane and carbon dioxide concentrations at this point were consistently high. *cis*-1,2-dichloroethene and vinyl chloride were the primary volatile components identified at this point. Trichloroethene, toluene, ethylbenzene, and xylenes were also identified. Although LFGR-08 had the highest concentrations of off-site landfill gas, this plume appeared to extend from LFGR-07 as far south as LFGR-14. Although the landfill gas plume leaving the western perimeter of the Solid Waste Area was about 700 feet wide, it appeared to extend only about 200 feet west from the landfill.

South of the Solid Waste Area, methane, carbon dioxide, and volatiles were found to migrate south of the transfer station road. This plume extended the width of the southern end of the Solid Waste Area and approximately 100 feet south of the transfer station road. The volatile organic compounds detected south of the solid waste area varied from those detected to the north and west. The high concentrations of *cis*-1,2-DCE and vinyl chloride exhibited in the landfill gas north and west of the Solid Waste Area were not present south of the disposal area.

Volatile organics were detected at three permanent residential sampling locations (LFG-LHR, LFG-GT, and LFG-AD). Methane was detected at only one of these (LFG-LHR).

G. Contaminant Fate and Transport

Predominant transport processes for contaminants identified at the Site are leachate runoff, landfill gas migration, groundwater flow through overburden and bedrock, and surface water and sediment movement. Landfill gas migration, groundwater, and leachate are the primary contaminant transport mechanisms in the unsaturated zone. Venting of landfill gas was evident where soil/fill

cover material was thin or absent; however, movement of gas into surface soil may decrease volatilization to the atmosphere. In areas of high landfill gas contamination, groundwater quality was affected.

Highest contaminant concentrations in groundwater were found in wells adjacent to the disposal areas and decreased with distance from these areas. The predominant groundwater flow direction is south-southeast in the overburden and southeast in the bedrock, although mounding effects in the northwest portion of the Solid Waste Area facilitate radial migration of contaminants towards the west, north, and northeast. Mitchell Brook intercepts contamination in the shallow and deep overburden, while the Saugatucket River is a receptor for shallow and deep overburden and bedrock contamination. Glacial lacustrine deposits restrict the vertical movement of contaminants from deep to shallow overburden in the southern portion of the Site. Bedrock fractures provide pathways for contaminant transport in groundwater from overburden to bedrock.

Transport of contaminants via leachate has impacted surface soil, surface water, and sediment quality near the disposal areas. However, downgradient in the Saugatucket River, surface water and sediment contamination decreased. Likewise, in Mitchell Brook, contamination increased south of the Solid Waste Area but decreased after the confluence with the Saugatucket River. This trend indicates dilution of contaminated surface water by uncontaminated surface water and/or sediment retention of contamination.

VI CURRENT AND FUTURE SITE AND RESOURCE USES

A. Current Land Use

Current land use is varied within the Site. The landfills are and will remain inactive. The Solid Waste Area landfill is posted and partially fenced along Rose Hill Road and the transfer station road to restrict access. The properties within the Site boundary include residential and commercial uses. North and east of the Sewage Sludge Area, the Site owner conducts his business of sport, target and archery ranges, dog training, birding and exercising. A kennel is located on the northern portion of the Site, west of the Sewage Sludge Area. Sporting ranges are located north and east of the kennel. An active Town-operated regional transfer station and recycling center reside on the southeast corner of the Site. Saugatucket and Broadrock Roads, and a portion of Rose Hill Road (south and up to the Site), are serviced with public water; connections to the waterline were voluntary. Some residents located west and north of the Site along Rose Hill Road and along Broadrock Road are not connected to public water and use private wells. New housing developments, all of which are connected to municipal water, have been constructed southwest of the Site, on the west side of Rose Hill Road, northeast of the Site, across the River on Broadrock Road and southwest of the Site along Saugatucket Road. Across from the landfill on Rose Hill Road, small commercial excavation businesses and sand and gravel operations are conducted. A family-owned farm is located west-northwest of the Site, along Rose Hill Road.

B. Future Land Use

The Town of South Kingstown has indicated an interest in expanding the recycling operations in the vicinity of the transfer station. The Site owner has also shown interest in maintaining sporting and kennel operations within the Site boundary. The Town informed EPA and the State that it has had discussions with the Site owner's family members and abutters concerning certain real property acquisitions; however, EPA has not been involved in these discussions.

A 29- unit housing development (known as South Woods) is proposed north of the Site and south of Rte 138; this development will be connected to municipal water. Further, there are discussions among certain residents on Rose Hill Road and a local developer of a future proposal for a golf course within the footprint of the existing sand and gravel operations on Rose Hill Road.

Consolidation of the wastes from the Bulky Waste Area landfill onto the Solid Waste Area landfill may allow for more future, albeit restricted, uses on portions of the Site. Based on current zoning, it is reasonable to expect that the future land use will be similar to that which is currently in the immediate vicinity of the Site (i.e. rural residential with intespersed commercial real estate along Rose Hill Road and rural residential along Broadrock and Saugatucket Road.

C. Current and Future Surface Water Use

The River in the vicinity of the Site is classified by the State as a Class B waterway meaning that the River is not of drinking water quality but is presumed to have a good aesthetic, recreational, and ecological value. As documented in the RI/FS and the Preliminary Natural Resource Survey (PNRS), leachate production and groundwater flow from the landfill result in impacts to aquatic life and water quality in the Saugatucket River, Mitchell Brook (and, according to the PNRS, to the Saugatucket Pond). These waters are listed for biodiversity impacts on the State's 1998 list of impaired waters. Under Section 303 of the Federal Clean Water Act, the State is required to develop a total Maximum Daily Load (TMDL) program for bringing impaired waters into compliance with state water quality standards and supporting all designated uses. Rhode Island has stated that development of TMDLs for the aforementioned waterbodies will begin in the year 2000. The selected remedy will be consistent with the State's TMDL's goals.

The Saugatucket River Heritage Corridor Coalition has adapted a goal of maintaining swimmable/fishable water quality conditions in the watershed. Regionally, plans are being drawn to develop a protective greenway and bike trail to follow portions of the Saugatucket River in Wakefield and surrounding communities.

D. Current and Future Groundwater Use

Rhode Island does not have an EPA-endorsed Comprehensive State Ground Water Protection Program (CSGWPP) – EPA's process for groundwater decisionmaking by states. Therefore,

Superfund guidance requires EPA to follow the NCP for federal groundwater classification in states without a CSGWPP and to coordinate with the States during remediation activities. The federal classification for this Site groundwater is Class II-B, defined as a potential drinking water source and water having other beneficial uses. Local area groundwater surrounding the Site is classified as Class II-A which is defined as a current drinking water source and water having other beneficial uses.[1]

Although Rhode Island does not have an endorsed CSGWPP, RIDEM did submit correspondence in December 1996 setting forth its opinion on the use and value of groundwater aquifer underlying the Site as medium use (designates a flexible approach to groundwater remediation). Ultimately, all of the aquifer, except that underlying the footprint of the disposal area, would be restored to GA (suitable for public or private drinking water use without treatment); the aquifer under the disposal area would be restored to GB (degraded--not suitable for public or private drinking water). The State also noted some small GA-NA (non-attainment areas with pollutant concentrations greater than those suitable for public or private drinking water without treatment). Restoration for GA-NA areas is to drinking water standards with some flexibility on time for attaining those standards.

EPA believes that its remediation plans for this Site are consistent with both the federal and state classifications for use and value of the groundwater aquifer. Source control measures will prevent further migration of contaminant into the groundwater as well as prevent further leachate from entering the groundwater and surface water. Excavation and consolidation of the Bulky Waste Area, a portion of which currently sits in the groundwater table, also eliminates a significant source of contamination to groundwater. It is also possible that capping will, over time, eliminate any possible mounding effects of groundwater in the Solid Waste Disposal area. Once the source control remedy has been implemented, additional data produced during long-term monitoring will indicate whether or not further response actions are necessary to bring groundwater to appropriate use and value standards.

VII. SUMMARY OF SITE RISKS

A baseline risk assessment was performed to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants associated with the Site assuming no remedial action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial

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[1]Groundwater Use and Value Determination Guidance, EPA Region1-New England, (April 3, 1996); EPA Office of Solid Waste and Emergency Response (OSWER) Dir. 9283.1-09, April 4, 1997; EPA's Groundwater Protection Strategy (Office of Groundwater Protection, August 1984); and Guidelines for Groundwater Classification under the EPA Groundwater Protection Strategy (Final Draft, Office of Groundwater Protection, November 1986).

action. The public health risk assessment followed a four step process: 1) contaminant identification, which identified those hazardous substances which, given the specifics of the Site were of significant concern; 2) exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure; 3) toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances, and 4) risk characterization, which integrated the three earlier steps to summarize the potential and actual risks posed by hazardous substances at the Site, including carcinogenic and non-carcinogenic risks. A summary of those aspects of the human health risk assessment which support the need for remedial action is discussed below followed by a summary of the environmental risk assessment.

A. Human Health Risk Assessment

Only groundwater, at the three landfill areas and at nearby residences, and air, at the Solid Waste Area (i.e., landfill gas) and nearby residences, present a Reasonable Maximum Exposure (RME) cancer risk greater than 10-4 or an HI >1. Forty-three contaminants of concern (listed in Tables 27 through 34 for groundwater, and Tables 35, 36, 37 through 42, 43, and 44 for air) of more than 50 contaminants detected at the Site were selected for evaluation in the human health risk assessment. The contaminants of concern for groundwater and for air from the Final Supplemental Human Health Risk Assessment (November 1998) were selected to represent potential Site related hazards based on toxicity, concentration, frequency of detection, and mobility and persistence in the environment. They represent a subset of all the compounds evaluated in the baseline risk assessment. Tables 28, 30, 32, and 34 for ground water, and 36, 38, 40, and 44 for air, from the Final Supplemental Human Health Risk Assessment also contain the exposure point concentrations used to evaluate the RME in the baseline risk assessment. Estimates of average or central tendency exposure concentrations can be found in the Final Supplemental Human Health Risk Assessment. Tables 45 and 46 from the Final Supplemental Human Health Risk Assessment and Table 47 (for air) as well as Tables 48 through 50 and 51 (for groundwater) from the Final RI Report (May 1994) provide a summary of the range of detected concentrations and frequency of detection for the compounds of concern in both media.

Potential human health effects associated with exposure to the contaminants of concern were estimated quantitatively or qualitatively through the development of several hypothetical exposure pathways. These pathways were developed to reflect the potential for exposure to hazardous substances based on the present uses, potential future uses, and location of the Site. The following is a brief summary of just the exposure pathways that were found to present a significant risk. A more thorough description of all exposure pathways evaluated in the risk assessment including estimates for an average exposure scenario, can be found in Section 7.0 of the Final Supplemental Human Health Risk Assessment, November, 1998.

For the inhalation of contaminated ambient and indoor air, both measured and modeled concentrations were evaluated. For modeling, measured landfill gas concentrations were used and

adjusted using emission and dispersion modeling. Exposures to ambient air at the Solid Waste Area surface were assumed to occur for an adult Site visitor 4 hr/day, 150 days/year, for 30 years. At the nearby residences, adult inhalation exposures were assumed to occur 24 hr/day, 350 days/year, for 30 years.

Excess lifetime cancer risks were determined for each exposure pathway by multiplying a daily intake level with the chemical specific cancer potency factor. Cancer potency factors have been developed by EPA from epidemiological or animal studies to reflect a conservative "upper bound" of the risk posed by potentially carcinogenic compounds. That is, the true risk is unlikely to be greater than the risk predicted. The resulting risk estimates are expressed in scientific notation as a probability (e.g. 1×10^{-6} for 1/1,000,000) and indicate (using this example), that an average individual is not likely to have greater that a one in a million chance of developing cancer over 70 years as a result of site-related exposure (as defined) to the compound at the stated concentration. All risks estimated represent an "excess lifetime cancer risk" or the additional cancer risk on top of that which we all face from other causes such as cigarette smoke or exposure to ultraviolet radiation from the sun. The chance of an individual developing cancer from all other (non-site related) causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site related exposure is 10^{-4} to 10^{-6}. Current EPA practice considers carcinogenic risks to be additive when assessing exposure to a mixture of hazardous substances.

In assessing the potential for adverse effects other than cancer, a hazard quotient (HQ) is calculated by dividing the daily intake level by the reference dose (RfD) or other suitable benchmark. Reference doses have been developed by EPA and they represent a level to which an individual may be exposed that is not expected to result in any deleterious effect. RfDs are derived from epidemiological or animal studies and incorporate uncertainty factors to help ensure that adverse health effects will not occur. A HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g. liver) within or across all media to which a given individual may reasonably be exposed. A HI <1 indicates that toxic noncarcinogenic effects are unlikely.

The scope of the first operable unit response for this Site is a source control action as part of a phased clean up approach. Groundwater and the risks posed by contaminants in groundwater will be further assessed using monitoring data collected during the implementation of the first operable unit and any additional studies deemed necessary and addressed under a second operable unit response action. However, based on the findings of the RI, EPA acknowledges that the cumulative excess RME cancer risk posed by present and potential future ingestion of groundwater as a drinking water source is outside of EPA's acceptable risk range for Site related exposures. Tables 52 through 55 depict the carcinogenic and non-carcinogenic risk summary for the contaminants of concern in groundwater evaluated to reflect present and potential future adult residential ingestion of Site groundwater as drinking water corresponding to the reasonable maximum exposure (RME) scenario. As such, the risk posed by this exposure route justifies the use of institutional controls as

part of the remedy for this first operable unit response.

Tables 56 through 60 depict the carcinogenic and non-carcinogenic risk summary for the contaminants of concern in air evaluated to reflect present and potential future inhalation of ambient air by Solid Waste Area visitors and ambient/indoor air by area residents corresponding to the reasonable maximum exposure (RME) scenario. Only those exposure pathways deemed relevant to the remedy being proposed are presented in this ROD. In addition, only those compounds contributing an RME cancer risk in excess of 10^{-6} or an HQ>1 have been presented. Readers are referred to Section 7.0 of the Final Supplemental Human Health Risk Assessment for a more comprehensive risk summary of all exposure pathways and for estimates of the central tendency risk. Toxicity information used for the risk calculations can be found in Tables 61 and 62 of the Final Supplemental Human Health Risk Assessment.

For the air pathway, benzene, 1,1-dichloroethene, 1,1,2,2-tetrachloroethane, and vinyl chloride contribute significantly to carcinogenic and non-carcinogenic risk. The cumulative excess RME cancer risks posed by the inhalation of measured outdoor air concentrations at the Solid Waste Area and measured ambient air concentrations at the nearby residences are 4.4×10^{-4} and 5×10^{-4}, respectively. Using modeled concentrations, the cumulative excess RME cancer risks posed by the inhalation of ambient air at the Solid Waste Area and ambient/indoor air at the nearby residences are 4.4×10^{-4} and 4.6×10^{-4}, respectively. Using measured indoor air concentrations at 220 Rose Hill Road, the cumulative excess RME cancer risk posed by the inhalation of air is 1.9×10^{-3}. The non-carcinogenic hazards posed by the inhalation of measured and modeled ambient air concentrations at the nearby residences are both 12 times the EPA safe level indicating that adverse blood effects are possible as a result of chronic exposure to benzene.

Limitations and uncertainties in the risk assessment include adequacy of site characterization and sampling, quality of analytical data, accuracy of exposure assumptions, use of modeling to develop EPCs, and development of toxicity values. Most important for this risk assessment, conservative exposure assumptions were used for exposure concentrations (i.e., maximum detected concentrations) and for frequency and duration of exposure. These conservative assumptions can potentially result in an overestimate of risk to human receptors. In addition, exposure point concentrations derived by modeling have considerable uncertainty since the modeled concentrations are based on: (1) limited sampling; (2) predicted, rather than measured landfill gas generation rates; and (3) conservative assumptions for specific input parameters. Each of these uncertainties may result in an over-, or under- estimate of receptor risk.

Further detail concerning the Human Health Risk Assessment can be found in Section 3.6 of the Administrative Record.

B. Ecological Risk Assessment

The major objective of the baseline ecological risk assessment was to evaluate potential adverse effects to ecological resources from exposure to Site contaminants. The baseline ecological risk assessment provides quantitative risk estimates for aquatic communities since information on the nature and extent of contamination suggested that potential impacts to ecological resources were most likely to occur in aquatic areas; thus, data (e.g., quantitative benthic surveys and toxicity testing) were collected to support a full quantitative assessment. The baseline ecological risk assessment provides a qualitative evaluation for terrestrial communities since risks were expected to be small and data collection to support a quantitative assessment was thus not considered necessary. The baseline ecological risk assessment was conducted consistent with applicable United States Environmental Protection Agency guidance documents on ecological assessments and ecological risk assessments.

Contaminant Identification

Risks were evaluated through the development of media-specific ecological effect levels, which are defined as the concentration of a particular contaminant in a particular medium below which no adverse effects to ecological receptors are likely to occur. Ecological effect levels were developed based on established numerical criteria (e.g., United State Environmental Protection Agency and RIDEM ambient water quality criteria) or on information obtained from the literature. These effect levels can be used to assess baseline risks to ecological receptors by comparing the effect levels to existing contaminant levels in the on-site media. In addition, toxicity testing with on-site sediments and leachate served to more fully define baseline risks to aquatic receptors.

Media that were investigated as part of this remedial investigation included surface water, groundwater, leachate, surface sediment, surface soil, subsurface soil, and landfill gas. Based on likely exposure pathways (see section 7.3 of the RI) for species observed or expected to occur on Site, the following exposure pathways were identified for further evaluation under the baseline ecological risk assessment as potential concerns to ecological resources:

- Surface water in the Saugatucket River and Mitchell Brook, as well as in downgradient surface waters fed by these water bodies
- Leachate from landfill seeps
- Surface sediment in the Saugatucket River and Mitchell Brook
- Surface soil, especially in the three disposal areas
- Landfill gas, especially in the Solid Waste Area

Groundwater and subsurface soils (soils at depths greater than two feet) were eliminated as media of ecological concern since organisms on Site have limited direct contact with these media.

Tables 63 through 67 summarize the occurrence of chemicals detected in surface water, leachate, surface sediment, and surface soils samples collected within the Site study area. In summary, chemicals of ecological concern for surface water are aluminum, iron and manganese (Table 68). For leachate, aluminum, iron, lead and manganese are the chemicals of ecological concern while aluminum and iron are of ecological concern in the surface sediments. Copper, lead and manganese were identified as the chemicals of concern for surface soils. No compounds are of ecological concern in landfill gas.

Exposure Assessment

Within exposure assessment, the potential exposure pathways for various species groups such as plants, benthic invertebrates, fish, amphibians, reptiles, mammals and birds were directly or indirectly evaluated to determine those considered to be at risk of significant exposure from Site contaminants.

Table 69 lists the assessment and measurement endpoints for selected species groups for which a potential exposure risk has been identified and for which quantitative data exist. Since only the aquatic system was studied in detail, assessment and measurement endpoints are established only for benthic invertebrates and fish. Terrestrial and semiaquatic taxa were qualitatively evaluated.

Information on the toxicity of the five chemicals of ecological concern (iron, aluminum, manganese, copper, and lead) to ecological receptors was summarized in the toxicity assessment of the ecological risk assessment. In addition, the correlation between the abundance and diversity of species within the benthic community and contaminant concentrations was also presented. Because of the potential synergistic effects of contaminants in sediments and the overall lack of existing sediment toxicity information in the literature, toxicity tests were conducted on sediment samples from three locations at the Site as described in section 2.5.7.6 of the Remedial Investigation. Additionally, toxicity testing was conducted for water column organisms on leachate samples from the Site.

In summary, the results of the correlation analyses indicate that, at least in the water column, total species densities and community structure (occurrence of dominant species) are directly correlated to iron concentration in the Saugatucket River. Total densities and densities of dominant species decrease with increasing iron concentration in the Saugatucket River. This indicates that iron in the water column, although not acutely toxic, is resulting in decreased productivity. The concentration of aluminum does not appear to negatively affect the macrobenthic community.

Toxicity tests were conducted on sediments using two aquatic invertebrates, *Hyalella azteca* and *Ceriodaphnia dubia* and on the fathead minnow, *Pimephales promelas*. Composite leachate

samples were collected from the Site and toxicity tests performed using the test organisms, *C. dubia and P. promelas*. The methodologies used in the toxicity testing are described in detail in sections 2.5.7.3 and 2.7.5.4 of the RI. Detailed reports of the tests can be found in Appendix F of the RI.

Table 70 summarizes the mean weight of surviving *Hyalella azteca* in the ten-day growth test. There was variability in growth among samples, but no statistically significant difference in growth was found between samples. The mean weight of surviving organisms in the Saugatucket River was lowest in samples from locations SE-05 and SE-06 (downstream of the leachate seeps), suggesting that the growth of these organisms may be adversely influenced by contamination from the seeps. Sediments from these locations also contained the highest iron concentrations. In Mitchell Brook, the mean weight of surviving organisms was lowest (although not statistically significant) at the two downstream locations (Table 70), suggesting that contamination from the disposal areas may be affecting growth in these organisms.

Percent survival of *Ceriodaphnia dubia* in the Saugatucket River was slightly lower (although not statistically significant) in the samples from locations downstream of the major leachate seep (SE-05, SE-06, SE-11; Table 71), suggesting some potential influence on survival of organisms from the leachate contaminants. In Mitchell Brook, survival was slightly higher in the samples from the two downstream locations (SE-07 and SE-12; Table 71). In general, however, it does not appear that the contamination from the Site significantly affected the survival rate of the test organisms, since mortality at all locations was very low and not statistically difference from the laboratory control samples.

In the Saugatucket River, the survival rate of *Pimephales promelas* was lowest at the most upstream sample location (SE-02) and highest at the most downstream sample location (SE-11). Survival in the intermediate locations varied (Table 72), suggesting that no distinct correlation between survival rate and contamination was associated with the disposal areas adjacent to the river for these organisms. In Mitchell Brook, the survival rate was lower in samples from the two downstream locations (Table 72), suggesting that the survival rate in the brook samples may be influenced by Site contamination. Sediments from these two locations contained higher levels of contaminants than the upstream location. As with the other two test organisms, there was no statistical difference in survival rate between the reference sample and any of the test samples.

Based on the statistical results of these tests, it was concluded that there was no significant difference between the reference and study area samples in sediment toxicity. This indicates that the sediments at the Site do not exhibit acute or chronic toxicity to representative, aquatic species.

Toxicity tests were performed using composite leachate samples from the Site and the test organisms *C. dubia* and *P. promelas*. Results from these tests are summarized in Tables 73 and 74. Test results indicate that the leachate was acutely toxic to *C. dubia* and also caused reproductive effects. Some chronic toxicity also occurred in the fathead minnow (*P. promelas*).

Risk Characterization

As discussed in section 3.4 of the RI, the benthic community in the Saugatucket River is generally diverse. However, community composition and relative abundance of organisms appear to be influenced by the proximity to the landfill and leachate seeps. The benthic grab samples from the sediments adjacent to the largest leachate seep were distinctly different from samples at upstream and downstream locations, indicating that the community structure at this location may be the result of adaption to the chemical influence of the sediments, and thus, is different from the community structure that would be expected in the absence of the chemical influence. Concentrations of the chemicals of ecological concern in the sediments were generally higher at the two locations immediately downstream of the major leachate seep (SE-05 and SE-06) than at the most upstream (SE-02) and most downstream (SE-11) locations. This trend is especially evident for iron, where the concentration at SE-05 and SE-06 is two orders of magnitude greater than at the upstream location. This difference in iron concentration, and to a lesser degree aluminum, may be directly influencing the benthic community structure. Results of the sediment toxicity tests also indicate that contamination in the sediments may result in lower survival rates for sensitive organisms, resulting in a shift in community structure.

In the water column of the Saugatucket River, the density of macroinvertebrates appears to be directly influenced by the disposal areas. The density of organisms significantly decreases downstream of the disposal areas where contaminant concentrations in the surface water are higher. Additionally, the occurrence of pollution-sensitive taxa decreases downstream of the disposal areas, indicating that these species are less able to tolerate the more stressful environmental conditions. This increase in densities of organisms corresponds to an increase in the concentrations of the chemicals of ecological concern in surface water from upstream to downstream locations, especially with respect to iron and manganese.

In Mitchell Brook, as with the Saugatucket River, the benthic community structure associated with contaminated sediments was distinctly different from the structure at locations less influenced by the disposal area contamination. Total species densities were lower downstream of the disposal areas even though the physical characteristics of the sediments were similar. This corresponds to an increase in the concentrations of the chemicals of ecological concern immediately downstream of the disposal areas (SE-09). This indicates that chemical contamination from the disposal areas may be affecting densities. The macrobenthic community in the water column in Mitchell Brook exhibits this same trend of decreased species densities downstream of the disposal areas associated with increased concentrations of the chemicals of ecological concern.

No quantitative assessment of the fish community in the water bodies of the Site study area was conducted. However, based on the physical characteristics of the water bodies (such as water flow and sediment type), these areas would be expected to support both resident and migratory fish populations. However, based on observations made during aquatic sampling, Mitchell Brook and

the Saugatucket River do not appear to support a healthy fish community on the Site, since few fish were observed during aquatic sampling. The lack of fish may be related to chemical contamination in the water column since both aluminum and iron exceeded AWQC. AWQC are designed to protect most aquatic organisms from the toxic effects of contaminants. Additionally, results of the leachate toxicity tests indicate that this media can produce chronic toxicity in fathead minnows. Sediment toxicity tests also suggest that there may be decreased survival rates in minnows at sediment contaminant levels associated with the study area.

The *in-situ* benthic community exhibits some apparent effects from Site contamination particularly with respect to community structure (as described in sections 3.4 and 7.5.1 of the RI). However, the results of the correlation analyses suggest that there is no significant linear correlation between species densities and sediment contamination. Also, the results of the sediment toxicity tests indicate that the sediments do not produce acute or chronic toxicity in sensitive aquatic organisms. These results suggest that the effects on the benthic community are likely to be attributable to surface water contamination and not sediment contamination. This is supported by the fact that concentrations of the chemicals of ecological concern in surface water and leachate exceed AWQC and that the leachate is acutely toxic in toxicity tests.

Ecological risk from the chemicals of ecological concern in surface water and leachate can be characterized by comparing contaminant concentrations to known ecological effect levels. For iron and aluminum, the ecological effect levels were based on ambient water quality criteria for protecting aquatic life. For iron, the chronic effect level is 1,000 μg/L in surface water, and for aluminum is 87 μg/L. Iron was measured at up to 65 times the criteria in surface water while aluminum was measured at up to 13 times its criteria value. Concentrations of these chemicals in surface waters throughout the Site frequently exceeded criteria levels, especially in areas downstream of leachate seeps. Thus, there is a risk to aquatic organisms in the surface waters from exposure to these chemicals of ecological concern. Concentrations of iron and aluminum in leachate also exceeded AWQC by up to four orders of magnitude for iron and up to three orders of magnitude for aluminum. The risk to aquatic organisms is confirmed by results from the leachate toxicity testing, which indicated that the leachate is acutely toxic to aquatic organisms. Additionally, the correlation analysis shows significant negative correlation between iron concentration and species densities in the surface water.

In summary, baseline risk to aquatic organisms may occur as a result of exposure to the chemicals of ecological concern in the surface water and leachate. There does not appear to be an existing risk to aquatic organisms due to exposure to sediments.

In contrast, baseline risks to terrestrial and semiaquatic organisms are not likely to be significant over most of the Site study area. Areas of soil associated with leachate seeps, and the leachate itself, may pose some risks to biota. Due to the small areas affected, however, this risk is not likely to be significant. Food chain effects are not of concern, although indirect effects from reduced prey abundance in aquatic areas may be occurring. Small areas of dead trees associated with high

methane levels in soil gas are also not considered significant, due to the extremely limited areas over which these effects have been observed.

Uncertainty

There are many sources of uncertainty associated with an ecological risk assessment. Each component of an ecological risk assessment (i.e., receptor selection, toxicity assessment, and exposure assessment) has some uncertainty associated with it. The principal uncertainty associated with this analysis involves the determination of ecological effect levels. For many chemicals, especially for the terrestrial assessment, toxicity data were very limited and criteria values were often unavailable. To compensate for this, the most conservative values were generally used to represent a reasonable worst-case scenario.

A second uncertainty involves using chemical-specific effect levels for individual compounds to assess toxicity. This approach fails to account for multiple exposure pathways, exposures to multiple chemicals, and potential additive or synergistic effects. This uncertainty is most evident for the terrestrial portion of the ecological risk assessment; the aquatic portion included toxicity testing with on-site media, which accounts for these factors.

Conclusion

The baseline human health risk assessment revealed that area adult residents and adult visitors to the Solid Waste Area potentially exposed to compounds of concern in groundwater and air via ingestion and inhalation, respectively, may present an unacceptable human health risk (e.g. cancer risk$>10^{-4}$ or HI>1).

Results of the baseline ecological risk assessment identified concentrations of iron and aluminum in surface waters throughout the Site frequently exceeded criteria levels, especially in areas downstream of leachate seeps. Thus, there is a risk to aquatic organisms in the surface waters from exposure to these chemicals of ecological concern. Concentrations of iron and aluminum in leachate also exceeded AWQC by up to four orders of magnitude for iron and up to three orders of magnitude for aluminum. The risk to aquatic organisms is confirmed by results from the leachate toxicity testing, which indicated that the leachate is acutely toxic to aquatic organisms. Additionally, the correlation analysis between benthic community composition and chemical concentrations, show a significant negative correlation between iron concentration and species densities in the surface water.

The human health and ecological risk assessments identified unacceptable risks posed by actual or threatened releases of hazardous substances from this Site which if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment. Therefore, groundwater, air (i.e., landfill gas) and leachate are the media of focus for the remedial alternatives presented for this Site.

VIII. REMEDIAL OBJECTIVES AND DEVELOPMENT AND SCREENING OF ALTERNATIVES

A. Statutory Requirements/Response Objectives

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences, including: A requirement that EPA's remedial action, when complete, must comply with all federal and more stringent state environmental standards, requirements, criteria or limitations, unless a waiver is invoked; a requirement that EPA select a remedial action that is cost-effective and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and a preference for remedies in which treatment which permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances is a principal element over remedies not involving such treatment. Response alternatives were developed to be consistent with these Congressional mandates.

Based on preliminary information relating to types of contaminants, environmental media of concern, and potential exposure pathways, remedial action objectives were developed to aid in the development and screening of alternatives. These remedial action objectives were developed to mitigate existing and future potential threats to public health and the environment. These response objectives are:

- To reduce the potential exposure of area residents and those at the landfill to landfill gases (i.e., vinyl chloride, benzene, 1,1-dichloroethene, and 1,1,2,2-tetrachloroethane) in ambient and indoor air via inhalation that may present a human health risk in excess of the EPA target risk range of 10^{-6} to 10^{-4} for carcinogenic compounds or with a total HI>1 for noncarcinogenic compounds with similar toxic endpoints.

- To reduce the potential exposure of area residents to organic and inorganic contaminants of concern (i.e., vinyl chloride, 1,2-dichloroethene, acrylamide, benzene, pentachlorophenol, bis(2-ethylhexyl)phthalate, antimony, arsenic, cadmium, manganese, beryllium, chromium, and lead) in groundwater via ingestion that may present a human health risk in excess of the EPA target risk range of 10^{-6} to 10^{-4} for carcinogenic compounds or with a total HI>1 for noncarcinogenic compounds with similar toxic endpoints through institutional controls.

- To reduce contaminant migration via leachate to surface waters and sediments of Mitchell Brook in order to improve water quality and designated uses, including aquatic life support.

- To reduce contaminant migration via leachate to surface waters and sediments of the Saugatucket River in order to improve water quality and designated uses, including aquatic life support.

B. Technology and Alternative Development and Screening

CERCLA and the NCP set forth the process by which remedial actions are evaluated and selected. Because many CERCLA municipal landfill sites share similar characteristics, they lend themselves to remediation by similar technologies. EPA has established a number of expectations as to the types of technologies that should be considered and alternatives that should be developed; they are listed in the National Contingency Plan (NCP), 40 CFR 300.430(a)(1). For CERCLA municipal landfill sites, it is expected that;

1. The principal threats posed by a site will be treated wherever practical, such as in the case of remediation of a hot spot.

2. Engineering controls such as containment will be used for waste that poses a relatively low long-term threat or where treatment is impractical.

3. A combination of methods will be used as appropriate to achieve protection of human health and the environment. An example of combined methods for municipal landfill sites would be treatment of hot spot in conjunction with containment (capping) of the landfill contents.

4. Institutional controls such as deed restrictions will be used to supplement engineering controls, as appropriate, to prevent exposure to hazardous wastes.

5. Innovative technologies will be considered when such technologies offer the potential for superior treatment performance or lower costs for performance similar to that of demonstrated technologies.

6. Groundwater will be returned to beneficial uses whenever practical, within a reasonable time, given the particular circumstances of the Site.

In accordance with these requirements, a range of alternatives were developed for the Site.

With respect to source control, the RI/FS developed a range of alternatives in which treatment that reduces the toxicity, mobility, or volume of the hazardous substances is a principal element. This range included an alternative that removes or destroys hazardous substances to the maximum extent feasible, eliminating or minimizing to the degree possible the need for long term management. This range also included alternatives that treat the principal threats posed by the Site

but vary in the degree of treatment employed and the quantities and characteristics of the treatment residuals and untreated waste that must be managed; alternative(s) that involve little or no treatment but provide protection through engineering or institutional controls; and a no action alternative.

With respect to ground water response action, the RI/FS developed a limited number of remedial alternatives that attain site specific remediation levels within different timeframes using different technologies; and a no action alternative. However, groundwater will be addressed in a second operable unit, based on monitoring data collected during the implementation of the first operable unit and any additional studies deemed necessary, as explained in Section VII A. above.

As discussed in Section 2 of the FS, treatment technology options were identified, assessed and screened based on implementability, effectiveness, and cost. These technologies were combined into source control (SC) (no action, limited action, containment and treatment,) and management of migration (MOM) alternatives. The MOM alternatives will be evaluated as part of a second operable unit, based on monitoring data collected during the implementation of the first operable unit and any additional studies deemed necessary. Section 3 of the FS presented the remedial alternatives developed by combining the technologies identified in the previous screening process in the categories identified in Section 300.430(e) (3) of the NCP. The purpose of the initial screening was to narrow the number of potential remedial actions for further detailed analysis while preserving a range of options. Each alternative was then evaluated in detail in Sections 4 and 5 of the FS.

In summary, the no action, limited action, and four source control (containment and treatment) remedial alternatives were retained as possible options for the cleanup of the Site. These six alternatives were selected herein for detailed analysis.

IX. DESCRIPTION OF ALTERNATIVES

This Section provides a narrative summary of each alternative evaluated.

- **Alternative 1:** *No-Action*
  The Site would remain as is; there would be no remedial action of any of the contaminated media. However, long-term monitoring of existing ground water monitoring wells, landfill gas and surface water stations located throughout the Site would be monitored for at least thirty years to detect any change that would require intervention. Five-year statutory reviews to determine protectiveness would be conducted as required. A schematic of this alternative is shown in Figure 28, Appendix A.

Estimated Time for Design and Construction:	*<1 year*
Estimated Time of Operation:	*> 30 years*
Estimated Capital Cost:	*$100,000*
*Estimated Operations and Maintenance Costs (**net present worth**):*	*$3,460,000*
*Estimated Total Cost (**net present worth**):*	*$3,570,000*

- **Alternative 2:** *Limited Action*
  This alternative would include the long-term environmental monitoring and statutory five-year reviews as described above, establish institutional controls for access and for use of groundwater in the form deed restrictions including land use easements and covenants to prevent access to restricted areas of the Site and to prevent the future use, direct contact and exposure to, or hydraulic alteration of contaminated groundwater. This alternative would also provide landfill gas control contingencies for the nearby residential dwellings which are, or may be, impacted by migrating landfill gas. A schematic of this alternative is shown in Figure 29, Appendix A.

Estimated Time for Design and Construction:	*1 year*
Estimated Time of Operation:	*>30 years*
Estimated Capital Cost:	*$360,000*
*Estimated Operations and Maintenance Costs (**net present worth**):*	*$3,480,000*
*Estimated Total Cost (**net present worth**):*	*$3,840,000*

EPA's Preferred Alternative, as presented in the Proposed Plan, was Alternative 3A.

- **Alternative 3A:** *Containment and Landfill Gas Treatment via an Enclosed Flare*
  This alternative would include the long-term environmental monitoring, statutory five-year reviews and establishment of institutional controls as described above, apply protective (Subtitle-C or its performance equivalent), multi-layer caps onto the Solid Waste and Bulky Waste Areas, install an active perimeter and internal gas collection system on the Solid Waste Area with treatment of the gases via combustion through an enclosed flare, and install a passive landfill gas venting system on the Bulky Waste Area. In addition, EPA would collect data to assess the need for conducting any further remedial responses concerning groundwater and surface water as a component of the long-term monitoring program. A schematic of this alternative is shown in Figure 30, Appendix A.

Estimated Time for Design and Construction:	*2 years*
Estimated Time of Operation:	*<15 years for LFG; >30 years GW/Leachate*
Estimated Capital Cost:	*$6,420,000*
*Estimated Operations and Maintenance Costs (**net present worth**):*	*$7,000,000*
*Estimated Total Cost (**net present worth**):*	*$13,420,000*

- **Alternative 3B:** *Containment and Landfill Gas Treatment via Photocatalytic Oxidation*

  This alternative would include the long-term environmental monitoring, statutory five-year reviews, establishment of institutional controls, protective covers, installation of a passive landfill gas venting system on the Bulky Waste Area, an active perimeter and internal gas collection system on the Solid Waste Area as described above, with treatment of the gases via photocatalytic oxidation. In addition, EPA would collect data to assess the need for conducting any additional remedial responses concerning groundwater and surface water as a component of the long-term monitoring program. A schematic of this alternative is shown in Figure 31, Appendix A.

Estimated Time for Design and Construction:	*2 years*
Estimated Time of Operation:	*<15 years for LFG; >30 years GW/Leachate*
Estimated Capital Cost:	*$6,560,000*
*Estimated Operations and Maintenance Costs (**net present worth**):*	*$6,630,000*
*Estimated Total Cost (**net present worth**):*	*$13,190,000*

- **Alternative 4A:** *Containment, Leachate Collection and On-site Treatment, and Landfill Gas Treatment*

  This alternative would include the long-term environmental monitoring, statutory five-year reviews, establishment of institutional controls, protective covers, installation of a passive landfill gas venting system on the Bulky Waste Area, an active perimeter and internal gas collection system on the Solid Waste Area as described in 3A above. Additionally, added measures to collect and treat leachate in the Bulky Waste Area would be implemented and treated waters would be discharged on-site through injection wells. A schematic of this alternative is shown in Figure 32, Appendix A.

Estimated Time for Design and Construction:	*2 years*
Estimated Time of Operation:	*<15 years for LFG; >30 years GW/Leachate*
Estimated Capital Cost:	*$7,240,000*
*Estimated Operations and Maintenance Costs (**net present worth**):*	*$8,830,000*
*Estimated Total Cost (**net present worth**):*	*$16,070,000*

EPA's Selected Remedy is Alternative 4B. The NCP allows EPA to re-evaluate its remedy preference in response to new information and in consideration of comments received during the public comment period. In review of all information and comments received, EPA modified its preferred remedy to Alternative 4B.

- **Alternative 4B:** *Consolidation of the Bulky Waste Area onto the Solid Waste Area, Containment, Leachate Collection and Management (during consolidation), and Landfill Gas Collection and Treatment (Solid Waste Area)*
  This alternative would include the long-term environmental monitoring, statutory five-year reviews and establishment of institutional controls as described above. Instead of capping the Bulky Waste Area, this disposal area would be excavated and consolidated onto the Solid Waste Area which would then be capped and an active perimeter and internal landfill gas collection system installed and treatment of the gases via combustion (enclosed flare) as required to achieve ARARs. Leachate and waters collected from runoff and de-watering operations during the consolidation phase would be managed and discharged according to appropriate regulations. As with Alternative 3A, EPA would collect data to assess the need for conducting any additional remedial responses concerning groundwater and surface water as a component of the long-term monitoring program. A schematic of this alternative is shown in Figure 33, Appendix A.

Estimated Time for Design and Construction:	*2 years*
Estimated Time of Operation:	*<15 years for LFG; >30 years GW/Leachate*
Estimated Capital Cost:	*$11,360,000*
*Estimated Operations and Maintenance Costs (**net present worth**):*	*$6,680,000*
*Estimated Total Cost (**net present worth**):*	*$18,040,000*

X. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 121(b)(1) of CERCLA presents several factors that at a minimum EPA is required to consider in its assessment of alternatives. Building upon these specific statutory mandates, the National Contingency Plan articulates nine evaluation criteria to be used in assessing the individual remedial alternatives.

A detailed analysis was performed on the alternatives using the nine evaluation criteria in order to select a Site remedy. The following is a summary of the comparison of each alternative's strength and weakness with respect to the nine evaluation criteria. These criteria are summarized as follows:

Threshold Criteria

The two threshold criteria described below must be met in order for the alternatives to be eligible for selection in accordance with the NCP.

1. **Overall protection of human health and the environment** addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering

controls, or institutional controls.

2. **Compliance with applicable or relevant and appropriate requirements (ARARs)** addresses whether or not a remedy will meet all of the ARARs of other Federal and State environmental laws and/or provide grounds for invoking a waiver.

Primary Balancing Criteria

The following five criteria are utilized to compare and evaluate the elements of one alternative to another that meet the threshold criteria.

3. **Long-term effectiveness and permanence** addresses the criteria that are utilized to assess alternatives for the long-term effectiveness and permanence they afford, along with the degree of certainty that they will prove successful.

4. **Reduction of toxicity, mobility, or volume through treatment** addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the Site.

5. **Short term effectiveness** addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.

6. **Implementability** addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

7. **Cost** includes estimated capital and Operation and Maintenance (O&M) costs, as well as present-worth costs.

Modifying Criteria

The modifying criteria are used on the final evaluation of remedial alternatives generally after EPA has received public comment on the RI/FS and Proposed Plan.

8. **State acceptance** addresses the State's position and key concerns related to the preferred alternative and other alternatives, and the State's comments on ARARs or the proposed use of waivers.

9. **Community acceptance** addresses the public's general response to the alternatives described in the Proposed Plan and RI/FS report.

A detailed tabular assessment of each alternative according to the nine criteria can be found in Table 5-1 of the Feasibility Study.

Following the detailed analysis of each individual alternative, a comparative analysis, focusing on the relative performance of each alternative against the nine criteria, was conducted. The section below presents the nine criteria and a brief narrative summary of the alternatives and the strengths and weaknesses according to the detailed and comparative analysis.

1. Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

The preamble to the NCP and EPA's Guidance for conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites, OSWER Dir. 9355.3-11 (Febuarary, 1991) identifies municipal landfills as a type of site where treatment of the waste may be impracticable because of the size and heterogeneity of the contents. EPA generally considers containment to be an appropriate response action for large municipal landfills. Because the Rose Hill Regional Landfill Site is a large municipal landfill, the alternatives evaluated consider containment of the wastes to be the appropriate response action for source control. Further, consideration of consolidation of the Bulky Waste materials onto the Solid Waste Area provides for added protectiveness to ecological receptors by removing an uncontrolled source area from the proximity of the Saugatucket River wetland and bank and consolidating these materials into a single waste area to be properly controlled and appropriately monitored. In addition, innovative cap materials will be considered when such materials offer the potential for superior performance or lower costs for performance equivalent to that of demonstrated materials.

Alternatives 1 and 2 do not meet this criterion, while Alternatives 4A and 4B would attain adequate protection of human health and the environment, with 4B offering a higher degree of environmental protectiveness through the excavation and consolidation of the bulky waste area. Alternatives 3A and 3B would attain adequate protection of human health, but would only approach adequate attainment for protection of the environment, since some amount of leachate continue to reach surface water/sediment bodies. Alternatives 3A through 4B capture and treat landfill gas emissions in protection of human health. Under 3A and 3B, additional response actions would likely be necessary for the Bulky Waste Area (BWA) since leachate would continue to be produced after the caps were installed and functioning. This is primarily due to the anticipated seasonal fluctuations of ground water elevations contacting wastes beneath the Bulky

Waste landfill cap. While reduced by the placement of a cap on the BWA, leachate breakout may continue to impact the Saugatucket River.

Human Health Protection

Alternative 1 provides no protection against human health risks and, thus, does not meet this threshold criteria. The estimated cancer risk and hazard index would continue to exceed EPA's target cancer risk range of 10^{-6} to 10^{-4} and the target non-cancer risk limit of 1 for those exposure pathways identified in the baseline risk assessment. Alternative 1 also provides no protection from potential future risks if off-site migration of contamination occurs. This Alternative will not be carried through the rest of the comparative analysis, except for cost.

Alternative 2 uses institutional controls (access and ground water restrictions in the form of easements and covenants) and landfill gas control contingency measures to provide some degree of overall protection of human health by reducing the potential for human exposures to occur. Overall risks to human health at the Site may be lessened by Alternative 2. Considering the magnitude of risk posed at the Site and the geographic extent of the ground water exceedances of water quality standards and extent of landfill gas emissions, institutional controls and the contingency measures, by themselves, are inadequate to provide protectiveness at the Site over the long term. Therefore, Alternative 2, which relies solely on institutional controls and contingency measures where risk is demonstrated to be outside EPA's acceptable risk range, are less protective than alternatives 3A through 4B. Since contamination at the Site is not reduced or contained under this alternative, off-site exposures to COCs in ambient air or indoor air at nearby residences would exceed the EPA target cancer risk range. This occurs even at locations with the residential LFG control contingency since these systems are appropriate only for reducing safety risks from methane in soil gas.

Human health risks from inhalation exposures are reduced to acceptable levels by engineering controls and access restrictions for Alternatives 3A through 4B. These alternatives also use engineering controls to increase the protection of human health from inhalation exposures to COCs originating in landfill gas (cap installation, LFG collection, and treatment of LFG at the Solid Waste Area). Risks from inhalation exposures to COCs in soil gas in ambient air and indoor air at nearby residences are expected to be reduced to within EPA's target risk range under these alternatives.

Alternative 2 does not provide source reduction of existing groundwater contamination at the Site; Alternatives 3A through 4A do provide source reduction through installation of a cap in alternatives as well as provide leachate control to help reduce subsequent groundwater impacts by minimizing infiltration from precipitation. Alternative 4B adds and extra measure of protectiveness by physically moving part of the source waste out of the groundwater table and away from the Saugatucket River through excavation and consolidation of the bulky waste area. Furthermore, Alternatives 4A and 4B use a leachate collection and contaminant management

system to provide additional leachate control. For Alternatives 3A through 4B, potential future risks from groundwater ingestion at the Site would not exceed the EPA target cancer risk range as long as groundwater institutional controls are fully implemented and remain effective. Overall protection of human health from this exposure pathway for Alternatives 3A through 4B would also depend on long-term monitoring.

Ecological Protection

The no action and limited action alternatives, Alternative 1 and 2, respectively, are not protective of the environment and, thus, do not satisfy this criterion. These alternatives provide no reduction in long- or short-term risks to ecological receptors relative to baseline levels since there would be no reduction in contaminant migration via leachate and groundwater. Therefore, the documented adverse impacts to the aquatic community as were described in Section VII. B, especially to Mitchell Brook and the Saugatucket River, would persist under these two alternatives.

Under Alternatives 3A and 3B, capping of the two disposal areas would decrease ecological exposures to site-related contaminants in wetland and aquatic habitats since leachate generation and subsequent discharge to Mitchell Brook and the Saugatucket River would be reduced.

Alternatives 4A and 4B are more protective of the environment, since capping of the disposal areas, landfill consolidation and installation of leachate collection and a contaminant management system would prevent additional migration of Site-related contaminants to wetland and aquatic habitats. Leachate generation and subsequent discharge to Mitchell Brook and the Saugatucket River would be substantially controlled under Alternative 4A; and virtually eliminated under Alternative 4B. Alternative 4A would allow for collection and treatment of leachates through the duration of the response whereas Alternative 4B need only provide short-term collection and treatment of leachate during the consolidation process.

The remedial alternatives differ in the magnitude of potential impacts to ecological habitats. While the no action alternative would not disturb ecological habitats, contaminants would remain to continue their adverse effects on the habitats. For the limited action alternative, some minor, short-term impacts to small areas of wetland and upland habitats would occur due to fence installation. For Alternatives 3A, 3B, and 4A, capping the disposal areas and constructing the leachate collection and management system would result in some temporary and/or minor impacts to ecological habitat, the filling of one small emergent wetland forming in a depression within the landfill (<0.15 acres) and impacts to forested wetlands (0 to 0.5 acres). These potential impacts can be mitigated and are lowest for Alternatives 3A and 3B and highest for Alternatives 4A and 4B (due to the number and extent of remedial actions to be conducted).

For Alternatives 3A through 4B, the caps and leachate collection/management systems also have the potential to affect the hydrology of on-site wetlands, Saugatucket River and Mitchell Brook. These potential impacts are relatively low for Alternatives 3A and 3B compared to Alternatives 4A

and 4B (due to the presence of leachate collection systems). However, most impacts can be mitigated through engineering controls.

2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address hazardous substances, the remedial action to be implemented at the Site, the location of the Site, or other circumstances present at the Site. Relevant and appropriate requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law which, while not applicable to the hazardous materials found at the Site, the remedial action itself, the Site location or other circumstances at the Site, nevertheless address problems or situations sufficiently similar to those encountered at the Site that their use is well-suited to the Site.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for a invoking waiver.

Compliance with ARARs is met by Alternatives 3A through 4B but not attained by Alternatives 1 and 2.

The no action and limited action alternatives, Alternatives 1 and 2 respectively, fail to meet requirements for hazardous waste landfills. Alternatives 3A through 4B meet the Rhode Island and federal regulatory requirements for a hazardous waste landfill cap.

Since this Record of Decision anticipates a source control response, ground water cleanup is not addressed and cleanup goals are not set for any of the alternatives. A second operable unit response is planned to evaluate and manage the migration of contaminants that have impacted, or may continue to impact, local area groundwater. However, all alternatives will comply with those portions of the regulations which apply to installing groundwater monitoring wells and compliance monitoring. Management of the migration of contaminants to ground water will be based on data obtained from the first operable unit monitoring and any additional studies that are deemed necessary in order to further characterize the extent of contamination to ground water.

A similar approach will be taken with respect to surface water. As a source control response, surface water clean up is not addressed in this operable unit. Therefore water quality standards will be used to measure the effectiveness of the remedy with respect to cap effectiveness, leachate

production, and any other discharges to on-site surface water. Management of the migration of contaminants to surface water will be based on data obtained from the first operable unit monitoring and any additional studies for assessing any continued impact to surface water.

Landfill gas emissions controls, proposed under Alternatives 3A through 4B, would be designed, installed, and operated to meet Rhode Island Air Pollution Control Regulations and the federal Clean Air Act. Emissions from the gas treatment systems would attain RIDEM Air Pollution Control Regulation No. 7, which prohibits the emission of air contaminants detrimental to person or property. These emissions would also be expected to be below the minimum reportable quantities and acceptable ambient levels set forth in RIDEM air toxics rules, No. 22. Under this regulation, air quality modeling may be required to determine allowable emissions.

Alternatives 3A through 4B also include a condensate aboveground storage tank and condensate pump stations which are regulated as ancillary equipment to tanks. This condensate is assumed to be hazardous by characteristic and would require off-site disposal at a RCRA-compliant TSDF. The tank and pump stations would need to be installed in compliance with state and federal tank rules. Underground components would also need to comply with appropriate UST rules.

For Alternative 2, there would be no actions taken in wetlands or buffer zones. For Alternatives 3A through 4B, wetlands-related ARARs would be met through on-site mitigation (replacement of forested wetlands) and through proper hydrological design (to mitigate potential hydrological impacts to surface water bodies and wetlands due to the caps and/or the collection and treatment systems).

State ARARs relating to threatened and endangered species or their habitat, if any are found, would be met under all alternatives through consultation with the appropriate state agency. The baseline ecological risk assessment did not identify any significant exposure pathways to Site contaminants for any endangered species which could potentially occur on the Site.

For Alternatives 3A through 4B, actions must be taken during construction to protect (or mitigate unavoidable impacts to) wetlands, surface water bodies, the flood plain, and the nearby cemetery.

3. Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

This section summarizes the evaluation for risks remaining at the Site after Remedial Action Objectives have been met, and risk from management of residuals.

Magnitude of Residual Risk: Human Health

Exposure pathways which exceed acceptable human health risk levels include inhalation exposures at the Site, inhalation exposures from indoor air and ambient air at off-site receptors and groundwater ingestion exposures at the Site.

Alternative 2 does not provide long-term effectiveness and permanence since no source reduction or containment measures are implemented under this alternative. While this alternative reduces residual human health risks through the use of institutional controls and residential landfill gas contingencies, residual human health risks from ambient air inhalation exposures of off-site receptors may continue to exceed acceptable risk levels.

Through engineering controls and treatment, Alternatives 3A through 4B provide an increase in long-term effectiveness and permanence compared to Alternative 2 by controlling and reducing Site COCs in ambient air and soil gas. As a result, residual human health risks from inhalation exposures at off-site receptors would be reduced to acceptable risk levels.

Alternatives 3A through 4B also provide increased long-term effectiveness and permanence with respect to residual human health risks from exposures to groundwater contamination over Alternative 2. Active remediation including capping, landfill gas and leachate collection and management in addition to institutional controls provide greater reductions in long-term residual human health risks from ingestion of groundwater. Alternative 4B provides the greatest long-term effectiveness and permanence with regard to site risks through the physical removal of the bulky waste source area from the groundwater table and from the proximity to the Saugatucket River.

There are some byproducts resulting from the treatment trains proposed for the various alternatives that could pose long-term risks; however, these potential risks are assumed to be minimal since they could be mitigated by using appropriate engineering controls where possible and by using proper operating and transport methods and procedures. For example, the LFG collection and treatment system proposed for Alternatives 3A through 4B will produce a condensate waste stream and combustion products at the enclosed flare. Alternatives 4A and 4B will generate byproducts from the treatment train for collected leachate. However, these waste streams and off-gasses will be properly managed and the risk is thought to be minimal.

Magnitude of Residual Risk: Ecological

The limited action Alternative 2 would not result in a quantifiable long-term reduction in risk to ecological receptors since leachate would continue to be generated and enter Mitchell Brook and the Saugatucket River. Documented adverse impacts to the aquatic communities in these water bodies would continue from exposure to this leachate.

Long-term risks to ecological receptors in wetland and aquatic habitats would be reduced under Alternatives 3A through 4A due to installation of caps on the Solid Waste and Bulky Waste Areas. Long-term risks to ecological receptors in wetland and aquatic habitats would be significantly reduced or eliminated under Alternatives 4B.

Adequacy and Reliability of Controls

Alternative 2 would not involve treatment controls for groundwater/leachate or landfill gas, but provides protection through access and ground water restrictions (easements and covenants) and the LFG control contingency. The effectiveness of these controls is based upon their ability to be readily enforced by both private parties and governmental agencies. Such controls also depend on the cooperation of adjacent property owners. Therefore institutional controls, by themselves, are not sufficient as the sole protective measures implemented at the Site. Further, these controls are dependent upon the frequency of routine monitoring. The adequacy and reliability of monitoring is, in turn, dependent upon the use of proper sampling and analytical procedures. Even if institutional controls are effective, however, protection of human health from risks posed by off-site inhalation of ambient air is not adequate under Alternative 2.

Horizontal containment (capping) proposed under Alternatives 3A through 4B would adequately reduce or eliminate the infiltration of precipitation into waste, thereby reducing the generation of leachate. The cap would require long-term maintenance to ensure that its integrity is not compromised. The cap would also reduce the groundwater mound reducing contact between in-place refuse and groundwater. This action reduces the volume of groundwater that becomes contaminated as well as the quantity of leachate produced. The caps, however, may not eliminate all leachate production. There is a high degree of confidence associated with caps in relation to their ability to reduce infiltration of precipitation and control the escape of landfill gas.

The leachate collection system proposed under Alternatives 4A and 4B would reduce the leachate production near the Saugatucket River. Fencing and/or other security measures will prevent the public from coming in contact with untreated water and management systems.

Excavation and consolidation of the Bulky Waste Area (Alternative 4B) would eliminate the future generation of leachate from the Bulky Waste Area, assuming all contaminants are removed. If removal of waste is incomplete (i.e., some wastes remain in place) in the Bulky Waste Area, additional controls (i.e., a cap and long-term leachate collection) may be necessary. Further, monitoring of the groundwater and surface water after the Bulky Waste material is excavated and consolidated under the cap, will collect data to assess the extent to which the attenuation of these residuals is occurring, so any unacceptable impact to local groundwater and surface waters can be addressed in OU 2 as required.

The reliability and adequacy of the LFG collection and treatment systems proposed under Alternatives 3A through 4B is initially dependent on the collection system. Landfill gas not

captured by the active internal collection system would be captured by the active perimeter collection system. The perimeter system and cap provide a secondary containment of landfill gas and further reduce fugitive emissions to ambient air.

Treatment by enclosed flare is proposed for Alternatives 3A, 4A and 4B. The release of untreated Site COCs exiting the enclosed flare would be very low due to the high destruction removal efficiencies that can be expected (95% minimum for all VOCs).

Alternative 3B proposes LFG treatment by photocatalytic oxidation. Because photocatalytic oxidation is an innovative technology, its reliability over years of operation has not been determined. The technology has not yet been tested on landfill gas. Therefore, alternatives 3A, 4A and 4B are considered more reliable than 3B.

Each of the alternatives would require periodic five-year reviews to examine the reliability and adequacy of the options and technologies selected. Five year reviews would be necessary to evaluate the effectiveness of any of these alternatives because hazardous substances would remain on-site in concentrations above health-based levels.

4. **Reduction of Toxicity, Mobility, or Volume through Treatment**

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Treatment/Recycling Processes Utilized

Alternative 2 does not utilize any treatment processes beyond natural attenuation and therefore do not remediate source areas. In Alternative 2, utilization of the LFG control contingency would only result in negligible reduction of toxicity, mobility, and volume of the treated waste. Alternatives 3A, 4A, and 4B treat captured landfill gases by combustion in an enclosed flare, reducing the toxicity and mobility of landfill gas migrating off the Site. Similar to Alternative 3A, Alternative 3B also treats COCs in LFG, but does not destroy methane. Alternatives 4A and 4B additionally treat groundwater/leachate using precipitation, media filtration and UV/chemical oxidation.

Amount of Hazardous Materials Treated or Recycled

The total flow rate of leachate that would be managed under Alternatives 4A and 4B is approximately 5 gpm. Under Alternative 4B, the Bulky Waste Area leachate is expected to comprise all of this flow during excavation and consolidation process. During landfill excavation and consolidation the flow rate of leachate at the Bulky Waste Area may increase or fluctuate due to ground disturbances and/or dewatering processes but will be virtually eliminated once consolidation is complete.

Under Alternatives 3A, 4A, and 4B the majority of the LFG would be burned using an enclosed flare. Under Alternative 3B, the majority of the LFG would be treated using photocatalytic oxidation. Only limited quantities of landfill gas would be addressed under Alternative 2 through the residential LFG control contingency.

Degree of Expected Reductions in Toxicity, Mobility, or Volume

While none of the alternatives remove the source of LFG contamination, Alternatives 3A through 4B provide the greatest degree of reduction in COC toxicity, mobility, and volume from landfill gas through appropriate controls. Alternatives 3A, 3B, and 4A provide progressively more reduction in COC toxicity, mobility and volume for groundwater/leachate. Alternative 4B, when completed, provides the most long-term reduction in leachate COC mobility and volume than Alternatives 3A through 4A since the Bulky Waste Area landfill will be excavated and consolidated away from the Saugatucket River..

Irreversibility

Alternatives 3A through 4B are irreversible with respect to implemented treatment technologies and process options which destroy Site COCs. To a small extent, Alternative 2 (through the LFG control contingency) also irreversibly removes or destroys Site COCs.

Type and Quantity of Residuals

Alternative 3A would generate condensate from the landfill gas collection system as well as combustion by-products. Landfill gas condensate is expected to generate at a rate of 125 gal/10^6 ft^3 of extracted gas. Combustion gases would be expected to include trace nitrogen oxides, sulfur oxides, and small quantities of undestroyed COCs. Alternative 3B would also generate condensate from the LFG collection system as well as residuals such as methane and possibly small quantities of hydrogen chloride. Alternatives 4A and 4B would generate landfill gas condensate and combustion by-products (at the same rates as predicted for Alternative 3A). Drilling and construction soils from installation of the LFG collection and treatment system and filter sludges from the leachate management systems would also be generated. The sludge would be expected to contain hydroxide sludges of aluminum, iron, and manganese. Alternative 4B would generate waste, soil and scrap metal residuals during landfill excavation. There may also be minor amounts of hazardous waste encountered under this alternative. These residuals will be properly handled through appropriate waste management and disposal practices.

Further reduction in toxicity and mobility of Site COCs in groundwater would be achieved with Alternative 4B. Landfill consolidation would eliminate a waste source (Bulky Waste Area) from the immediate vicinity of the Saugatucket River and from within the water table in this area.

5. Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers and the community during construction and operation of the remedy until cleanup goals are achieved.

Protection of Community and Workers During Remedial Actions

Short-term risks include any additional risks to the community or workers at the Site from exposures as a result of construction measures and implementation of remediation activities.

Alternative 2 has nominal increases of short-term risks due to installation of the residential LFG control contingency as well as fence installation.

Alternatives 3A through 4B would result in additional short-term risks to the community and workers from ingestion and inhalation exposures to soil particles in dust during preparation of disposal areas for capping and inhalation exposures to VOCs from invasive work at the Solid Waste Area. Air sampling and monitoring would be used to evaluate any potential risks from inhalation exposures, and engineering controls would be used to reduce any potential inhalation risks from invasive activities. Dust control measures would be used to mitigate potential soil ingestion or inhalation exposures. Concentrations of COCs are expected to be the highest at the Site, therefore, workers at the Site would also use appropriate PPE to mitigate any potential risks from exposures.

Alternatives 4A and 4B may present short-term risks in addition to those described for Alternatives 3A and 3B, as a result of additional invasive work required for the installation of leachate collection and management system. These short-term risks can be mitigated by a variety of measures. Air sampling and monitoring would be used to evaluate any potential risks to the community. As discussed above, engineering controls would also be used to minimize the degree of invasive work to mitigate potential risks from this exposure pathway. Workers would also wear appropriate PPE to mitigate any potential risks from increased exposures at the Site. Alternative 4B also present short-term risks due to landfill excavation and consolidation of the Bulky Waste Area landfill onto the Solid Waste Area landfill. Similar to above, these risks could be mitigated by sampling/monitoring, engineering controls and PPE.

Environmental Impacts

Minimal short-term habitat impacts would occur under Alternative 2. Short-term risks to ecological receptors are likely to increase slightly due to the mobilization of contaminants during horizontal containment operations for Alternatives 3A through 4B. These alternatives would also temporarily displace some resident organisms, and some mortality of resident organisms would occur during capping operations.

Direct, relatively short-term (1 year) habitat impacts would occur during remedial construction activities for Alternatives 3A through 4B and would affect approximately 30 acres of habitat, including one small emergent wetland and up to 0.5 acres of forested wetlands (Alternatives 4A and 4B). Most of the impacted areas occur on top of the disposal areas; the primary disturbance would occur during installation of the caps. These impacts are lowest for Alternative 3A and 3B and highest for Alternatives 4A and 4B (due to the greater extent of remedial activities), although differences among these alternatives are not substantial. Additional disturbances include construction of roadways, leachate collection systems, and installation of materials management facilities. Disturbed areas would be restored following remediation. The increase for potential erosion, run-off, and sedimentation related to invasive activities for Alternatives 4A and 4B would be mitigated with appropriate engineering controls.

Time Until Remedial Action Objectives are Achieved

The time required to meet RAOs varies depending upon the active remedial measures for these disposal areas.

For Alternative 2 the time to achieve the RAO for landfill gas and leachate will exceed 30 years since there is no active treatment; for Alternatives 3A through 4B the timeframe falls to less than 15 years for landfill gas because active treatment is part of the remedy. To achieve the RAO for leachate in Alternative 3A and 3B, the timeframe is greater than 30 years because there is no active leachate control; for Alternatives 4A and 4B the RAO is achieved much sooner given the leachate control and management system. Consolidation of the bulky waste area in Alternative 4B may accelerate the time to reach the RAO for leachate by removing a significant source from the vicinity of the River.

For groundwater, all Alternatives reach the RAO of prohibiting ingestion through institutional controls at the same time.

6. Implementability

Technical Feasibility

There are not significant differences between Alternatives 3A, 3B, and 4A with regard to ability to construct and operate the associated technologies and process options. Alternatives 4B is similar to those above except for consolidation of the BWA and SWA landfills. Since Alternative 2 only includes residential contingencies, installation and operation will be simplified in comparison to the above alternatives. Details regarding construction and operating technologies and process options are discussed below.

Gas extraction wells would be installed in the Solid Waste Area in Alternatives 3A through 4B. Installation of the wells would necessitate drilling into disposal areas. Obstructions may be encountered in the disposal areas, which may complicate the drilling operation. Installation of the

perimeter LFG collection system would be complicated by the power lines and proximity of residences along Rose Hill Road. The perimeter system should be constructed outside the limit of waste. However, this may only be possible if some perimeter wells are installed within Rose Hill Road.

Cap construction in Alternatives 3A through 4B would require stripping existing vegetation, installation and seaming of a geomembrane, backfill and compaction of the soil components of the cap, and revegetation. Installation of the geomembrane would be complicated by the numerous gas extraction wells. The top of each extraction well would penetrate the cap and the measures taken to prevent leakage around these penetrations would slow and increase the cost of the cap installation. Level B PPE may be necessary especially during invasive construction activities. This would slow the schedule and increase the cost of construction significantly.

Alternatives 4A and 4B would also involve the construction of a leachate collection and management system. Portions of the leachate collection and management system may be in disposal areas, which would cause the similar problems as mentioned above with respect to the landfill gas collection system. The leachate management system would involve building construction, connection of the different skid mounted processes, utility connection, and piping from the extraction systems.

Administrative Feasibility

Institutional controls (access and deed restrictions) are included in Alternatives 2 through 4B; therefore, administrative feasibility is the same with respect to this component. Effort required for administrative implementability will increase incrementally from Alternatives 3A through 4B because those alternatives include the construction of landfill gas collection and treatment and leachate collection and management systems. Further administrative feasibility details are described below.

Implementation of restrictive covenants in the form of property deed restrictions in Alternatives 2 through 4B would require significant long-term coordination between federal, state, local authorities, and private property owners.

Environmental monitoring programs proposed under all five alternatives would require coordination with the State of Rhode Island and the property owners of record. Long-term coordination would be required for analytical services and review and maintenance of data.

Under CERCLA, actual permits are not required for remediation activities. Compliance with the substantive requirements of the permit is, however, required. Thus, while an air permit would not be required for operation of the enclosed flare or photocatalytic oxidation unit in Alternatives 3A through 4B, designs must meet state standards. The condensate storage tank and pump stations would need to be designed and installed in compliance with state and federal rules, including appropriate UST rules.

Availability of Services and Materials

Contractors familiar with landfill gas applications would be required to install residential contingency control systems in Alternative 2. Large volumes of capping materials (topsoil, earth, sand, etc., some of which may be available locally or within the Site boundary and which could be used where appropriate) would be necessary under Alternatives 3A through 4B. Construction contractors familiar with methane safety as well as fugitive vapors/COCs would be required for Alternatives 3A through 4B. Also for those alternatives, fabrication of the LFG treatment system would take significant lead time and may be limited to specific, specialty contractors. Contractors would be necessary for construction of the extraction system, discharge wells, leachate management system, building, and piping in Alternatives 4A through 4B. OSHA-trained contractors will be required for landfill excavation, consolidation, and cap construction under Alternatives 3A through 4B. In all alternatives, consulting specialists, equipment and services are readily available to perform monitoring.

Alternatives 3A through 4B will generate a waste stream (landfill gas condensate) that may require disposal at a RCRA-compliant TSDF. Alternatives 4A and 4B may require disposal of any wastewater management system byproducts. There may also be a need for a RCRA-compliant TSDF if hazardous waste is encountered during the landfill excavation/consolidation process (Alternative 4B). Although there are no RCRA-compliant facilities in Rhode Island which would accept these RCRA wastes, availability of this service is not expected to present any difficulties.

7. **Cost**

A detailed summary of costs for each alternative is presented in Appendix G of the Feasibility Study (Administrative Record at Section 4.6). A revised summary of costs for alternatives 4A and 4B are also presented in the Administrative Record at Section 4.1. The total net present cost (capital plus operations and maintenance over the duration of the remedial action) for the six alternatives evaluated ranges from $3.57 million to $18.04 million. The cost summary presented in Table 5-2 of the Final Feasibility Study has been updated for the Record of Decision (see Table 75).

The cost differential between Alternatives 1 and 2 is relatively low ($0.3 million) as the major cost component for each would be annual expenditures associated with environmental monitoring. Both alternatives have a relatively low capital cost component. The costs of Alternative 3A ($13.4 million) and 3B ($13.2 million) are significantly more than the previous two alternatives. The additional costs are required principally for installation of the cap(s), and an active internal and perimeter landfill gas collection and treatment systems. The difference in costs between Alternatives 3A and 3B is due to capital costs of the two LFG treatment systems. Landfill gas collection and treatment is conducted for a 15-year duration based on estimates of LFG production. The difference in costs between Alternatives 3A ($13.42 million), 3B ($13.19 million) and that of 4A ($16.06 million) is leachate control and management predominantly for the Bulky Waste Area over the long term at an additional cost of $2.64 or $2.87 million, respectively. Alternative 4B (which includes excavation and consolidation of the Bulky Waste Area) adds an additional $2

million and allows for leachate collection and management during the excavation and consolidation of the Bulky Waste Area.

The costs presented above are estimates which may be used to compare the relative expense of each alternative. A 20% contingency is utilized to account for any inaccuracy in the costs. Based on the accuracies of the estimates, the cost differences between alternatives may not be significant. To provide a better analysis of the costs, cost sensitivities are provided as described below.

Key cost variables were tested to determine the cost sensitivity of each of the alternatives. The results of this sensitivity analysis were originally presented in Table 5-2 of the Final Feasibility Study and updated accordingly in Table 75 of this ROD. The variables tested include: discount rate (for net present worth estimation), total capital costs, total annual (e.g. O&M) costs, contingency, and O&M duration related to the landfill gas components of each alternative.

Variation of the discount rate was evaluated at 5 % and 9%. These values are estimated to be reasonable lower and upper bounds, respectively, for long-term financial performance and reflect values above the rate of inflation.

Total capital and annual costs were varied from the base case by a +50% increase and -30% decrease. This range was selected based upon the minimum accuracy of the costs required pursuant to EPA's RI/FS guidance.

Variation of the contingency costs were evaluated at 15 % and 25%. These values are estimated to be reasonable lower and upper bounds, respectively, for the degree of cost unknowns associated with these remedial alternatives.

O&M duration of the landfill gas components of each of the alternatives was varied based on the range of times possible for natural attenuation of landfill gas from the Solid Waste Area. As described in Section 4.1.2.5 of the Feasibility Study, the Solid Waste Area is expected to generate landfill gas for 5 to 15 years. Since 15 years was evaluated as the base case, lower durations were used in the cost sensitivity of 5 years (low value of range) and 10 years (midpoint of range).

In Table 5-2 of the Final Feasibility Study, "Overall" costs reflect the highest and lowest total cost of each alternative for any of the variables evaluated. Based on this, the potential sensitivity range of costs varies from a low value of $3.57 million (for Alternative 1) to a high value of $18.04 million (for Alternative 4B).

Treating the landfill gas via an enclosed flare was selected over the photocatalytic oxidation for its proven track record as a technology readily available and for an insignificant percentage increase in cost compared to photocatalytic oxidation. The significant improvement realized by selecting excavation and consolidation over capping in place (alternative 4A versus 4B) is the permanent removal of a primary source of contamination from the vicinity of the River resulting in a far

greater reduction of leachate production rather then the construction and long-term operation and maintenance of a leachate collection and management system for the Bulky Waste Area if capped in place.

8. State Acceptance

The State's comments on the Proposed Plan are provided in Appendix D, the Responsiveness Summary. In general, the State has expressed its support for Alternative 4B with modifications. The State does not believe that Alternatives 1,2, 3A, 3B, and 4A provide adequate protection of human health and the environment. The State supports deferring the decision as to the need for groundwater treatment to sometime in the future, when the decision on ground water is based upon presumably improved conditions resulting from the source control measures taken under this response. The State believes that the remedy selection as outlined herein accurately defines, recognizes and complies with all environmental regulations promulgated by the Department of Environmental Management. The State of Rhode Island concurs with the selected remedy. The State's letter of concurrence, documenting the State's position on the selected remedy is provided in Appendix C of this ROD.

9. Community Acceptance

The comments received from the community on the RI/FS and the Proposed Plan during the public comment period and EPA's responses to these comments are summarized in the Responsiveness Summary in Appendix D.

During the public comment period, the Proposed Plan offered the alternatives evaluated here and two additional management of migration alternatives. The community expressed its support for all alternatives except alternatives 1 through 3B, which they felt to be inadequately protective. Many of the comments received from the community raised serious objections to EPA's preferred alternative presented in the Proposed Plan. There was considerable concern that merely capping the Bulky Waste Area in place and conducting further study to address leachate and groundwater would not eliminate a significant source of contaminants to the Site surface waters. As a result of these comments and in light of new information presented during the public comment period, EPA modified its remedy to actively address the Bulky Waste Area through excavation and consolidation.

XI. THE SELECTED REMEDY

The selected remedy is Alternative 4B, modified to take into account its role as the first operable unit of a phased approach to remediate the environmental contamination caused by the Site. By implementing Alternative 4B as a first operable unit, the remedy will control the sources of contamination at the Site by limiting the extent to which precipitation will percolate and infiltrate through waste materials and minimizing the further migration of the contaminated groundwater plume. Management of the migration of contaminants from the Site will be based on data obtained

from monitoring conducted under the first operable unit and any additional studies that are deemed necessary to further assess Site impacts, characterize the extent of contamination, and assess the need to develop and evaluate alternatives for future actions.

In summary, this first operable unit remedy provides the following components:

1. Excavate and consolidate the Bulky Waste Area landfill materials onto the Solid Waste Area landfill;

2. Collect and effectively manage leachate and waters collected from runoff and de-watering operations during the excavation of the Bulky Waste Area ;

3. Construct a multi-layer hazardous waste cap using innovative and cost efficient cover materials, as may be appropriate and as further defined in design, over the extent of the Solid Waste Area landfill and consolidated Bulky Waste Area materials;

4. Inspect and monitor the integrity and performance of the landfill cap over time;

5. Assess, control, collect, and treat landfill gas emissions by an active internal and perimeter gas collection system and thermal treatment of such gasses through the use of an enclosed flare and continue monitoring landfill gas concentrations to assess the need to modify the landfill gas collection treatment system as necessary;

6. Implement access restrictions and Institutional Controls (land title restrictions including, but not limited to, easements and restrictive covenants) on land use and the use of, or hydraulic alteration of, groundwater where Preliminary Remediation Goals (PRGs) (based on MCLs, MCLGs) and/or other health based standards are exceeded.

7. Install a chain link fence and/or other physical barriers where necessary to prevent Site access, injury and/or exposure;

8. Long-term monitoring of surface water, groundwater air and leachate emergence;

9. Perform operation and maintenance activities throughout the life of the remedy; and

10. Conduct statutory five year review as required.

The Bulky Waste Area will be excavated to the extent necessary to ensure that all municipal solid waste from the designated area is properly excavated, collected and consolidated onto the Solid Waste Area landfill. Information gathered by the Town in April 1999, indicates that a portion of the Bulky Waste deposits are in contact with the ground water table. Therefore, appropriate de-watering and leachate collection operations, including the collection and management of excavation trench

waters and runoff from the staged materials, will be necessary. Proper on-site management and disposal strategies for such waters will be developed in design and implemented during construction. Possible management options are: On-site discharge without treatment, onsite discharge with treatment by precipitation, media filtration, ultraviolet/chemical oxidation, or off-site disposal dependent upon contaminant characteristics and/or concentrations in these process waters. These collected waters will be discharged on-site either through groundwater recharge wells, in which case the substantive provisions of the Rhode Island Rules and Regulations for Groundwater Quality and Rhode Island Underground Injection Control Regulations will be met, or by discharge to surface water, in accordance with the state regulations for Water Pollution Control and Ambient Water Quality Criteria (Water Quality Regulations and Water Quality Standards). The extent to which the Bulky Waste Area is excavated will be based on past data, design assessments, repetitive visual inspection of the excavation base and side walls, bucket observations, and other methodologies developed in the design phase to assure, to the greatest practical extent, that all physical evidence of waste deposits are removed from the Bulky Waste Area, irrespective of the level of groundwater within the excavation. The goal of this source control component is to effectively remove and contain the contaminant mass so as to significantly reduce contaminant migration through leachate production to surface waters and sediments of Mitchell Brook and the Saugatucket River and to reduce migration of landfill gas.

Waste materials will be properly staged prior to consolidation onto the Solid Waste Area. The Solid Waste Area will be appropriately prepared (grubbed and dressed) such that consolidation of the waste materials is timely and without unnecessary delay. Monitoring of hazardous conditions, runoff, fugitive dust emissions, and nuisance odors will be conducted throughout the response and contingency planning. Engineering controls will be implemented if necessary to mitigate any adverse impacts.

The use of innovative cap construction materials will be evaluated in the design phase for cost effectiveness while maintaining long-term effectiveness and permanence. Additionally, the EPA-NE technical guidance concerning alternative cap design will also be consulted and considered during the design phase. The cap will be designed and constructed to meet state hazardous waste closure requirements. The use of onsite materials for cover material will be considered where appropriate. Landfill gas emissions will be extensively monitored and controlled as required through the use of an active internal and perimeter gas collection and treatment system and on-site thermal destruction of COCs using an enclosed flare. The flare's destruction removal efficiencies for COCs will meet State and Federal ambient air quality standards. Assessments of gas constituents, concentrations, flow rates, piping and flare sizing will be conducted during design to determine the most efficient system needed and enhance and detail the construction specifications of the gas collection and treatment system. Long-term monitoring of landfill gas concentrations and treatment system performance will be conducted to evaluate and determine modifications necessary for system efficiency or other changes in landfill gas treatment.

The remedy also includes a long-term monitoring program, institutional controls, and operation and maintenance.

The costs and cleanup time frames for the selected remedy are summarized as follows:

Estimated Time for Design and Construction:	*2-3 years*
Estimated Time of Operation:	*<15 years for LFG; >30 years GW/Leachate*
Estimated Capital Cost:	*$11,360,000*
*Estimated Operations and Maintenance Costs (**net present worth**):*	*$6,680,000*
*Estimated Total Cost (**net present worth**):*	*$18,040,000*

As provided in the NCP, EPA will conduct a review of the Site at least once every five years after the initiation of remedial action at the Site since hazardous substances, pollutants and contaminants will remain at the Site. This will ensure that the remedial action continues to protect human health and the environment.

An expected outcome of the selected remedy is that the Solid Waste Area will no longer present an unacceptable risk to area residents and those at the Site through the inhalation of landfill gas. Another expected outcome of the selected remedy is that ground water in the vicinity of the Site will not present an unacceptable risk to area residents through ingestion as a result of the use of institutional controls. The second operable unit will address management of migration. The selected remedy will also provide environmental and ecological benefits such as incremental improvement of a riverine and wetland ecosystem by minimizing contaminant migration into wetland habitat adjacent to the River, and by improving the resource of the upland area associated with the former Bulky Waste Area.

XII. STATUTORY DETERMINATIONS

The remedial action selected for implementation at the Rose Hill Regional Landfill Superfund Site is consistent with CERCLA and, the NCP. The selected remedy is protective of human health and the environment, attains ARARs and is cost effective. The selected remedy partially satisfies the statutory preference for treatment which permanently and significantly reduces the mobility, toxicity or volume of hazardous substances as a principal element. Additionally, the selected remedy utilizes alternate treatment technologies or resource recovery technologies to the maximum extent practicable.

A. The Selected Remedy is Protective of Human Health and the Environment

The remedy for the Rose Hill Regional Landfill will permanently reduce the risks posed to human health and the environment by controlling exposures to human and environmental receptors through treatment, engineering controls, and institutional controls. Specifically, the risk presented by this Site is the possible exposure to and ingestion of contaminated groundwater and exposure to and

inhalation of contaminated air. The selected remedy uses a combination of consolidation, capping of wastes and collecting and treating landfill gases and institutional controls to prevent or minimize the continued release of hazardous substances from the Site.

B. The Selected Remedy Attains ARARs

This remedy will attain all applicable or relevant and appropriate federal and state requirements.

Environmental laws from which ARARs for the selected remedial action are derived can be found in Table 76, in Appendix B of this Record of Decision. The table provides a brief synopsis of the ARARs and an explanation of the actions necessary to meet the ARARs. These tables also indicate whether the ARARs are applicable or relevant and appropriate to the actions to be taken at the Site. In addition to ARARs, the tables describe standards that are To-Be-Considered (TBC) with respect to remedial actions. A full description of the ARARs are also located in Section 4 Administrative Record (Feasibility Study).

The principal ARARs are also discussed below.

Principal ARARs for Groundwater

The purpose of the remedy selected in this ROD is to control the sources of contamination; therefore, no groundwater cleanup levels are established in this ROD. Since no cleanup levels are established, no chemical specific ARARs for groundwater have been identified.

The action specific ARARs for source control include groundwater requirements set out in the Rhode Island Rules and Regulations for Groundwater Quality, and the more stringent of the Rhode Island Rules and Regulations for Hazardous Waste, or the federal hazardous waste rules at 40 CFR 264 Subtitle F, and 40 CFR 258 Subtitle E. Because groundwater cleanup levels are not established in this ROD, only those provisions related to implementing a groundwater monitoring program will be complied with. In addition, maximum contaminant levels and non-zero maximum contaminant level goals (MCLs/non-zero MCLGs) in the Safe Drinking Water Act have been identified as action specific ARARs solely for the purpose of measuring the performance of the source control remedy.

If the underground injection option is selected in connection with the dewatering of the Bulky Waste during consolidation, action-specific ARARs include the substantive requirements of the RI Rules and Regulations for Underground Injection Control.

Principal ARARS for Surface Water

Chemical and action specific ARARs address the protection of surface water bodies.

If the surface water discharge option is selected in connection with the dewatering of the Bulky

Waste during consolidation, action-specific ARARs include the substantive requirements of the NPDES provisions of the Clean Water Act, and those of the RIPDES program if more stringent than the federal requirements. Additionally, the Rhode Island Water Quality Standards and Water Quality Regulations define the water quality antidegradation policy of the State. The Rhode Island Water Quality Standards are based on Federal Ambient Water Quality Criteria which set standards for surface water quality for the protection of human health and aquatic life. Any state standards which are more stringent than federal standards must be complied with if the surface water discharge option is selected. The ecological Preliminary Remediation Goals presented in Table 78 list background levels for aluminum and manganese and the AWQC concentration. Although not cleanup levels, the source control remedy will reduce surface water concentrations as close as possible to these levels.

Principal ARARs for Wetlands

State and Federal regulations for the protection of wetlands are closely linked with those for the protection of surface water bodies; however, protection of wetlands is based on location specific criteria. Generally, actions are required to minimize or prevent the destruction, degradation, alteration or net loss of wetlands, as defined by the State of Rhode Island Department of Environmental Management Freshwater Wetlands Act and Federal Protection of Wetlands Executive Order regulations.

Principal ARARs for Air Quality

Air quality protection requirements are action-specific. Federal National Ambient Air Quality Standards (NAAQS) are not ARARs but are guidelines for specific criteria pollutants for air emission sources. NAAQS define levels of air quality which the EPA judges are necessary to protect public health. The State Air Pollution Control Regulations must contain, at a minimum, the federal air quality requirements. Landfill gas controls will meet the NESHAPs for vinyl chloride and benzene. Federal air regulations also require the collection, control and monitoring of Non-Methane Organic Compounds (NMOCs) such as benzene and ethane. RCRA requirements for air emissions from thermal units, process vents and equipment leaks are also included as ARARs. The human health Preliminary Remediation Goals are presented in Table 79. Although not cleanup levels, the remedy will reduce contaminant concentrations in ambient air as close as possible to these levels.

State Air Pollution Control Regulations mandate compliance with specific standards for such parameters as particulate emissions, installation of air pollution control and monitoring equipment and adherence to the Federal NAAQS. Included in the State Air Pollution Control Regulations are the State Air Toxics Regulations. This regulation prohibits emission of specified contaminants at rates which would result in ground level concentrations greater than acceptable ambient levels set in the regulation. Acceptable ambient levels are specified as maximum contaminant concentrations contributed by a stationary air toxic source at or beyond the facility property line.

Principal Hazardous Waste ARARs

Hazardous Waste Management regulations are action-specific ARARs. Federal regulations governing the management of hazardous waste are promulgated under the Resource Conservation and Recovery Act (RCRA). The State of Rhode Island was granted final authorization by EPA in 1986 to administer its hazardous waste program in lieu of the federal government's base RCRA program. The state program is set forth at Rule 5.00 et seq. of the "Rules and Regulations for Hazardous Waste Management" (Rhode Island Hazardous Waste Rules), as amended. Thus, these state regulations govern the management of hazardous waste activities and set operational standards for hazardous waste management facilities.

Principal To Be Considered Requirements

EPA's regional guidance for the capping of hazardous waste landfills will be considered during the design phase in order to develop a cap for the Site which meets the performance standards of both the Rhode Island Hazardous Waste Rules and RCRA Subtitle C. EPA's Technical Guidance Document on Final Covers on Hazardous Waste Landfills and Surface Impoundments, which provides guidance on constructing landfill caps to meet RCRA subtitle C requirements, will also be considered during design of the cap.

C. The Selected Remedial Action is Cost-Effective

In the Agency's judgment, the selected remedy is cost effective, i.e., the remedy affords overall effectiveness proportional to its costs. In selecting this remedy, once EPA identified alternatives that are protective of human health and the environment and that attain ARARs, EPA evaluated the overall effectiveness of each alternative by assessing the relevant three criteria: Long term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short term effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs. The revised costs of this remedial alternative are summarized in Table 80 of this ROD.

EPA believes that the combination of consolidation, capping and landfill gas treatment is sufficient to: 1) prevent migration of landfill gas; 2) prevent consumption of groundwater through the use of institutional controls; 3) reduce production of leachate to prevent the further degradation of surface waters and improve aquatic life.

While it is an effective source control remedy, it is not known whether source control alone will achieve a permanent or long-term solution to all risks posed at the Site. The assessments conducted under the first operable unit will assess the effectiveness of the remedy implemented pursuant to this ROD, at which time further remedial action may be determined to be necessary to achieve a permanent solution to the risks posed by the groundwater and surface water contamination at the Site. Additional costs that would be incurred to implement a remedy designed to manage the

migration of contamination at the Site (for example, through installing a groundwater collection and treatment system) may not be necessary if the selected remedy proves sufficient as a long-term, permanent solution.

D. The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable

Once the Agency identified those alternatives that attain ARARs and that are protective of human health and the environment, EPA identified the alternative which best utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. This determination is based on balancing the following factors: 1) long-term effectiveness and permanence; 2) reduction of toxicity, mobility or volume through treatment; 3) short-term effectiveness; 4) implementability; and 5) cost. The balancing test emphasized long-term effectiveness and permanence and the reduction of toxicity, mobility and volume through treatment; and considered the preference for treatment as a principal element, the bias against off-site land disposal of untreated waste, and community and state acceptance. The selected remedy provides the best balance of trade-offs among the alternatives.

E. The Selected Remedy Satisfies the Preference for Treatment Which Permanently and Significantly Reduces the Toxicity, Mobility or Volume of the Hazardous Substances as a Principal Element

CERCLA and the NCP set forth the process by which remedial actions are evaluated and selected. Because many CERCLA municipal landfill sites share similar characteristics, they lend themselves to remediation by similar technologies. EPA has established a number of expectations as to the types of technologies that should be considered and alternatives that should be developed; they are listed in the National Contingency Plan (40 CFR 300.430(a)(1)) and EPA Guidance Document "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites" EPA/540/P-91/001. See Section VIII. B. for a detailed list of expectations for remediating municipal landfills.

Each of the above criteria has been met in selecting alternative 4B as a source control remedy. Principal threats posed by the Site include the exposure to and inhalation of landfill gas and the exposure to and ingestion of contaminated groundwater. Through the use of active landfill gas control and treatment technology, the air exposure pathway will be addressed by collecting and permanently treating the gases with an enclosed flare. Institutional controls coupled with long-term monitoring will prevent exposure to and ingestion of contaminated groundwater. Operable unit two will further address site risks from groundwater and surface water, if necessary. Engineering controls in the first operable unit, including the excavation, consolidation of the BWA onto the SWA and construction of a protective cap, will contain and may accelerate natural attenuation of the contamination. Data produced from the monitoring programs in the first operable unit will determine the need for any future response actions at the Site.

XII. DOCUMENTATION OF SIGNIFICANT CHANGES

On February 2 , 1999, EPA presented a Proposed Plan (preferred alternative) for remediation of the Site. EPA's Preferred Alternative, as presented in the Proposed Plan, was Alternative 3A.

During an extended public comment period (from February 2, 1999 to May 3, 1999) the public, State and local representatives expressed strong concerns about certain aspects of the preferred alternative, in particular the in-place capping of the Bulky Waste Area landfill. The opposition to capping the BWA was based on its close proximity to the Saugatucket River and the ecological risk to the benthic aquatic communities within the River. State and local representatives and members of the public preferred an alternative that would remove the Bulky Waste Area and consolidate and cap this waste material with that of the Solid Waste Area thereby providing an additional measure of protection for the area along the River. During the Public Comment Period, the Town of South Kingstown presented EPA with new information demonstrating that the Bulky Waste Area may be predominantly comprised of municipal solid waste, contrary to previous information supplied by the Town during the RI. This information, together with the public's desire to provide further protective measures for the River, led EPA to reevaluate its preference.

The NCP allows EPA to re-evaluate its remedy preference in response to new information and in consideration of comments received during the public comment period. After consideration of all the public comments received on the Proposed Plan, and in light of the new information as described above, EPA is of the opinion that these changes do not require the issuance of a new Proposed Plan. While EPA has selected a modified remedy from the preferred remedy described in the Proposed Plan, the remedy selected and described in the ROD is essentially the same but for two exceptions: 1) the Bulky Waste Area will be excavated and consolidated onto the Solid Waste Area instead of capped in place; and 2) a leachate collection and management system is included. This remedy was presented as Alternative 4B in the FS and Proposed Plan.

In the course of its review of public comments on the Proposed Plan, EPA noted an error in its calculation of costs concerning alternative 4B. The error was in the calculated sum concerning landfill consolidation costs relating to cost recovery of reclaimed metals. Therefore, the revised cost for this alternative based on the final FS Report assumptions are as follows: A capital cost of $8.3 million and an O&M cost of $7.1 million for a total of $15.4 million. The Proposed Plan estimated $16.9 million for the cost of alternative 4B, resulting in a difference of $1.5 million. This cost differential is inconsequential, however, in light of EPA's guidance for Feasibility Studies which permits estimates to have an accuracy of +50 percent to -30 percent. When presented with the new information from the Town of South Kingstown, EPA revised its cost estimate to reflect an increase in materials use, volume of wastes to be excavated/consolidated (minus the cost to reclaim metals), and length of time to complete the tasks. The resulting total costs are those set forth in the ROD for Alternative 4B and reflect an increase of approximately $1 million over the costs presented in the Proposed Plan, or approximately $2.6 million over the estimated costs in the revised estimate in the Administrative Record at section 4.1.

Finally, this Record of Decision clarifies EPA's position concerning its approach in assessing the need for conducting any additional remedial responses concerning groundwater and surface water as a component of the long-term monitoring program. EPA has identified this remedy as a first operable unit of a two operable unit approach to remediate the environmental contamination caused by the Site. The first operable unit will control the sources of contamination at the Site by limiting infiltration and percolation of precipitation through waste materials which are causing a continued release of hazardous substances to the air, ground water and surface water. Further migration of hazardous substances, pollutants and contaminants to groundwater and surface water will therefore be minimized. Once the source control remedy is implemented, further studies will evaluate the need to manage the migration of contaminants from the Site. Management of the migration of contaminants from the Site will be based on data obtained from the first operable unit monitoring and any additional studies that are deemed necessary in order to further assess Site impacts, characterize the extent of contamination, and assess the need to develop and evaluate alternatives for future actions should it be found necessary to do so.

XIII. STATE ROLE

The Rhode Island Department of Environmental Management has reviewed the various alternatives and has indicated its support for the selected remedy. The State has also reviewed the Remedial Investigation, Risk Assessment and Feasibility Study to determine if the selected remedy is in compliance with applicable or relevant and appropriate State Environmental laws and regulations. The State of Rhode Island concurs with the selected remedy for the Rose Hill Regional Landfill Superfund Site. A copy of the declaration of concurrence is attached as Appendix C.

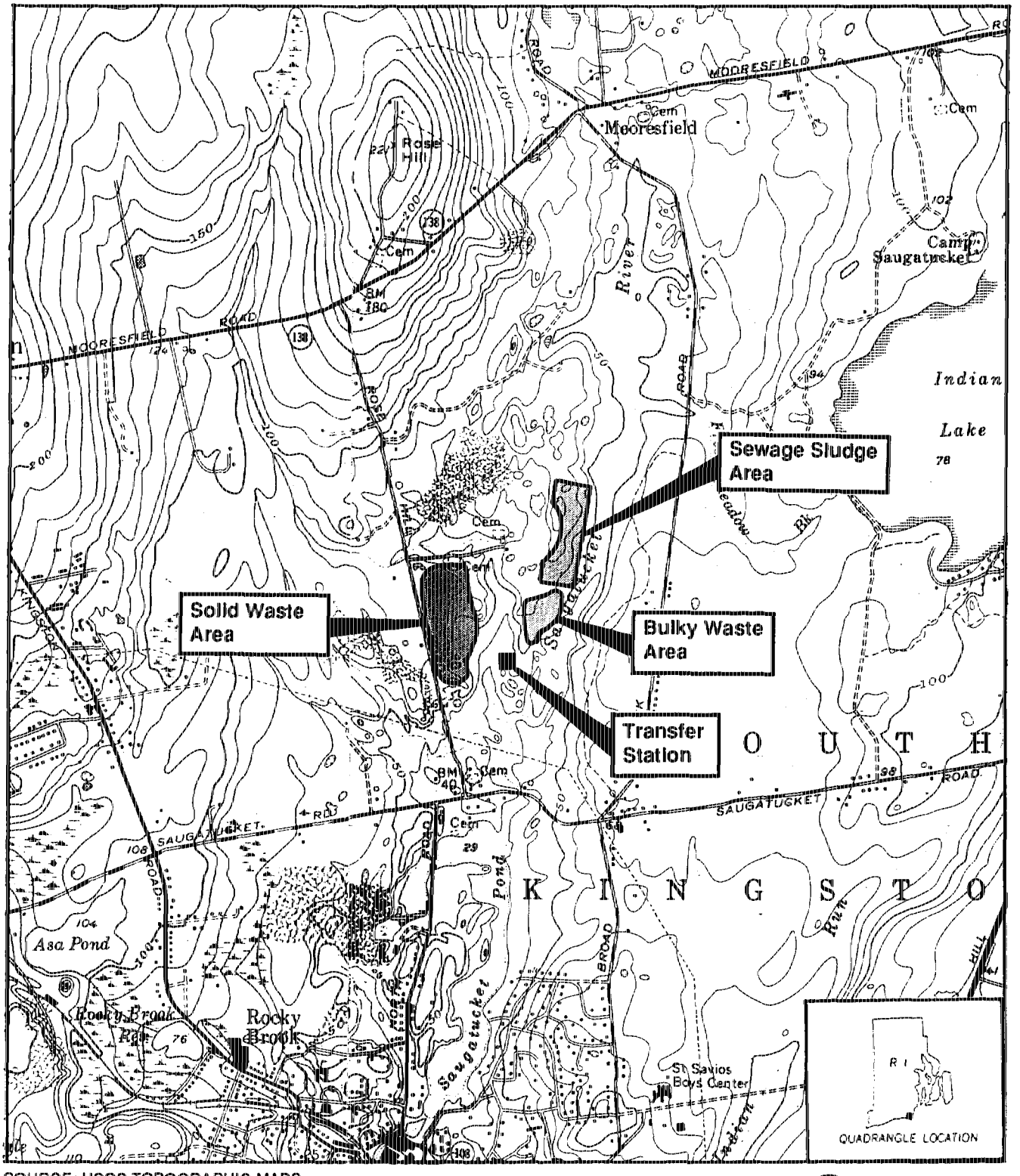
APPENDIX A

RECORD OF DECISION
Rose Hill Regional Landfill Superfund Site

LIST OF FIGURES

LIST OF FIGURES

1 Location of the Rose Hill Regional Landfill Site
2 Rose Hill Site Study Area
3 Seepage Meter and Mini-Piezometer Construction Detail
4 Site Map
5 Volatile Organics Detected in Surface Soil
6 Semivolatile Organics, Pesticides and PCBs Detected in Surface Soil
7 Surface Water Flow Map
8 Organic Compounds Detected in Subsurface Soil
9 Estimated Aerial Extent of Volatile Organics in Groundwater
10 Vertical Distribution of Volatile Organics in Groundwater
11 Surface Water/Sediment Sampling Locations
12 Organic Compounds Detected in Surface Water
13 Inorganics Detected in Surface Water (Unfiltered)
14 Metal Trends in Mitchell Brook Surface Water
15 Metal Trends in Saugatucket River Surface Water
16 Organic Compounds Detected in Sediment
17 Inorganics Detected in Sediment
18 Metal Trends in Mitchell Brook Sediment
19 Metal Trends in Saugatucket River Sediment
20 Leachate Sampling Locations
21 Organic Compounds Detected in Leachate
22 Inorganics Detected in Leachate
23 Landfill Gas Locations Sampled In December, 1991
24 TO-14 and Reduced Sulfur Analysis Sampling Locations
25 Temporary Landfill Gas Sampling Locations Sampled in June 1991
26 Distribution of Organic Chemicals Detected in Landfill Gas Using SUMMA Canisters and TO-14 Analysis
27 Permanent Landfill Gas Sampling Locations
28 Schematic of Alternative #1 Components
29 Schematic of Alternative #2 Components
30 Schematic of Alternative #3a and #3b Components
31 Schematic of Alternative #3a and #3b Components
32 Schematic of Alternative #4a Components
33 Schematic of Alternative #4b Components

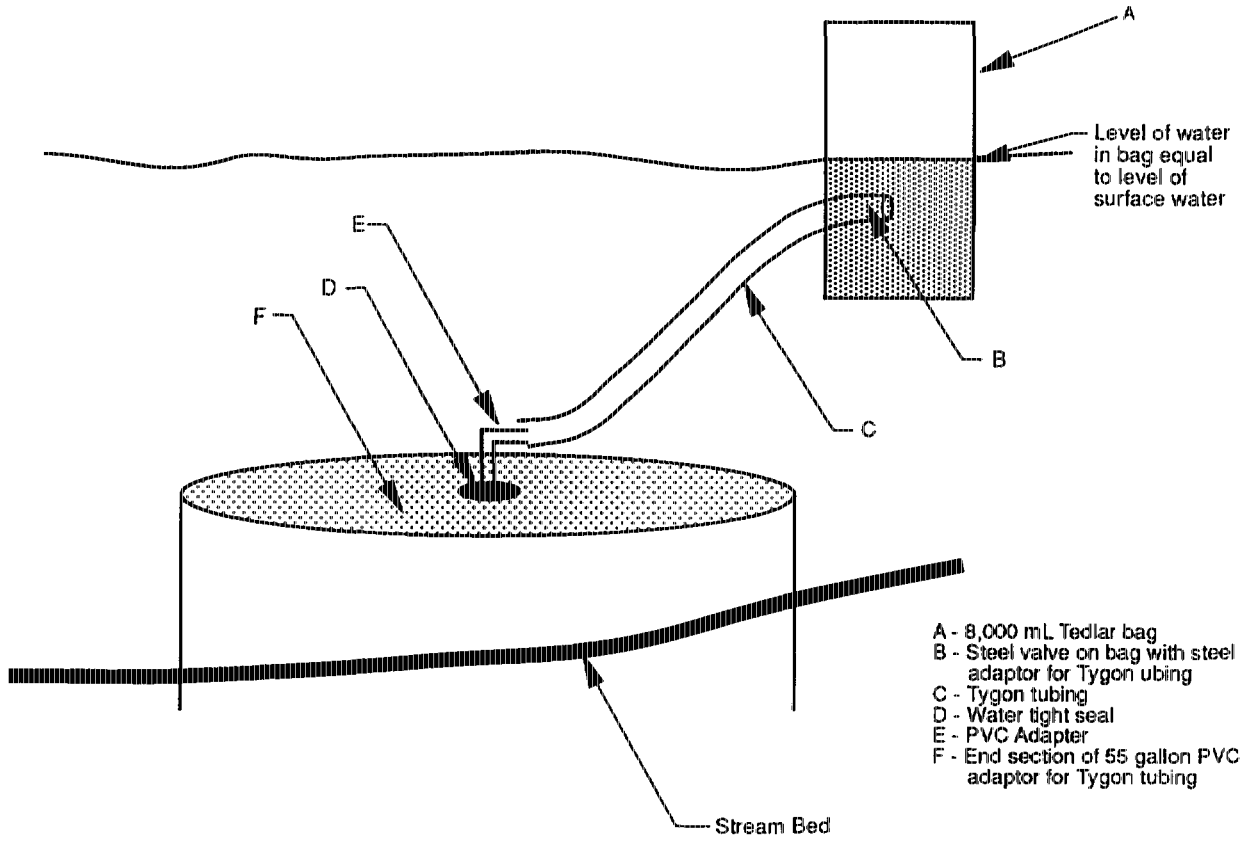


SOURCE: USGS TOPOGRAPHIC MAPS
KINGSTON, RI, 1970
NARRGANSETT PIER, RI, 1975

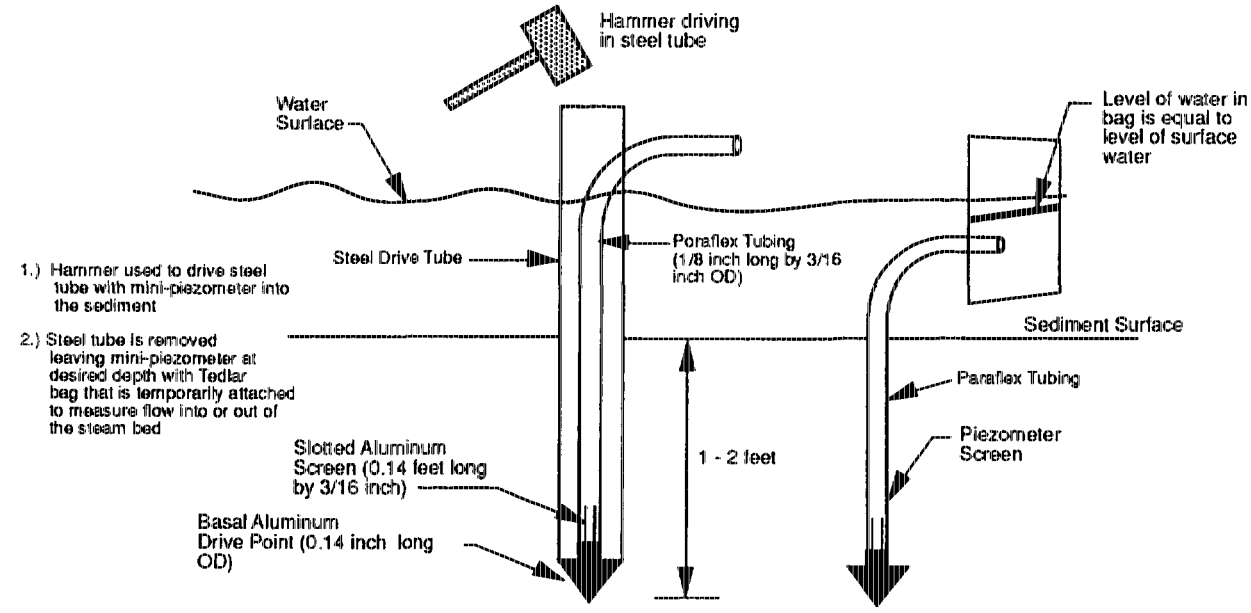
2000 0 2000
SCALE IN FEET

FIGURE 1 LOCATION OF THE ROSE HILL REGIONAL LANDFILL SITE

METCALF & EDDY



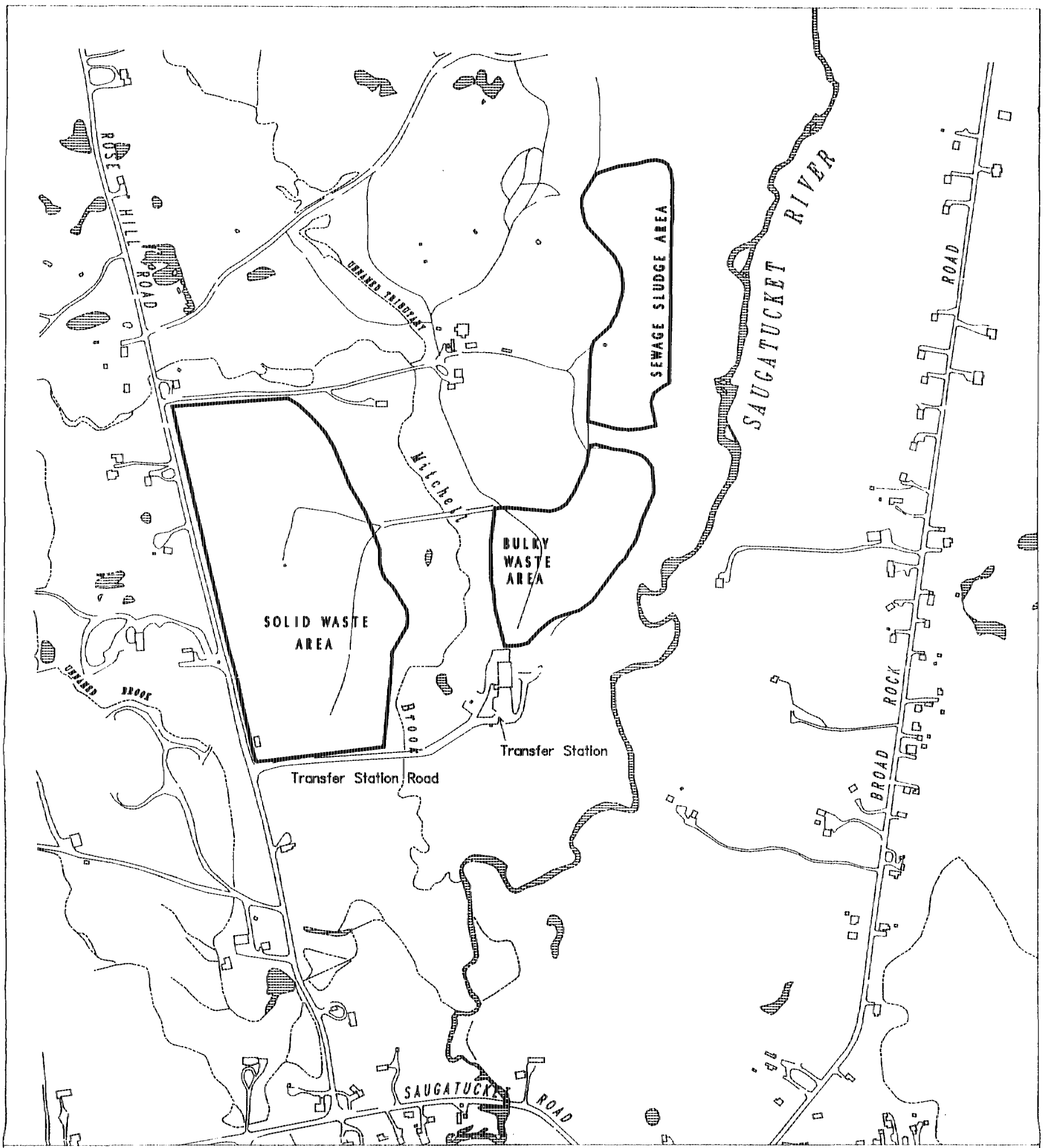
SEEPAGE METER



MINI-PIEZOMETER

FIGURE 3
SEEPAGE METER AND MINI-PIEZOMETER CONSTRUCTION DETAIL

2799jp



Primary Road

Secondary Road

Stream or Brook

Landfill Area

Lake, Pond, or River

SCALE IN FEET

500 0 100 500

FIGURE 2

ROSE HILL SITE STUDY AREA

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY

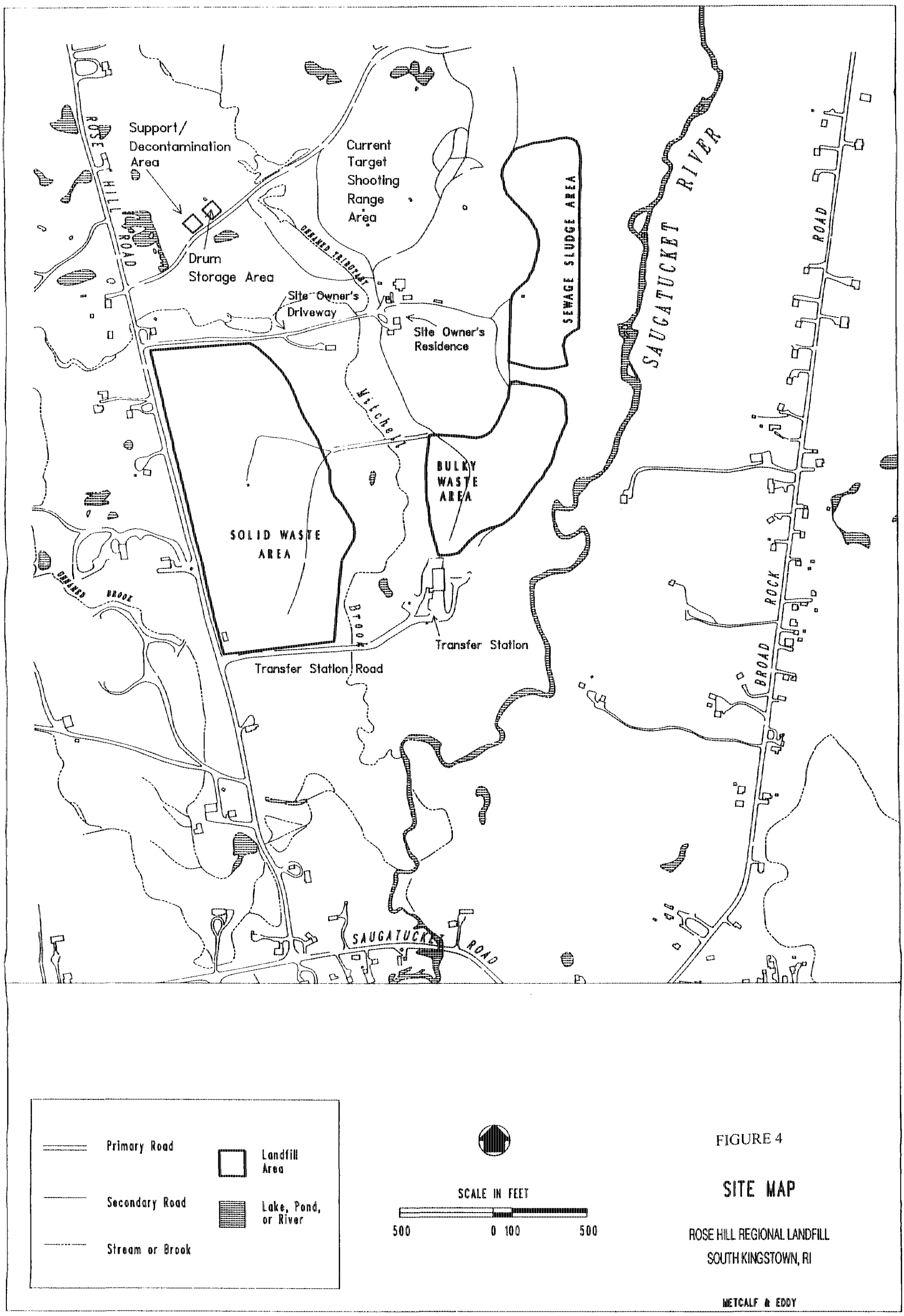


FIGURE 4

SITE MAP

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY

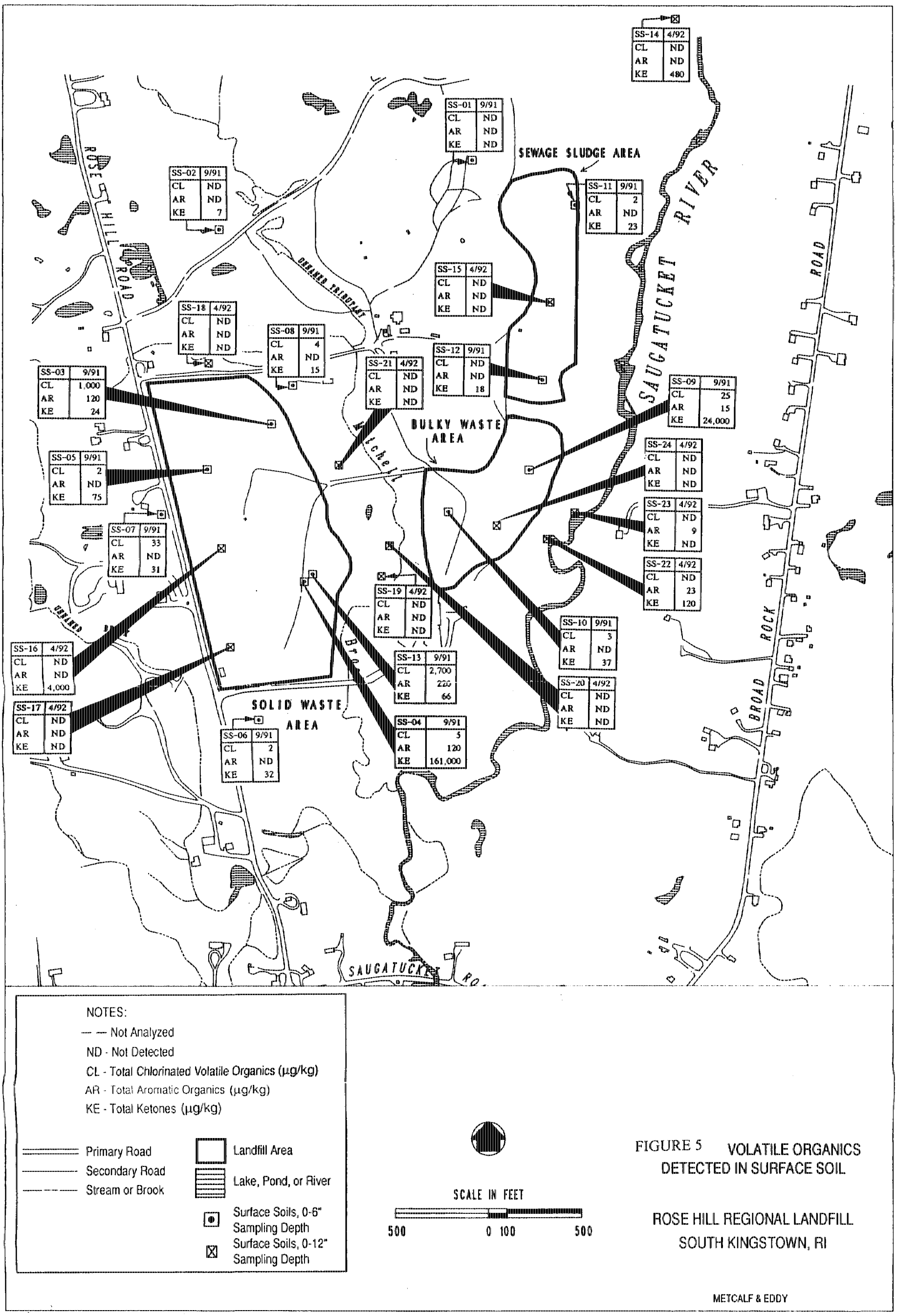


FIGURE 5 VOLATILE ORGANICS DETECTED IN SURFACE SOIL

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY

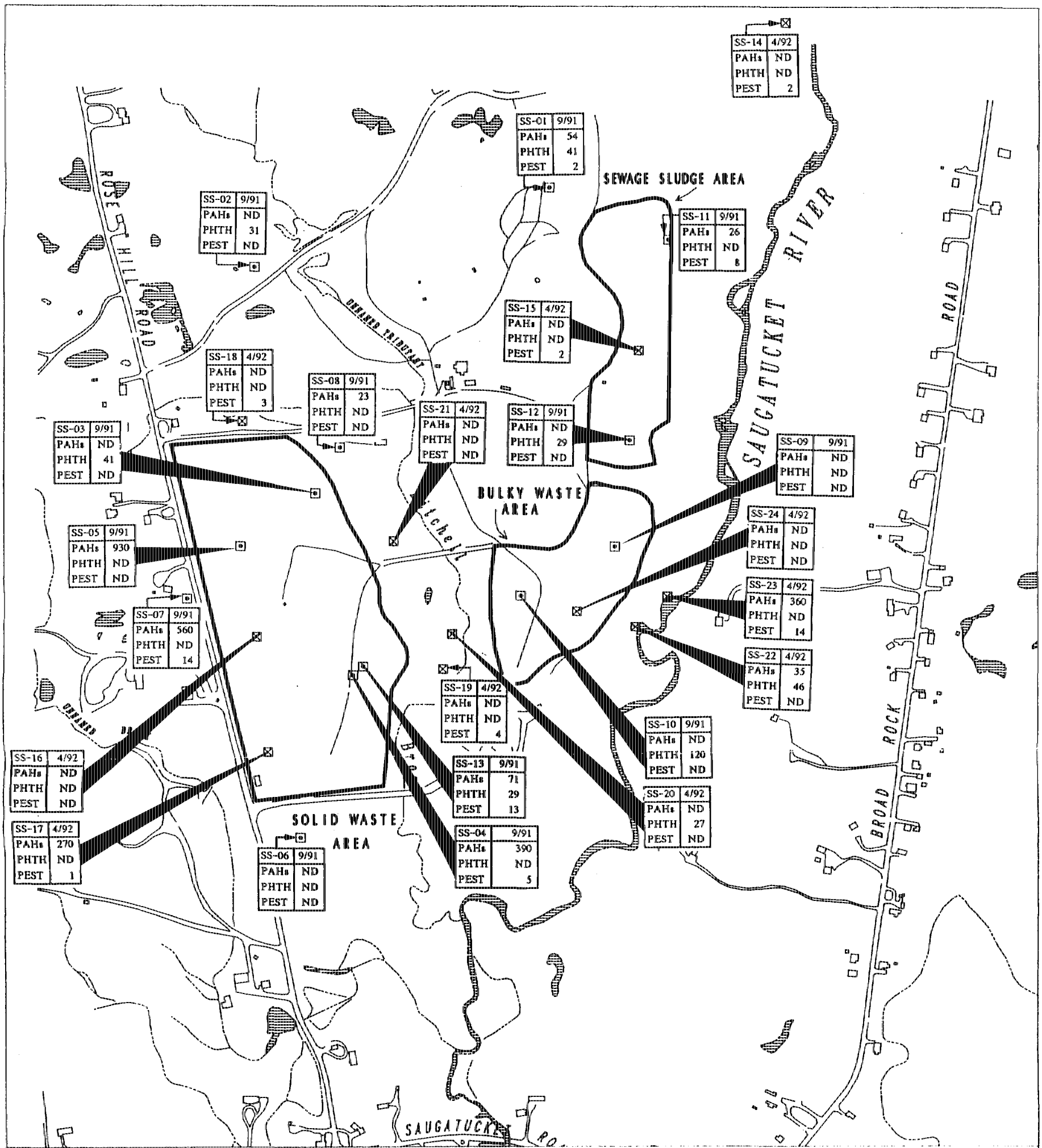


FIGURE 6 SEMIVOLATILE ORGANICS, PESTICIDES, AND PCBs DETECTED IN SURFACE SOIL

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

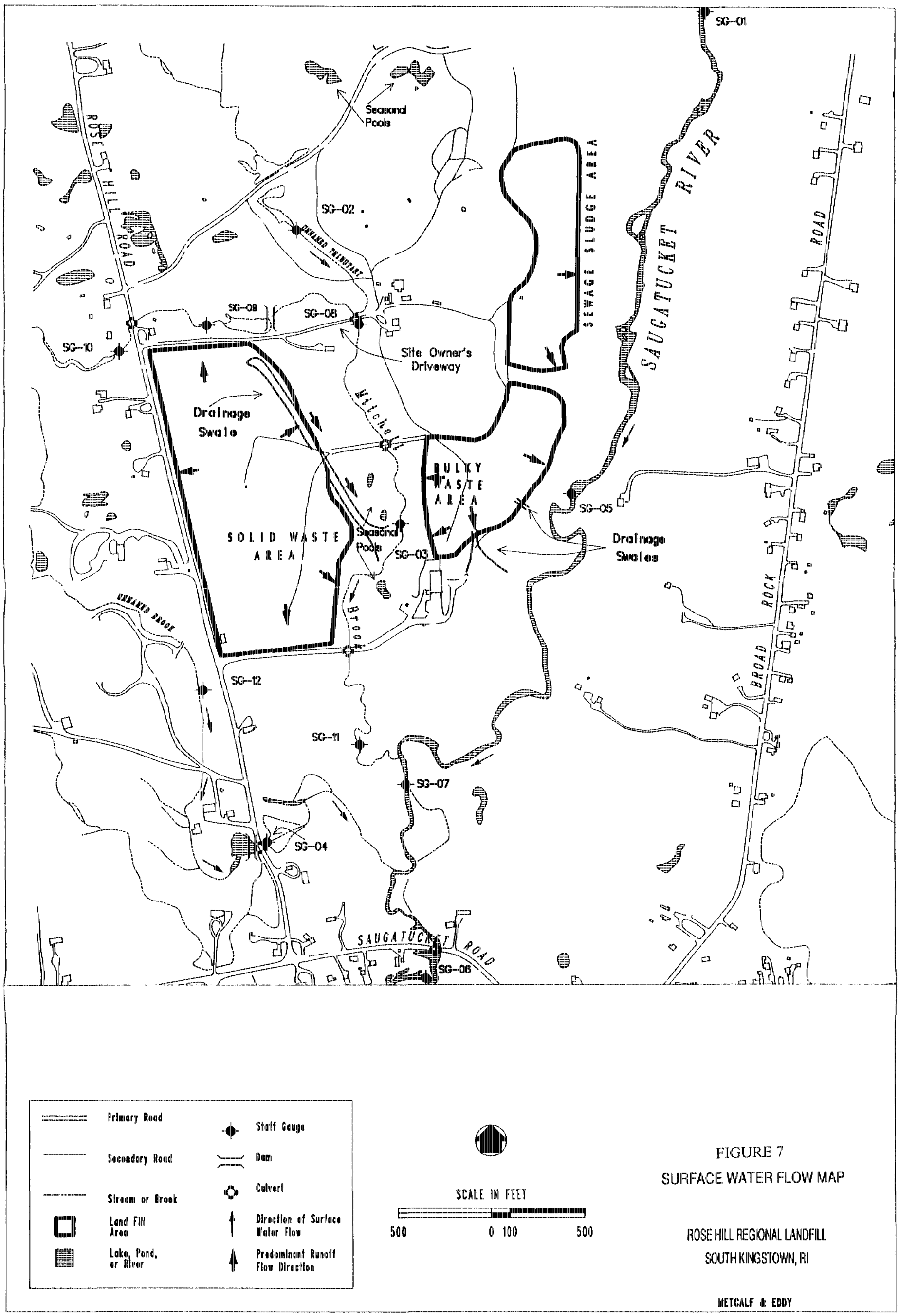
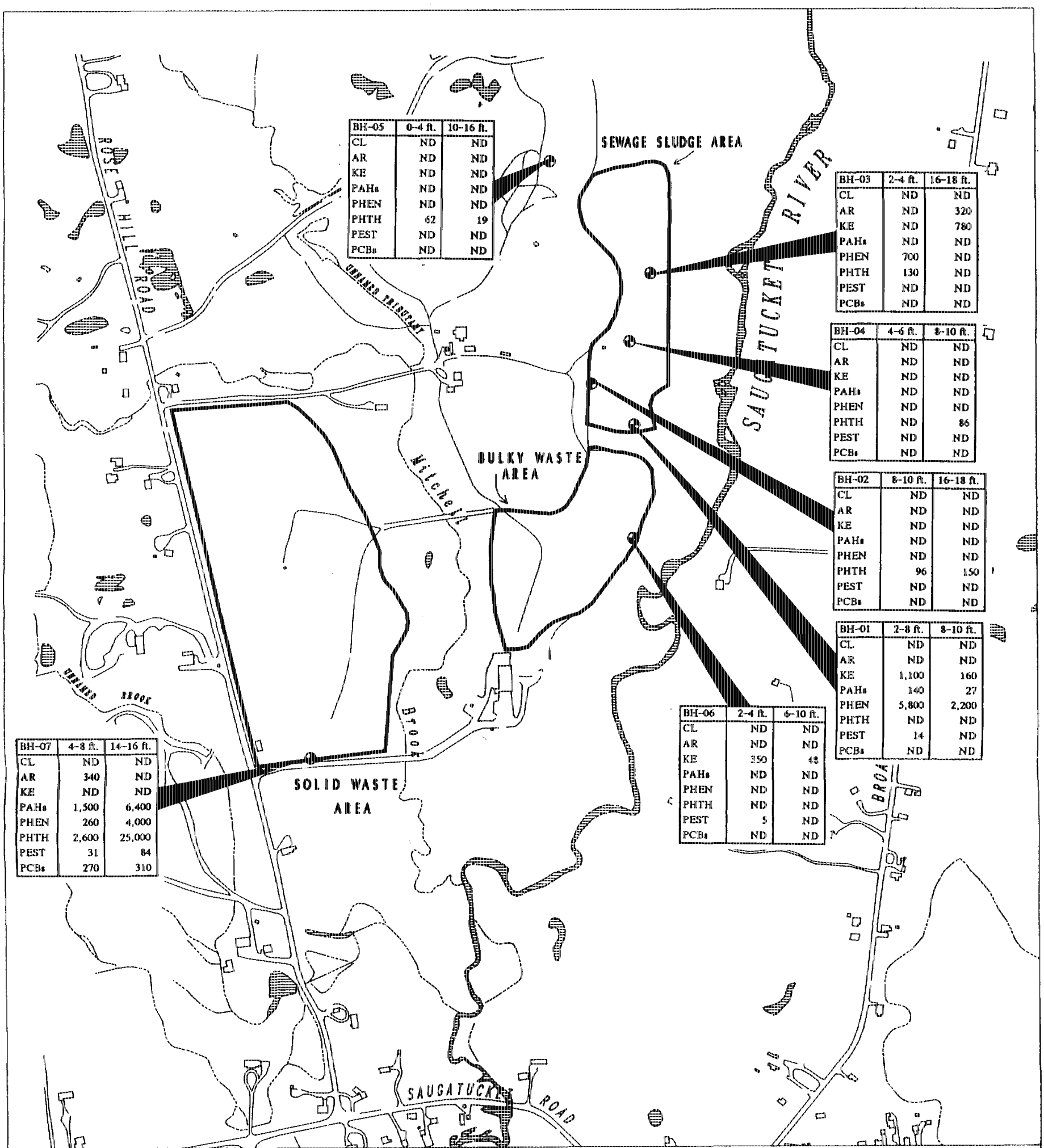


FIGURE 7
SURFACE WATER FLOW MAP

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY



BH-05	0-4 ft.	10-16 ft.
CL	ND	ND
AR	ND	ND
KE	ND	ND
PAHs	ND	ND
PHEN	ND	ND
PHTH	62	19
PEST	ND	ND
PCBs	ND	ND

BH-03	2-4 ft.	16-18 ft.
CL	ND	ND
AR	ND	320
KE	ND	780
PAHs	ND	ND
PHEN	700	ND
PHTH	130	ND
PEST	ND	ND
PCBs	ND	ND

BH-04	4-6 ft.	8-10 ft.
CL	ND	ND
AR	ND	ND
KE	ND	ND
PAHs	ND	ND
PHEN	ND	ND
PHTH	ND	86
PEST	ND	ND
PCBs	ND	ND

BH-02	8-10 ft.	16-18 ft.
CL	ND	ND
AR	ND	ND
KE	ND	ND
PAHs	ND	ND
PHEN	ND	ND
PHTH	96	150
PEST	ND	ND
PCBs	ND	ND

BH-01	2-8 ft.	8-10 ft.
CL	ND	ND
AR	ND	ND
KE	1,100	160
PAHs	140	27
PHEN	5,800	2,200
PHTH	ND	ND
PEST	14	ND
PCBs	ND	ND

BH-06	2-4 ft.	6-10 ft.
CL	ND	ND
AR	ND	ND
KE	350	48
PAHs	ND	ND
PHEN	ND	ND
PHTH	ND	ND
PEST	5	ND
PCBs	ND	ND

BH-07	4-8 ft.	14-16 ft.
CL	ND	ND
AR	340	ND
KE	ND	ND
PAHs	1,500	6,400
PHEN	260	4,000
PHTH	2,600	25,000
PEST	31	84
PCBs	270	310

NOTES: Except for volatile analysis, samples werecomposited when split-spoon recovery was insufficient.

— —Not Analyzed
ND - Not Detected
CL - Total Chlorinated Organics (µg/kg)
AR - Total Aromatic Organics (µg/kg)
KE - Total Ketones (µg/kg)
PAHs - Total Polycyclic Aromatic Hydrocarbons (µg/kg)
PHEN - Total Phenols (µg/kg)
PEST - Total Pesticides (µg/kg)
PCBs - Total Polychlorinated Biphenyls (µg/kg)

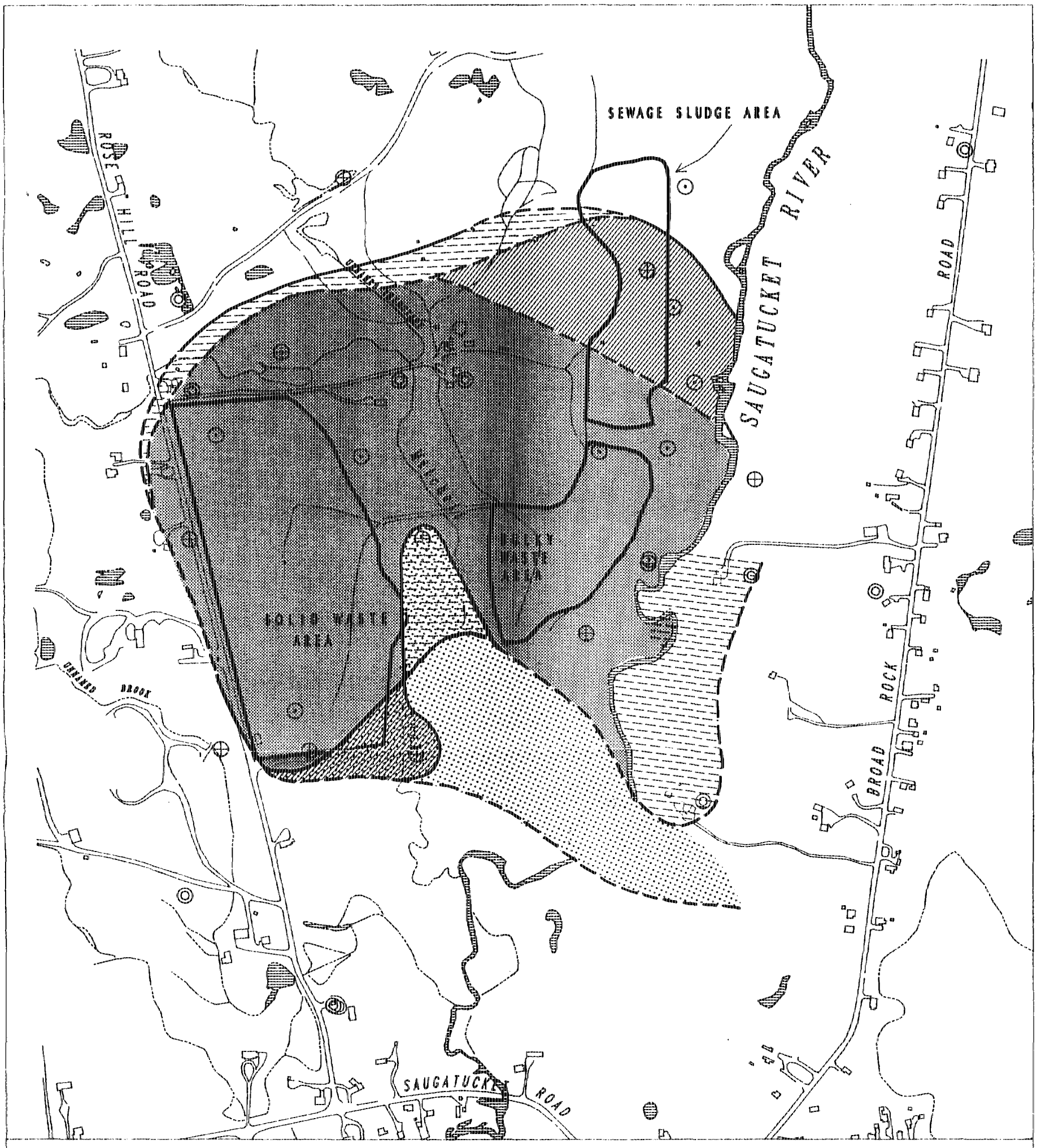
Primary Road
Secondary Road
Stream or Brook
Landfill Area
Lake, Pond, or River
Landfill Analytical Soil Boring

SCALE IN FEET
500 0 100 500

FIGURE 8 ORGANIC COMPOUNDS DETECED IN SUBSURFACE SOIL

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY



NOTE: Extent is based on presence or absence of chlorinated or aromatic volatiles in on-site monitoring wells. Presence was noted if volatile organics were detected at least once during the study period. Bedrock is shown using bedrock residential wells.

- Shallow Overburden Flow Zone
- Deep Overburden Flow Zone
- Bedrock Flow Zone
- All Three Flow Zones
- Primary Road
- Secondary Road
- Stream or Brook
- Landfill Area
- Lake, Pond, or River
- Existing Monitoring Well
- New Monitoring Well
- Residential Well

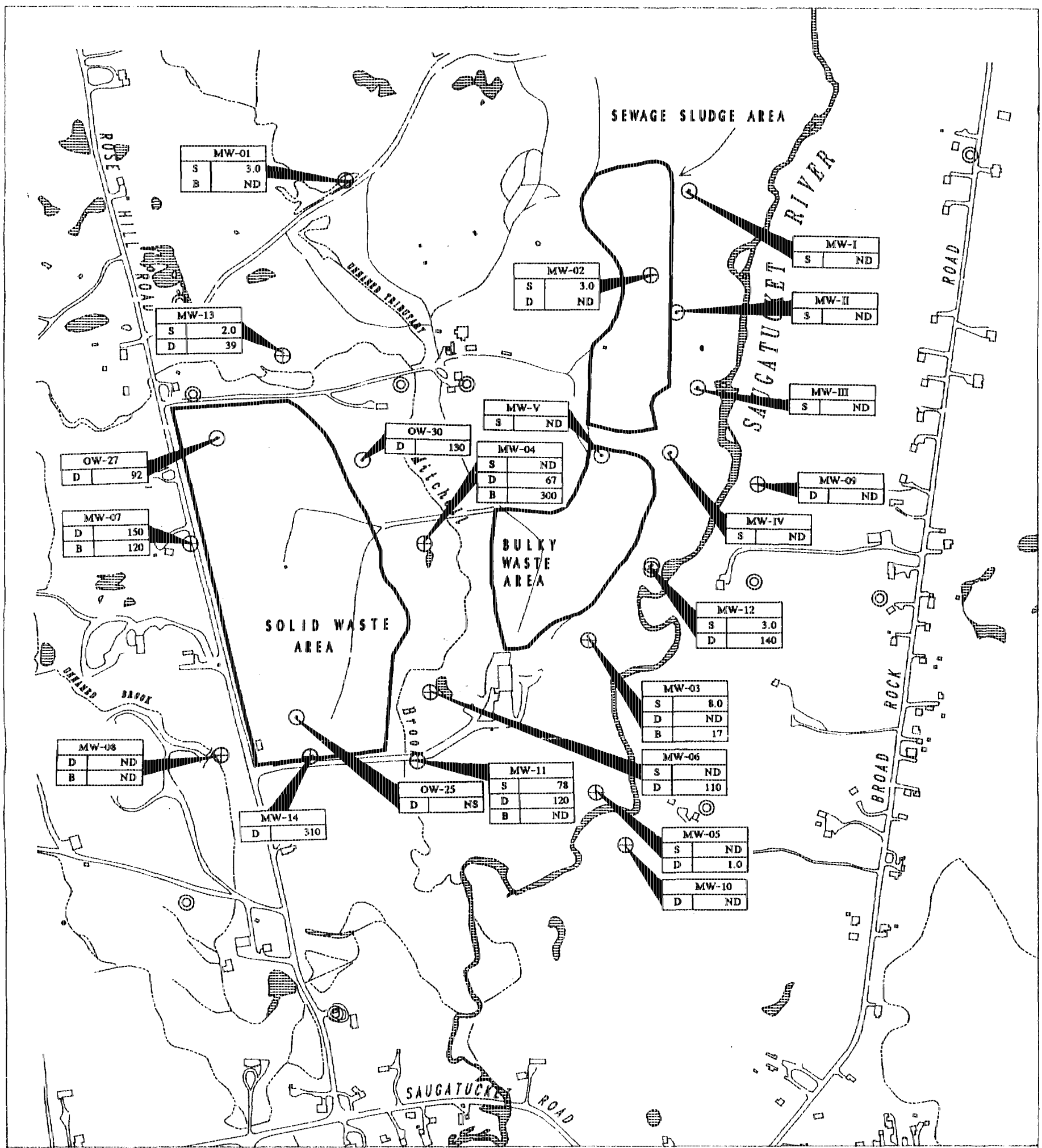
SCALE IN FEET

500 0 100 500

FIGURE 9 ESTIMATED AERIAL EXTENT OF VOLATILE ORGANICS IN GROUNDWATER

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY



NOTE: The total volatile organic cocentrations are presented in µg/L based on data collected in September/October 1991

S Shallow Overburden Well
D Deep Overburden Well
B Bedrock Well
ND Not Detected
NS Not Sampled

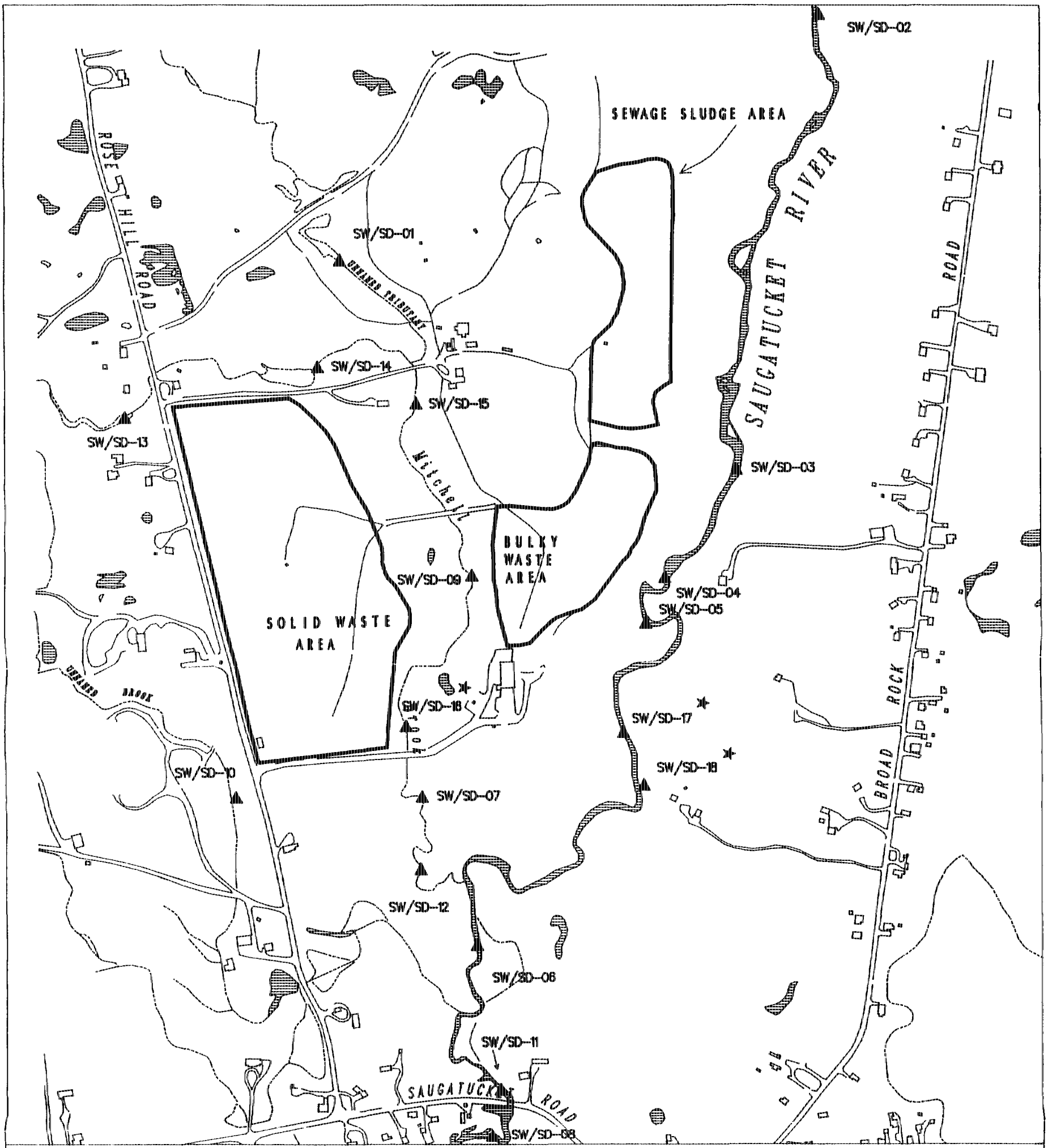
Primary Road
Secondary Road
Stream or Brook
Landfill Area
Lake, Pond, or River
Existing Monitoring Well
New Monitoring Well
Residential Well

SCALE IN FEET
500 0 100 500

FIGURE 10 VERTICAL DISTRIBUTION OF VOLATILE ORGANICS IN GROUNDWATER

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY



Note: ✳ – These three locations were added in may 1992 as part of the ecological investigation.

Primary Road

Secondary Road

Stream or Brook

Landfill Area

Lake, Pond, or River

Surface Water/ Sediment Sampling Location

SCALE IN FEET

500 0 100 500

FIGURE 11

SURFACE WATER/SEDIMENT SAMPLING LOCATIONS

ROSE HILL REGIONAL LANDFILL

SOUTH KINGSTOWN, RI

METCALF & EDDY

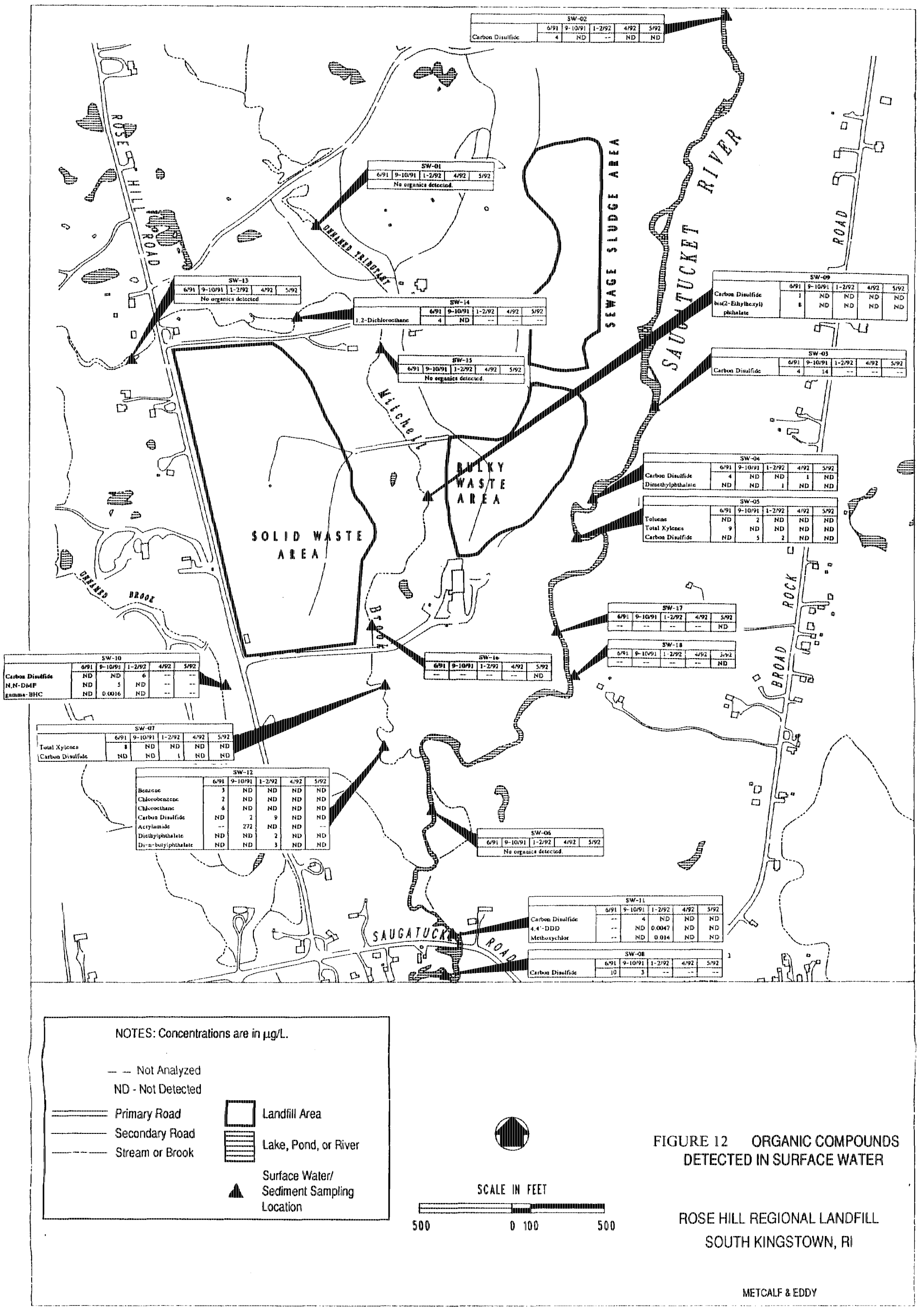
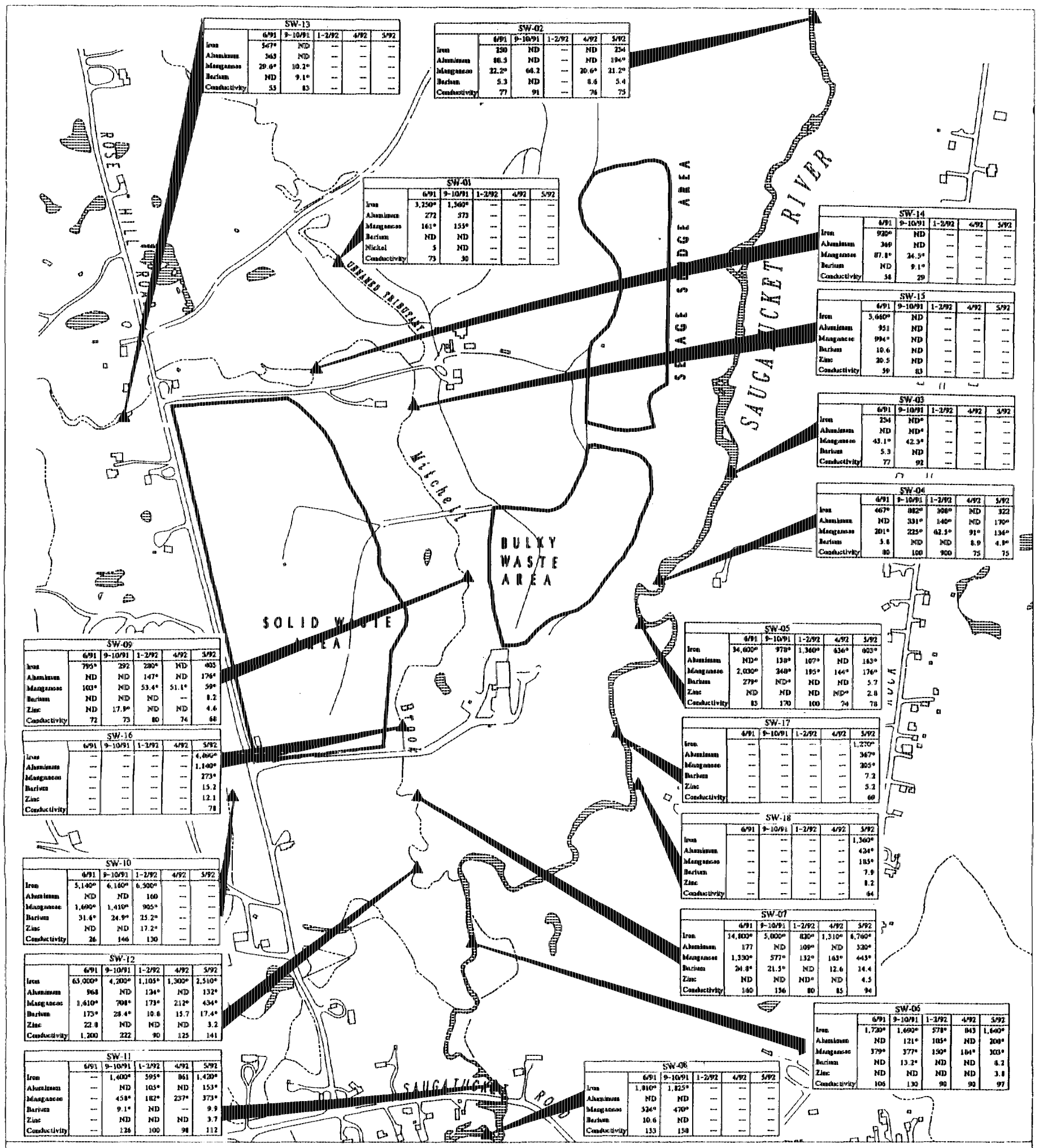


FIGURE 12 ORGANIC COMPOUNDS DETECTED IN SURFACE WATER

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY



SW-13	6/91	9-10/91	1-2/92	4/92	5/92
Iron	567*	ND	--	--	--
Aluminum	365	ND	--	--	--
Manganese	29.6*	10.2*	--	--	--
Barium	ND	9.1*	--	--	--
Conductivity	53	83	--	--	--

SW-02	6/91	9-10/91	1-2/92	4/92	5/92
Iron	250	ND	--	ND	234
Aluminum	88.9	ND	--	ND	194*
Manganese	22.2*	66.2	--	20.6*	21.2*
Barium	5.3	ND	--	8.6	5.4
Conductivity	77	91	--	76	75

SW-01	6/91	9-10/91	1-2/92	4/92	5/92
Iron	3,250*	1,560*	--	--	--
Aluminum	272	373	--	--	--
Manganese	161*	155*	--	--	--
Barium	ND	ND	--	--	--
Nickel	5	ND	--	--	--
Conductivity	73	30	--	--	--

SW-14	6/91	9-10/91	1-2/92	4/92	5/92
Iron	920*	ND	--	--	--
Aluminum	369	ND	--	--	--
Manganese	87.1*	24.3*	--	--	--
Barium	ND	9.1*	--	--	--
Conductivity	58	29	--	--	--

SW-15	6/91	9-10/91	1-2/92	4/92	5/92
Iron	3,660*	ND	--	--	--
Aluminum	951	ND	--	--	--
Manganese	994*	ND	--	--	--
Barium	10.6	ND	--	--	--
Zinc	20.5	ND	--	--	--
Conductivity	59	83	--	--	--

SW-03	6/91	9-10/91	1-2/92	4/92	5/92
Iron	234	ND*	--	--	--
Aluminum	ND	ND*	--	--	--
Manganese	43.1*	42.3*	--	--	--
Barium	5.3	ND	--	--	--
Conductivity	77	92	--	--	--

SW-04	6/91	9-10/91	1-2/92	4/92	5/92
Iron	467*	882*	300*	ND	322
Aluminum	ND	331*	140*	ND	170*
Manganese	201*	225*	62.3*	91*	136*
Barium	5.8	ND	ND	8.9	4.8*
Conductivity	80	100	900	75	75

SW-05	6/91	9-10/91	1-2/92	4/92	5/92
Iron	34,600*	970*	1,360*	636*	603*
Aluminum	ND*	130*	107*	ND	163*
Manganese	2,030*	340*	195*	144*	176*
Barium	279*	ND*	ND	ND	5.7
Zinc	ND	ND	ND	ND*	2.8
Conductivity	83	170	100	74	78

SW-09	6/91	9-10/91	1-2/92	4/92	5/92
Iron	795*	292	280*	ND	403
Aluminum	ND	ND	147*	ND	176*
Manganese	103*	ND	53.4*	51.1*	59*
Barium	ND	ND	ND	--	8.2
Zinc	ND	17.9*	ND	ND	4.6
Conductivity	72	73	80	74	68

SW-16	6/91	9-10/91	1-2/92	4/92	5/92
Iron	--	--	--	--	4,060*
Aluminum	--	--	--	--	1,140*
Manganese	--	--	--	--	273*
Barium	--	--	--	--	15.2
Zinc	--	--	--	--	12.1
Conductivity	--	--	--	--	78

SW-17	6/91	9-10/91	1-2/92	4/92	5/92
Iron	--	--	--	--	1,270*
Aluminum	--	--	--	--	367*
Manganese	--	--	--	--	305*
Barium	--	--	--	--	7.2
Zinc	--	--	--	--	5.2
Conductivity	--	--	--	--	60

SW-18	6/91	9-10/91	1-2/92	4/92	5/92
Iron	--	--	--	--	1,360*
Aluminum	--	--	--	--	424*
Manganese	--	--	--	--	185*
Barium	--	--	--	--	7.9
Zinc	--	--	--	--	8.2
Conductivity	--	--	--	--	64

SW-10	6/91	9-10/91	1-2/92	4/92	5/92
Iron	5,140*	6,160*	6,500*	--	--
Aluminum	ND	ND	160	--	--
Manganese	1,690*	1,410*	905*	--	--
Barium	31.6*	24.9*	25.2*	--	--
Zinc	ND	ND	17.2*	--	--
Conductivity	26	146	130	--	--

SW-07	6/91	9-10/91	1-2/92	4/92	5/92
Iron	14,800*	5,000*	830*	1,310*	6,760*
Aluminum	177	ND	109*	ND	320*
Manganese	1,330*	577*	132*	163*	443*
Barium	26.8*	21.5*	ND	12.6	14.4
Zinc	ND	ND	ND*	ND	4.5
Conductivity	160	136	80	85	94

SW-12	6/91	9-10/91	1-2/92	4/92	5/92
Iron	63,000*	4,200*	1,105*	1,300*	2,510*
Aluminum	968	ND	134*	ND	132*
Manganese	1,610*	708*	173*	212*	434*
Barium	175*	28.4*	10.6	15.7	17.4*
Zinc	22.8	ND	ND	ND	3.2
Conductivity	1,200	222	90	125	141

SW-06	6/91	9-10/91	1-2/92	4/92	5/92
Iron	1,720*	1,690*	578*	843	1,600*
Aluminum	ND	121*	105*	ND	200*
Manganese	379*	377*	150*	104*	303*
Barium	ND	15.2*	ND	ND	6.2
Zinc	ND	ND	ND	ND	3.8
Conductivity	106	130	90	90	97

SW-11	6/91	9-10/91	1-2/92	4/92	5/92
Iron	--	1,400*	595*	861	1,420*
Aluminum	--	ND	105*	ND	153*
Manganese	--	458*	182*	237*	373*
Barium	--	9.1*	ND	--	9.9
Zinc	--	ND	ND	ND	3.7
Conductivity	--	126	100	98	112

SW-08	6/91	9-10/91	1-2/92	4/92	5/92
Iron	1,810*	1,825*	--	--	--
Aluminum	ND	ND	--	--	--
Manganese	524*	470*	--	--	--
Barium	10.6	ND	--	--	--
Conductivity	133	138	--	--	--

NOTES: Metal concentrations provided for unfiltered samples in µg/L and specific conductance in µmhos/cm

-- — Not Analyzed

ND - Not Detected

* Also Detected in Filtered Sample

Primary Road

Secondary Road

Stream or Brook

Landfill Area

Lake, Pond, or River

Surface Water/ Sediment Sampling Location

SCALE IN FEET

500 0 100 500

FIGURE 13 INORGANICS DETECTED IN SURFACE WATER (UNFILTERED)

ROSE HILL REGIONAL LANDFILL

SOUTH KINGSTOWN, RI

METCALF & EDDY

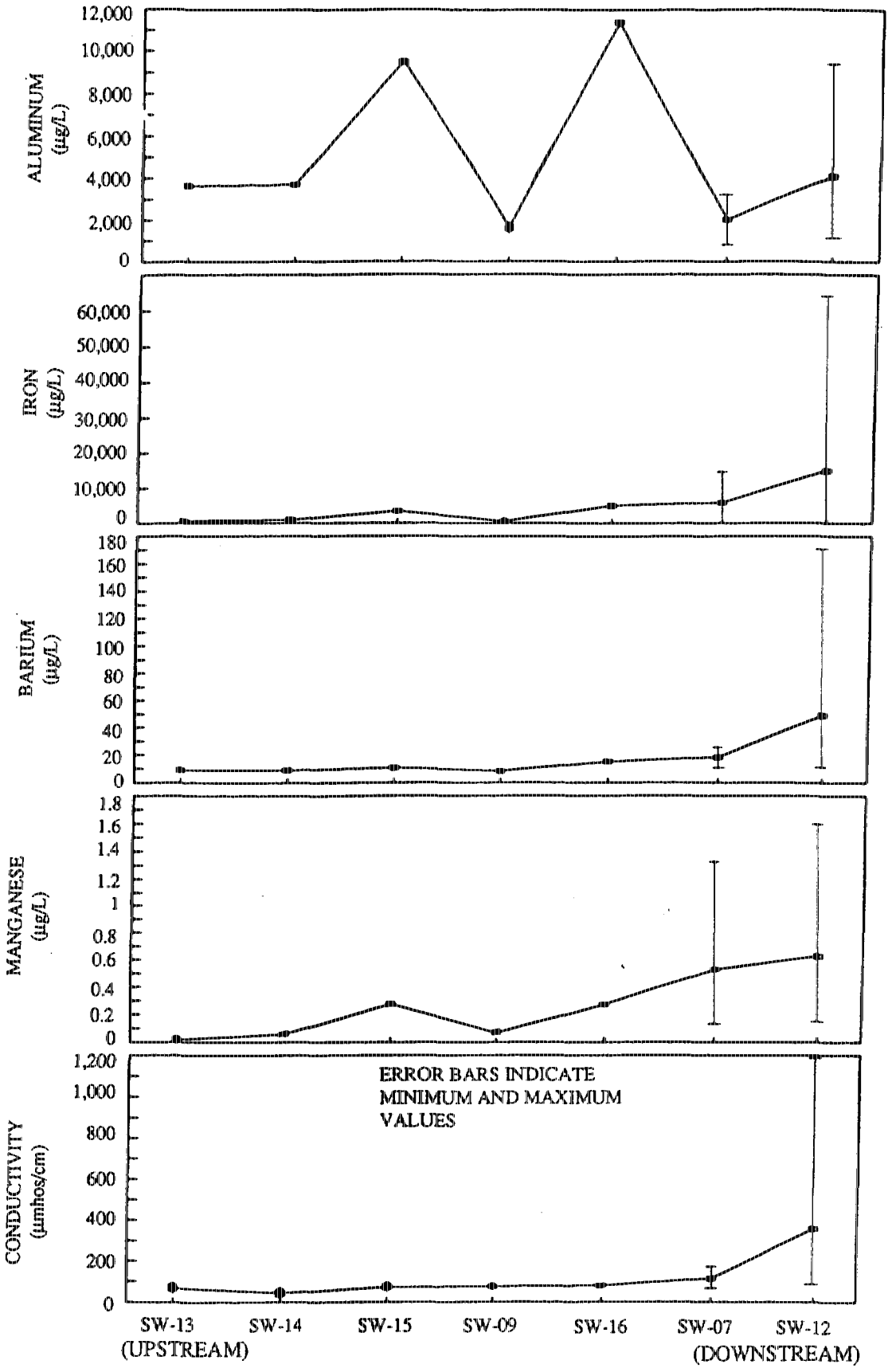


FIGURE 14

METAL TRENDS IN MITCHELL BROOK SURFACE WATER

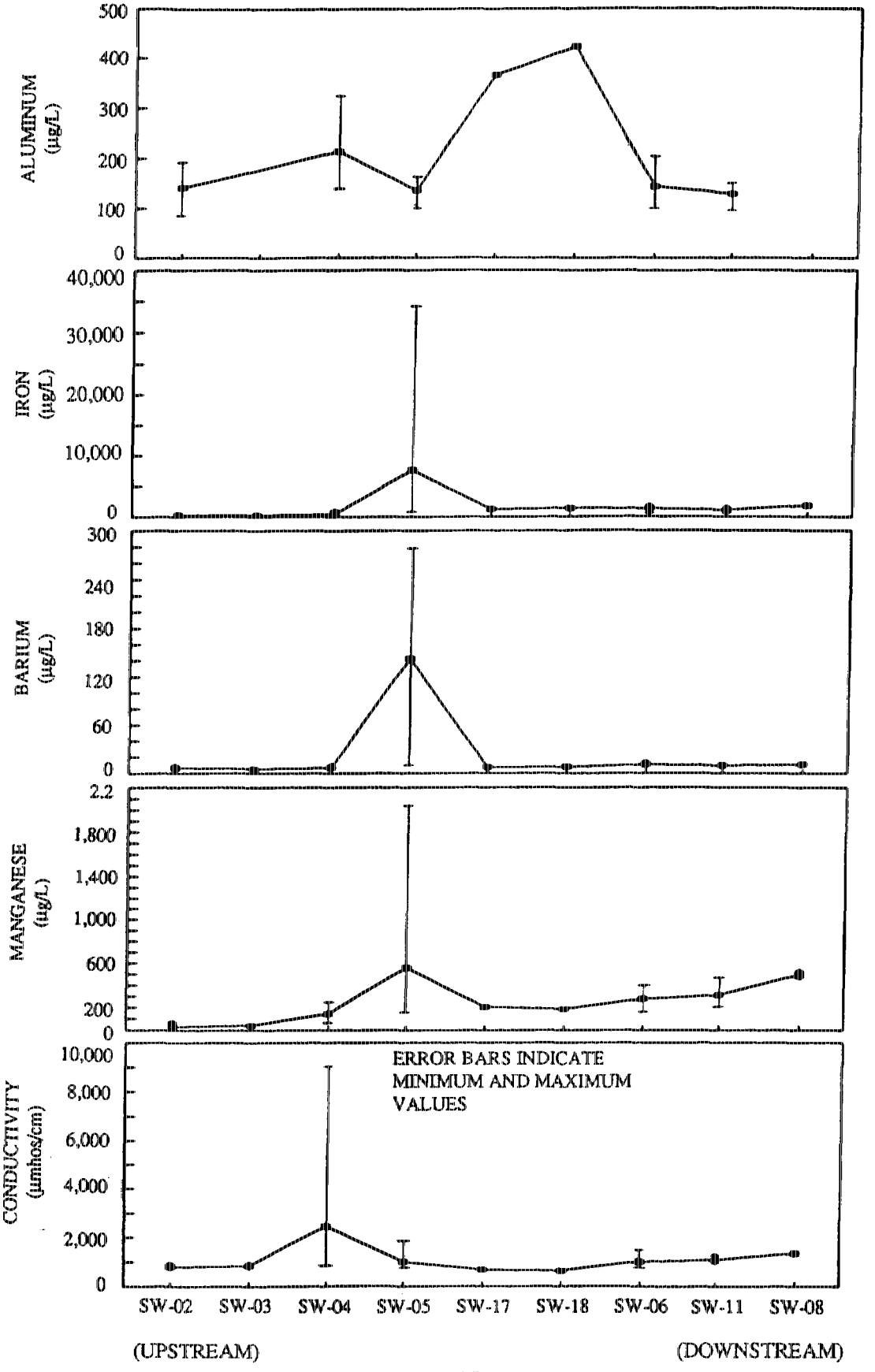


FIGURE 15

METAL TRENDS IN SAUGATUCKET RIVER SURFACE WATER

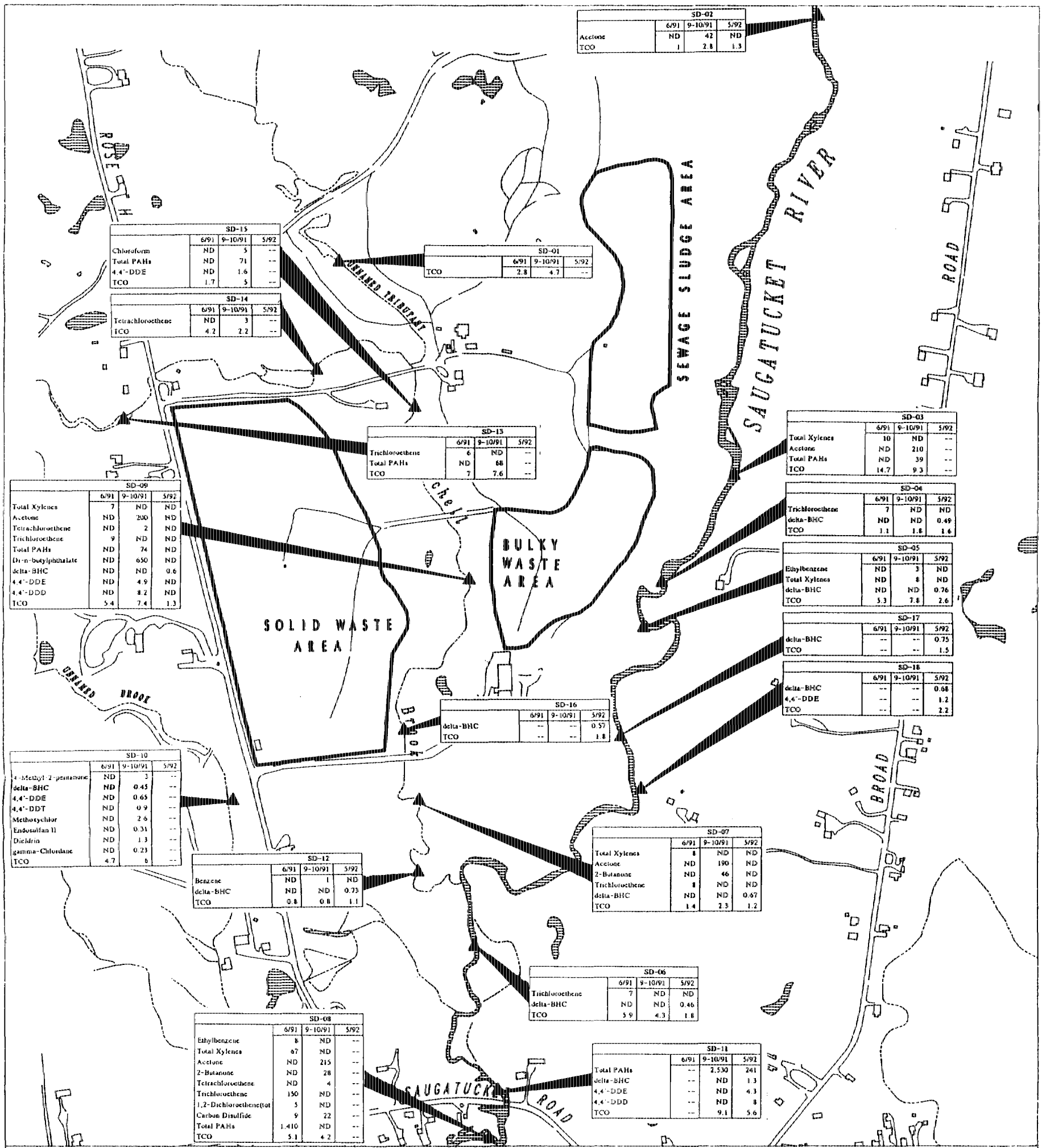
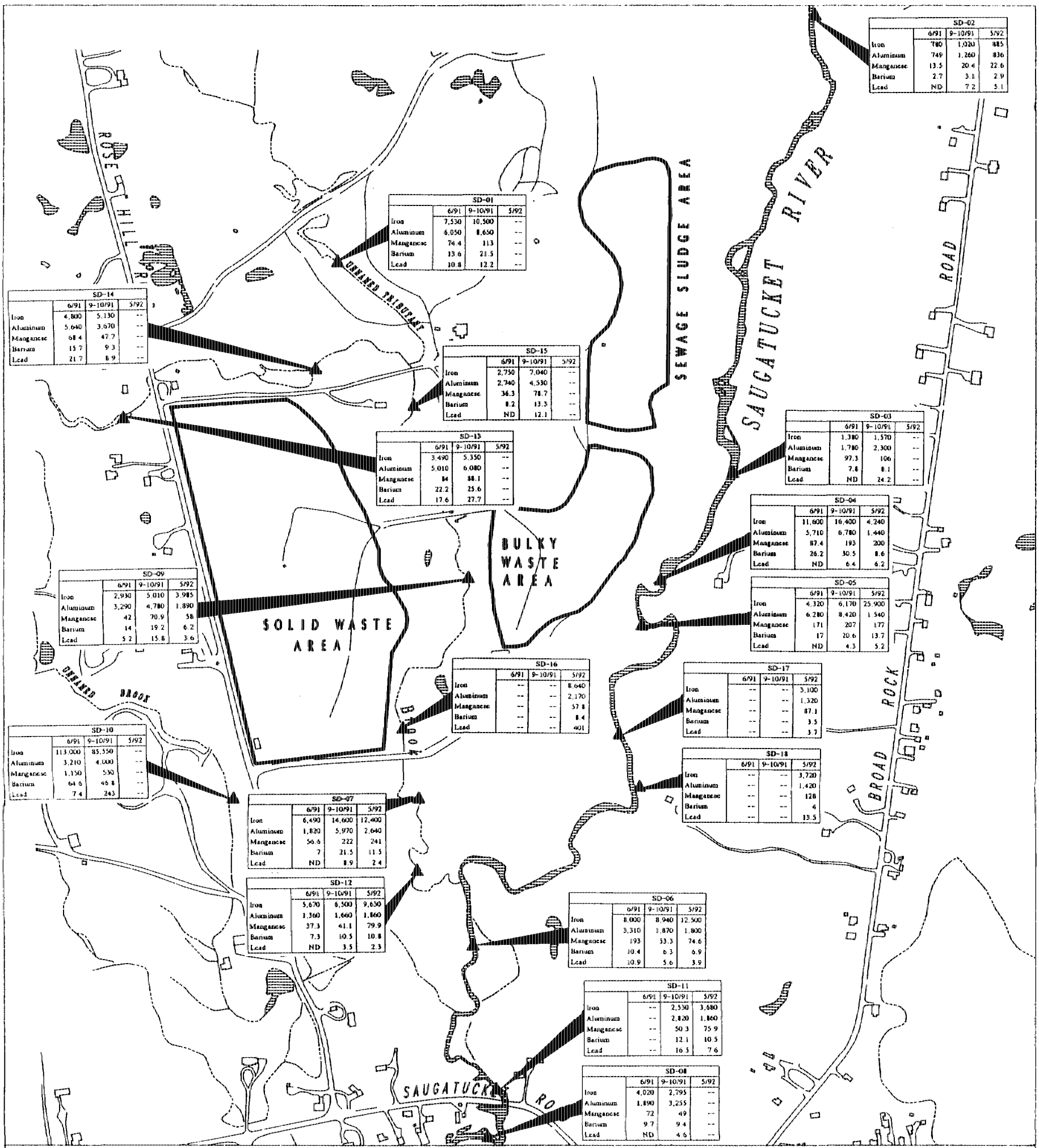


FIGURE 16 ORGANIC COMPOUNDS DETECTED IN SEDIMENT

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY



SD-01	6/91	9-10/91	5/92
Iron	7,530	10,500	--
Aluminum	6,050	8,650	--
Manganese	74.4	113	--
Barium	13.6	21.5	--
Lead	10.8	12.2	--

SD-02	6/91	9-10/91	5/92
Iron	780	1,020	885
Aluminum	749	1,260	836
Manganese	13.5	20.4	22.6
Barium	2.7	3.1	2.9
Lead	ND	7.2	5.1

SD-03	6/91	9-10/91	5/92
Iron	1,380	1,570	--
Aluminum	1,780	2,300	--
Manganese	97.3	106	--
Barium	7.8	8.1	--
Lead	ND	24.2	--

SD-04	6/91	9-10/91	5/92
Iron	11,600	16,400	4,240
Aluminum	5,710	6,780	1,440
Manganese	87.4	193	200
Barium	26.2	30.5	8.6
Lead	ND	6.4	6.2

SD-05	6/91	9-10/91	5/92
Iron	4,320	6,170	25,900
Aluminum	6,280	8,420	1,540
Manganese	171	207	177
Barium	17	20.6	13.7
Lead	ND	4.3	5.2

SD-06	6/91	9-10/91	5/92
Iron	8,000	8,940	12,500
Aluminum	3,310	1,870	1,800
Manganese	193	53.3	74.6
Barium	10.4	6.3	6.9
Lead	10.9	5.6	3.9

SD-07	6/91	9-10/91	5/92
Iron	6,490	14,600	12,400
Aluminum	1,820	5,970	2,640
Manganese	56.6	222	241
Barium	7	21.5	11.5
Lead	ND	8.9	2.4

SD-08	6/91	9-10/91	5/92
Iron	4,020	2,795	--
Aluminum	1,890	3,255	--
Manganese	72	49	--
Barium	9.7	9.4	--
Lead	ND	4.6	--

SD-09	6/91	9-10/91	5/92
Iron	2,930	5,010	3,985
Aluminum	3,290	4,780	1,890
Manganese	42	70.9	58
Barium	14	19.2	6.2
Lead	5.2	15.8	3.6

SD-10	6/91	9-10/91	5/92
Iron	113,000	85,550	--
Aluminum	3,210	4,000	--
Manganese	1,150	530	--
Barium	64.6	46.8	--
Lead	7.4	243	--

SD-11	6/91	9-10/91	5/92
Iron	--	2,530	3,680
Aluminum	--	2,820	1,860
Manganese	--	50.3	75.9
Barium	--	12.1	10.5
Lead	--	16.5	7.6

SD-12	6/91	9-10/91	5/92
Iron	5,670	6,500	9,650
Aluminum	1,360	1,660	1,860
Manganese	37.3	41.1	79.9
Barium	7.3	10.5	10.8
Lead	ND	3.5	2.3

SD-13	6/91	9-10/91	5/92
Iron	3,490	5,350	--
Aluminum	5,010	6,080	--
Manganese	84	88.1	--
Barium	22.2	25.6	--
Lead	17.6	27.7	--

SD-14	6/91	9-10/91	5/92
Iron	4,800	5,130	--
Aluminum	5,640	3,670	--
Manganese	68.4	47.7	--
Barium	15.7	9.3	--
Lead	21.7	8.9	--

SD-15	6/91	9-10/91	5/92
Iron	2,750	7,040	--
Aluminum	2,740	4,530	--
Manganese	36.3	78.7	--
Barium	8.2	13.3	--
Lead	ND	12.1	--

SD-16	6/91	9-10/91	5/92
Iron	--	--	8,640
Aluminum	--	--	2,170
Manganese	--	--	57.8
Barium	--	--	8.4
Lead	--	--	401

SD-17	6/91	9-10/91	5/92
Iron	--	--	3,100
Aluminum	--	--	1,320
Manganese	--	--	87.1
Barium	--	--	3.5
Lead	--	--	3.7

SD-18	6/91	9-10/91	5/92
Iron	--	--	3,720
Aluminum	--	--	1,420
Manganese	--	--	128
Barium	--	--	4
Lead	--	--	13.5

FIGURE 17 INORGANICS DETECTED IN SEDIMENT

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY

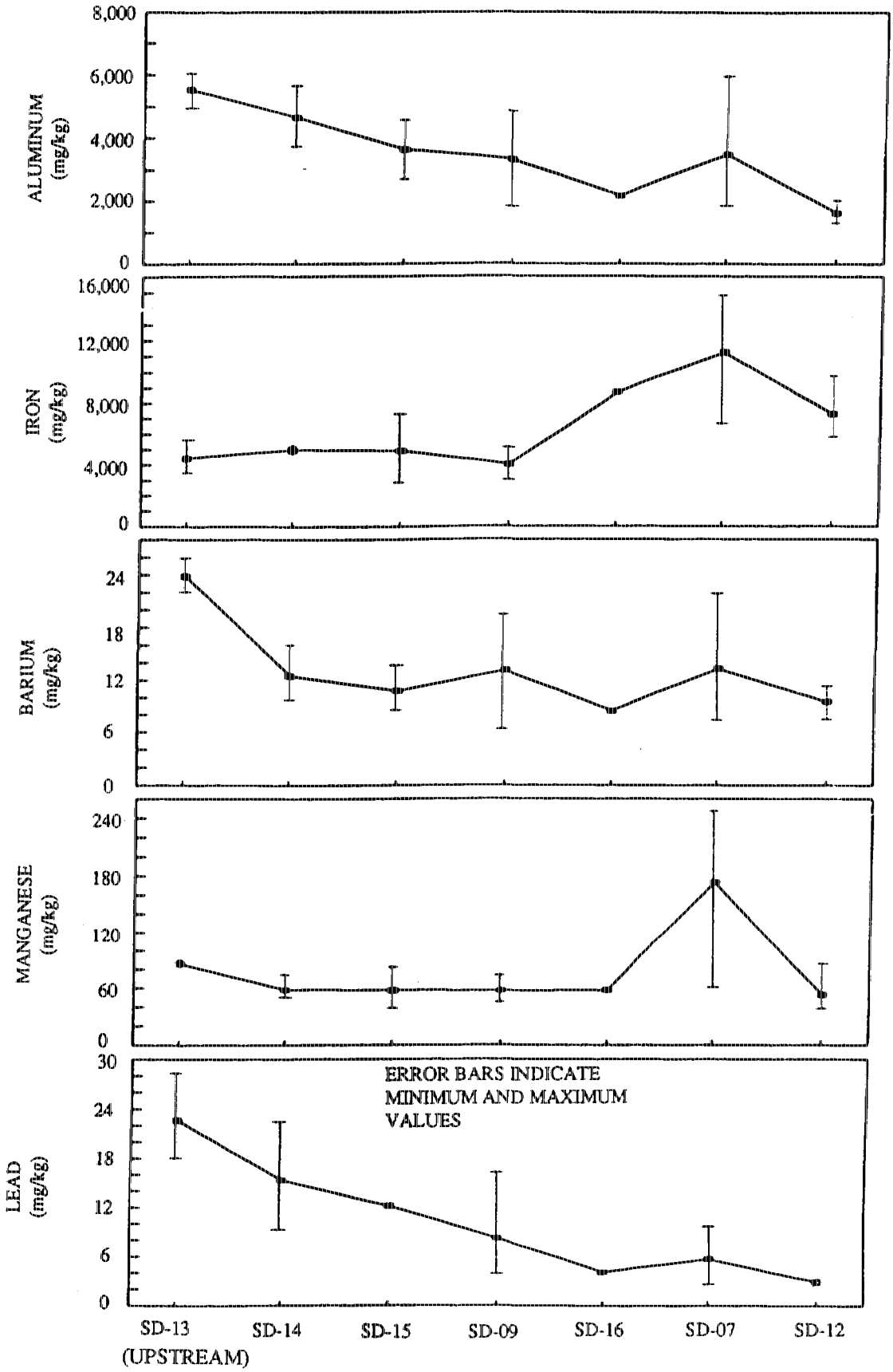


FIGURE 18
METAL TRENDS IN MITCHELL BROOK SEDIMENT

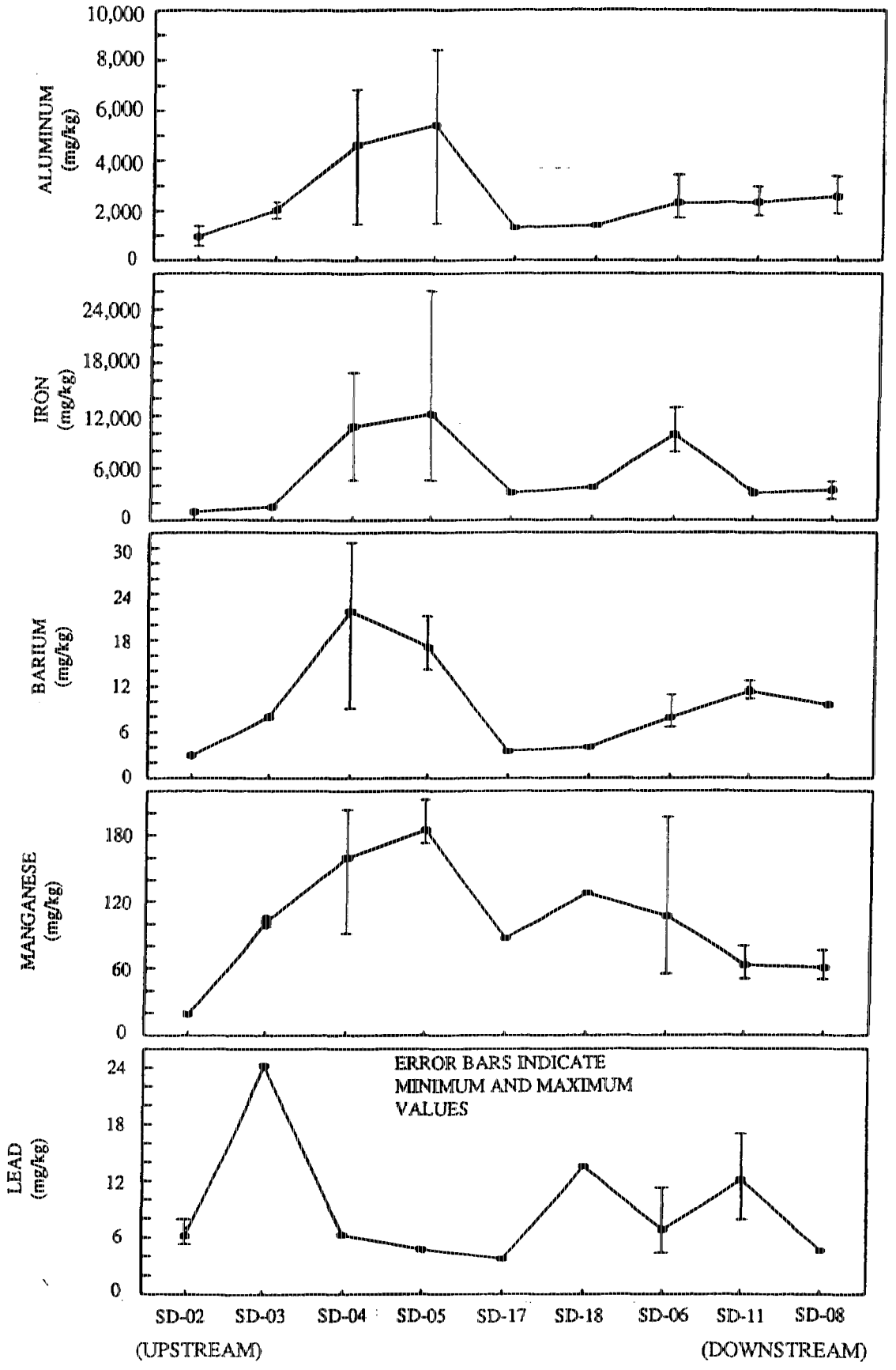


FIGURE 19
METAL TRENDS IN SAUGATUCKET RIVER SEDIMENT

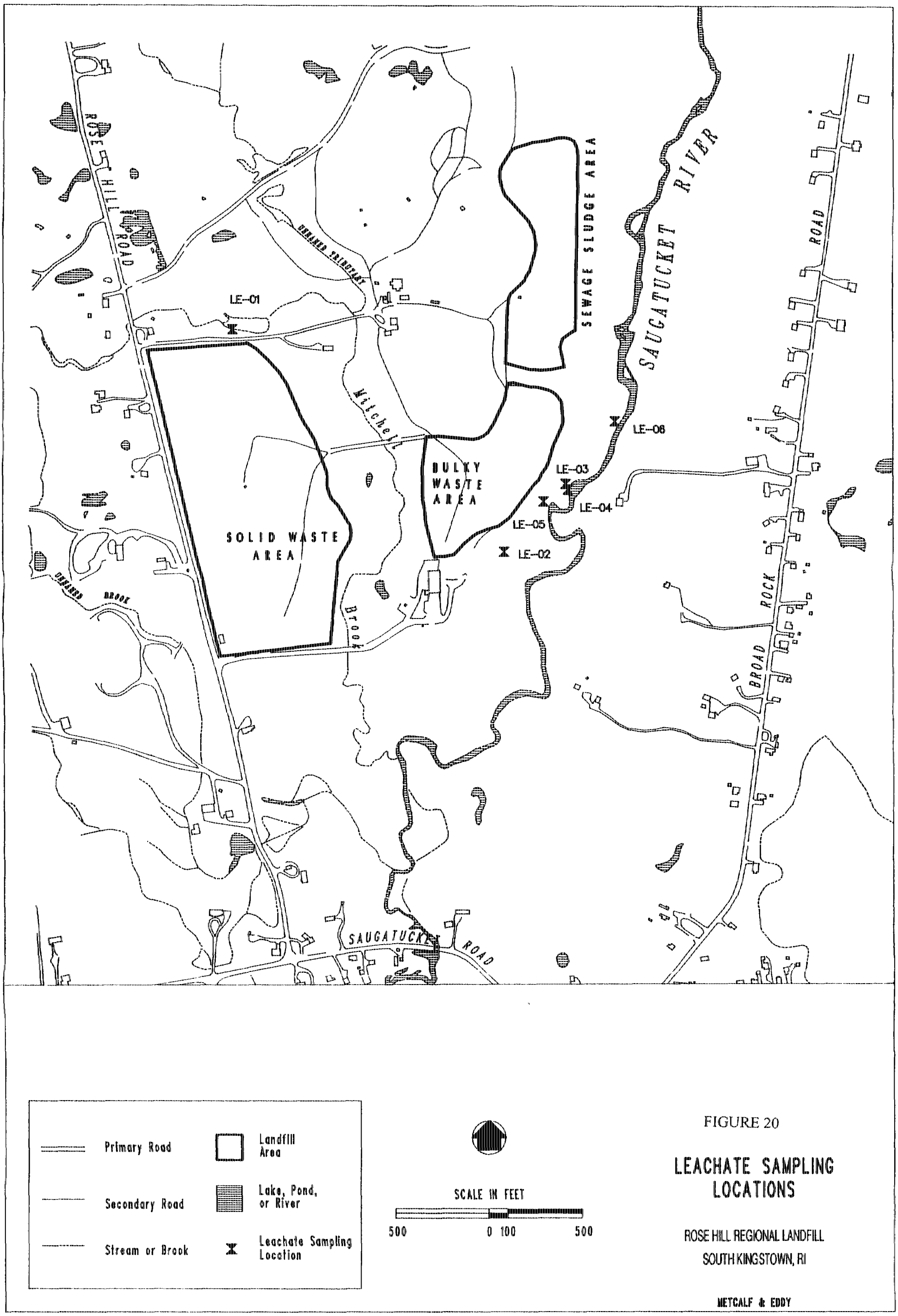
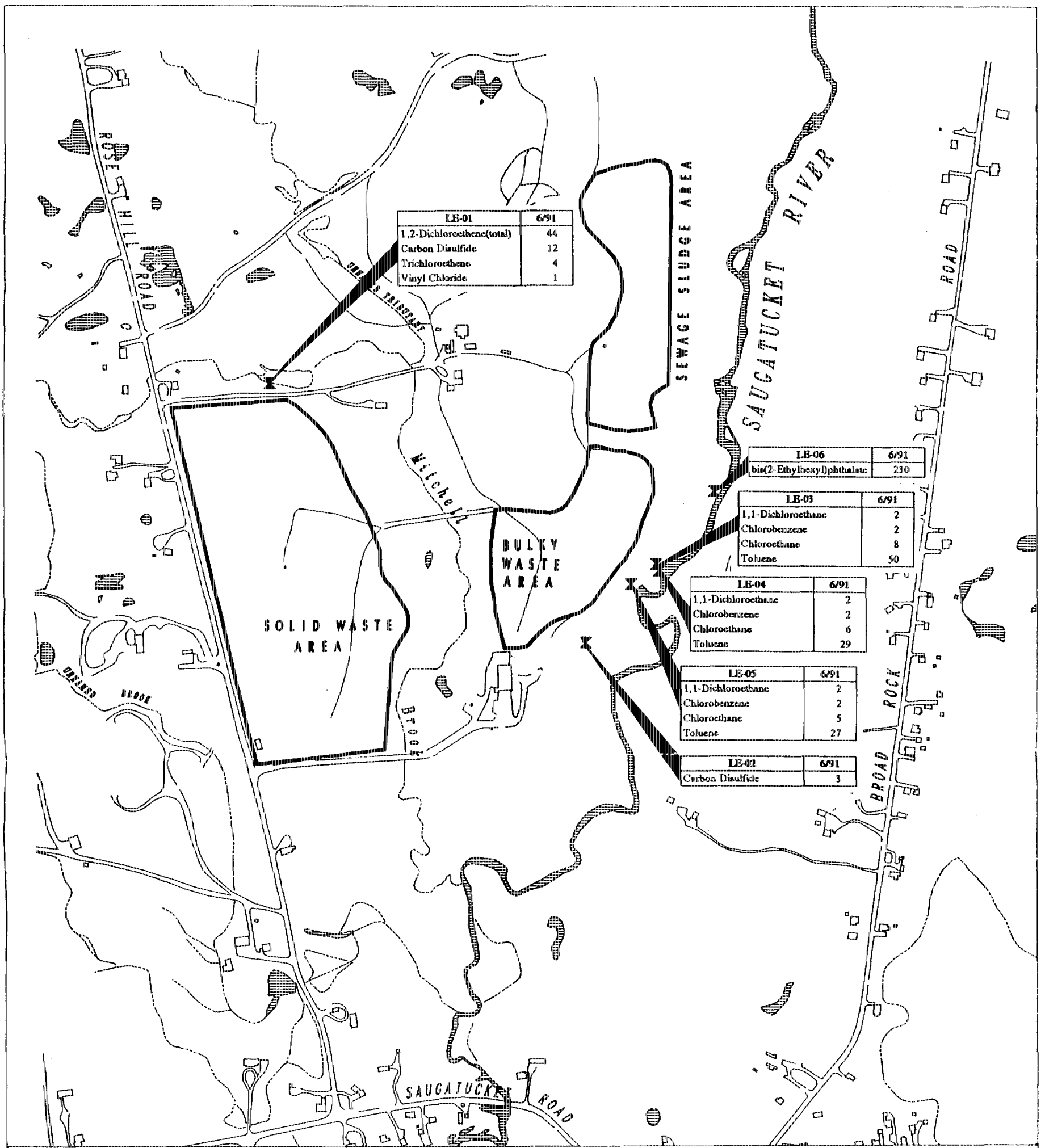


FIGURE 20

LEACHATE SAMPLING LOCATIONS

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY



NOTES:

All concentrations presented in µg/L

— — Not Analyzed

ND - Not Detected

Primary Road

Secondary Road

Stream or Brook

Landfill Area

Lake, Pond, or River

Leachate Sampling Location

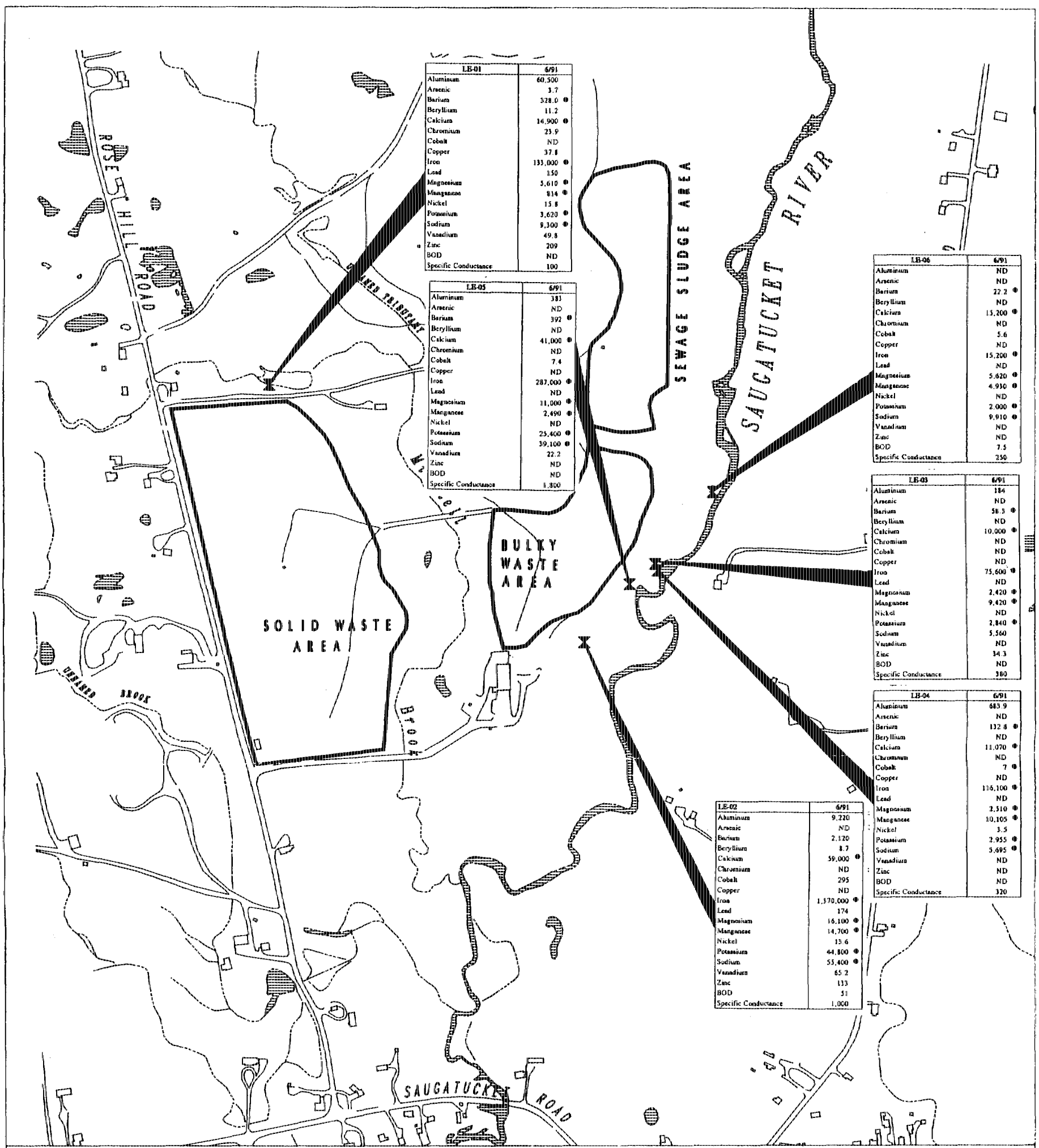
SCALE IN FEET

500 0 100 500

FIGURE 21 ORGANIC COMPOUNDS DETECTED IN LEACHATE

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY



NOTES: Unfiltered metal concentrations and BOD (biochemical oxygen demand) are presented in µg/L. Specific conductance is presented in µmhos/cm

— — Not Analyzed

ND - Not Detected

• Also Detected in Filtered Sample

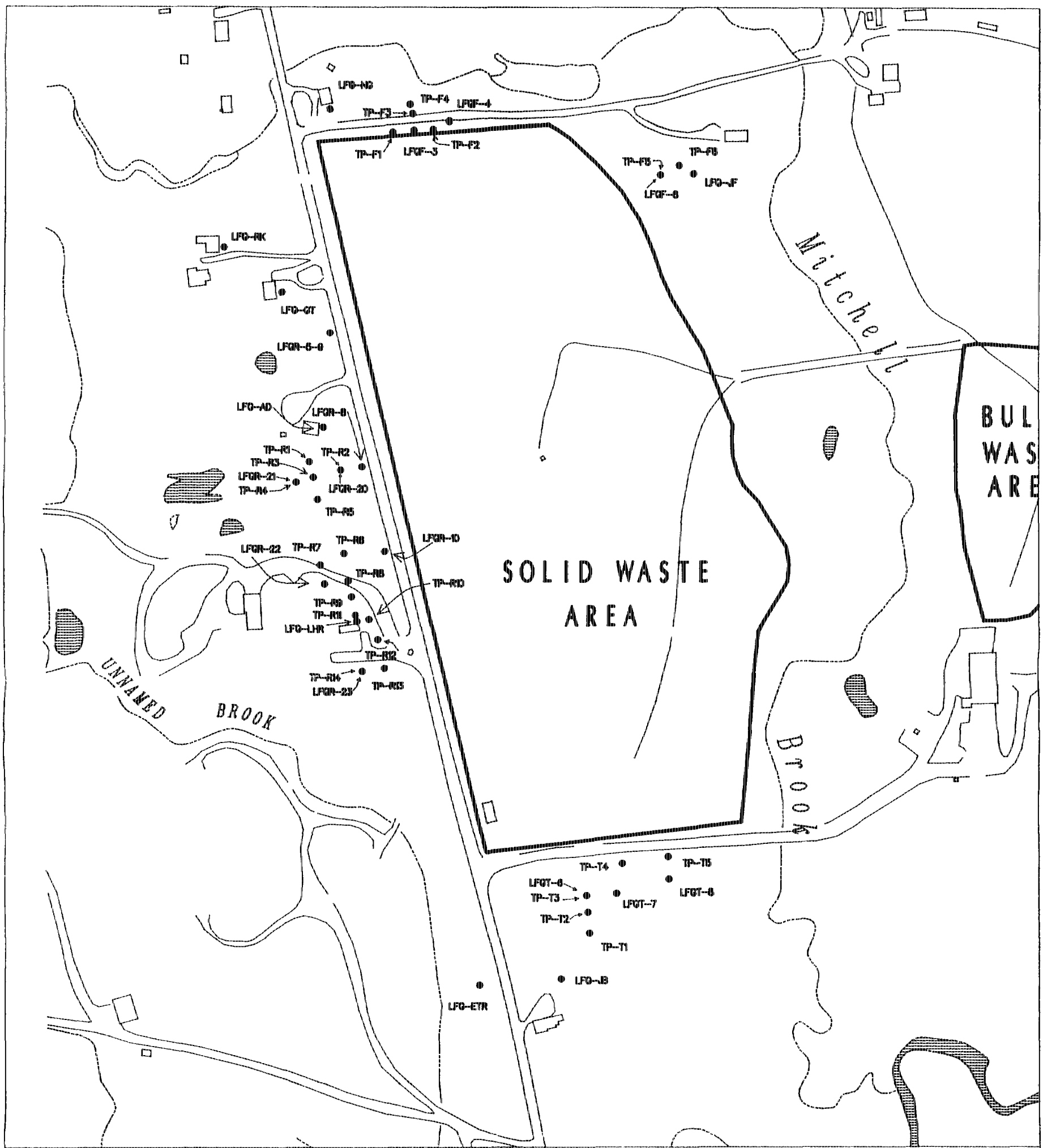
Primary Road
Secondary Road
Stream or Brook
Landfill Area
Lake, Pond, or River
Leachate Sampling Location

SCALE IN FEET
500 0 100 500

FIGURE 22 INORGANICS DETECTED IN LEACHATE

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY



NOTES: LFG - Permanent points.
TP - Temporary points sampled only in December, 1991.
Some points have both an LFG and a TP label. These points were first sampled as temporary points and then installed as permanent sampling locations.

Primary Road
Secondary Road
Stream or Brook
Landfill Area
Lake, Pond, or River
December 1991 Sampling Locations

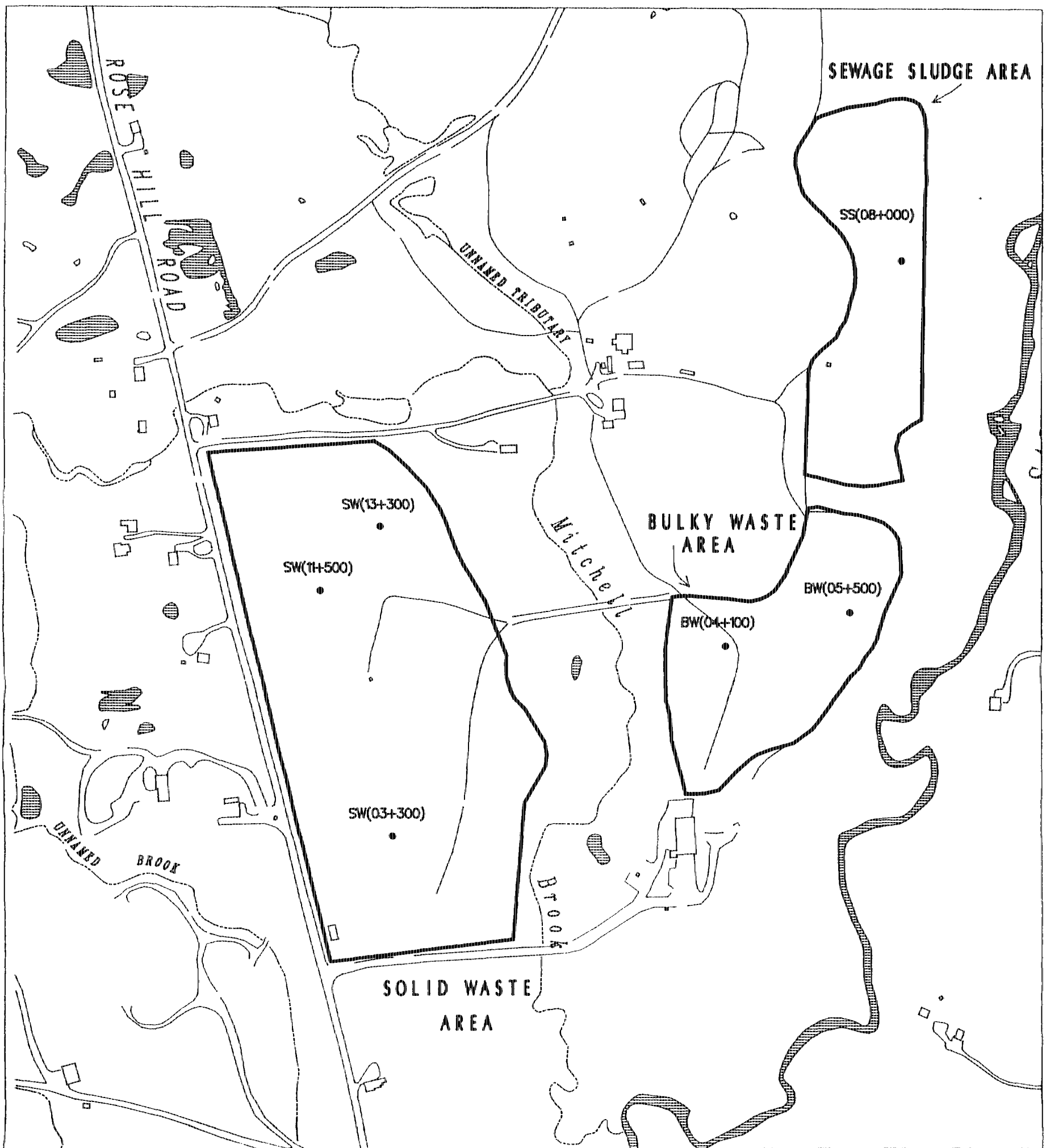
SCALE IN FEET
250 0 100 250

FIGURE 23

LANDFILL GAS LOCATIONS SAMPLED IN DECEMBER, 1991

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY



Primary Road

Secondary Road

Stream or Brook

Landfill Area

Lake, Pond, or River

Locations of TO-14 and Reduced Sulfer Analysis of Landfill Gas

SCALE IN FEET

350 0 100 350

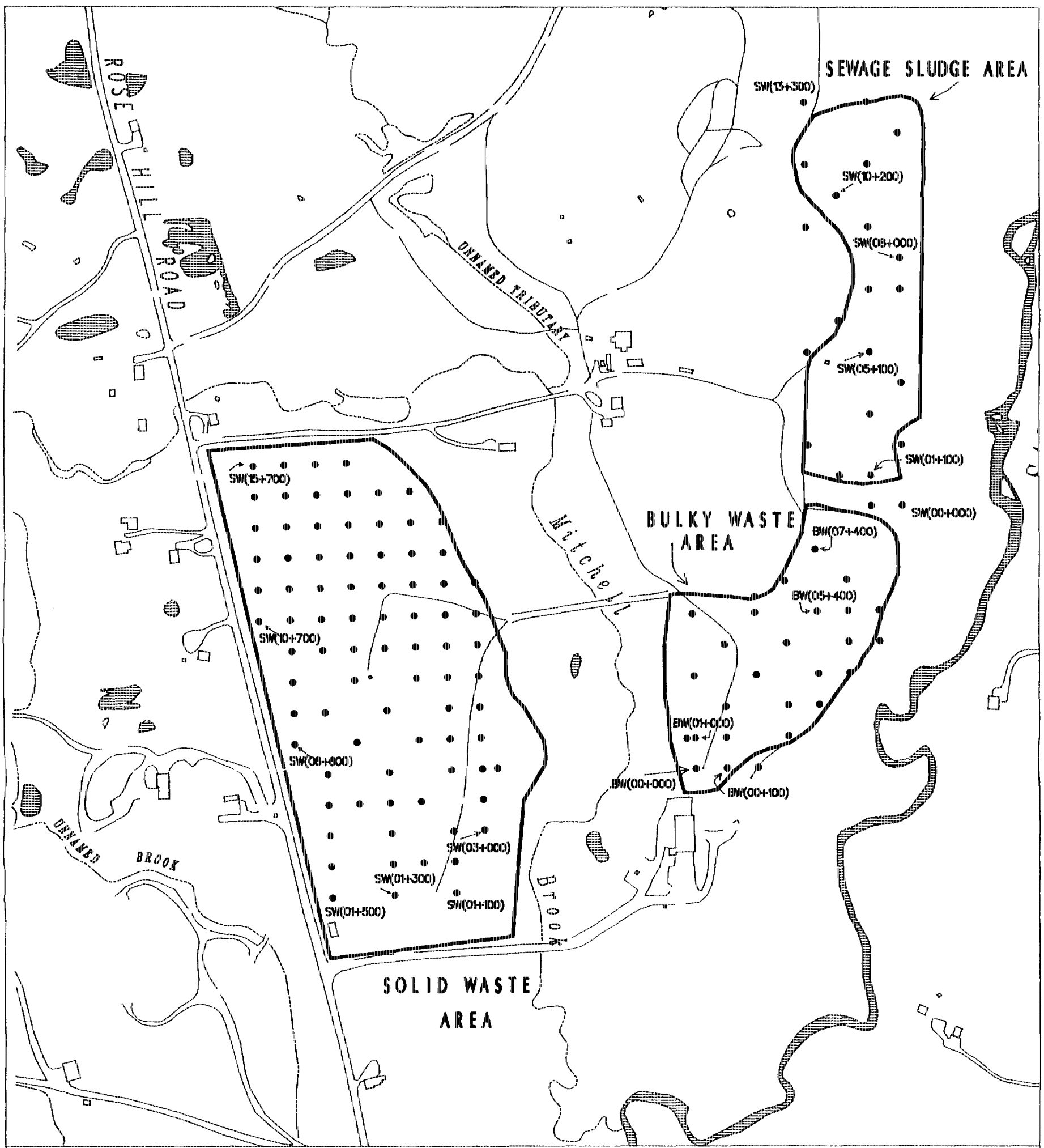
FIGURE 24

TO-14 and Reduced Sulfur Analysis Sampling Locations

ROSE HILL REGIONAL LANDFILL

SOUTH KINGSTOWN, RI

METCALF & EDDY



Note: Not all points are labeled due to limitations in the available space.
Sampling locations were approximately based on a 100-foot-by-100-foot grid.

Primary Road
Secondary Road
Stream or Brook
Landfill Area
Lake, Pond, or River
Landfill Gas Sampling Location

SCALE IN FEET
350 0 100 350

FIGURE 25

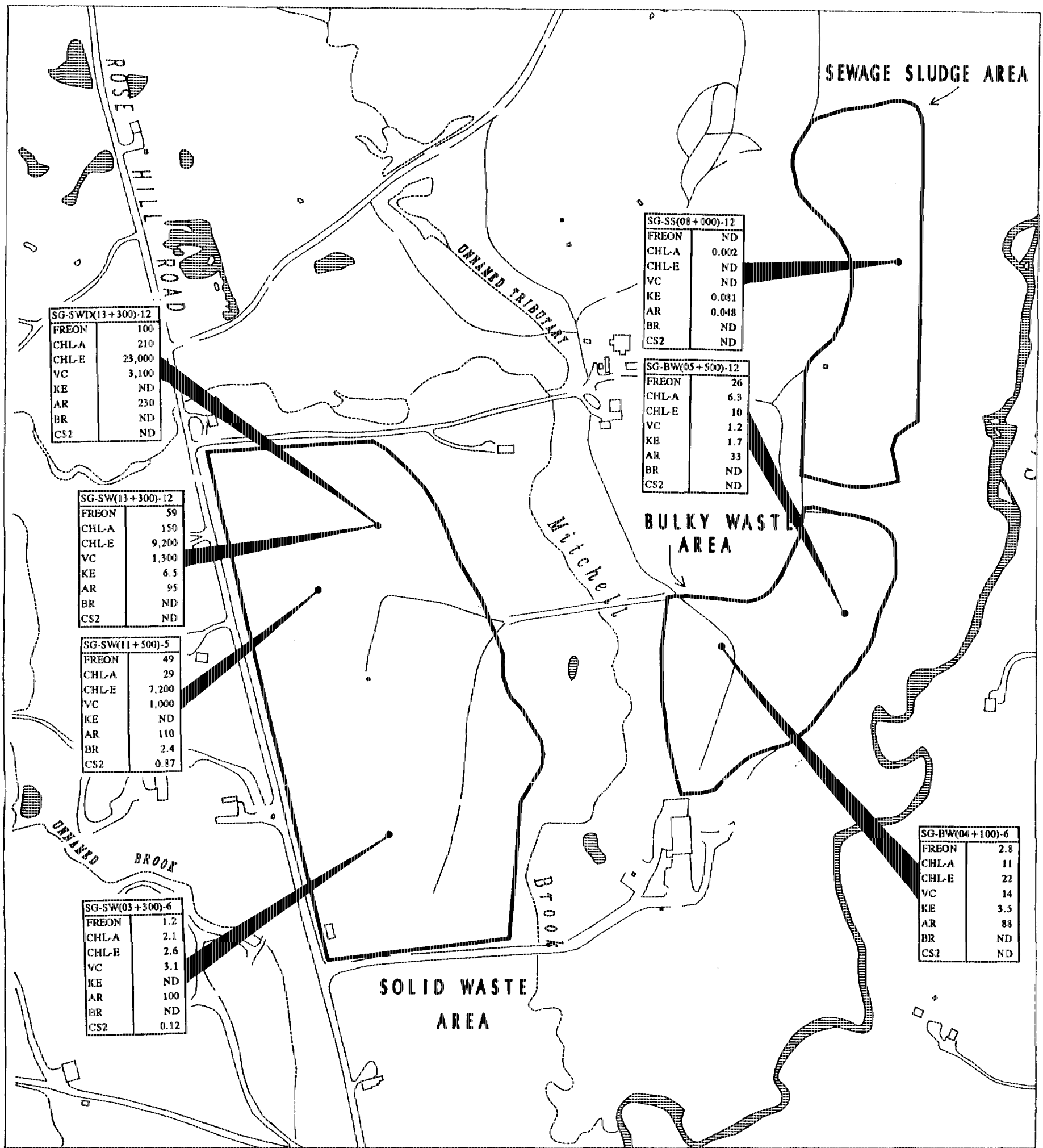
TEMPORARY LANDFILL GAS SAMPLING LOCATIONS SAMPLED IN JUNE, 1991

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY

NOTES: LFG - Permanent points.
TP - Temporary points sampled only in December, 1991.
Some points have both an LFG and a TP label. These points were first sampled as temporary points and then installed as permanent sampling locations.

METCALF & EDDY



NOTES: All results reported in mg/m³

— — Not Analyzed
CHL - A - Chlorinated Alkanes
CHL - E - Chlorinated Alkenes
VC - Vinyl Chloride
KE - Total Ketones
AR - Total Aromatics
BR - Total Brominated Compounds
CS2 - Carbon Disulfide

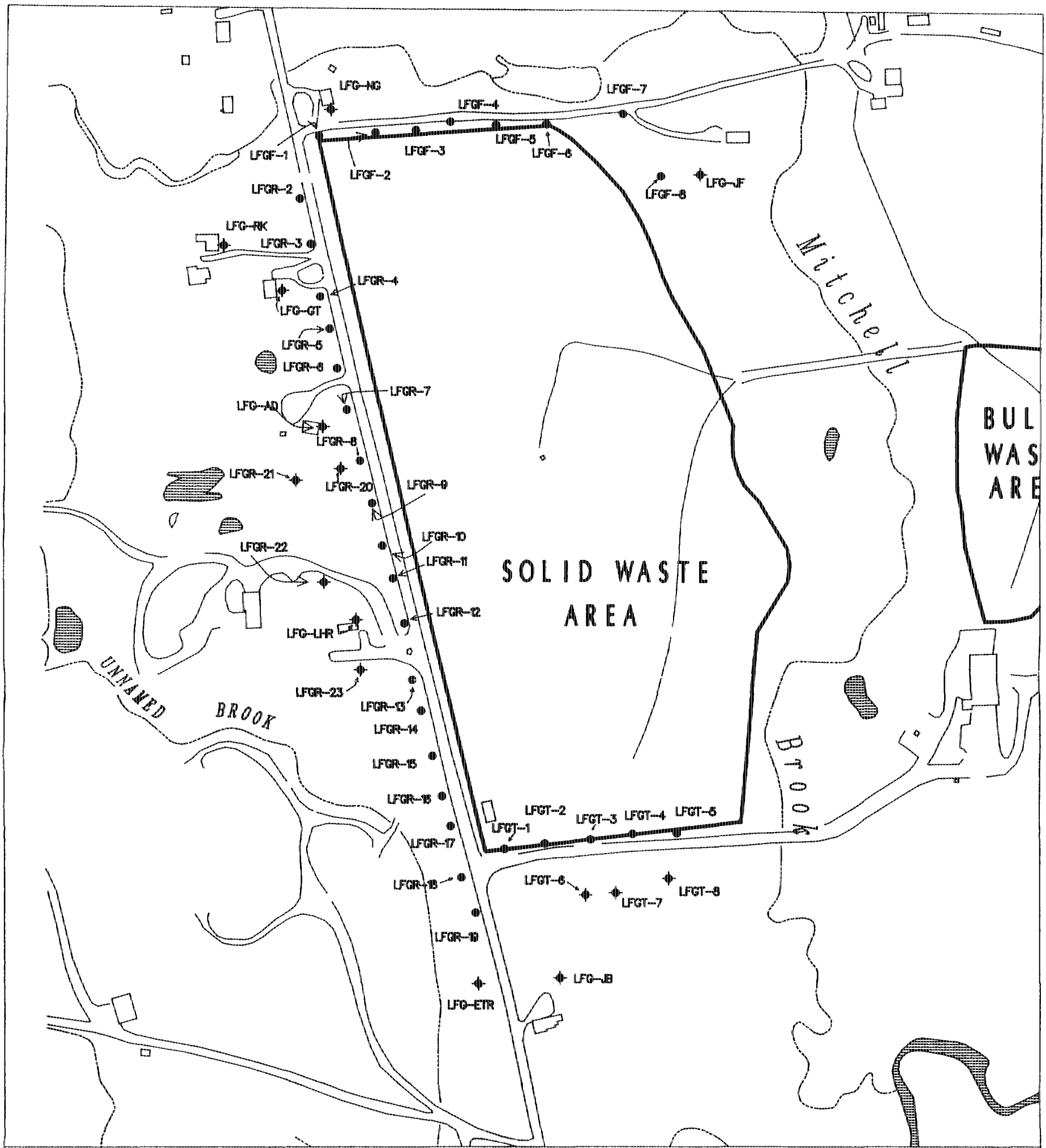
Primary Road
Secondary Road
Stream or Brook
Landfill Area
Lake, Pond, or River
Locations of TO-14 and Reduced Sulfer Analysis of Landfill Gas

SCALE IN FEET
350 0 100 350

FIGURE 26
DISTRIBUTION OF ORGANIC CHEMICALS DETECTED IN LANDFILL GAS USING SUMMA CANISTERS AND TO-14 ANALYSIS

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY



Primary Road

Secondary Road

Stream or Brook

Landfill Area

Lake, Pond, or River

Landfill Gas Sampling Location, installed in June/July 1991.

Landfill Gas Samping Location, installed in December 1991.

SCALE IN FEET

250 0 100 250

FIGURE 27

PERMANENT LANDFILL GAS SAMPLING LOCATIONS

ROSE HILL REGIONAL LANDFILL

SOUTH KINGSTOWN, RI

METCALF & EDDY

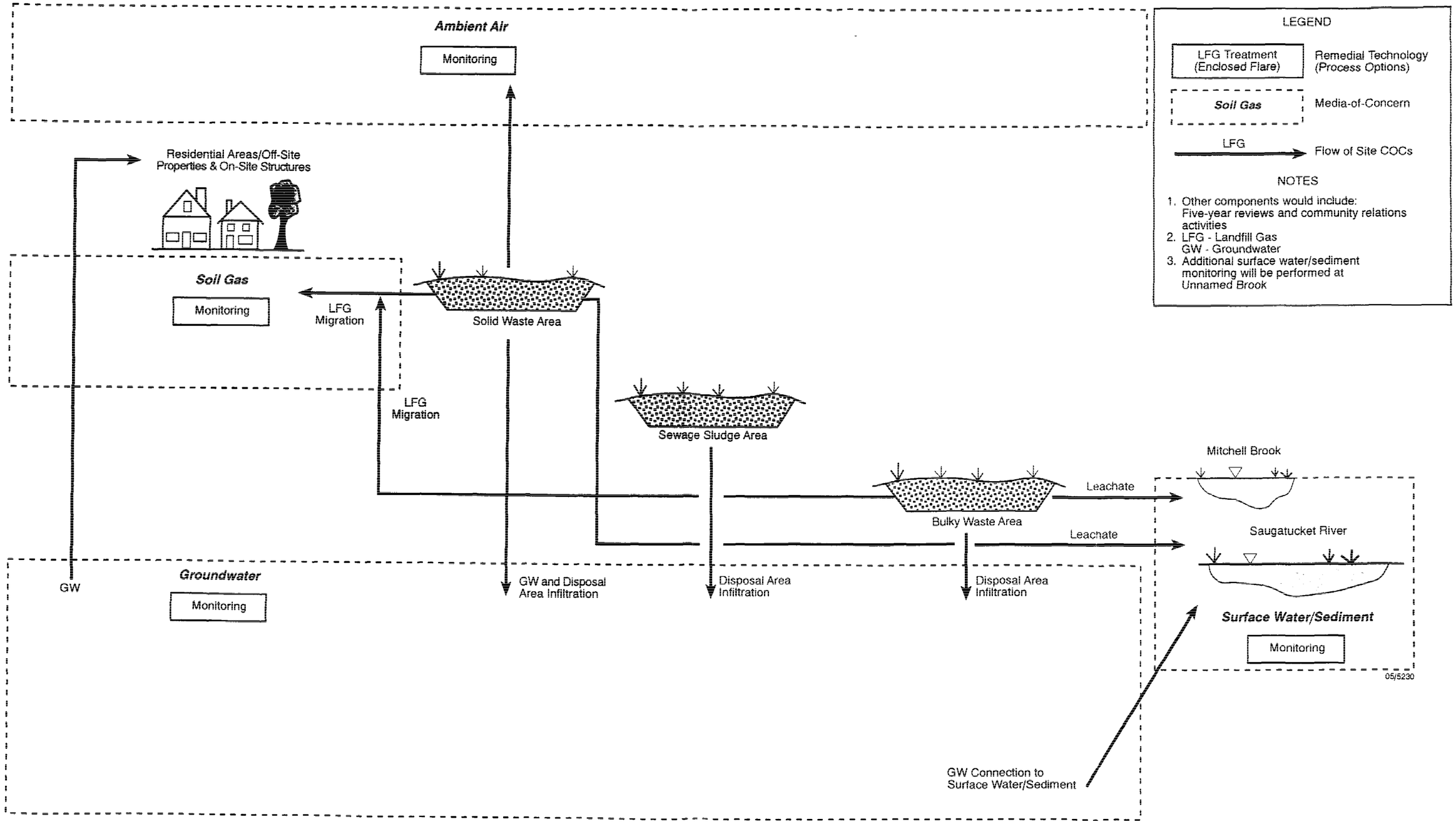


FIGURE 28

SCHEMATIC OF ALTERNATIVE #1 COMPONENTS

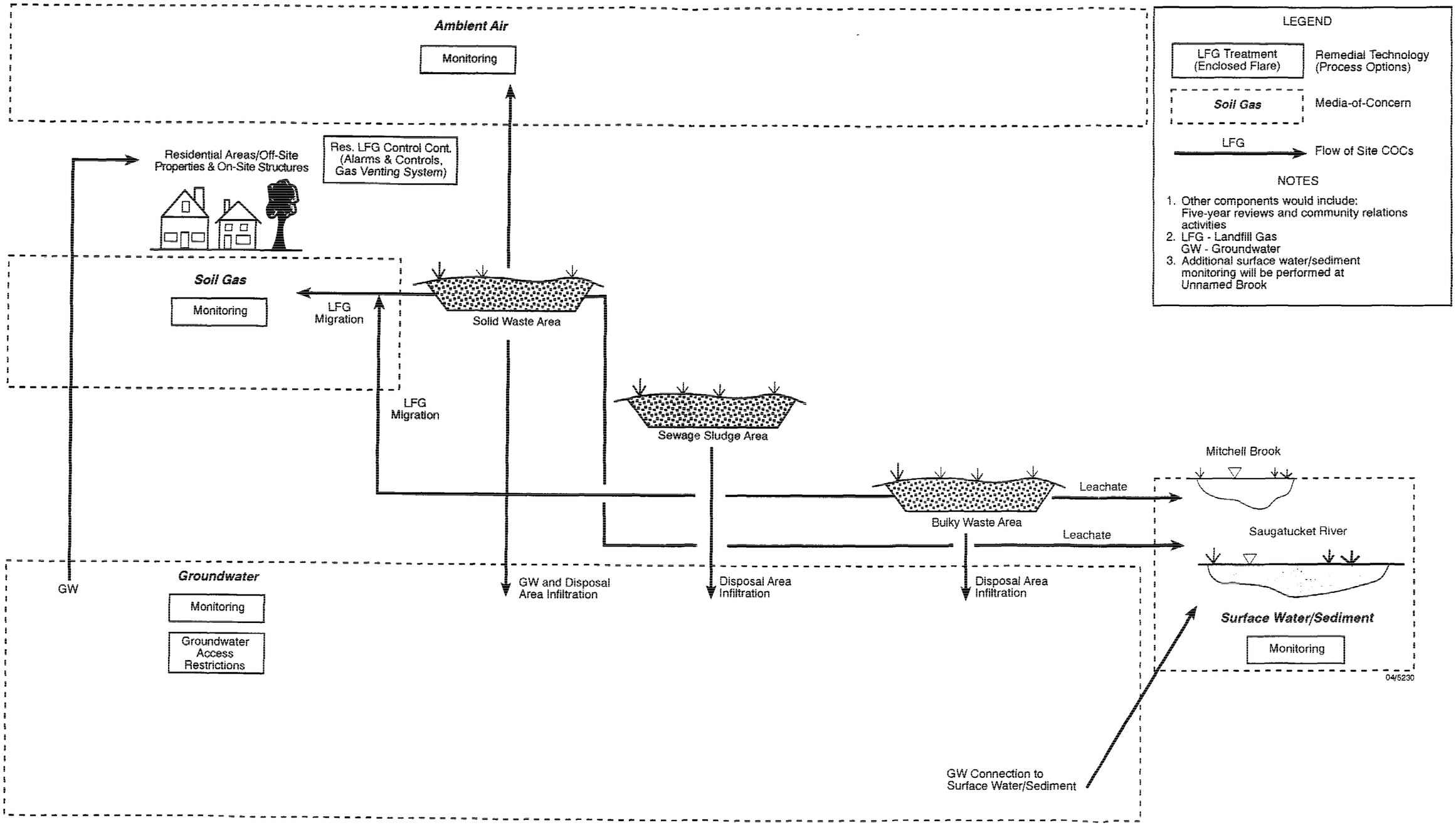


FIGURE 29

SCHEMATIC OF ALTERNATIVE #2 COMPONENTS

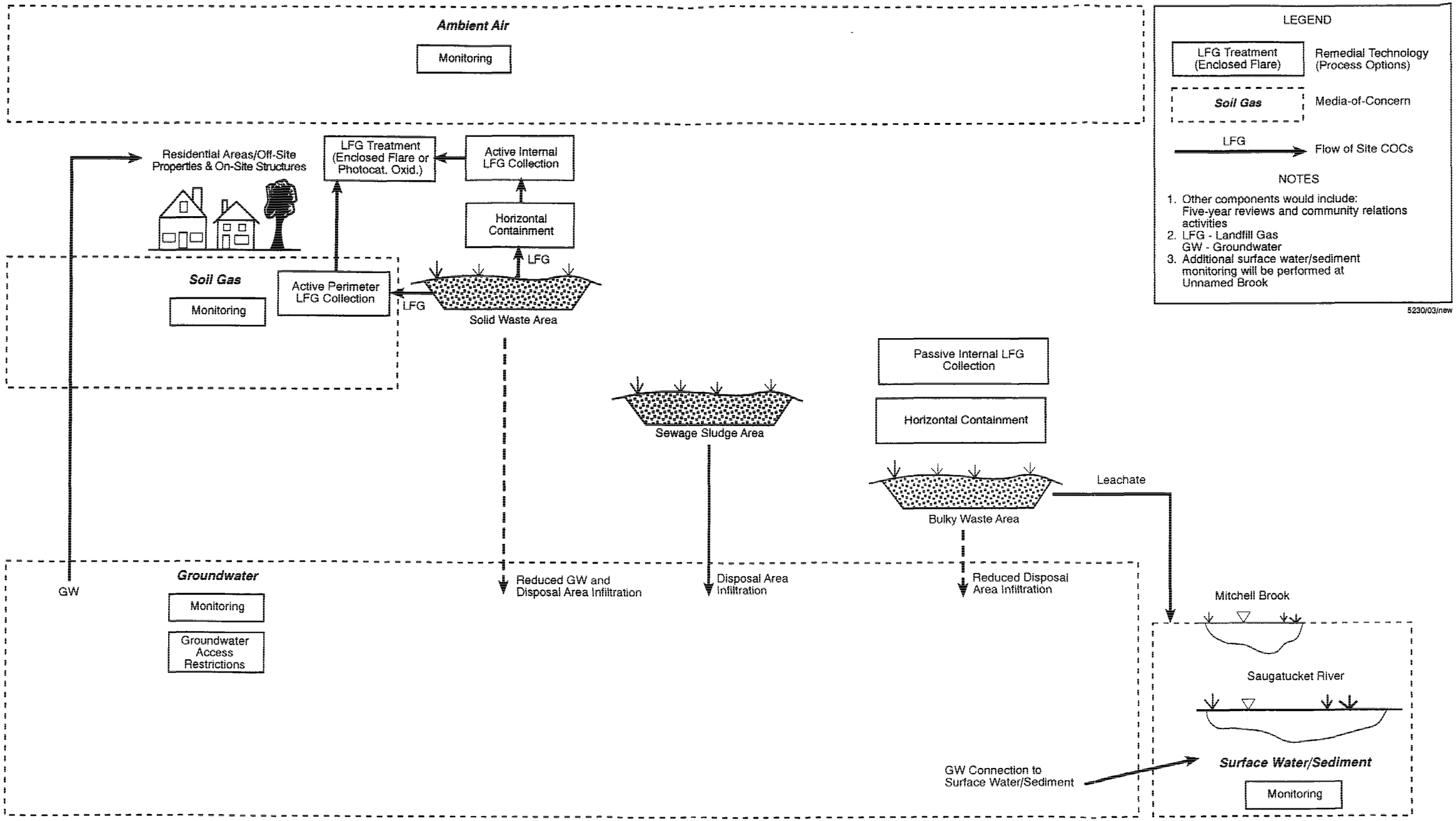


FIGURE 30 + FIGURE 31

SCHEMATIC OF ALTERNATIVES #3a and 3b COMPONENTS

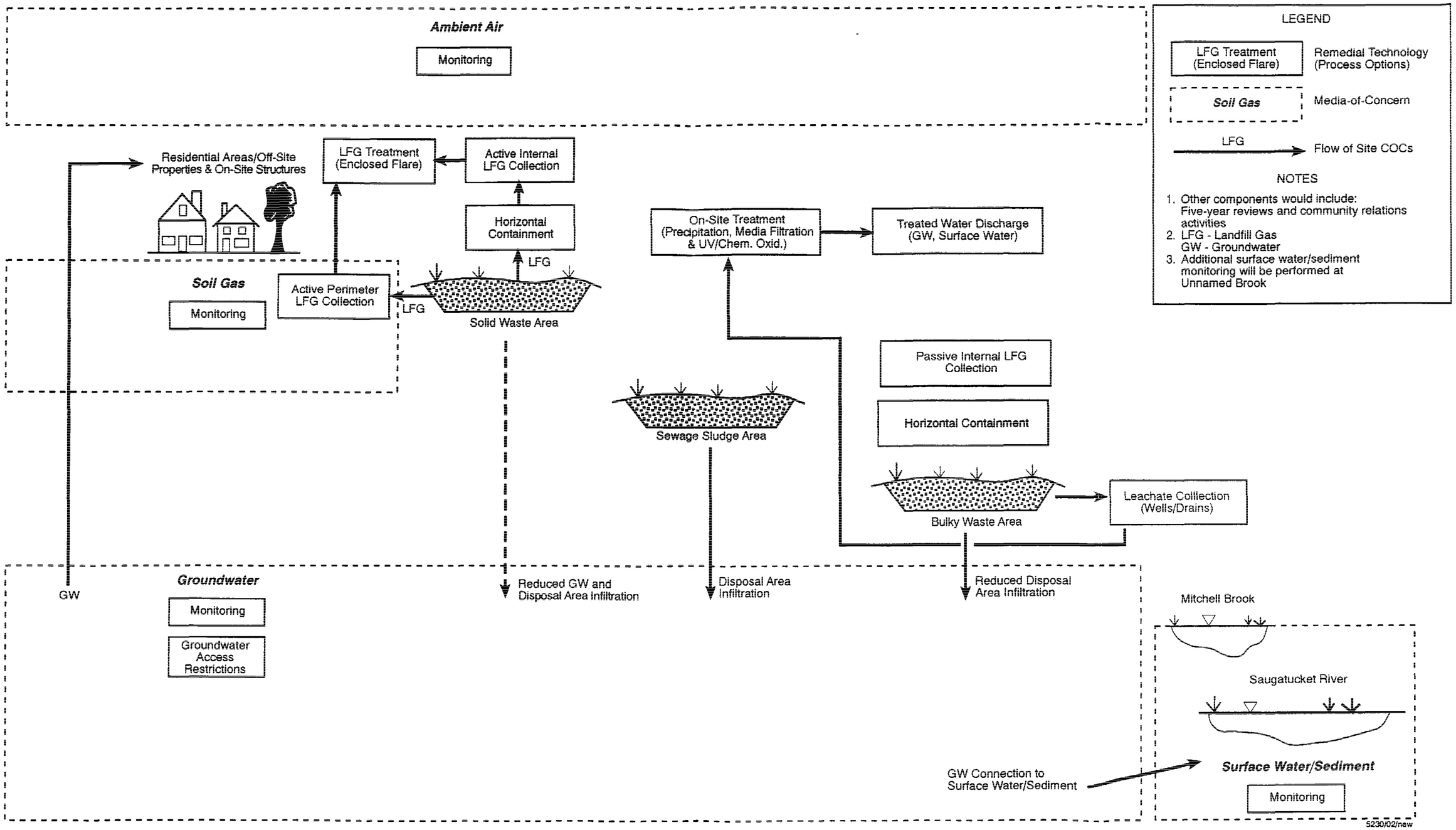


FIGURE 32
SCHEMATIC OF ALTERNATIVE #4a COMPONENTS

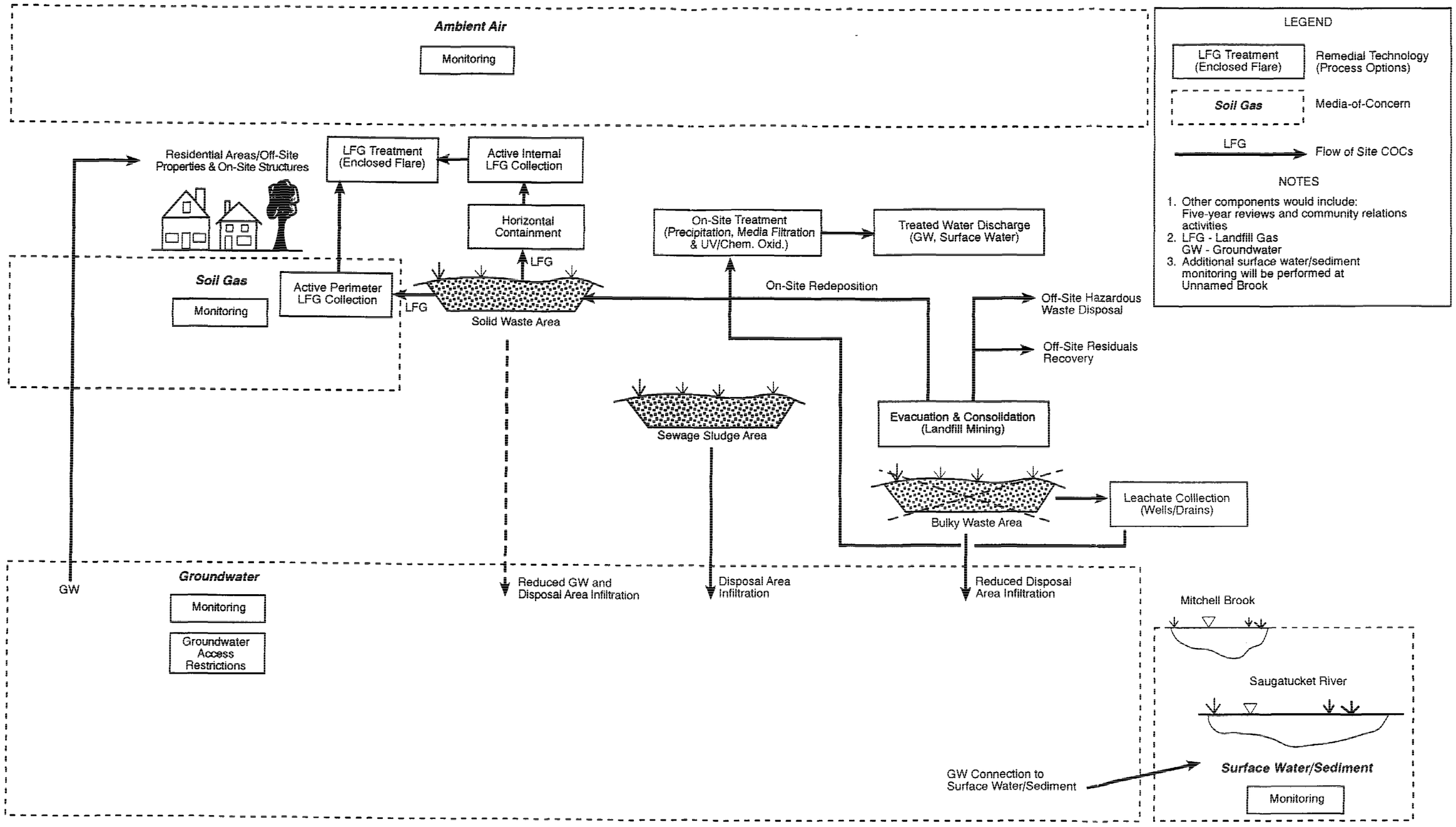


FIGURE 33

SCHEMATIC OF ALTERNATIVE #4b COMPONENTS

APPENDIX B

RECORD OF DECISION
Rose Hill Regional Landfill Superfund Site

LIST OF TABLES

LIST OF TABLES

1 Chronology of Activities at the Rose Hill Regional Landfill
2 Chronology of RI Field Investigation at the Rosehill Regional Landfill Site
3 Location Groupings Used in Nature and Extent, Rose Hill RI
4 Summary of Chemicals Detected in Surface Soil, September/October 1991
5 Summary of Chemicals Detected in Surface Soil, April 1992
6 Summary of Chemicals Detected in Subsurface Soil, August 1991
7 Background Metal Concentrations in Surficial Soils in the Eastern U.S. and Rhode Island
8 Sewage Sludge Concentration Statistics from the 1988 National Survey and the 1980 40 City Survey
9 Summary of Chemicals Detected in Groundwater, June 1991
10 Summary of Chemicals Detected in Groundwater, September/October 1991
11 Summary of Chemicals Detected in Groundwater, January/February 1992
12 Summary of Chemicals Detected in Groundwater, April 1992
13 Summary of Chemicals Detected in Residential Wells, June 1991
14 Summary of Chemicals Detected in Residential Wells, September/October 1991
15 Summary of Chemicals Detected in Residential Wells, January/February 1992
16 Summary of Chemicals Detected in Residential Wells, September 1993
17 Summary of Chemicals Detected in Surface Water, June 1991
18 Summary of Chemicals Detected in Surface Water, September/October 1991
19 Summary of Chemicals Detected in Surface Water, January/February 1992
20 Summary of Chemicals Detected in Surface Water, April 1992
21 Summary of Chemicals Detected in Surface Water, May 1992
22 Summary of Chemicals Detected in Sediment, June 1991
23 Summary of Chemicals Detected in Sediment, September 1991
24 Summary of Chemicals Detected in Sediment, May 1992
25 Summary of Chemicals Detected in Leachate, June 1991
26 Summary of Chemicals Detected in Leachate, April 1992
27 Potential Risk from Ingestion of Site Groundwater within the Solid Waste Area (As Drinking Water) - Average Concentrations used for an Adult Exposure
28 Potential Risk from Ingestion of Site Groundwater within the Solid Waste Area (As Drinking Water) - Maximum Concentrations used for an Adult Exposure
29 Potential Risk from Ingestion of Site Groundwater within the Bulky Waste Area (As Drinking Water) - Average Concentrations used for an Adult Exposure
30 Potential Risk of Ingestion of Site Groundwater within the Bulky Waste Area (As Drinking Water) - Maximum Concentrations used for an Adult Exposure
31 Potential Risk from Ingestion of Site Groundwater within the Sewage Sludge Area (As Drinking Water) - Average Concentrations used for an Adult Exposure
32 Potential Risk from Ingestion of Site Groundwater within the Sewage Sludge Area (As Drinking Water) - Maximum Concentrations used for an Adult Exposure

33 Potential Risk from Ingestion of Groundwater from Residential Wells - Average Concentrations used for an Adult Exposure
34 Potential Risk from Ingestion of Groundwater from Residential Wells - Maximum Concentrations used for an Adult Exposure
35 Potential Risk from Inhalation of Outdoor Air by Adults in the Solid Waste Area - Average Concentrations used based on Soil Gas Contamination Collected by SUMMA Canister
36 Potential Risk from Inhalation of Outdoor Air by Adults in the Solid Waste Area Maximum Concentrations used based on Soil Gas Contamination Collected by SUMMA Canisters
37 Potential Risk from Inhalation of Ambient Air by Nearby Residents - Average Concentrations used for an Adult Exposure
38 Potential Risk from Inhalation of Ambient Air by Nearby Residents - Maximum Concentrations used for an Adult Exposure
39 Potential Risk from Inhalation of Indoor Air by Nearby Residents - Average Concentration of Vinyl Chloride used for an Adult Exposure
40 Potential Risk from Inhalation of Indoor Air by Nearby Residents - Maximum Concentration of Vinyl Chloride used for an Adult Exposure
41 Potential Central Tendency Risks for a Current / Future Site Visitor to the Solid Waste Area, from Inhalation of Ambient Air, Estimated form SUMMA Canister Samples of Landfill Gas and Box Dispersion Model
42 Potential RME Risks for a Current / Future Site Visitor to the Solid Waste Area, from Inhalation of Ambient Air, Estimated form SUMMA Canister Samples of Landfill Gas and Box Dispersion Model
43 Potential Central Tendency Risks for a Current / Future Resident, from Inhalation of Ambient and IndoorAir, Estimated form SUMMA Canister Samples of Residential Area Ambient Air
44 Potential RME Risks for a Current / Future Resident, from Inhalation of Ambient and IndoorAir, Estimated form SUMMA Canister Samples of Residential Area Ambient Air
45 Summary Statistics for Solid Waste Area Landfill Gas
46 Summary Statistics, Ambient Air Measurements near Residences
47 Summary Statistics for Indoor Air from 220 Rose Hill Road
48 Summary Statistics for Groundwater from the Solid Waste Area
49 Summary Statistics for Groundwater from the Bulky Waste Area
50 Summary Statistics for Groundwater from the Sewage Sludge Area
51 Summary Statistics for Groundwater from the Residential Wells
52 Risk Assessment Summary, Reasonable Maximum Exposure
53 Risk Assessment Summary, Reasonable Maximum Exposure
54 Risk Assessment Summary, Reasonable Maximum Exposure
55 Risk Assessment Summary, Reasonable Maximum Exposure
56 Risk Assessment Summary, Reasonable Maximum Exposure
57 Risk Assessment Summary, Reasonable Maximum Exposure
58 Risk Assessment Summary, Reasonable Maximum Exposure
59 Risk Assessment Summary, Reasonable Maximum Exposure
60 Risk Assessment Summary, Reasonable Maximum Exposure

61 Oral Dose-Response Values for Chemicals of Concern
62 Inhalation Dose-Response Values for Ambient Air Chemicals of Concern
63 Rose Hill Regional Landfill Ecological Risk Assessment - Surface Water Contaminant Screening
64 Rose Hill Regional Landfill Ecological Risk Assessment - Leachate Contaminant Screening
65 Rose Hill Regional Landfill Ecological Risk Assessment - Sediment Contaminant Screening
66 Rose Hill Regional Landfill Ecological Risk Assessment - Surface Soil Contaminant Screening
67 Rose Hill Regional Landfill Ecological Risk Assessment - United States Surface Soil Background Levels for Metals (mg/kg)
68 Summary of the Ecological Chemicals of Concern
69 Assessment and Measurement Endpoints for Selected Species Groups
70 Summary of Weight of Surviving Organisms in *Hyallela azteca* 10-Day Sediment Toxicity Tests
71 Survival Rate of *Ceriodaphnia dubia* in 7-Day Static Renewal Sediment Toxicity Tests
72 Survival Rate of *Pimephales promelas* in 96-Hour Chronic Sediment Toxicity Tests
73 Summary of Leachate Toxicity Tests
74 Summary of Survival Rates in Leachate Toxicity Tests
75 Cost Sensitivity Analysis Summary
76 Action-Specific ARARs, Criteria and Guidance: Alternative #4B
77 Human Health Preliminary Remediation Goals for Groundwater
78 Ecological Preliminary Remediation Goals for Surface Water
79 Human Health Preliminary Remediation Goals for Ambient Air
80 Comparison of Costs for Alternatives #4a & #4b (Old & Current) Rose Hill Regional Landfill

TABLE 1 . **CHRONOLOGY OF ACTIVITIES AT THE ROSE HILL REGIONAL LANDFILL**

Year	Activity Affecting Landfill Operations
1967	Solid waste landfill begins operation in an abandoned gravel quarry off Rose Hill Road.
	Court order limits use of landfill by prohibiting disposal of combustibles.
1970	State Division of Solid Waste Management suggests to South Kingstown director of public works that liquid waste from Peacedale Processing be spread over the other waste if the town continued to accept Peacedale waste for disposal.
1971	State Division of Solid Waste Management notifies South Kingstown town manager that liquid waste from Peacedale Processing is improperly being disposed of; again, town is told to spread liquid waste on top of other waste if it continues to accept Peacedale waste.
1973	Town of Narragansett enters into an agreement with South Kingstown to engage in a regional landfill and disposal program concerning Rose Hill and West Kingston landfill facilities.
1975	Town of South Kingstown retains independent professional engineer to conduct groundwater study because the landfill facility has been found to be the source of objectionable groundwater in off-site private well. A new well is installed by town to this residence.
1976	South Kingstown Town Council votes to lease additional property (Lots OL16A and OL16 on Block 93A) for landfill facility from private resident.
1977	Town of South Kingstown retains engineering firm to conduct site analysis and develop operation plans for solid waste activities to comply with state regulations. Engineering report deems site suitable for bulky waste disposal and sludge landfill and recommends monitoring of water quality at four wells close to site.
	State Water Resource Board notifies State Division that site is not adequate as a landfill site; leachate formation and drainage noted as reasons for disapproval.
	Sewage sludge landfill begins operations.
	Town of South Kingstown recommends Rose Hill Regional Landfill as disposal site for refuse, bulky waste, and sewage sludge, if acceptable to state health authorities.
1978	Bulky waste disposal area opens.
	Town of South Kingstown initiates monitoring of seven residential wells in landfill area for water quality parameters.

TABLE 1 **(Continued). CHRONOLOGY OF ACTIVITIES AT THE ROSE HILL REGIONAL LANDFILL**

Year	Activity Affecting Landfill Operations
	Monitoring well installation begins at landfill. By 1982, eleven monitoring wells have been installed.
1979	State orders cities and towns to provide for collection of waste oil.
	RIDEM collects sample from drum at landfill; analysis shows presence of trichloroethylene. The glue waste is also known to contain dimethyl formamide and cellosolve solvent. State bans glue waste from Rose Hill Regional Landfill because industrial waste should not have been dumped at refuse facility.
1980	State Department of Waste Management official is quoted in newspaper, stating that Peacedale Processing glue wastes must be exposed to air and in solid form before disposal.
1981	Peacedale Processing notifies EPA Region I that laminating adhesive containing trichloroethylene was disposed of at the Rose Hill Regional Landfill from 1971 to 1979.
	Results of sampling document high copper and zinc concentrations in sludge; this is consistent with test results of December 1978 and October 1979. Origin of source is not resolved.
1982	Solid waste landfill closes; solid waste is disposed of in bulky waste area until transfer station is completed.
	Highest concentration of volatile organic compounds is reported; 1,2-dichloroethene is substance having highest concentration level.
	Town of South Kingstown redelivers a $\pm$6-acre parcel to private resident and votes to purchase 15.03-acre parcel from same resident.
1983	Town of South Kingstown declares zone change to accommodate transfer station.
	Court order prohibits disposal of combustibles at Rose Hill Regional Landfill.
	EPA conducts identification and preliminary assessment; potential hazards to human health through contaminated well and contaminated water supply, groundwater, and soil are identified.
	Sampling in Saugatucket River below confluence with Mitchell Brook shows presence of substance susceptible to biological and chemical oxidation, qualitatively indicating contamination.
	Bulky waste disposal area and sewage sludge landfill close.

TABLE 1 **(Continued). CHRONOLOGY OF ACTIVITIES AT THE ROSE HILL REGIONAL LANDFILL**

Year	Activity Affecting Landfill Operations
1984	Landfill rental payments from town of South Kingstown to Frisella cease as of June 30, 1984.
	Consultant site inspection shows volatile organic compounds at detectable levels in groundwater on site, in bedrock and overburden residential wells, and in soils in bulky waste disposal area. Sampling of surface water shows no contamination from volatile organic compounds.
	Later sampling is conducted by the town for iron, phosphate, total Kjeldahl nitrogen, and chemical oxygen demand (COD); COD shows levels indicative of contamination.
1985	Town of South Kingstown extends municipal water supply line to residents on Rose Hill Road.
	Sampling analysis indicates that volatile organic compounds continue to be released to underlying groundwater on site. Compounds are not detected in Saugatucket River, Mitchell Brook, or downgradient at groundwater and surface water locations.
	Consultant recommends that monitoring of water and soil continue even though low contamination releases do not appear to adversely affect water quality.
1986	Neither heavy metals nor volatile organic compounds are detected in RIDEM monitoring wells; high conductivity appears in some groundwater monitoring wells but not in others.
1987	Volatile organic compounds are detected in breathing zone at bulky waste and solid waste disposal areas; concentrations detected higher than background levels. Low resistivity survey indicates likely contamination of overburden.
	Rose Hill Regional Landfill is ranked for inclusion on the NPL (score 38.11).
	Consulting team observes leachate pools in solid waste landfill area.
	Consultants learn that portion of landfill area has been rezoned; action may allow development of property.
	Rose Hill Regional Landfill is proposed on NPL update #7 on 6/24/88.
1989	Rose Hill Regional Landfill is placed on NPL 10/4/89.

TABLE 2 CHRONOLOGY OF THE RI FIELD INVESTIGATION AT THE ROSE HILL REGIONAL LANDFILL SITE, SOUTH KINGSTOWN, RI

DATE			ACTIVITY
4/12/91	-	4/15/91	Residential Well Field Survey
5/27/91	-	6/19/91	Mobilization Activities
	5/15/91		Clearing of Geophysical Lines
5/21/91	-	6/13/91	Geophysical Survey
5/20/91	-	5/31/91	Existing Well Survey/Development
5/28/91	-	5/31/91	Wetland Delineation
5/30/91	-	5/31/91	Wildlife Survey
6/5/91	-	6/18/91	Staff Gauge and Mini-Piezometer Installation
6/3/91	-	6/7/91	Field and Benthic Survey
	6/14/91		Residential Well Development
6/17/91	-	7/12/91	Soil Gas Survey - Landfill Temporary Points and Installation of Permanent Points
6/18/91	-	6/28/91	Round 1 - Environmental Sampling
	7/9/91		Site Surveying Began
7/21/91	-	9/9/91	Monitoring Well Installation
8/15/91	-	9/9/91	New Well Development
8/20/91	-	8/26/91	Landfill Analytical Soil Boring drilling and sampling
	8/27/91		Permeability Test Boring drilling
9/3/91	-	9/5/91	Settlement Platform Installation
	9/18/91		Settlement Platforms surveyed
9/23/91	-	10/9/91	Round 2 - Environmental Sampling
9/23/91	-	9/25/91	Soil Gas Survey - Analysis of Temporary and Permanent Points
9/30/91	-	10/2/91	Seepage Meter and Mini-Piezometer Readings
10/28/91	-	11/1/91	Slug Testing
11/4/91	-	11/6/91	Additional Geophysical Survey Activities
11/21/91	-	5/11/92	Long Term Monitoring
12/16/91	-	12/20/91	Soil Gas Survey - Installation of Residential Points and Temporary Point Analysis

TABLE 2 (Continued). CHRONOLOGY OF THE RI FIELD INVESTIGATION AT THE ROSE HILL REGIONAL LANDFILL SITE, SOUTH KINGSTOWN, RI

DATE			ACTIVITY
1/22/92	-	1/23/92	Soil Gas Survey - Residential and Permanent Point Analysis
1/27/92	-	2/5/92	Round 3 - Environmental Sampling
2/19/92	-	2/20/92	Soil Gas Survey - Residential and Permanent Point Analysis
3/20/92	-	3/24/92	Soil Gas Survey - Residential and Permanent Point Analysis
4/6/92	-	4/15/92	Round 4 - Environmental Sampling
	4/15/92		Settlement Platforms surveyed
4/21/92	-	4/24/92	Soil Gas Survey - Residential and Permanent Point Analysis
5/7/92	-	5/13/92	Soil Gas Survey - SUMMA Cannisters and Reduced Sulfur Analysis
5/20/92	-	5/23/92	Artifical Substrate Removal and Benthic Sampling
5/26/92	-	6/1/92	Round 5 - Environmental Sampling
9/21/93	-	9/23/93	Round 6 - Environmental Sampling

TABLE 3 LOCATION GROUPINGS USED IN NATURE AND EXTENT, ROSE HILL REGIONAL LANDFILL SITE

SURFACE SOIL

Background	Sewage Sludge Area	Bulky Waste Area	Solid Waste Area	Non-Disposal Area
SS-01	SS-11	SS-09	SS-03	SS-06 (south of transfer station road
SS-02	SS-12	SS-10	SS-04	SS-07 (residential)
SS-14	SS-15	SS-24	SS-05	SS-08 (residential)
			SS-13	SS-18 (adjacent to Mitchell Brook)
			SS-16	SS-19 (near Mitchell Brook)
			SS-17	SS-20 (near Mitchell Brook)
				SS-21 (near Mitchell Brook)
				SS-22 (near Saugatucket River)
				SS-23 (near Saugatucket River)

SUBSURFACE SOIL

Background	Sewage Sludge Area	Bulky Waste Area	Solid Waste Area
BH-05	BH-01	BH-06	BH-O7 [MW-14-01]
	BH-02		
	BH-03		
	BH-04		

GROUNDWATER - MONITORING WELLS

Background	Shallow Overburden	Deep Overburden	Bedrock
MW-01-01	MW-I	OW-25	MW-03-03
(shallow overburden)	MW-II	OW-27	MW-04-03
MW-01-02	MW-III	OW-30	MW-07-02
(bedrock)	MW-IV	MW-02-02	MW-08-02
	MW-V	MW-03-02	MW-11-03
	MW-02-01	MW-04-02	
	MW-03-01	MW-05-02	
	MW-04-01	MW-06-02	
	MW-05-01	MW-07-01	
	MW-06-01	MW-08-01	
	MW-11-01	MW-09-01	
	MW-12-01	MW-10-01	
	MW-13-01	MW-11-02	
		MW-12-02	
		MW-13-02	
		MW-14-01	

TABLE 3 (Continued). LOCATION GROUPINGS USED IN NATURE AND EXTENT, ROSE HILL REGIONAL LANDFILL SITE

RESIDENTIAL WELLS			
RES #1 - RES #10			
LEACHATE			
	Saugatucket River	Mitchell Brook	
	LE-02	LE-01	
	LE-03		
	LE-04		
	LE-05		
	LE-06		
SURFACE WATER			
Saugatucket River	Mitchell Brook	unnamed brook	unnamed tributary
SW-02	SW-07	SW-10	SW-01
SW-03	SW-09		
SW-04	SW-12		
SW-05	SW-13		
SW-06	SW-14		
SW-08	SW-15		
SW-11	SW-16		
SW-17			
SW-18			
SEDIMENT			
Saugatucket River	Mitchell Brook	unnamed brook	unnamed tributary
SD-02	SD-07	SD-10	SD-01
SD-03	SD-09		
SD-04	SD-12		
SD-05	SD-13		
SD-06	SD-14		
SD-08	SD-15		
SD-11	SD-16		
SD-17			
SD-18			

TABLE 4 SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL, SEPTEMBER/OCTOBER 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS MINIMUM	RANGE OF DETECTION LIMITS MAXIMUM	BACKGROUND RANGE OF CONCENTRATIONS (3) MINIMUM	BACKGROUND RANGE OF CONCENTRATIONS (3) MAXIMUM	SEWAGE SLUDGE FREQUENCY OF DETECTION (2)	SEWAGE SLUDGE ARITHMETIC AVERAGE	SEWAGE SLUDGE RANGE OF CONCENTRATIONS (3) MINIMUM	SEWAGE SLUDGE RANGE OF CONCENTRATIONS (3) MAXIMUM	SEWAGE SLUDGE MAXIMUM LOCATION	BULKY WASTE FREQUENCY OF DETECTION (2)	BULKY WASTE ARITHMETIC AVERAGE	BULKY WASTE RANGE OF CONCENTRATIONS (3) MINIMUM	BULKY WASTE RANGE OF CONCENTRATIONS (3) MAXIMUM	BULKY WASTE MAXIMUM LOCATION	SOLID WASTE FREQUENCY OF DETECTION (2)	SOLID WASTE ARITHMETIC AVERAGE	SOLID WASTE RANGE OF CONCENTRATIONS (3) MINIMUM	SOLID WASTE RANGE OF CONCENTRATIONS (3) MAXIMUM	SOLID WASTE MAXIMUM LOCATION	NON-DISPOSAL AREA FREQUENCY OF DETECTION (2)	NON-DISPOSAL AREA ARITHMETIC AVERAGE	NON-DISPOSAL AREA RANGE OF CONCENTRATIONS (3) MINIMUM	NON-DISPOSAL AREA RANGE OF CONCENTRATIONS (3) MAXIMUM	NON-DISPOSAL AREA MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	AREA OF OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/kg)																										
Benzene	11	17	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	2 / 4	6.0	6 J	6 J	SS-13	0 / 3	—	—	—	—	SS-03	Solid Waste
Toluene	11	17	—	—	0 / 2	—	—	—	—	1 / 2	4.5 *	3 J		SS-09	3 / 4	65	58	110 J	SS-13	0 / 3	—	—	—	—	SS-13	Solid Waste
Ethylbenzene	11	17	—	—	0 / 2	—	—	—	—	1 / 2	4.0 *	2 J		SS-09	3 / 4	14	11 J	21 J	SS-13	0 / 3	—	—	—	—	SS-13	Solid Waste
Total Xylenes	11	17	—	—	0 / 2	—	—	—	—	1 / 2	8.0	10 J		SS-09	3 / 4	39	20	84 J	SS-13	0 / 3	—	—	—	—	SS-13	Solid Waste
Acetone	11	17	7 J		2 / 2	18	14	23	SS-11	2 / 2	12,000	37 J	23,700 J	SS-09	2 / 4	45,000	75	160,000 J	SS-04	3 / 3	21	15 J	32 J	SS-06	SS-04	Solid Waste
2-Butanone	11	17	—	—	1 / 2	5.0 *	4 J		SS-12	1 / 2	360	717 J		SS-09	3 / 4	230	24 J	830 J	SS-04	1 / 3	9.0	15 J		SS-07	SS-04	Solid Waste
4-Methyl-2-pentanone	11	17	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	1 / 4	5.9 *	3 J		SS-04	0 / 3	—	—	—	—	SS-04	Solid Waste
2-Hexanone	11	17	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	1 / 4	6.6 *	6 J		SS-04	0 / 3	—	—	—	—	SS-04	Solid Waste
Tetrachloroethene	11	17	—	—	1 / 2	3.8 *	2 J		SS-11	2 / 2	8.0	3 J	13 J	SS-09	3 / 4	4.1	2 J	5 J	SS-04	1 / 3	5.5 *	4 J		SS-08	SS-09	Bulky Waste
Trichloroethene	11	17	—	—	0 / 2	—	—	—	—	1 / 2	4.0 *	2 J		SS-09	0 / 4	—	—	—	—	0 / 3	—	—	—	—	SS-09	Bulky Waste
1,1,1-Trichloroethane	11	17	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	1 / 4	7.1	8 J		SS-03	0 / 3	—	—	—	—	SS-03	Solid Waste
1,1-Dichloroethene	11	17	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	1 / 4	5.6 *	4 J		SS-13	0 / 3	—	—	—	—	SS-13	Solid Waste
1,2-Dichloroethene(total)	11	17	—	—	0 / 2	—	—	—	—	1 / 2	7.0	8 J		SS-09	2 / 4	850	970 J	2,400 J	SS-13	1 / 3	14	31 J		SS-07	SS-13	Solid Waste
1,1-Dichloroethane	11	17	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	1 / 4	11	25		SS-03	1 / 3	4.7 *	2 J		SS-07	SS-03	Solid Waste
Chloroform	11	17	—	—	0 / 2	—	—	—	—	1 / 2	4.0 *	2 J		SS-09	2 / 4	5.0 *	2 J	3 J	SS-03	1 / 3	5.2 *	2 J		SS-06	SS-03	Solid Waste
Vinyl Chloride	11	17	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	2 / 4	66	4 J	250	SS-13	0 / 3	—	—	—	—	SS-13	Solid Waste
SEMIVOLATILE ORGANICS (µg/kg)																										
Phenanthrene	350	550	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	2 / 4	160 *	55 J	110 J	SS-05	1 / 3	150 *	65 J		SS-07	SS-05	Solid Waste
Fluoranthene	350	550	25 J		0 / 2	—	—	—	—	0 / 2	—	—	—	—	3 / 4	120	33 J	160 J	SS-05	1 / 3	150 *	73 J		SS-07	SS-05	Solid Waste
Pyrene	350	550	29 J		1 / 2	100 *	26 J		SS-11	0 / 2	—	—	—	—	3 / 4	120	38 J	170 J	SS-05	2 / 3	100	23 J	115 J	SS-07	SS-05	Solid Waste
Benzo(a)anthracene	350	550	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	2 / 4	150 *	37 J	78 J	SS-05	1 / 3	140 *	46 J		SS-07	SS-05	Solid Waste
Chrysene	350	550	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	2 / 4	150 *	33 J	95 J	SS-05	1 / 3	140 *	53 J		SS-07	SS-05	Solid Waste
Benzo(b)fluoranthene	350	550	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	2 / 4	150 *	39 J	76 J	SS-05	1 / 3	140 *	55 J		SS-07	SS-05	Solid Waste
Benzo(k)fluoranthene	350	550	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	2 / 4	140 *	28 J	64 J	SS-05	1 / 3	140 *	47 J		SS-07	SS-05	Solid Waste
Benzo(a)pyrene	350	550	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	2 / 4	150 *	31 J	68 J	SS-05	1 / 3	140 *	36 J		SS-07	SS-05	Solid Waste
Benzo(g,h,i)perylene	350	550	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	2 / 4	140 *	23 J	57 J	SS-05	1 / 3	140 *	32 J		SS-07	SS-05	Solid Waste
Indeno(1,2,3-cd)pyrene	350	550	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	2 / 4	140 *	23 J	52 J	SS-05	1 / 3	140 *	34 J		SS-07	SS-05	Solid Waste
4-Chloroaniline	350	550	—	—	1 / 2	340	490		SS-11	0 / 2	—	—	—	—	0 / 4	—	—	—	—	0 / 3	—	—	—	—	SS-11	Sewage Sludge
Diethylphthalate	350	550	31 J		1 / 2	114 *	29 J		SS-12	0 / 2	—	—	—	—	1 / 4	160 *	29 J		SS-13	0 / 3	—	—	—	—	SS-13	Solid Waste (4)
Butylbenzylphthalate	350	550	41 J		0 / 2	—	—	—	—	1 / 2	160 *	120 J		SS-10	1 / 4	180 *	41 J		SS-03	0 / 3	—	—	—	—	SS-10	Bulky Waste
PESTICIDES (µg/kg)																										
4,4'-DDE	3.5	20	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	1 / 4	3.4	7.6		SS-13	1 / 3	4.2	8.8		SS-07	SS-07	Non-Disposal
4,4'-DDD	3.5	20	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	1 / 4	2.8	5.2 J		SS-13	0 / 3	—	—	—	—	SS-13	Solid Waste
4,4'-DDT	3.4	20	1.2 J		0 / 2	—	—	—	—	0 / 2	—	—	—	—	1 / 4	2.8	4.7 J		SS-04	1 / 3	3.0	5.2 J		SS-07	SS-07	Non-Disposal
Aldrin	1.8	10	0.6 J		0 / 2	—	—	—	—	0 / 2	—	—	—	—	0 / 4	—	—	—	—	0 / 3	—	—	—	—	SS-01	Background
Dieldrin	3.5	20	—	—	1 / 2	3.2	4.5 J		SS-11	0 / 2	—	—	—	—	0 / 4	—	—	—	—	0 / 3	—	—	—	—	SS-11	Sewage Sludge
alpha-Chlordane	1.8	10	—	—	1 / 2	2.3	3.7 J		SS-11	0 / 2	—	—	—	—	0 / 4	—	—	—	—	0 / 3	—	—	—	—	SS-11	Sewage Sludge
PCBs																										
None Detected																										
METALS (mg/kg)																										
Aluminum	2.7	3.8	12,200	16,600	2 / 2	4,900	3,450	6,360	SS-11	2 / 2	8,800	8,630	8,940	SS-09	4 / 4	9,400	7,650	11,000	SS-03	3 / 3	8,700	1,740	13,000	SS-07	SS-07	Non-Disposal (4)
Iron	1.2	1.7	12,300	18,100	2 / 2	8,800	7,190	10,400	SS-11	2 / 2	11,000	10,600	11,650	SS-09	4 / 4	11,000	9,970	12,100	SS-03	3 / 3	11,000	4,090	14,700	SS-07	SS-07	Non-Disposal (4)
Calcium	4.1	5.8	645	712	2 / 2	470	263	680	SS-11	2 / 2	640	588	685	SS-10	4 / 4	670	534	781	SS-05	3 / 3	620	196	952	SS-08	SS-08	Non-Disposal
Magnesium	5.3	7.6	1,110	1,220	2 / 2	940	773	1,100	SS-11	2 / 2	1,100	946	1,270	SS-10	4 / 4	1,700	1,310	1,990	SS-13	3 / 3	1,000	381	1,710	SS-08	SS-13	Solid Waste
Potassium	90.1	128.9	673	909	2 / 2	750	653	847	SS-11	2 / 2	670	566	766	SS-10	3 / 4	680	612	944	SS-13	3 / 3	560	308	717	SS-08	SS-13	Solid Waste
Antimony	5.1	7.3	—	—	1 / 2	41	78.8 J		SS-11	0 / 2	—	—	—	—	0 / 4	—	—	—	—	0 / 3	—	—	—	—	SS-11	Sewage Sludge
Arsenic	0.2	0.3	2.1 J	2.8	2 / 2	0.69	0.52 J	0.86 J	SS-11	2 / 2	1.2	1.05	1.3 J	SS-10	4 / 4	1.3	0.81	1.6 J	SS-13	2 / 3	2.2	3.1 J	3.4 J	SS-07	SS-07	Non-Disposal
Barium	0.2	0.3	15.4	37.8	2 / 2	34	8.5	58.9	SS-11	2 / 2	16	16.4	16.5	SS-10	4 / 4	18	17.0	20.3	SS-13	3 / 3	13	5.2	16.9	SS-08	SS-11	Sewage Sludge
Cadmium	0.6	0.9	—	—	0 / 2	—	—	—	—	0 / 2	—	—	—	—	0 / 4	—	—	—	—	1 / 3	0.44	0.62 J		SS-07	SS-07	Non-Disposal
Chromium	1.6	2.3	11.2	17.5	2 / 2	7.6	5.3 J	9.8	SS-11	2 / 2	8.7	7.7	9.8	SS-10	4 / 4	11	9.7	12.8	SS-13	3 / 3	10	3.2	13.9	SS-07	SS-07	Non-Disposal (4)
Cobalt	1.2	1.7	3.0	3.6	2 / 2	3.3	3.0	3.6	SS-11	2 / 2	4.0	3.3	4.8	SS-10	4 / 4	4.6	4.0	5.7	SS-13	2 / 3	3.6	3.8	6.2	SS-08	SS-08	Non-Disposal
Copper	0.8	1.2	3.5	5.3	1 / 2	51	99.3		SS-11	0 / 2	—	—	—	—	4 / 4	69	5.4	253	SS-03	1 / 3	9.4 *	6.3		SS-07	SS-03	Solid Waste
Lead	0.2	0.3	14.3 J	30.1	2 / 2	7.2	2.6 J	11.8 J	SS-11	2 / 2	5.6	5.6 J	5.6 J	SS-10	4 / 4	9.3	7.3 J	11.5 J	SS-13	3 / 3	14	3.1	27.4 J	SS-07	SS-07	Non-Disposal (4)
Manganese	0.4	0.6	104	267	2 / 2	120	96.4	135	SS-12	2 / 2	130	108	154	SS-09	4 / 4	110	92.1	131	SS-04	3 / 3	120	86.6	167	SS-08	SS-08	Non-Disposal (4)
Mercury	0.1	0.13	—	—	1 / 2	0.16	0.28		SS-11	0 / 2	—	—	—	—	0 / 4	—	—	—	—	0 / 3	—	—	—	—	SS-11	Sewage Sludge
Nickel	3.3	4.7	4.1	5.5	2 / 2	4.6	3.9	5.4	SS-11	2 / 2	5.0	3.3 J	6.6	SS-10	4 / 4	8.0	5.2	10.3	SS-03	1 / 3	4.8	10.6		SS-08	SS-08	Non-Disposal
Silver	0.6	0.9	—	—	1 / 2	0.95	1.6		SS-11	0 / 2	—	—	—	—	2 / 4	0.58	0.73	0.87	SS-13	0 / 3	—	—	—	—	SS-11	Sewage Sludge
Thallium	0.2	0.3	—	—	1 / 2	0.18	0.25 J		SS-12	0 / 2	—	—	—	—	1 / 4	0.18	0.3		SS-03	0 / 3	—	—	—	—	SS-03	Solid Waste
Vanadium	0.6	0.9	21.0	25.7	1 / 2	7.7	12.0		SS-11	2 / 2	14	13.2	15.0	SS-10	4 / 4	18	13.7	22.9	SS-13	3 / 3	17	3.2	27.2	SS-07	SS-07	Non-Disposal
Zinc	1.2	1.7	22.3	30.1	2 / 2	38	19.9	56.5	SS-11	2 / 2	29	22.7	36.0	SS-09	4 / 4	36	24.4	40.5	SS-03	3 / 3	30	20.8	37.4	SS-08	SS-11	Sewage Sludge

TABLE 4 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL, SEPTEMBER/OCTOBER 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS MINIMUM	RANGE OF DETECTION LIMITS MAXIMUM	BACKGROUND RANGE OF CONCENTRATIONS (3) MINIMUM	BACKGROUND RANGE OF CONCENTRATIONS (3) MAXIMUM	SEWAGE SLUDGE FREQUENCY OF DETECTION (2)	SEWAGE SLUDGE ARITHMETIC AVERAGE	SEWAGE SLUDGE RANGE OF CONCENTRATIONS (3) MINIMUM	SEWAGE SLUDGE RANGE OF CONCENTRATIONS (3) MAXIMUM	SEWAGE SLUDGE MAXIMUM LOCATION	BULKY WASTE FREQUENCY OF DETECTION (2)	BULKY WASTE ARITHMETIC AVERAGE	BULKY WASTE RANGE OF CONCENTRATIONS (3) MINIMUM	BULKY WASTE RANGE OF CONCENTRATIONS (3) MAXIMUM	BULKY WASTE MAXIMUM LOCATION	SOLID WASTE FREQUENCY OF DETECTION (2)	SOLID WASTE ARITHMETIC AVERAGE	SOLID WASTE RANGE OF CONCENTRATIONS (3) MINIMUM	SOLID WASTE RANGE OF CONCENTRATIONS (3) MAXIMUM	SOLID WASTE MAXIMUM LOCATION	NON-DISPOSAL AREA FREQUENCY OF DETECTION (2)	NON-DISPOSAL AREA ARITHMETIC AVERAGE	NON-DISPOSAL AREA RANGE OF CONCENTRATIONS (3) MINIMUM	NON-DISPOSAL AREA RANGE OF CONCENTRATIONS (3) MAXIMUM	NON-DISPOSAL AREA MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	AREA OF OVERALL MAX. LOC.
SOIL QUALITY PARAMETERS																										
Cyanide - Not Detected																										
TOTAL COMBUSTIBLE ORGANICS (%)																										
Organic Content	NA		6.8	7.5	2 / 2	1.8	0.9	2.8	SS-11	2 / 2	2.4	1.9	2.9	SS-10	4 / 4	5.2	2.3	9.4	SS-13	3 / 3	6.5	3.2	12.6	SS-07	SS-07	Non-Disposal
Solids Content	NA		71.7	78.5	2 / 2	88	84.2	91.2	SS-12	2 / 2	86	84.6	88.0	SS-09	4 / 4	77	63.8	85.3	SS-05	3 / 3	77	71.4	80.9	SS-06	SS-12	Sewage Sludge
Moisture Content	NA		21.5	28.3	2 / 2	12	8.8	15.7	SS-11	2 / 2	14	12.0	15.4	SS-10	4 / 4	23	14.7	36.1	SS-13	3 / 3	23	19.1	28.6	SS-07	SS-13	Solid Waste

NOTES:

1. Analytical data is presented in Appendix D.
2. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits.
   Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
3. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included.
   A single concentration is presented when only one positive detection occurred.
4. The actual highest concentration for this chemical was detected in a background sample.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

— Analyte was not detected in samples.

TABLE 5 SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL, APRIL 1992 (1)

CHEMICAL	RANGE OF DETECTION LIMITS MINIMUM	RANGE OF DETECTION LIMITS MAXIMUM	BACKGROUND CONCEN-TRATIONS	SEWAGE SLUDGE FREQUENCY OF DETECTION (2)	SEWAGE SLUDGE CONCEN-TRATIONS	SEWAGE SLUDGE LOCATION	BULKY WASTE FREQUENCY OF DETECTION (2)	BULKY WASTE CONCEN-TRATIONS	BULKY WASTE LOCATION	SOLID WASTE FREQUENCY OF DETECTION (2)	SOLID WASTE ARITHMETIC AVERAGE	SOLID WASTE RANGE OF CONCENTRATIONS (3) MINIMUM	SOLID WASTE RANGE OF CONCENTRATIONS (3) MAXIMUM	SOLID WASTE MAXIMUM LOCATION	NON-DISPOSAL AREA FREQUENCY OF DETECTION (2)	NON-DISPOSAL AREA ARITHMETIC AVERAGE	NON-DISPOSAL AREA RANGE OF CONCENTRATIONS (3) MINIMUM	NON-DISPOSAL AREA RANGE OF CONCENTRATIONS (3) MAXIMUM	NON-DISPOSAL AREA MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	AREA OF OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/kg)																					
Toluene	11	32	—	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	2 / 6	6.6	2 J	9 J	SS-23	SS-23	Non-Disposal
Ethylbenzene	11	32	—	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	1 / 6	8.9	9 J		SS-22	SS-22	Non-Disposal
Total Xylenes	11	32	—	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	1 / 6	9.3	11.5 J		SS-22	SS-22	Non-Disposal
Acetone	11	32	480	0 / 1	—	—	0 / 1	—	—	1 / 2	2,000	4,000		SS-16	1 / 6	34	98.5 J		SS-22	SS-16	Solid Waste
2-Butanone	11	32	—	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	1 / 6	11	19.5 J		SS-22	SS-22	Non-Disposal
SEMIVOLATILE ORGANICS (µg/kg)																					
Naphthalene	350	1,100	—	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	1 / 6	250 *	34.5 J		SS-22	SS-22	Non-Disposal
Phenanthrene	350	1,100	—	0 / 1	—	—	0 / 1	—	—	1 / 2	110 *	31 J		SS-17	1 / 6	200 *	59 J		SS-23	SS-23	Non-Disposal
Fluoranthene	350	1,100	—	0 / 1	—	—	0 / 1	—	—	1 / 2	120 *	60 J		SS-17	1 / 6	200 *	64 J		SS-23	SS-23	Non-Disposal
Pyrene	350	1,100	—	0 / 1	—	—	0 / 1	—	—	1 / 2	110 *	40 J		SS-17	1 / 6	210 *	120 J		SS-23	SS-23	Non-Disposal
Benzo(a)anthracene	350	1,100	—	0 / 1	—	—	0 / 1	—	—	1 / 2	100 *	22 J		SS-17	0 / 6	—	—	—	—	SS-17	Solid Waste
Chrysene	350	1,100	—	0 / 1	—	—	0 / 1	—	—	1 / 2	100 *	21 J		SS-17	1 / 6	200 *	55 J		SS-23	SS-23	Non-Disposal
Benzo(b)fluoranthene	350	1,100	—	0 / 1	—	—	0 / 1	—	—	1 / 2	110 *	26 J		SS-17	1 / 6	200 *	57 J		SS-23	SS-23	Non-Disposal
Benzo(k)fluoranthene	350	1,100	—	0 / 1	—	—	0 / 1	—	—	1 / 2	100 *	24 J		SS-17	0 / 6	—	—	—	—	SS-17	Solid Waste
Benzo(a)pyrene	350	1,100	—	0 / 1	—	—	0 / 1	—	—	1 / 2	100 *	23 J		SS-17	0 / 6	—	—	—	—	SS-17	Solid Waste
Benzo(g,h,i)perylene	350	1,100	—	0 / 1	—	—	0 / 1	—	—	1 / 2	100 *	19 J		SS-17	0 / 6	—	—	—	—	SS-17	Solid Waste
Diethylphthalate	350	1,100	—	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	2 / 6	220 *	27 J	45.5 J	SS-22	SS-22	Non-Disposal
PESTICIDES (µg/kg)																					
4,4'-DDE	3.5	11	0.99 J	0 / 1	—	—	0 / 1	—	—	1 / 2	1.1 *	0.33 J		SS-17	3 / 6	3.3	0.38 J	11 J	SS-23	SS-23	Non-Disposal
4,4'-DDD	3.5	11	—	0 / 1	—	—	0 / 1	—	—	1 / 2	1.0 *	0.24 J		SS-16	0 / 6	—	—	—	—	SS-16	Solid Waste
4,4'-DDT	3.5	11	1.0 J	0 / 1	—	—	0 / 1	—	—	1 / 2	1.4 *	0.90 J		SS-17	3 / 6	2.1	0.38 J	3.4 J	SS-23	SS-23	Non-Disposal
Endrin Ketone	3.5	11	0.46 J	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	1 / 6	2.8 *	2.3 J		SS-18	SS-18	Non-Disposal
PCBs																					
None Detected																					
METALS (mg/kg)																					
Aluminum	4.50	13.90	10,700	1 / 1	6,740	SS-15	1 / 1	6,500	SS-24	2 / 2	5,100	4,590	5,650	SS-16	6 / 6	6,400	2,520	14,400	SS-18	SS-18	Non-Disposal
Iron	4.70	14.50	12,700	1 / 1	9,240	SS-15	1 / 1	9,240	SS-24	2 / 2	9,400	6,840	12,000	SS-16	6 / 6	40,000	6,020	149,000	SS-23	SS-23	Non-Disposal
Calcium	7.00	21.40	213	1 / 1	470	SS-15	1 / 1	442	SS-24	2 / 2	390	309	476	SS-17	6 / 6	600	146	1,870	SS-23	SS-23	Non-Disposal
Magnesium	4.50	13.90	1,360	1 / 1	1,300	SS-15	1 / 1	1,150	SS-24	2 / 2	1,000	1,030	1,060	SS-16	6 / 6	490	185	732	SS-18	SS-15	Sewage Sludge (4)
Potassium	16.90	51.70	443	1 / 1	518	SS-15	1 / 1	504	SS-24	2 / 2	700	630	766	SS-17	6 / 6	250	106	472	SS-21	SS-17	Solid Waste
Arsenic	0.42	1.30	—	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	1 / 6	1.5	3.5		SS-18	SS-18	Non-Disposal
Barium	0.21	0.63	11	1 / 1	15.8	SS-15	1 / 1	14.4	SS-24	2 / 2	16	15.5	16.9	SS-16	6 / 6	31	9.2	86.2 J	SS-23	SS-23	Non-Disposal
Beryllium	0.21	0.63	0.39	1 / 1	0.4	SS-15	1 / 1	0.52	SS-24	2 / 2	0.78	0.46	1.1	SS-16	6 / 6	0.57	0.37	0.88	SS-22	SS-16	Solid Waste
Chromium	0.62	1.90	—	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	1 / 6	4.5	12.1 J		SS-18	SS-18	Non-Disposal
Cobalt	0.62	1.90	—	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	2 / 6	4.2	7.1	12.8	SS-23	SS-23	Non-Disposal
Copper	0.44	0.66	4.3	1 / 1	9.9	SS-15	1 / 1	5.6	SS-24	2 / 2	6.6	5.5	7.6	SS-16	2 / 4	2.8	2.8 J	5.4	SS-19	SS-15	Sewage Sludge
Lead	0.21	6.40	11.1	1 / 1	4.4	SS-15	1 / 1	4.3	SS-24	2 / 2	4.0	3.9	4.1	SS-16	6 / 6	33	4.4	124	SS-23	SS-23	Non-Disposal
Manganese	0.21	0.63	82	1 / 1	97.3	SS-15	1 / 1	105	SS-24	2 / 2	130	114	138	SS-16	6 / 6	1,100	12.9	6,120	SS-23	SS-23	Non-Disposal
Mercury	0.09	0.32	0.17	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	2 / 6	0.14	0.2	0.41	SS-23	SS-23	Non-Disposal
Nickel	0.62	0.99	—	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	1 / 5	2.4	6.2 J		SS-22	SS-22	Non-Disposal
Selenium	0.83	5.90	—	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	1 / 6	1.6	5.9 J		SS-18	SS-18	Non-Disposal
Thallium	0.21	0.64	0.28 J	0 / 1	—	—	0 / 1	—	—	0 / 2	—	—	—	—	0 / 6	—	—	—	—	SS-14	Background
Vanadium	0.41	1.30	16.5	1 / 1	12.1	SS-15	1 / 1	10.2	SS-24	2 / 2	8.6	6.9	10.2	SS-16	6 / 6	11	5.7	21.3	SS-18	SS-18	Non-Disposal
Zinc	2.40	3.60	21 J	1 / 1	22.1 J	SS-15	1 / 1	19.3 J	SS-24	2 / 2	23	19.8 J	25.7 J	SS-16	4 / 4	15	10.3 J	18.5 J	SS-20	SS-16	Solid Waste
SOIL QUALITY PARAMETERS																					
Cyanide - Not Detected																					

NOTES:

1. Analytical data is presented in Appendix D.
2. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
3. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.
4. The actual highest concentration for this chemical was detected in a background sample.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

— Analyte was not detected in samples.

TABLE 6 SUMMARY OF CHEMICALS DETECTED IN SUBSURFACE SOIL, AUGUST 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	RANGE OF DETECTION LIMITS (2) MAXIMUM	BACKGROUND RANGE OF CONCENTRATIONS (4) MINIMUM	BACKGROUND RANGE OF CONCENTRATIONS (4) MAXIMUM	SEWAGE SLUDGE FREQUENCY OF DETECTION (3)	SEWAGE SLUDGE ARITHMETIC AVERAGE	SEWAGE SLUDGE RANGE OF CONCENTRATIONS (4) MINIMUM	SEWAGE SLUDGE RANGE OF CONCENTRATIONS (4) MAXIMUM	SEWAGE SLUDGE MAXIMUM LOCATION	BULKY WASTE FREQUENCY OF DETECTION (3)	BULKY WASTE ARITHMETIC AVERAGE	BULKY WASTE RANGE OF CONCENTRATIONS (4) MINIMUM	BULKY WASTE RANGE OF CONCENTRATIONS (4) MAXIMUM	BULKY WASTE MAXIMUM LOCATION	SOLID WASTE FREQUENCY OF DETECTION (3)	SOLID WASTE ARITHMETIC AVERAGE	SOLID WASTE RANGE OF CONCENTRATIONS (4) MINIMUM	SOLID WASTE RANGE OF CONCENTRATIONS (4) MAXIMUM	SOLID WASTE MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	AREA OF OVERALL MAX. LOC.
VOLATILE ORGANICS (µg/kg)																					
Toluene	10	3,100	--	--	1 / 8	48	320		BH-03 (18 - 20 ft)	0 / 2	--	--	--	--	0 / 2	--	--	--	--	BH-03 (18 - 20 ft)	Sewage Sludge
Acetone	10	3,100	--	--	3 / 8	170	84 J	740 J	BH-01 (4 - 6 ft)	2 / 2	200	48 J	350 J	BH-06 (2 - 4 ft)	0 / 2	--	--	--	--	BH-01 (4 - 6 ft)	Sewage Sludge
2-Butanone	10	3,100	--	--	3 / 8	85	73 J	340 J	BH-01 (4 - 6 ft)	0 / 2	--	--	--	--	0 / 2	--	--	--	--	BH-01 (4 - 6 ft)	Sewage Sludge
SEMIVOLATILE ORGANICS (µg/kg)																					
Naphthalene	340	3,600	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	2 / 2	1,200	200 J	2,200 J	BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
2-Methylnaphthalene	340	3,600	--	--	2 / 8	150 *	27 J	140 J	BH-01 (2 - 8 ft)	0 / 2	--	--	--	--	2 / 2	2,000	700	3,300 J	BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
Phenanthrene	340	3,600	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	2 / 2	540	150 J	920 J	BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
Fluoranthene	340	3,600	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	1 / 2	970 *	140 J		BH-07 (4 - 8 ft)	BH-07 (4 - 8 ft)	Solid Waste
Pyrene	340	3,600	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	1 / 2	980 *	160 J		BH-07 (4 - 8 ft)	BH-07 (4 - 8 ft)	Solid Waste
Benzo(a)anthracene	340	3,600	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	1 / 2	930 *	63 J		BH-07 (4 - 8 ft)	BH-07 (4 - 8 ft)	Solid Waste
Chrysene	340	3,600	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	1 / 2	940 *	84 J		BH-07 (4 - 8 ft)	BH-07 (4 - 8 ft)	Solid Waste
1,2-Dichlorobenzene	340	3,600	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	1 / 2	1,000 *	240 J		BH-07 (4 - 8 ft)	BH-07 (4 - 8 ft)	Solid Waste
1,4-Dichlorobenzene	340	3,600	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	1 / 2	950 *	97 J		BH-07 (4 - 8 ft)	BH-07 (4 - 8 ft)	Solid Waste
Phenol	340	3,600	--	--	1 / 8	180	240 J		BH-01 (2 - 8 ft)	0 / 2	--	--	--	--	0 / 2	--	--	--	--	BH-01 (2 - 8 ft)	Sewage Sludge
2-Methylphenol	340	3,600	--	--	1 / 8	270	700		BH-03 (16 - 20 ft)	0 / 2	--	--	--	--	1 / 2	2,100	4,000		BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
4-Methylphenol	340	3,600	--	--	2 / 8	1,100	2,200	5,600	BH-01 (2 - 8 ft)	0 / 2	--	--	--	--	1 / 2	1,000 *	260 J		BH-07 (4 - 8 ft)	BH-01 (2 - 8 ft)	Sewage Sludge
Diethylphthalate	340	3,600	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	2 / 2	460	140 J	790 J	BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
Di-n-butylphthalate	340	3,600	62 J		4 / 8	160 *	40 J	120 J	BH-02 (16 - 18 ft)	0 / 2	--	--	--	--	2 / 2	1,300	320 J	2,300 J	BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
bis(2-Ethylhexyl)phthalate	340	3,600	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	1 / 2	1,900	2,000		BH-07 (4 - 8 ft)	BH-07 (4 - 8 ft)	Solid Waste
Di-n-octylphthalate	340	3,600	19 J		2 / 8	170 *	26 J	86 J	BH-03 (16 - 20 ft)	0 / 2	--	--	--	--	1 / 2	1,900	3,600 J		BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
Butylbenzylphthalate	340	3,600	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	2 / 2	9,000	96 J	18,000	BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
PESTICIDES (µg/kg)																					
4,4'-DDE	3.4	4.0	--	--	0 / 8	--	--	--	--	1 / 2	3.2	4.6		BH-06 (2 - 4 ft)	2 / 2	22	12.0	31.0	BH-07 (4 - 8 ft)	BH-07 (4 - 8 ft)	Solid Waste
4,4'-DDD	3.4	4.0	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	1 / 2	14	26.0		BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
Dieldrin	3.4	4.0	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	1 / 2	7.9	14.0		BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
alpha-Chlordane	1.7	2.1	--	--	1 / 8	1.6	6.2		BH-01 (2 - 8 ft)	0 / 2	--	--	--	--	1 / 2	9.0	17.0		BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
gamma-Chlordane	1.7	2.1	--	--	1 / 8	1.7	7.5		BH-01 (2 - 8 ft)	0 / 2	--	--	--	--	1 / 2	8.0	15.0		BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
PCBs (µg/kg)																					
Aroclor-1242	34	40	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	1 / 2	160	310.0		BH-07 (14 - 18 ft)	BH-07 (14 - 18 ft)	Solid Waste
Aroclor-1254	34	40	--	--	0 / 8	--	--	--	--	0 / 2	--	--	--	--	1 / 2	140	270.0		BH-07 (4 - 8 ft)	BH-07 (4 - 8 ft)	Solid Waste
METALS (mg/kg)																					
Aluminum	5.42	6.34	3,955	11,800	7 / 8	4,400	3,705	6,000	BH-04 (4 - 6 ft)	2 / 2	7,000	5,100	8,810	BH-06 (2 - 4 ft)	2 / 2	4,400	3,620	5,250	BH-07 (4 - 8 ft)	BH-06 (2 - 4 ft)	Bulky Waste (5)
Iron	3.62	4.22	6,415	12,800	8 / 8	6,700	3,400	8,635	BH-02 (16 - 18 ft)	2 / 2	8,100	6,620	9,530	BH-06 (2 - 4 ft)	2 / 2	6,200	4,800	7,540	BH-07 (4 - 8 ft)	BH-06 (2 - 4 ft)	Bulky Waste (5)
Magnesium	6.63	7.74	966	1,350	8 / 8	1,100	419	1,700	BH-01 (8 - 10 ft)	2 / 2	1,000	846	1,150	BH-06 (6 - 10 ft)	2 / 2	910	738	1,090	BH-07 (4 - 8 ft)	BH-01 (8 - 10 ft)	Sewage Sludge
Potassium	50.4	58.90	415	888	8 / 8	760	367	1,450	BH-01 (8 - 10 ft)	2 / 2	680	401	963	BH-06 (6 - 10 ft)	2 / 2	700	618	780	BH-07 (4 - 8 ft)	BH-01 (8 - 10 ft)	Sewage Sludge
Antimony	3.42	3.99	--	--	4 / 8	5.8	5.4 J	16.8 J	BH-01 (2 - 8 ft)	1 / 2	4.0	6.0 J		BH-06 (6 - 10 ft)	1 / 2	4.0	6.0 J		BH-07 (4 - 8 ft)	BH-01 (2 - 8 ft)	Sewage Sludge
Barium	0.40	0.47	19.1		5 / 8	19	10.1 J	54.3	BH-01 (2 - 8 ft)	2 / 2	17	14.6	19.8	BH-06 (6 - 10 ft)	2 / 2	19	16.0	22.9	BH-07 (4 - 8 ft)	BH-01 (2 - 8 ft)	Sewage Sludge
Beryllium	0.20	0.23	0.47	0.59	8 / 8	0.52	0.35	0.71	BH-04 (8 - 10 ft)	2 / 2	0.58	0.55	0.61	BH-06 (2 - 4 ft)	2 / 2	0.54	0.39	0.7	BH-07 (4 - 8 ft)	BH-04 (8 - 10 ft)	Sewage Sludge
Chromium	1.41	1.64	3.8	9.2	8 / 8	4.8	1.6	8.9	BH-01 (8 - 10 ft)	2 / 2	4.6	3.0	6.3	BH-06 (2 - 4 ft)	2 / 2	5.5	5.5	5.5	BH-07 (4 - 8 ft)	BH-01 (8 - 10 ft)	Sewage Sludge (5)
Cobalt	0.80	0.94	3.1	5.4	8 / 8	3.5	1.0	6.3	BH-04 (4 - 6 ft)	2 / 2	3.5	3.5	3.5	BH-06 (2 - 4 ft)	2 / 2	2.6	1.8	3.3	BH-07 (4 - 8 ft)	BH-04 (4 - 6 ft)	Sewage Sludge
Copper	2.21	2.58	3.4	3.5	7 / 8	16	4.2	79.2	BH-01 (2 - 8 ft)	2 / 2	3.7	3.3	4.1	BH-06 (2 - 4 ft)	2 / 2	13	7.4	18.9	BH-07 (4 - 8 ft)	BH-01 (2 - 8 ft)	Sewage Sludge
Lead	0.39	0.47	2.6	12.6	7 / 8	4.0	2.3	8.8	BH-01 (2 - 8 ft)	2 / 2	33	4.5	61.4	BH-06 (2 - 4 ft)	2 / 2	20	19.4	20.2	BH-07 (4 - 8 ft)	BH-06 (2 - 4 ft)	Bulky Waste
Manganese	1.81	2.11	125	148	5 / 8	110	106	213	BH-02 (16 - 18 ft)	1 / 2	82	116		BH-06 (2 - 4 ft)	0 / 2	--	--	--	--	BH-02 (16 - 18 ft)	Sewage Sludge
Mercury	0.09	0.11	0.15 J		3 / 8	0.12	0.13 J	0.47 J	BH-01 (2 - 8 ft)	2 / 2	0.22	0.20 J	0.24 J	BH-06 (6 - 10 ft)	2 / 2	0.28	0.18 J	0.39 J	BH-07 (4 - 8 ft)	BH-01 (2 - 8 ft)	Sewage Sludge
Vanadium	0.60	0.70	6.2	19.3	7 / 8	7.4	5.7	11.4	BH-01 (8 - 10 ft)	2 / 2	9.0	6.7	11.3	BH-06 (2 - 4 ft)	2 / 2	7.4	5.5	9.3	BH-07 (4 - 8 ft)	BH-01 (8 - 10 ft)	Sewage Sludge (5)
Zinc	1.61	1.88	12.1 J	20.0	7 / 8	41	16.5	188	BH-01 (2 - 8 ft)	2 / 2	57	18.9	95.9	BH-06 (2 - 4 ft)	2 / 2	57	45.5	68.2	BH-07 (14 - 18 ft)	BH-01 (2 - 8 ft)	Sewage Sludge
SOIL QUALITY PARAMETERS																					
Cyanide - Not Detected																					
TOTAL COMBUSTIBLE ORGANICS (%)																					
Organic Content	NA		0.7		2 / 2	1.8	0.5	3.0	BH-01 (2 - 8 ft)	1 / 1	NA	1.0		BH-06 (6 - 10 ft)	1 / 1	NA	3.8		BH-07 (4 - 14 ft)	BH-07 (4 - 14 ft)	Solid Waste
Solids Content	NA		89		2 / 2	85	75.8	94.7	BH-03 (16 - 20)	1 / 1	NA	91.3		BH-06 (6 - 10 ft)	1 / 1	NA	87.1		BH-07 (4 - 14 ft)	BH-03 (16 - 20 ft)	Sewage Sludge
Moisture Content	NA		11.1		2 / 2	15	5.3	24.3	BH-01 (2 - 8 ft)	1 / 1	NA	8.7		BH-06 (6 - 10 ft)	1 / 1	NA	13.0		BH-07 (4 - 14 ft)	BH-01 (2 - 8 ft)	Sewage Sludge

TABLE 6 (Continued). SUMMARY OF CHEMICALS DETECTED IN SUBSURFACE SOIL, AUGUST 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	RANGE OF DETECTION LIMITS (2) MAXIMUM	BACKGROUND RANGE OF CONCENTRATIONS (4) MINIMUM	BACKGROUND RANGE OF CONCENTRATIONS (4) MAXIMUM	SEWAGE SLUDGE FREQUENCY OF DETECTION (3)	SEWAGE SLUDGE ARITHMETIC AVERAGE	SEWAGE SLUDGE RANGE OF CONCENTRATIONS (4) MINIMUM	SEWAGE SLUDGE RANGE OF CONCENTRATIONS (4) MAXIMUM	SEWAGE SLUDGE MAXIMUM LOCATION	BULKY WASTE FREQUENCY OF DETECTION (3)	BULKY WASTE ARITHMETIC AVERAGE	BULKY WASTE RANGE OF CONCENTRATIONS (4) MINIMUM	BULKY WASTE RANGE OF CONCENTRATIONS (4) MAXIMUM	BULKY WASTE MAXIMUM LOCATION	SOLID WASTE FREQUENCY OF DETECTION (3)	SOLID WASTE ARITHMETIC AVERAGE	SOLID WASTE RANGE OF CONCENTRATIONS (4) MINIMUM	SOLID WASTE RANGE OF CONCENTRATIONS (4) MAXIMUM	SOLID WASTE MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	AREA OF OVERALL MAX. LOC.
GRAIN SIZE (%)																					
Clay	NA		3.1		2 / 2	1.4	0.4	2.3	BH-01 (2 - 8 ft)	1 / 1	NA	5.5		BH-06 (6 - 10 ft)	1 / 1	NA	3.5		BH-07 (4 - 14 ft)	BH-06 (6 - 10 ft)	Bulky Waste
Gravel	NA		6.5		2 / 2	6.2	5.5	6.8	BH-01 (2 - 8 ft)	1 / 1	NA	8.8		BH-06 (6 - 10 ft)	1 / 1	NA	8.1		BH-07 (4 - 14 ft)	BH-06 (6 - 10 ft)	Bulky Waste
Sand	NA		51.1		2 / 2	71	61.4	79.9	BH-03 (16 - 20)	1 / 1	NA	59.8		BH-06 (6 - 10 ft)	1 / 1	NA	60.7		BH-07 (4 - 14 ft)	BH-03 (16 - 20 ft)	Sewage Sludge
Silt	NA		39.4		2 / 2	22	14.1	29.4	BH-01 (2 - 8 ft)	1 / 1	NA	25.8		BH-06 (6 - 10 ft)	1 / 1	NA	27.6		BH-07 (4 - 14 ft)	BH-01 (2 - 8 ft)	Sewage Sludge (5)
PERMEABILITY (ft/dy)																					
Hydraulic Conductivity	NA		0.0414		2 / 2	0.38	0.162	0.595	BH-03 (16 - 20)	1 / 1	NA	0.0408		BH-06 (6 - 10 ft)	1 / 1	NA	0.286		BH-07 (4 - 14 ft)	BH-03 (16 - 20 ft)	Sewage Sludge

NOTES:

1. Analytical data is presented in Appendix D.
2. If all sample detection limits are the same, a single detection limit is presented.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.
5. The actual highest concentration for this chemical was detected in a background sample.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

-- Analyte was not detected in samples.

TABLE 7 **BACKGROUND METAL CONCENTRATIONS IN SURFICIAL SOILS IN THE EASTERN U.S., AND RHODE ISLAND**

	EASTERN UNITED STATES (1)		RHODE ISLAND (2)
	ARITHMETIC AVERAGE (mg/kg)	RANGE (mg/kg)	(mg/kg)
Aluminum	5.7	700 to > 10,000	>100,000
Iron	25,000	100 to > 100,000	30,000
Calcium	6,300	100 to 280,000	11,000
Magnesium	4,600	50 to > 50,000	7,000
Potassium	15,000	50 to 37,000	15,000
Sodium	7,800	< 500 to 50,000	15,000
Barium	420	10 to 1,500	500
Beryllium	0.85	< 1 to 7	ND
Antimony	0.76	< 1 to 8.8	---
Arsenic	7.4	0.1 to 73	3.5
Cadmium	---	---	---
Chromium	52	1 to 1,000	50
Cobalt	9.2	< 0.3 to 70	10
Copper	22	< 1 to 700	15
Lead	17	< 10 to 300	15
Manganese	640	< 2 to 7,000	500
Mercury	0.12	0.01 to 3.4	0.24
Nickel	18	< 5 to 700	15
Selenium	0.45	< 0.1 to 3.9	0.9
Silver	---	---	---
Thallium	8.6	2.2 to 23	---
Vanadium	66	< 7 to 300	70
Zinc	52	< 5 to 2,900	300,000

NOTES:

--- - No data available

1. Shacklette and Boerngen, 1984
2. Boerngen and Shacklette, 1981; data present for one sample

TABLE 8 SEWAGE SLUDGE CONCENTRATION STATISTICS FROM THE 1988 NATIONAL SURVEY AND THE 1980 40 CITY SURVEY

Analyte	NSSS (1)		40 City Survey	
	Mean	Standard Deviation	Mean	Standard Deviation
METALS	mg/kg	mg/kg	mg/kg	mg/kg
Arsenic	9.9	18.8	6.7	6.59
Berylium	0.37	0.34	1.63	2.1
Cadmium	6.94	11.86	69.0	252
Chromium	119	339	429	441
Copper	741	961	892	524
Lead	134	198	369	332
Mercury	5.22	15.5	2.8	2.6
Molybdenum	9.24	16.6	17.7	16.7
Nickel	42.7	94.8	135	169
Selenium	5.16	7.34	7.3	29.1
Zinc	1,200	1,550	1,590	1,760
ORGANICS **	µg/kg	µg/kg	µg/kg	µg/kg
Benzene	*	*	1,782	4,273
Benzo(a)pyrene	*	*	138	472
Bis(2-ethylhexyl)-phthalate	74,721	598,376	155,585	157,443
Trichloroethene	*	*	8,139	30,685

SOURCE: Federal Register, 1990.

NOTES: (1) - NSSS--National Sewage Sludge Survey

* - Indicates that there were not enough detected results to determine a mean or a standard deviation.

** - Only those analytes that were detcted greater then 20% of the time are listed.

TABLE 9 SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER, JUNE 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	RANGE OF DETECTION LIMITS (2) MAXIMUM	SHALLOW OVERBURDEN FREQUENCY OF DETECTION (3)	SHALLOW OVERBURDEN ARITHMETIC AVERAGE	SHALLOW OVERBURDEN RANGE OF CONCENTRATIONS (4) MINIMUM	SHALLOW OVERBURDEN RANGE OF CONCENTRATIONS (4) MAXIMUM	SHALLOW OVERBURDEN MAXIMUM LOCATION	DEEP OVERBURDEN FREQUENCY OF DETECTION (3)	DEEP OVERBURDEN ARITHMETIC AVERAGE	DEEP OVERBURDEN RANGE OF CONCENTRATIONS (4) MINIMUM	DEEP OVERBURDEN RANGE OF CONCENTRATIONS (4) MAXIMUM	DEEP OVERBURDEN MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	FLOW ZONE OF OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/L)														
Benzene		5	0 / 5	—	—	—	—	3 / 3	18	7	28	OW-25	OW-25	Deep Overburden
Toluene		5	1 / 5	15	64		MW-II	2 / 3	91	120	150	OW-30	OW-30	Deep Overburden
Ethylbenzene		5	0 / 5	—	—	—	—	3 / 3	38	17	72	OW-25	OW-25	Deep Overburden
Total Xylenes		5	0 / 5	—	—	—	—	3 / 3	100	39	210	OW-25	OW-25	Deep Overburden
Chlorobenzene		5	0 / 5	—	—	—	—	2 / 3	5.8	2 J	13	OW-25	OW-25	Deep Overburden
2-Butanone		10	0 / 3	—	—	—	—	1 / 3	50	140		OW-30	OW-30	Deep Overburden
4-Methyl-2-pentanone		10	0 / 5	—	—	—	—	1 / 3	14	31		OW-30	OW-30	Deep Overburden
1,1,1-Trichloroethane		5	0 / 5	—	—	—	—	1 / 3	13	34		OW-30	OW-30	Deep Overburden
1,1-Dichloroethene		5	1 / 5	2.4 *	2 J		MW-V	0 / 3	—	—	—	—	MW-V	Shallow Overburden
1,2-Dichloroethene(total)		5	0 / 5	—	—	—	—	3 / 3	250	3 J	730	OW-30	OW-30	Deep Overburden
1,1-Dichloroethane		5	0 / 5	—	—	—	—	2 / 3	74	1 J	220 J	OW-30	OW-30	Deep Overburden
1,2-Dichloropropane		5	0 / 5	—	—	—	—	2 / 3	2.5	2 J	3 J	OW-25	OW-25	Deep Overburden
Chloroethane		10	0 / 5	—	—	—	—	2 / 3	32	4 J	86	OW-30	OW-30	Deep Overburden
Vinyl Chloride		10	0 / 5	—	—	—	—	3 / 3	230	3 J	690 J	OW-30	OW-30	Deep Overburden
Carbon Disulfide		5	4 / 5	22	2 J	50	MW-II	3 / 3	47	3 J	87	OW-25	OW-25	Deep Overburden
SEMIVOLATILE ORGANICS (µg/L)														
Naphthalene		10	0 / 5	—	—	—	—	1 / 3	6.7	10		OW-25	OW-25	Deep Overburden
2-Methylnaphthalene		10	1 / 5	4.4 *	2 J		MW-V	0 / 3	—	—	—	—	MW-V	Shallow Overburden
1,4-Dichlorobenzene		10	0 / 5	—	—	—	—	1 / 3	12	25		OW-25	OW-25	Deep Overburden
Benzoic Acid		50	0 / 5	—	—	—	—	1 / 3	21 *	12 J		OW-30	OW-30	Deep Overburden
4-Methylphenol		10	1 / 5	5.4	7 J		MW-V	1 / 3	20	51 J		OW-30	OW-30	Deep Overburden
N-Nitroso-di-n-propylamine		10	0 / 5	—	—	—	—	1 / 3	6.7	10 J		OW-30	OW-30	Deep Overburden
PESTICIDES/PCBs														
None Detected														
METALS - UNFILTERED (µg/L)														
Aluminum	10	27	5 / 5	5,400	627 J	20,650 J	MW-III	3 / 3	15,000	917 J	22,700 J	OW-25	OW-25	Deep Overburden
Iron	7	18	5 / 5	33,000	794 J	73,600 J	MW-II	3 / 3	130,000	114,000 J	157,000 J	OW-27	OW-27	Deep Overburden
Calcium	7	28	5 / 5	4,900	1,020	8,460	MW-II	3 / 3	100,000	56,800	168,000	OW-25	OW-25	Deep Overburden
Magnesium	13	33	5 / 5	2,900	887	6,620	MW-III	3 / 3	25,000	5,990	62,000	OW-25	OW-25	Deep Overburden
Sodium	22	30	5 / 5	5,300	3,040	6,790	MW-IV	3 / 3	170,000	8,910 J	501,000	OW-25	OW-25	Deep Overburden
Potassium	42	251	5 / 5	2,500	499	4,970	MW-III	3 / 3	64,000	9,770	170,000	OW-25	OW-25	Deep Overburden
Arsenic	2	4	1 / 4	1.9	2.7		MW-II	2 / 2	6.7	4.8 J	8.6 J	OW-25	OW-25	Deep Overburden
Barium	1	2	4 / 5	35	19.5	105.7	MW-III	3 / 3	170	52.6 J	238	OW-27	OW-27	Deep Overburden
Beryllium	1		1 / 5	1.1	2.6		MW-III	0 / 3	—	—	—	—	MW-III	Shallow Overburden
Cadmium	1	3	1 / 5	5.0	19.4		MW-IV	1 / 3	14	40.0 J		OW-27	OW-27	Deep Overburden
Chromium	2	7	1 / 5	6.7	23.0		MW-III	2 / 3	37	44.8 J	62.5 J	OW-25	OW-25	Deep Overburden
Cobalt	2	4	2 / 5	9.0	16.1 J	21.0	MW-IV	2 / 3	22	29.4	33.1	OW-27	OW-27	Deep Overburden
Copper	3	11	2 / 5	26	45.5	75.5	MW-III	1 / 3	46	107		OW-25	OW-25	Deep Overburden
Lead	1	2	1 / 5	17	71.9 J		MW-III	2 / 3	120	173 J	181 J	OW-25	OW-25	Deep Overburden
Manganese	1	9	5 / 5	2,000	44.0	4,340 J	MW-IV	3 / 3	1,900	1,020 J	2,970 J	OW-30	MW-IV	Shallow Overburden
Nickel	4	6	4 / 5	12	5.4	23.5	MW-III	2 / 3	50	67.9	79.0	OW-27	OW-27	Deep Overburden
Vanadium	2	3	1 / 5	7.4	27.9		MW-III	2 / 3	29	36.7	45.2	OW-25	OW-25	Deep Overburden
Zinc	3	8	3 / 5	83	32.5	210 J	MW-IV	2 / 2	3300	645 J	5,980 J	OW-27	OW-27	Deep Overburden
METALS - FILTERED (µg/L)														
Iron	7	18	2 / 5	19,000	32,000	64,300 J	MW-II	3 / 3	76,000	20,800	115,000	OW-30	OW-30	Deep Overburden
Calcium	7	28	4 / 5	4,400	3,420	8,210	MW-II	3 / 3	90,000	59,800	137,000	OW-25	OW-25	Deep Overburden
Magnesium	13	33	5 / 5	1,800	716	3,940	MW-II	3 / 3	23,000	3,070	59,800	OW-25	OW-25	Deep Overburden
Sodium	22	30	5 / 5	5,900	3,410	8,280	MW-IV	3 / 3	190,000	10,200	540,000	OW-25	OW-25	Deep Overburden
Potassium	42	251	5 / 5	1,300	260	3,370	MW-II	3 / 3	63,000	5,780	171,000	OW-25	OW-25	Deep Overburden
Antimony	11	17	0 / 5	—	—	—	—	1 / 3	10	19.4		OW-25	OW-25	Deep Overburden
Barium	1	2	3 / 5	10	10.6	21.5	MW-II	3 / 3	68	47.5 J	87.9	OW-25	OW-25	Deep Overburden
Cobalt	2	4	1 / 5	3.5	5.0		MW-II	0 / 3	—	—	—	—	MW-II	Shallow Overburden
Manganese	1	9	3 / 5	1,700	524	4,160	MW-IV	3 / 3	1,200	191	2,850 J	OW-30	MW-IV	Shallow Overburden
Mercury	0.2		0 / 5	—	—	—	—	1 / 3	0.28	0.63		OW-25	OW-25	Deep Overburden
Nickel	4	6	1 / 5	3.6	7.8		MW-IV	1 / 3	4.4	9.2		OW-25	OW-25	Deep Overburden
Zinc	3	8	3 / 5	31	39.1	57.5	MW-IV	2 / 2	32	19.2	43.9	OW-25	MW-IV	Shallow Overburden
WATER QUALITY PARAMETERS														
Sulfide (mg/L)	0.05		5 / 5	1.5	0.64	2.70	MW-I	3 / 3	2.2	1.70	3.30	OW-27	OW-27	Deep Overburden
Cyanide	Not Detected													
Total Organic Carbon (mg/L)	1.0		0 / 5	—	—	—	—	2 / 2	44	24 J	65 J	OW-30	OW-30	Deep Overburden
Biochemical Oxygen Demand (mg/L)	2.4		1 / 5	3.4	8.0		MW-II	1 / 2	62	120		OW-30	OW-30	Deep Overburden
Hardness (mg/L)	NA		5 / 5	24	6	48	MW-III	3 / 3	360	167	675	OW-25	OW-25	Deep Overburden
pH	NA		5 / 5	6.7	6.1	7.1	MW-V	3 / 3	6.7	6.6	6.8	OW-30	MW-V	Shallow Overburden
Specific Conductance (µmhos/cm)	NA		5 / 5	130	21	260	MW-II	3 / 3	2,400	750	5,600	OW-25	OW-25	Deep Overburden

NOTES:

1. Analytical data is presented in Appendix D.
2. If all sample detection limits are the same, a single detection limit is presented.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

— Analyte was not detected in samples.

TABLE 10 SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER, SEPTEMBER/OCTOBER 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	RANGE OF DETECTION LIMITS (2) MAXIMUM	BACKGROUND CONCENTRATIONS SHALLOW OVERBURDEN	BACKGROUND CONCENTRATIONS BEDROCK	SHALLOW OVERBURDEN FREQUENCY OF DETECTION (3)	SHALLOW OVERBURDEN ARITHMETIC AVERAGE	SHALLOW OVERBURDEN RANGE OF CONCENTRATIONS (4) MINIMUM	SHALLOW OVERBURDEN RANGE OF CONCENTRATIONS (4) MAXIMUM	SHALLOW OVERBURDEN MAXIMUM LOCATION	DEEP OVERBURDEN FREQUENCY OF DETECTION (3)	DEEP OVERBURDEN ARITHMETIC AVERAGE	DEEP OVERBURDEN RANGE OF CONCENTRATIONS (4) MINIMUM	DEEP OVERBURDEN RANGE OF CONCENTRATIONS (4) MAXIMUM	DEEP OVERBURDEN MAXIMUM LOCATION	BEDROCK FREQUENCY OF DETECTION (3)	BEDROCK ARITHMETIC AVERAGE	BEDROCK RANGE OF CONCENTRATIONS (4) MINIMUM	BEDROCK RANGE OF CONCENTRATIONS (4) MAXIMUM	BEDROCK MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	FLOW ZONE OF OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/L)																				
Benzene	10	50	--	--	1 / 13	5.6	13		MW-11-01	7 / 15	8.8	2 J	31	MW-14-01	0 / 5	--	--	--	--	MW-14-01	Deep Overburden
Toluene	10	50	--	--	2 / 13	4.5 *	1 J	2 J	MW-13-01	7 / 15	20	1 J	170	MW-14-01	3 / 5	4.6	1 J	10	MW-04-03	MW-14-01	Deep Overburden
Ethylbenzene	10	50	--	--	2 / 13	5.7	3 J	16	MW-11-01	9 / 15	9.9	2 J	23	MW-07-01	1 / 5	4.2 *	1 J		MW-04-03	MW-07-01	Deep Overburden
Total Xylenes	10	50	--	--	2 / 13	4.9	4 J	5 J	MW-11-01	9 / 15	15	4 J	49	MW-07-01	2 / 5	4.0	1 J	4 J	MW-04-03	MW-07-01	Deep Overburden
Chlorobenzene	10	50	--	--	0 / 13	--	--	--	--	2 / 15	6.3 *	5 J	5 J	MW-11-02	0 / 5	--	--	--	--	MW-11-02	Deep Overburden
Acetone	10	10	--	--	0 / 13	--	--	--	--	1 / 15	12	71 J		MW-12-02	2 / 5	36	16 J	120	MW-04-03	MW-04-03	Bedrock
2-Butanone	10	50	--	--	0 / 13	--	--	--	--	1 / 15	6.6	9 J		MW-13-02	1 / 5	30	130		MW-04-03	MW-04-03	Bedrock
4-Methyl-2-pentanone	10	50	--	--	0 / 13	--	--	--	--	1 / 15	6.3 *	5 J		MW-13-02	1 / 5	4.6 *	3 J		MW-04-03	MW-13-02	Deep Overburden
Tetrachloroethene	10	50	--	--	0 / 13	--	--	--	--	0 / 15	--	--	--	--	1 / 5	4.2 *	1 J		MW-04-03	MW-04-03	Bedrock
Trichloroethene	10	50	3 J	--	0 / 13	--	--	--	--	2 / 15	6.1 *	2 J	5 J	OW-27	1 / 5	4.6 *	3 J		MW-04-03	OW-27	Deep Overburden
1,1,1-Trichloroethane	10	50	--	--	0 / 13	--	--	--	--	0 / 15	--	--	--	--	1 / 5	4.6 *	3 J		MW-07-02	MW-07-02	Bedrock
1,1-Dichloroethene	10	50	--	--	0 / 13	--	--	--	--	0 / 15	--	--	--	--	1 / 5	4.4 *	2 J		MW-07-02	MW-07-02	Bedrock
1,2-Dichloroethene(total)	10	50	--	--	2 / 13	4.7 *	3 J	3 J	MW-11-01	6 / 15	9.7	1 J	41	MW-14-01	2 / 5	21	10	79	MW-07-02	MW-07-02	Bedrock
1,1-Dichloroethane	10	50	--	--	2 / 13	4.5 *	1 J	3 J	MW-11-01	8 / 15	6.9	2 J	16	MW-07-01	2 / 5	9.2	7 J	24	MW-07-02	MW-07-02	Bedrock
1,2-Dichloroethane	10	50	--	--	0 / 13	--	--	--	--	1 / 15	6.1 *	1 J		MW-06-02	0 / 5	--	--	--	--	MW-06-02	Deep Overburden
1,2-Dichloropropane	10	50	--	--	0 / 13	--	--	--	--	1 / 15	6.1 *	2 J		MW-14-01	0 / 5	--	--	--	--	MW-14-01	Deep Overburden
Chloroethane	10	50	--	--	1 / 13	6.7	27		MW-11-01	7 / 15	22	2 J	72	MW-06-02	1 / 5	5.6	8 J		MW-04-03	MW-06-02	Deep Overburden
Vinyl Chloride	10	50	--	--	1 / 13	5.0	5 J		MW-11-01	2 / 15	7.5	8 J	19	OW-27	0 / 5	--	--	--	--	OW-27	Deep Overburden
Carbon Disulfide	10	50	--	--	0 / 13	--	--	--	--	2 / 15	6.4	4 J	7 J	OW-27	1 / 5	4.6 *	3 J		MW-07-02	OW-27	Deep Overburden
WATER SOLUBLE ORGANICS (µg/L)																					
Acrylamide	200	2,000	--	--	0 / 12	--	--	--	--	1 / 15	110	229 J		MW-04-02	0 / 5	--	--	--	--	MW-04-02	Deep Overburden
N,N-DMF	50	500	--	--	2 / 13	39	50 J	183	MW-03-01	3 / 15	79	92 J	596	MW-14-01	2 / 5	400	537 J	1,390 J	MW-07-02	MW-07-02	Bedrock
SEMIVOLATILE ORGANICS (µg/L)																					
Naphthalene	10	20	--	--	1 / 13	5.2 *	3 J		MW-11-01	6 / 15	4.4	1 J	8 J	MW-14-01	0 / 5	--	--	--	--	MW-14-01	Deep Overburden
2-Methylnaphthalene	10	20	--	--	0 / 13	--	--	--	--	2 / 15	4.5 *	1 J	2 J	OW-27	0 / 5	--	--	--	--	OW-27	Deep Overburden
1,2-Dichlorobenzene	10	20	--	--	1 / 13	5.2 *	2 J		MW-11-01	3 / 15	4.4 *	2 J		MW-11-02	0 / 5	--	--	--	--	MW-11-01	Shallow Overburden
1,4-Dichlorobenzene	10	20	--	--	1 / 13	5.2 *	3 J		MW-11-01	4 / 15	4.5	2 J	5 J	MW-07-01	0 / 5	--	--	--	--	MW-07-01	Deep Overburden
Phenol	10	20	--	--	0 / 13	--	--	--	--	1 / 15	4.7 *	1.0 J		OW-30	1 / 5	5	5 J		MW-04-03	MW-04-03	Bedrock
2-Methylphenol	10	20	--	--	0 / 13	--	--	--	--	2 / 15	4.8	0.9 J	6 J	MW-14-01	0 / 5	--	--	--	--	MW-14-01	Deep Overburden
4-Methylphenol	10	20	--	--	0 / 13	--	--	--	--	3 / 15	5.5	2 J	17	MW-13-02	1 / 5	4.2 *	1 J		MW-04-03	MW-13-02	Deep Overburden
2,4-Dimethylphenol	10	20	--	--	0 / 13	--	--	--	--	2 / 15	4.6 *	0.9 J	3 J	MW-11-02	0 / 5	--	--	--	--	MW-11-02	Deep Overburden
4-Chloro-3-methylphenol	10	20	--	--	0 / 13	--	--	--	--	3 / 15	4.5 *	1 J	3 J	OW-27	0 / 5	--	--	--	--	OW-27	Deep Overburden
Pentachlorophenol	25	50	--	--	1 / 13	12.7 *	3 J		MW-13-01	0 / 15	--	--	--	--	0 / 5	--	--	--	--	MW-13-01	Shallow Overburden
Diethylphthalate	10	20	--	--	0 / 13	--	--	--	--	5 / 15	7.0	9 J	17	MW-07-01	1 / 5	4.1 *	0.7 J		MW-11-03	MW-07-01	Deep Overburden
Di-n-butylphthalate	10	20	--	--	1 / 13	5.0 *	0.5 J		MW-I	1 / 15	4.7 *	0.6 J		OW-27	0 / 5	--	--	--	--	OW-27	Deep Overburden
bis(2-Ethylhexyl)phthalate	10	20	--	--	0 / 13	--	--	--	--	0 / 15	--	--	--	--	1 / 5	12	36		MW-04-03	MW-04-03	Bedrock
PESTICIDES (µg/L)																					
gamma-BHC(Lindane)	0.050	0.053	--	--	0 / 13	--	--	--	--	0 / 15	--	--	--	--	2 / 5	0.02 *	0.0057 J	0.011 J	MW-07-02	MW-07-02	Bedrock
Aldrin	0.050	0.053	--	--	0 / 13	--	--	--	--	0 / 15	--	--	--	--	1 / 5	0.02 *	0.003 J		MW-07-02	MW-07-02	Bedrock
Dieldrin	0.10	0.11	--	--	0 / 13	--	--	--	--	0 / 15	--	--	--	--	1 / 5	0.04 *	0.0035 J		MW-04-03	MW-04-03	Bedrock
alpha-Chlordane	0.050	0.050	--	--	1 / 13	0.02 *	0.0030 J		MW-02-01	1 / 15	0.02 *	0.0028 J		MW-09-01	0 / 5	--	--	--	--	MW-02-01	Shallow Overburden
PCBs (µg/L)																					
Aroclor-1260	1.0	1.1	--	--	1 / 13	0.48 *	0.24 J		MW-05-01	1 / 15	0.49 *	0.16 J	J	MW-08-01	1 / 5	0.44 *	0.13 J		MW-08-02	MW-05-01	Shallow Overburden
METALS - UNFILTERED (µg/L)																					
Aluminum	13	31	19,700 J	201 J	13 / 13	16,000	1,010	55,600	MW-02-01	14 / 15	20,000	1,443 J	96,400 J	MW-07-01	2 / 5	640	1,410	1,570	MW-11-03	MW-07-01	Deep Overburden
Iron	6	12	31,500	--	13 / 13	41,000	3,640	118,000	MW-02-01	15 / 15	65,000	1,920 J	238,000	MW-07-01	4 / 5	2,800	1,270	5,080 J	MW-03-03	MW-07-01	Deep Overburden
Calcium	15	20	15,600	17,200	13 / 13	15,000	3,300	63,100	MW-11-01	15 / 15	34,000	5,230	91,900	MW-11-02	5 / 5	41,000	8,460 J	88,300	MW-07-02	MW-11-02	Deep Overburden
Magnesium	26	46	3,770	1,670	13 / 13	5,800	1,480	19,300	MW-11-01	15 / 15	13,000	1,560	52,000	MW-14-01	5 / 5	2,600	1,140 J	4,290	MW-04-03	MW-14-01	Deep Overburden
Sodium	13	57	15,400	8,190	9 / 13	15,000	4,570	75,100	MW-11-01	14 / 15	36,000	7,660	124,000	MW-14-01	5 / 5	31,000	10,500	59,500	MW-11-03	MW-14-01	Deep Overburden
Potassium	133	442	8,310	1,570	8 / 13	8,200	4,440	22,800	MW-11-01	13 / 15	24,000	2,870	139,000	MW-14-01	2 / 5	22,000	5,360	102,000	MW-07-02	MW-14-01	Deep Overburden
Antimony	25	47	--	--	1 / 13	20	74.2		MW-02-01	1 / 15	23	104.9		MW-12-02	0 / 5	--	--	--	--	MW-12-02	Deep Overburden
Arsenic	1	2	1.1	--	5 / 13	1.8	1.7	5.5	MW-II	7 / 15	2.5	1.1	9.7	MW-14-01	1 / 5	0.91	1 J		MW-03-03	MW-14-01	Deep Overburden

TABLE 10 (Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER, SEPTEMBER/OCTOBER 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	RANGE OF DETECTION LIMITS (2) MAXIMUM	BACKGROUND CONCENTRATIONS SHALLOW OVERBURDEN	BACKGROUND CONCENTRATIONS BEDROCK	SHALLOW OVERBURDEN FREQUENCY OF DETECTION (3)	SHALLOW OVERBURDEN ARITHMETIC AVERAGE	SHALLOW OVERBURDEN RANGE OF CONCENTRATIONS (4) MINIMUM	SHALLOW OVERBURDEN RANGE OF CONCENTRATIONS (4) MAXIMUM	SHALLOW OVERBURDEN MAXIMUM LOCATION	DEEP OVERBURDEN FREQUENCY OF DETECTION (3)	DEEP OVERBURDEN ARITHMETIC AVERAGE	DEEP OVERBURDEN RANGE OF CONCENTRATIONS (4) MINIMUM	DEEP OVERBURDEN RANGE OF CONCENTRATIONS (4) MAXIMUM	DEEP OVERBURDEN MAXIMUM LOCATION	BEDROCK FREQUENCY OF DETECTION (3)	BEDROCK ARITHMETIC AVERAGE	BEDROCK RANGE OF CONCENTRATIONS (4) MINIMUM	BEDROCK RANGE OF CONCENTRATIONS (4) MAXIMUM	BEDROCK MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	FLOW ZONE OF OVERALL MAX. LOC.
Barium	1	2	113	--	13 / 13	140	19.3	290	MW-11-01	13 / 15	180	26.6	454	MW-07-01	4 / 5	59	9.1	133	MW-08-02	MW-07-01	Deep Overburden
Beryllium	1		--	--	0 / 13	--	--	--	--	2 / 15	2.3	10.5 J	10.9	MW-07-01	0 / 5	--	--	--	--	MW-07-01	
Cadmium	3		--	--	0 / 13	--	--	--	--	1 / 15	4.1	39.9		OW-27	0 / 5	--	--	--	--	OW-27	Deep Overburden
Chromium	6	8	--	--	2 / 13	13.4	22.2	54.5 J	MW-02-01	5 / 15	24	17.5	141 J	MW-07-01	2 / 5	24	8.1 J	103 J	MW-07-02	MW-07-01	Deep Overburden
Cobalt	6	8	27.7	--	7 / 13	17.7	10.2	45.0	MW-I	6 / 15	18	14.0	53.8	MW-07-01	0 / 5	--	--	--	--	MW-07-01	Deep Overburden
Copper	4	5	--	--	7 / 13	42.7	12.4	104	MW-05-01	9 / 15	61	18.5	310	MW-07-01	0 / 5	--	--	--	--	MW-07-01	Deep Overburden
Lead	1	2	23.6	--	5 / 13	22.7	25.7	82.4	MW-02-01	7 / 15	42	10.9	307	MW-12-02	0 / 5	--	--	--	--	MW-12-02	Deep Overburden
Manganese	2		4,080	54.5 J	13 / 13	3,000	201	9,790	MW-04-01	15 / 15	2,500	489	9,995	MW-12-02	4 / 5	480	43.3 J	1,350	MW-08-02	MW-12-02	Deep Overburden
Mercury	0.2		--	--	1 / 13	0.11	0.22		MW-IV	1 / 15	0.11	0.28		OW-27	0 / 5	--	--	--	--	OW-27	Deep Overburden
Nickel	9	16	23.3		6 / 13	24	19.0	71.3	MW-12-01	6 / 15	33	26.8	125	MW-07-01	0 / 5	--	--	--	--	MW-07-01	Deep Overburden
Vanadium	3	5	15.9		8 / 13	22	6.5	101.0	MW-02-01	10 / 15	27	3 J	127	MW-07-01	1 / 5	3.6	9.8		MW-07-02	MW-07-01	Deep Overburden
Zinc	6	7	--	--	5 / 13	100	133 J	362 J	MW-02-01	6 / 15	630	103	7,360	OW-27	1 / 5	26	88.5 J		MW-03-03	OW-27	Deep Overburden
METALS - FILTERED (µg/L)																					
Aluminum	13	17	--	165 J	0 / 13	--	--	--	--	1 / 15	32	132 J		MW-03-02	0 / 5	--	--	--	--	MW-03-02	Deep Overburden (5)
Iron	6	7	3,150 J		10 / 13	17,000	89.0 J	56,900 J	MW-11-01	11 / 15	38,000	262 J	111,000 J	MW-07-01	0 / 5	--	--	--	--	MW-07-01	Deep Overburden
Calcium	8	20	11,000	17,300	12 / 13	12,000	3,110	61,700	MW-11-01	15 / 15	32,000	4,520	88,200	MW-11-02	5 / 5	40,000	8,355 J	88,400	MW-07-02	MW-07-02	Bedrock
Magnesium	14	26	1,890	1,750	13 / 13	3,200	660	18,400	MW-11-01	15 / 15	9,500	1,460	48,900	MW-14-01	5 / 5	2,200	404	4,240	MW-04-03	MW-14-01	Deep Overburden
Sodium	13	28	15,400	8,280	6 / 13	13,000	7,900	73,600	MW-11-01	13 / 15	36,000	7,940	146,000	MW-14-01	5 / 5	30,000	10,400	56,300	MW-07-02	MW-14-01	Deep Overburden
Potassium	73	442	3,930	1,740	3 / 13	4,500	11,700	21,400	MW-11-01	9 / 15	19,000	2,280	139,000	MW-14-01	2 / 5	22,000	5,260	104,000	MW-07-02	MW-14-01	Deep Overburden
Antimony	14	25	--	--	1 / 13	12	34.1		MW-04-01	2 / 15	11	12.0 J	20.4 J	OW-30	0 / 5	--	--	--	--	MW-04-01	Shallow Overburden
Arsenic	1	2	--	--	3 / 13	0.92	1.2 J	2.0	MW-II	4 / 15	1.5	2	7.7	MW-14-01	0 / 5	--	--	--	--	MW-14-01	Deep Overburden
Barium	1		15.9	--	7 / 13	34	13.2	251	MW-11-01	10 / 15	78	25.3	267	MW-11-02	4 / 5	47	5.0	108	MW-08-02	MW-11-02	Deep Overburden
Chromium	2	8	--	--	0 / 13	--	--	--	--	0 / 15	--	--	--	--	1 / 5	21	94.3		MW-07-02	MW-07-02	Bedrock
Cobalt	2	6	12.8	--	4 / 13	5.8	8.3	21.4	MW-IV	2 / 15	4.8	7.6	8.6	MW-14-01	0 / 5	--	--	--	--	MW-IV	Shallow Overburden
Copper	2	4	--	11.6	4 / 13	8.8	7.2	30.0	MW-IV	2 / 14	5.9	20.3	26.3	MW-03-02	0 / 5	--	--	--	--	MW-IV	Shallow Overburden
Lead	1		--	--	0 / 13	--	--	--	--	1 / 15	0.86	2.3		MW-09-01	0 / 5	--	--	--	--	MW-09-01	Deep Overburden
Manganese	1	2	3,560 J	--	11 / 13	2,000	38.1 J	6,660	MW-04-01	14 / 15	1,800	65.8 J	7,390 J	MW-12-02	4 / 5	240	2.0 J	603 J	MW-04-03	MW-12-02	Deep Overburden
Nickel	5	16	--	--	1 / 13	10	50.0		MW-12-01	5 / 15	11	10.0	31.5	MW-09-01	1 / 5	5.2 *	5.0		MW-04-03	MW-12-01	Shallow Overburden
Vanadium	2	3	--	--	0 / 13	--	--	--	--	0 / 14	--	--	--	--	1 / 5	1.6	3.0		MW-07-02	MW-07-02	Bedrock
Zinc	5	6	--	--	2 / 13	22	6.7 J	131	MW-12-01	3 / 15	15	8.4 J	54.2 J	MW-09-01	0 / 5	--	--	--	--	MW-12-01	Shallow Overburden
WATER QUALITY PARAMETERS																					
Sulfide (mg/L)	0.05		--	--	0 / 13	--	--	--	--	1 / 15	2.3	32 J		MW-05-02	0 / 5	--	--	--	--	MW-05-02	Deep Overburden
Cyanide (µg/L)	10		--	--	1 / 13	5.5	11.1 J		MW-V	0 / 15	--	--	--	--	0 / 5	--	--	--	--	MW-V	Shallow Overburden
Total Organic Carbon (mg/L)	0.5		19.0 J	--	9 / 13	16	7.3	63.9	MW-02-01	10 / 15	26	15.8 J	117.5 J	MW-14-01	1 / 5	2.9	7.8 J		MW-04-03	MW-14-01	Deep Overburden
Biochemical Oxygen Demand (mg/L)	1.0		--	--	4 / 13	3.8	4.0 J	12.7	MW-12-01	7 / 15	9.0	7.0 J	35.0	MW-14-01	0 / 4	--	--	--	--	MW-14-01	Deep Overburden
Hardness (mg/L)	NA		54	50	13 / 13	61	14	237	MW-11-01	15 / 15	140	30	366	MW-14-01	5 / 5	110	26 J	226	MW-07-02	MW-14-01	Deep Overburden
pH	NA		6.2	7.1	13 / 13	6.7	5.8	8.2	MW-I	15 / 15	6.7	6.2	7.3	MW-02-02	5 / 5	8.8	7.5	12.5	MW-07-02	MW-07-02	Bedrock
Specific Conductance (µmhos/cm)	NA		200	110	13 / 13	160	26	440	MW-03-01	15 / 15	650	50	2,150	MW-14-01	5 / 5	440	140	1200	MW-07-02	MW-14-01	Deep Overburden

NOTES:

1. Analytical data is presented in Appendix D.
2. If all sample detection limits are the same, a single detection limit is presented.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.
5. The actual highest concentration for this chemical was detected in a background sample.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

-- Analyte was not detected in samples.

TABLE 11 . SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER, JANUARY/FEBRUARY 1992 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	RANGE OF DETECTION LIMITS (2) MAXIMUM	BACKGROUND CONCENTRATIONS SHALLOW OVERBURDEN	BACKGROUND CONCENTRATIONS BEDROCK	SHALLOW OVERBURDEN FREQUENCY OF DETECTION (3)	SHALLOW OVERBURDEN ARITHMETIC AVERAGE	SHALLOW OVERBURDEN RANGE OF CONCENTRATIONS (4) MINIMUM	SHALLOW OVERBURDEN RANGE OF CONCENTRATIONS (4) MAXIMUM	SHALLOW OVERBURDEN MAXIMUM LOCATION	DEEP OVERBURDEN FREQUENCY OF DETECTION (3)	DEEP OVERBURDEN ARITHMETIC AVERAGE	DEEP OVERBURDEN RANGE OF CONCENTRATIONS (4) MINIMUM	DEEP OVERBURDEN RANGE OF CONCENTRATIONS (4) MAXIMUM	DEEP OVERBURDEN MAXIMUM LOCATION	BEDROCK FREQUENCY OF DETECTION (3)	BEDROCK ARITHMETIC AVERAGE	BEDROCK RANGE OF CONCENTRATIONS (4) MINIMUM	BEDROCK RANGE OF CONCENTRATIONS (4) MAXIMUM	BEDROCK MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	FLOW ZONE OF OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/L)																				
Benzene	10		—	—	1 / 4	6.5	11		MW-11-01	6 / 8	7.6	2 J	27	MW-14-01	2 / 4	4.8	4 J	5 J	MW-04-03	MW-14-01	Deep Overburden
Toluene	10		—	—	1 / 4	4.0 *	1 J		MW-02-01	5 / 8	12	1 J	52	MW-14-01	1 / 4	5.8	8 J		MW-04-03	MW-14-01	Deep Overburden
Ethylbenzene	10		—	—	2 / 4	6.0	1 J	13	MW-11-01	5 / 8	11	2 J	29	OW-27	0 / 4	—	--	—	—	OW-27	Deep Overburden
Total Xylenes	10		—	—	2 / 4	4.2	2 J	5 J	MW-11-01	6 / 8	24	6 J	78	OW-27	2 / 4	3.2 *	1 J	2 J	MW-04-03	OW-27	Deep Overburden
Chlorobenzene	10		—	—	2 / 4	3.5 *	2 J	2 J	MW-11-01	2 / 8	4.9	4 J	5 J	OW-27	0 / 4	—	--	—	—	OW-27	Deep Overburden
2-Butanone	10		—	—	0 / 4	—	—	—	—	0 / 8	—	—	—	—	1 / 4	41	150 J		MW-04-03	MW-04-03	Bedrock
4-Methyl-2-pentanone	10		—	—	0 / 4	—	—	—	—	1 / 8	5.4	8 J		MW-13-02	0 / 4	—	--	—	—	MW-13-02	Deep Overburden
Trichloroethene	10		—	—	0 / 4	—	—	—	—	0 / 8	—	—	—	—	1 / 4	4.5 *	3 J		MW-07-02	MW-07-02	Bedrock
1,1,1-Trichloroethane	10		—	—	0 / 4	—	—	—	—	0 / 8	—	—	—	—	1 / 4	4.5 *	3 J		MW-07-02	MW-07-02	Bedrock
1,2-Dichloroethene(total)	10		—	—	1 / 4	4.2 *	2 J		MW-11-01	3 / 8	5.1	1 J	9 J	MW-07-01	2 / 4	28	7 J	97	MW-07-02	MW-07-02	Bedrock
1,1-Dichloroethane	10		—	—	1 / 4	4.5 *	3 J		MW-11-01	5 / 8	5.4	2 J	12	OW-30	2 / 4	10	5 J	24	MW-07-02	MW-07-02	Bedrock
1,2-Dichloroethane	10		—	—	1 / 4	4.0 *	1 J		MW-11-01	0 / 8	—	—	—	—	0 / 4	—	--	—	—	MW-11-01	Shallow Overburden
1,2-Dichloropropane	10		—	—	1 / 4	4.5 *	3 J		MW-11-01	0 / 8	—	—	—	—	0 / 4	—	--	—	—	MW-11-01	Shallow Overburden
Chloroethane	10		—	—	2 / 4	12	9 J	27	MW-11-01	4 / 8	18	11	62	MW-11-02	1 / 4	5.0	5 J		MW-04-03	MW-11-02	Deep Overburden
Vinyl Chloride	10		—	—	0 / 4	—	—	—	—	0 / 8	—	—	—	—	1 / 4	10	24		MW-07-02	MW-07-02	Bedrock
Carbon Disulfide	10		—	—	0 / 4	—	—	—	—	2 / 8	4.0 *	1 J	1 J	MW-10-01	0 / 4	—	--	—	—	MW-10-01	Deep Overburden
WATER SOLUBLE ORGANICS (µg/L)																				
N,N-DMF	50		—	—	0 / 4	—	—	—	—	2 / 8	110	257 J	495	MW-14-01	2 / 4	490	469	1,440 J	MW-07-02	MW-07-02	Bedrock
SEMIVOLATILE ORGANICS (µg/L)																				
Naphthalene	10		—	—	1 / 4	4.8 *	4 J		MW-11-01	4 / 8	5.2	2 J	9 J	MW-14-01	0 / 4	—	--	—	—	MW-14-01	Deep Overburden
2-Methylnaphthalene	10		—	—	0 / 4	—	—	—	—	1 / 8	5.0	5 J		OW-27	0 / 4	—	--	—	—	OW-27	Deep Overburden
1,2-Dichlorobenzene	10		—	—	1 / 4	4.5 *	3 J		MW-11-01	1 / 8	4.6 *	2 J		MW-11-02	0 / 4	—	--	—	—	MW-11-01	Shallow Overburden
1,3-Dichlorobenzene	10		—	—	0 / 4	—	—	—	—	1 / 8	5.0	5 J		MW-14-01	0 / 4	—	--	—	—	MW-14-01	Deep Overburden
1,4-Dichlorobenzene	10		—	—	1 / 4	5.0	5 J		MW-11-01	4 / 8	3.5 *	1 J	3 J	MW-11-02	0 / 4	—	--	—	—	MW-11-01	Shallow Overburden
2-Methylphenol	10		—	—	0 / 4	—	—	—	—	0 / 8	—	—	—	—	1 / 4	4.2 *	2 J		MW-04-03	MW-04-03	Bedrock
4-Methylphenol	10		—	—	0 / 4	—	—	—	—	1 / 8	13	72		MW-13-02	0 / 4	—	--	—	—	MW-13-02	Deep Overburden
2,4-Dimethylphenol	10		—	—	0 / 4	—	—	—	—	2 / 8	4.9	3 J	6 J	MW-14-01	0 / 4	—	--	—	—	MW-14-01	Deep Overburden
Diethylphthalate	10		—	—	2 / 4	5.5	5 J	7 J	MW-03-01	5 / 8	6.1	1 J	16	OW-27	1 / 4	4.0 *	1 J		MW-04-03	OW-27	Deep Overburden
Di-n-butylphthalate	10		—	—	0 / 4	—	—	—	—	2 / 8	4.1 *	1 J	2 J	MW-14-01	2 / 4	3.8 *	2 J	3 J	MW-07-02	MW-07-02	Bedrock
PESTICIDES (µg/L)																				
beta-BHC	0.05	0.056	—	—	0 / 4	—	—	—	—	1 / 8	0.03	0.094 J		MW-14-01	0 / 4	—	--	—	—	MW-14-01	Deep Overburden
gamma-BHC(Lindane)	0.05	0.056	—	—	0 / 4	—	—	—	—	1 / 8	0.02 *	0.0051 J		MW-07-01	1 / 4	0.03 *	0.024 J		MW-07-02	MW-07-02	Bedrock
4,4'-DDD	0.10	0.11	—	—	1 / 4	0.04 *	0.0050 J		MW-02-01	0 / 8	—	—	—	—	0 / 4	—	--	—	—	MW-02-01	Shallow Overburden
4,4'-DDT	0.10	0.11	—	—	0 / 4	—	—	—	—	1 / 8	0.05 *	0.016 J		MW-14-01	0 / 4	—	--	—	—	MW-14-01	Deep Overburden
Methoxychlor	0.50	0.56	—	—	0 / 4	—	—	—	—	1 / 8	0.23 *	0.013 J		MW-11-02	0 / 4	—	--	—	—	MW-11-02	Deep Overburden
Heptachlor	0.05	0.056	—	0.0023 J	0 / 4	—	—	—	—	0 / 8	—	—	—	—	0 / 4	—	--	—	—	MW-01-02	Background
Heptachlor Epoxide	0.05	0.056	—	—	0 / 4	—	—	—	—	1 / 8	0.02 *	0.0063 J		MW-14-01	0 / 4	—	--	—	—	MW-14-01	Deep Overburden
Endosulfan II	0.10	0.11	—	—	0 / 4	—	—	—	—	1 / 8	0.05 *	0.0066 J		MW-14-01	1 / 4	0.04 *	0.0026 J		MW-04-03	MW-14-01	Deep Overburden
Aldrin	0.05	0.056	—	—	0 / 4	—	—	—	—	1 / 8	0.02 *	0.0043 J		MW-14-01	0 / 4	—	--	—	—	MW-14-01	Deep Overburden
Dieldrin	0.10	0.11	—	—	0 / 4	—	—	—	—	0 / 8	—	—	—	—	1 / 4	0.04 *	0.0034 J		MW-04-03	MW-04-03	Bedrock
Endrin Ketone	0.10	0.11	—	—	1 / 4	0.04 *	0.0028 J		MW-11-01	2 / 8	0.04 *	0.0032 J	0.0066 J	OW-27	0 / 4	—	--	—	—	OW-27	Deep Overburden
alpha-Chlordane	0.05	0.056	—	—	0 / 4	—	—	—	—	1 / 8	0.23 *	0.0036 J		MW-14-01	0 / 4	—	--	—	—	MW-14-01	Deep Overburden
PCBs																				
None Detected																				
METALS - UNFILTERED (µg/L)																				
Aluminum	20	66	43,300	433	4 / 4	37,000	20,400	55,100	MW-04-01	8 / 8	23,000	3,050	110,000	MW-07-01	4 / 4	510	28.5	906	MW-07-02	MW-07-01	Deep Overburden
Iron	11	35	71,200	13,700	4 / 4	79,000	38,450	114,000	MW-04-01	8 / 8	91,000	13,000	268,000	MW-07-01	4 / 4	14,000	858	37,100	MW-03-03	MW-07-01	Deep Overburden
Calcium	39	92	18,700	20,600	4 / 4	30,000	10,190	64,300	MW-11-01	8 / 8	44,000	5,430	87,600	OW-27	4 / 4	40,000	9,670	82,500	MW-07-02	OW-27	Deep Overburden
Magnesium	49	69	7,540	1,900	4 / 4	12,000	6,145	21,500	MW-11-01	8 / 8	17,000	3,260	44,700	MW-14-01	4 / 4	3,000	1,650	4,080	MW-04-03	MW-14-01	Deep Overburden
Sodium	34	38	16,400	10,700	4 / 4	28,000	6,460	69,700	MW-11-01	8 / 8	40,000	6,470	106,000	MW-11-02	4 / 4	36,000	10,900	58,800	MW-07-02	MW-11-02	Deep Overburden
Potassium	76	130	11,700	2,250	4 / 4	14,000	6,375	23,700	MW-11-01	8 / 8	31,000	4,340	119,000	MW-14-01	4 / 4	21,000	1,020	76,500	MW-07-02	MW-14-01	Deep Overburden
Barium	1	4	213	12.8	4 / 4	270	94.4	370	MW-03-01	8 / 8	200	48.9	508	MW-07-01	3 / 4	34	7.0	87.7	MW-11-03	MW-07-01	Deep Overburden
Beryllium	1		5.1 J	—	4 / 4	5.7	2.6	9.2 J	MW-03-01	4 / 8	2.8	1.5 J	13.7	OW-27	0 / 4	—	--	—	—	MW-07-01	Deep Overburden
Cadmium	1		—	—	0 / 4	—	—	—	—	1 / 8	5.0	33.8 J		MW-07-01	0 / 4	—	--	—	—	OW-27	Deep Overburden
Chromium	2	4	57.5	—	2 / 4	24	27.8 J	51.6	MW-04-01	4 / 8	30	5.6 J	154	MW-07-01	1 / 4	4.5	13.0 J		MW-07-02	MW-07-01	Deep Overburden
Cobalt	3		101	—	4 / 4	22	10.0	31.6	MW-04-01	7 / 8	17	5.3	53.8	MW-07-01	0 / 4	—	--	—	—	MW-12-02	Deep Overburden (5)

TABLE 11 (Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER, JANUARY/FEBRUARY 1992 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	MAXIMUM	BACKGROUND CONCENTRATIONS SHALLOW OVERBURDEN	BEDROCK	SHALLOW OVERBURDEN FREQUENCY OF DETECTION (3)	ARITHMETIC AVERAGE	RANGE OF CONCENTRATIONS (4) MINIMUM	MAXIMUM	MAXIMUM LOCATION	DEEP OVERBURDEN FREQUENCY OF DETECTION (3)	ARITHMETIC AVERAGE	RANGE OF CONCENTRATIONS (4) MINIMUM	MAXIMUM	MAXIMUM LOCATION	BEDROCK FREQUENCY OF DETECTION (3)	ARITHMETIC AVERAGE	RANGE OF CONCENTRATIONS (4) MINIMUM	MAXIMUM	MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	FLOW ZONE OF OVERALL MAX. LOC.
Iron	11	35	71,200	13,700	4 / 4	79,000	38,450	114,000	MW-04-01	8 / 8	91,000	13,000	268,000	MW-07-01	4 / 4	14,000	858	37,100	MW-03-03	MW-07-01	Deep Overburden
Calcium	39	92	18,700	20,600	4 / 4	30,000	10,190	64,300	MW-11-01	8 / 8	44,000	5,430	87,600	OW-27	4 / 4	40,000	9,670	82,500	MW-07-02	OW-27	Deep Overburden
Magnesium	49	69	7,540	1,900	4 / 4	12,000	6,145	21,500	MW-11-01	8 / 8	17,000	3,260	44,700	MW-14-01	4 / 4	3,000	1,650	4,080	MW-04-03	MW-14-01	Deep Overburden
Sodium	34	38	16,400	10,700	4 / 4	28,000	6,460	69,700	MW-11-01	8 / 8	40,000	6,470	106,000	MW-11-02	4 / 4	36,000	10,900	58,800	MW-07-02	MW-11-02	Deep Overburden
Potassium	76	130	11,700	2,250	4 / 4	14,000	6,375	23,700	MW-11-01	8 / 8	31,000	4,340	119,000	MW-14-01	4 / 4	21,000	1,020	76,500	MW-07-02	MW-14-01	Deep Overburden
Barium	1	4	213	12.8	4 / 4	270	94.4	370	MW-03-01	8 / 8	200	48.9	508	MW-07-01	3 / 4	34	7.0	87.7	MW-11-03	MW-07-01	Deep Overburden
Beryllium	1		5.1 J	—	4 / 4	5.7	2.6	9.2 J	MW-03-01	4 / 8	2.8	1.5 J	13.7	OW-27	0 / 4	--	--	--	—	MW-07-01	Deep Overburden
Cadmium	1		—	—	0 / 4	—	--	—	--	1 / 8	5.0	33.8 J		MW-07-01	0 / 4	--	—	—	—	OW-27	Deep Overburden
Chromium	2	4	57.5	—	2 / 4	24	27.8 J	51.6	MW-04-01	4 / 8	30	5.6 J	154	MW-07-01	1 / 4	4.5	13.0 J		MW-07-02	MW-07-01	Deep Overburden
Cobalt	3		101	—	4 / 4	22	10.0	31.6	MW-04-01	7 / 8	17	5.3	53.8	MW-07-01	0 / 4	--	--	--	--	MW-12-02	Deep Overburden (5)
Copper	3		115	—	3 / 4	38	33.7 J	73.3 J	MW-04-01	5 / 8	67	19.5 J	367	MW-07-01	0 / 4	--	--	--	--	MW-07-01	Deep Overburden
Lead	1		64.4	--	3 / 4	29	19.3 J	53.0	MW-04-01	3 / 8	29	15.9	148	OW-27	0 / 4	--	--	--	--	OW-27	Deep Overburden
Manganese	1		1,600	113	4 / 4	4,600	2,510	9,130	MW-04-01	8 / 8	2,400	290	5,610	MW-07-01	4 / 4	250	22.8	651	MW-04-03	MW-04-01	Shallow Overburden
Mercury	0.2		—	—	0 / 3	—	--	—	--	1 / 8	0.13	0.29		OW-27	0 / 1	--	--	--	--	OW-27	Deep Overburden
Nickel	4		30.0	—	4 / 4	25	19.3	34.2	MW-04-01	7 / 8	30	6.0	99.4	MW-07-01	1 / 4	3.5	8.0		MW-04-03	MW-07-01	Deep Overburden
Vanadium	2	3	36.3	—	4 / 4	42	27.2	67.2 J	MW-04-01	8 / 8	30	3.7	142 J	MW-07-01	1 / 4	3.0	8.6		MW-07-02	MW-07-01	Deep Overburden
Zinc	4	11	139	—	4 / 4	140	73.5	210 J	MW-04-01	6 / 8	920	25.7 J	6,320	OW-27	1 / 4	5.6	13.2 J		MW-11-03	OW-27	Deep Overburden
METALS - FILTERED (μg/L)																					
Aluminum	66		96.9	—	1 / 4	430	1,610		MW-04-01	1 / 8	45	131		MW-11-02	1 / 4	44	75.0		MW-11-03	MW-04-01	Shallow Overburden
Iron	35		251 J	45.7 J	4 / 4	24,000	764 J	58,000 J	MW-11-01	7 / 8	51,000	20,900 J	101,000 J	OW-27	4 / 4	200	114 J	310 J	MW-03-03	OW-27	Deep Overburden
Calcium	92		5,030	19,500	4 / 4	25,000	8,770	60,900	MW-11-01	8 / 8	41,000	4,220	81,100	MW-11-02	4 / 4	34,000	9,570	57,300	MW-07-02	MW-11-02	Deep Overburden
Magnesium	69		832	1,690	4 / 4	7,100	2,395	18,400	MW-11-01	8 / 8	12,000	1,550	44,200	MW-14-01	4 / 4	2,400	551	4,050	MW-04-03	MW-14-01	Deep Overburden
Sodium	34		12,400	9,920	4 / 4	28,000	5,320	68,400	MW-11-01	8 / 8	39,000	7,880	107,000	MW-11-02	4 / 4	36,000	10,600	61,300	MW-07-02	MW-11-02	Deep Overburden
Potassium	76		2,390	1,910	4 / 4	9,300	2,015	20,500	MW-11-01	8 / 8	25,000	600	116,000	MW-14-01	4 / 4	22,000	1,020	79,500	MW-07-02	MW-14-01	Deep Overburden
Antimony	31		--	--	0 / 4	--	--	--	--	1 / 8	18	31.5		OW-27	0 / 4	--	--	--	—	OW-27	Deep Overburden
Barium	1		--	--	3 / 4	80	39.9	222	MW-11-01	6 / 8	89	38.3	246	MW-11-02	2 / 4	26	34.0	69.0	MW-11-03	MW-11-02	Deep Overburden
Chromium	2		—	--	0 / 4	—	—	--	--	1 / 8	24	183 J		OW-27	1 / 4	4.9	16.6 J		MW-07-02	OW-27	Deep Overburden
Cobalt	3		--	--	1 / 4	5.4	9.9		MW-04-01	2 / 8	4.6	8.7	13.8	MW-04-02	0 / 4	—	--	—	—	MW-04-02	Deep Overburden
Copper	3		--	—	0 / 4	--	—	—	--	1 / 7	1.8	3.3		MW-10-01	0 / 4	--	--	—	—	MW-10-01	Deep Overburden
Manganese	1		159	31.2	4 / 4	2,800	1,335	5,290	MW-04-01	8 / 8	1,500	11.4	3,855	MW-13-02	3 / 4	190	55.2	547	MW-04-03	MW-04-01	Shallow Overburden
Mercury	0.2		--	--	0 / 4	--	--	--	--	0 / 8	--	--	--	—	2 / 4	0.18	0.23 J	0.29	MW-04-03	MW-04-03	Bedrock
Nickel	4		--	--	0 / 4	--	--	--	--	1 / 8	15	102 J		OW-27	0 / 4	—	--	--	—	OW-27	Deep Overburden
Vanadium	3		--	--	1 / 4	2.0	3.7		MW-11-01	2 / 8	2.8	4.0	9.3	MW-14-01	1 / 4	2.6	2.8		MW-07-02	MW-14-01	Deep Overburden
Zinc	11		—	--	1 / 4	7.6	13.7		MW-04-01	3 / 7	7.7	9 J	12.0	MW-07-01	0 / 4	—	--	—	—	MW-04-01	Shallow Overburden
WATER QUALITY PARAMETERS																					
Sulfide (mg/L)	1		—	—	0 / 4	--	—	—	—	1 / 8	1.1	4.94		MW-14-01	0 / 4	--	--	—	—	MW-14-01	Deep Overburden
Cyanide	Not Detected																				
Total Organic Carbon (mg/L)	0.5		15	11	4 / 4	52	28	105	MW-11-01	8 / 8	74	10	220	MW-14-01	3 / 4	15	6.3	34	MW-04-03	MW-14-01	Deep Overburden
Biochemical Oxygen Demand (mg/L)	1		—	--	1 / 4	5.7	19 J		MW-11-01	4 / 8	11	8.7	39 J	MW-13-02	1 / 4	4.6	17		MW-04-03	MW-13-02	Deep Overburden
Hardness (mg/L)	NA		78	59	4 / 4	120	51	249	MW-11-01	8 / 8	180	35	329	MW-14-01	4 / 4	110	31	218	MW-07-02	MW-14-01	Deep Overburden
pH	NA		6.2	7.8	4 / 4	6	6	6.8	MW-04-01	8 / 8	6.6	6.4	6.9	MW-04-02	4 / 4	8.1	6.2	11.2	MW-07-02	MW-07-02	Bedrock
Specific Conductance (μmhos)	NA		68	150	4 / 4	680	280	1,300	MW-11-01	8 / 8	910	125	1,800	MW-11-02	4 / 4	600	130	1,500	MW-07-02	MW-11-02	Deep Overburden

NOTES:

1. Analytical data is presented in Appendix D.
2. If all sample detection limits are the same, a single detection limit is presented.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.
5. The actual highest concentration for this chemical was detected in a background sample.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

-- Analyte was not detected in samples.

R = All sample values were rejected.

TABLE 12 SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER, APRIL 1992 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	RANGE OF DETECTION LIMITS (2) MAXIMUM	BACKGROUND CONCENTRATIONS SHALLOW OVERBURDEN	BACKGROUND CONCENTRATIONS BEDROCK	SHALLOW OVERBURDEN FREQUENCY OF DETECTION (3)	SHALLOW OVERBURDEN ARITHMETIC AVERAGE	SHALLOW OVERBURDEN RANGE OF CONCENTRATIONS (4) MINIMUM	SHALLOW OVERBURDEN RANGE OF CONCENTRATIONS (4) MAXIMUM	SHALLOW OVERBURDEN MAXIMUM LOCATION	DEEP OVERBURDEN FREQUENCY OF DETECTION (3)	DEEP OVERBURDEN ARITHMETIC AVERAGE	DEEP OVERBURDEN RANGE OF CONCENTRATIONS (4) MINIMUM	DEEP OVERBURDEN RANGE OF CONCENTRATIONS (4) MAXIMUM	DEEP OVERBURDEN MAXIMUM LOCATION	BEDROCK FREQUENCY OF DETECTION (3)	BEDROCK ARITHMETIC AVERAGE	BEDROCK RANGE OF CONCENTRATIONS (4) MINIMUM	BEDROCK RANGE OF CONCENTRATIONS (4) MAXIMUM	BEDROCK MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	FLOW ZONE OF OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/L)																				
Benzene	10	40	—	—	1 / 4	4.0 *	1 J		MW-12-01	4 / 7	5.4	3 J	8 J	MW-06-02	1 / 2	5.0	5 J		MW-07-02	MW-06-02	Deep Overburden
Toluene	10	40	—	—	2 / 4	33	12	110	MW-II	2 / 7	14	26	47	MW-07-01	0 / 2	—	—	—	—	MW-II	Shallow Overburden
Ethylbenzene	10	40	—	—	1 / 4	4.5 *	3 J		MW-12-01	4 / 7	10	3 J	22	OW-27	0 / 2	—	—	—	—	OW-27	Deep Overburden
Total Xylenes	10	40	—	—	1 / 4	6.0	9 J		MW-12-01	4 / 7	17	6 J	50.5	OW-27	1 / 2	3.5 *	2 J		MW-07-02	OW-27	Deep Overburden
Chlorobenzene	10	40	—	—	2 / 4	5.5	1 J	11	MW-12-01	2 / 7	4.8 *	4 J	4.5 J	OW-27	0 / 2	—	—	—	—	MW-12-01	Shallow Overburden
Styrene	10	40	—	—	0 / 4	—	—	—	—	1 / 7	5.7	10		OW-27	0 / 2	—	—	—	—	OW-27	Deep Overburden
Acetone	10	40	—	—	1 / 4	79	300		MW-II	1 / 7	71	470		OW-27	0 / 2	—	—	—	—	OW-27	Deep Overburden
2-Butanone	10	40	—	—	0 / 4	—	—	—	—	0 / 7	—	—	—	—	1 / 2	8.0	11		MW-07-02	MW-07-02	Bedrock
Trichloroethene	10	40	—	—	0 / 4	—	—	—	—	0 / 7	—	—	—	—	1 / 2	3.5 *	2 J		MW-07-02	MW-07-02	Bedrock
1,1,1-Trichloroethane	10	40	—	—	0 / 4	—	—	—	—	0 / 7	—	—	—	—	1 / 2	3.5 *	2 J		MW-07-02	MW-07-02	Bedrock
1,1-Dichloroethene	10	40	—	—	0 / 4	—	—	—	—	0 / 7	—	—	—	—	1 / 2	3.0 *	1 J		MW-07-02	MW-07-02	Bedrock
1,2-Dichloroethene(total)	10	40	—	—	0 / 4	—	—	—	—	5 / 7	35	1 J	130	MW-07-01	1 / 2	42	78		MW-07-02	MW-07-01	Deep Overburden
1,1-Dichloroethane	10	40	—	—	1 / 4	4.5 *	3 J		MW-12-01	3 / 7	20	2 J	100	OW-30	1 / 2	14	22		MW-07-02	OW-30	Deep Overburden
Chloroethane	10	40	—	—	1 / 4	6.0	9 J		MW-12-01	4 / 7	19	5.5 J	58	MW-06-02	0 / 2	—	—	—	—	MW-06-02	Deep Overburden
Vinyl Chloride	10	40	—	—	0 / 4	—	—	—	—	3 / 7	78	8.5 J	340	OW-30	1 / 2	8.5	12		MW-07-02	OW-30	Deep Overburden
Carbon Disulfide	10	40	1 J	11	1 / 4	4.5 *	3 J		MW-06-01	0 / 7	—	—	—	—	1 / 2	5.5 *	2 J		MW-08-02	MW-06-01	Shallow Overburden (5)
WATER SOLUBLE ORGANICS (µg/L)																				
N,N-DMF	50		—	—	0 / 4	—	—	—	—	1 / 7	42	142		OW-30	1 / 2	650	1,270		MW-07-02	MW-07-02	Bedrock
SEMIVOLATILE ORGANICS - CLP (µg/L)																				
Naphthalene	10		—	—	1 / 4	4.0 *	0.8 J		MW-12-01	3 / 7	4.2 *	2 J	4 J	MW-06-02	0 / 2	—	—	—	—	MW-06-02	Deep Overburden
2-Methylnaphthalene	10		—	—	0 / 4	—	—	—	—	1 / 7	4.6 *	2.5 J		OW-27	0 / 2	—	—	—	—	OW-27	Deep Overburden
1,2-Dichlorobenzene	10		—	—	0 / 4	—	—	—	—	2 / 7	3.9 *	1 J		MW-06-02	0 / 2	—	—	—	—	MW-06-02	Deep Overburden
1,4-Dichlorobenzene	10		—	—	1 / 4	4.0 *	1 J		MW-12-01	2 / 7	4.3 *	1.5 J	3.5 J	MW-07-01	0 / 2	—	—	—	—	MW-07-01	Deep Overburden
4-Chloroaniline	10		—	—	1 / 4	4.0 *	1 J		MW-II	0 / 7	—	—	—	—	0 / 2	—	—	—	—	MW-II	Shallow Overburden
Phenol	10		—	7 J	0 / 4	—	—	—	—	0 / 7	—	—	—	—	0 / 2	—	—	—	—	MW-01-02	Background
2-Methylphenol	10		—	—	2 / 4	3.5 *	0.9 J	3 J	MW-II	0 / 7	—	—	—	—	0 / 2	—	—	—	—	MW-II	Shallow Overburden
4-Methylphenol	10		—	—	1 / 4	19	60		MW-II	2 / 7	8.1	6.5 J	25	OW-30	0 / 2	—	—	—	—	MW-II	Shallow Overburden
2,4-Dimethylphenol	10		—	—	0 / 4	—	—	—	—	2 / 7	4.3 *	1 J	4 J	MW-06-02	0 / 2	—	—	—	—	MW-06-02	Deep Overburden
4-Chloro-3-methylphenol	10		—	—	0 / 4	—	—	—	—	2 / 7	4.3	0.9 J	4.5 J	OW-27	0 / 2	—	—	—	—	OW-27	Deep Overburden
Diethylphthalate	10		—	—	0 / 4	—	—	—	—	3 / 7	6.8	7 J	11.5	MW-07-01	0 / 2	—	—	—	—	MW-07-01	Deep Overburden
Di-n-butylphthalate	10		—	—	0 / 4	—	—	—	—	1 / 7	4.4 *	0.9 J		OW-27	0 / 2	—	—	—	—	OW-27	Deep Overburden
bis(2-Ethylhexyl)phthalate	10		—	—	0 / 4	—	—	—	—	1 / 7	4.4 *	0.9 J		MW-06-02	0 / 2	—	—	—	—	MW-06-02	Deep Overburden
PESTICIDES (µg/L)																				
delta-BHC	0.05		—	—	2 / 4	0.02 *	0.009 J	0.010 J	MW-II	1 / 7	0.02 *	0.006 J		MW-07-01	0 / 2	—	—	—	—	MW-II	Shallow Overburden
PCBs																				
None Detected																				
METALS - UNFILTERED (µg/L)																				
Aluminum	22		10,800	—	4 / 4	15,000	2,780	24,200 J	MW-II	6 / 7	8,600	3,460 J	25,850 J	MW-07-01	2 / 2	360	278 J	445 J	MW-08-02	MW-07-01	Deep Overburden
Iron	23		12,100	30,900	4 / 4	61,000	10,900	114,000 J	MW-II	7 / 7	56,000	8,830 J	114,500 J	MW-07-01	1 / 2	4,800	9,430 J		MW-08-02	MW-07-01	Deep Overburden
Calcium	34		11,500	14,100	4 / 4	10,000	6,230	14,300	MW-12-01	7 / 7	30,000	5,520	74,150	OW-27	2 / 2	33,000	25,500	40,500	MW-07-02	OW-27	Deep Overburden
Magnesium	22		2,940	1,500	4 / 4	4,700	2,400	7,100	MW-II	7 / 7	6,700	1,140	22,900	MW-06-02	2 / 2	2,700	1,300	4,140	MW-08-02	MW-06-02	Deep Overburden
Sodium	67		13,000	13,600	4 / 4	9,500	7,130 J	15,000	MW-06-01	7 / 7	23,000	6,730	101,000	MW-06-02	2 / 2	32,000	10,600	52,500	MW-07-02	MW-06-02	Deep Overburden
Potassium	82		4,370	2,590	4 / 4	8,700	4,330	16,500	MW-06-01	7 / 7	12,000	1,640	43,800	MW-06-02	2 / 2	36,000	4,420	67,700	MW-07-02	MW-07-02	Bedrock
Antimony	16		—	—	1 / 4	10	17.5		MW-05-01	0 / 7	—	—	—	—	0 / 2	—	—	—	—	MW-05-01	Shallow Overburden
Barium	1		79.8 J	18.6 J	4 / 4	98	60.8 J	146	MW-12-01	6 / 7	94	27.6	232 J	MW-06-02	2 / 2	72	25.8	118	MW-08-02	MW-06-02	Deep Overburden
Beryllium	1		1.4	—	3 / 4	2.3	2.6	3.4	MW-II	3 / 7	1.2	1.1	3.35	MW-07-01	0 / 2	—	—	—	—	MW-II	Shallow Overburden
Cadmium	2		—	—	0 / 4	—	—	—	—	1 / 7	3.7	19.55 J		OW-27	0 / 2	—	—	—	—	OW-27	Deep Overburden
Chromium	3		11.5	—	3 / 4	22	4.2	54.3 J	MW-II	3 / 7	13.1	18.6	33.4 J	MW-07-01	0 / 2	—	—	—	—	MW-II	Shallow Overburden
Cobalt	3		31.6	—	3 / 4	12	8.3	26.2	MW-II	4 / 7	7.4	3.2	22.1	OW-27	0 / 2	—	—	—	—	MW-II	Shallow Overburden (5)
Copper	2		24.4	—	2 / 4	28	43 J	55.9	MW-05-01	6 / 7	38	16.35 J	68.75 J	MW-07-01	0 / 2	—	—	—	—	MW-07-01	Deep Overburden
Lead	1	5	22.1	—	3 / 4	23	24 J	39.9 J	MW-II	3 / 7	17	7.8 J	69.85 J	OW-27	0 / 2	—	—	—	—	OW-27	Deep Overburden
Manganese	1		444	330	4 / 4	3,000	220	6,960	MW-12-01	7 / 7	1,000	338	1,760	MW-07-01	1 / 2	1,700	3,380		MW-08-02	MW-12-01	Shallow Overburden

TABLE 12 (Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER, APRIL 1992 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	RANGE OF DETECTION LIMITS (2) MAXIMUM	BACKGROUND CONCENTRATIONS SHALLOW OVERBURDEN	BACKGROUND CONCENTRATIONS BEDROCK	SHALLOW OVERBURDEN FREQUENCY OF DETECTION (3)	SHALLOW OVERBURDEN ARITHMETIC AVERAGE	SHALLOW OVERBURDEN RANGE OF CONCENTRATIONS (4) MINIMUM	SHALLOW OVERBURDEN RANGE OF CONCENTRATIONS (4) MAXIMUM	SHALLOW OVERBURDEN MAXIMUM LOCATION	DEEP OVERBURDEN FREQUENCY OF DETECTION (3)	DEEP OVERBURDEN ARITHMETIC AVERAGE	DEEP OVERBURDEN RANGE OF CONCENTRATIONS (4) MINIMUM	DEEP OVERBURDEN RANGE OF CONCENTRATIONS (4) MAXIMUM	DEEP OVERBURDEN MAXIMUM LOCATION	BEDROCK FREQUENCY OF DETECTION (3)	BEDROCK ARITHMETIC AVERAGE	BEDROCK RANGE OF CONCENTRATIONS (4) MINIMUM	BEDROCK RANGE OF CONCENTRATIONS (4) MAXIMUM	BEDROCK MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	FLOW ZONE OF OVERALL MAX. LOC.
Mercury	0.2		--	--	0 / 4	--	--	--	--	1 / 7	0.13	0.3 J		OW-27	0 / 2	--	--	--	--	OW-27	Deep Overburden
Nickel	3		9.3	4.8	2 / 4	17	3.6	49.4 J	MW-II	3 / 7	14	15.8	40.3 J	OW-27	0 / 2	--	--	--	--	MW-II	Shallow Overburden
Vanadium	2		--	--	3 / 4	20	19.7	35.2	MW-II	2 / 7	9.4	17.15	31.9	MW-07-01	0 / 2	--	--	--	--	MW-II	Shallow Overburden
Zinc	11		28.2 J	--	3 / 4	81	52.6 J	192 J	MW-II	7 / 7	450	18.8 J	2750 J	OW-27	1 / 2	9.4	13.3 J		MW-07-02	OW-27	Deep Overburden
METALS - FILTERED (μg/L)																					
Iron	23	5	--	--	3 / 4	39,000	3,040	80,300	MW-II	6 / 7	36,000	4,740	89,850	OW-27	1 / 2	2,900	5,770		MW-08-02	OW-27	Deep Overburden
Calcium	28	4	4,190	14,500	4 / 4	9,100	5,230	14,000	MW-12-01	7 / 7	29,000	5,150	66,100	OW-27	2 / 2	29,000	20,900	36,300	MW-07-02	OW-27	Deep Overburden
Magnesium	22	5	756	1,560	4 / 4	2,300	1,670	2,940	MW-12-01	7 / 7	5,100	1,150	22,200	MW-06-02	2 / 2	2,000	505	3,590	MW-08-02	MW-06-02	Deep Overburden
Sodium	34	7	14,000	14,300	4 / 4	9,000	5,430	15,300	MW-06-01	7 / 7	23,000	6,860	104,000	MW-06-02	2 / 2	33,000	10,800	55,000	MW-07-02	MW-06-02	Deep Overburden
Potassium	82	94	1,950	2,820	4 / 4	6,000	747	16,400	MW-06-01	7 / 7	10,000	787	44,000	MW-06-02	2 / 2	37,000	4,340	69,400	MW-07-02	MW-07-02	Bedrock
Barium	1	5	--	--	3 / 4	38	29.2	76.2	MW-12-01	3 / 7	49	36.7	215	MW-06-02	2 / 2	62	28.7	95.3	MW-08-02	MW-06-02	Deep Overburden
Lead	1	5	--	--	0 / 4	--	--	--	--	1 / 7	1.4	2.3		OW-27	0 / 2	--	--	--	--	OW-27	Deep Overburden
Manganese	1		47.4	64.8	4 / 4	2,700	26.4	6,770	MW-12-01	6 / 7	790	416	1,340	MW-06-02	1 / 2	1,400	2,800		MW-08-02	MW-12-01	Shallow Overburden
Nickel	3	5	--	--	0 / 4	--	--	--	--	2 / 7	4.5	5.8	18.3	MW-12-02	0 / 2	--	--	--	--	MW-12-02	Deep Overburden
Zinc	8	1	--	--	1 / 4	9.5	23 J		MW-12-01	2 / 7	11	18.4 J	35.8 J	MW-12-02	0 / 2	--	--	--	--	MW-12-02	Deep Overburden
WATER QUALITY PARAMETERS																					
Cyanide - Not Detected																					
Ammonia (mg/L)	0.0300		--	0.0750	3 / 4	5.9	0.320	17.1	MW-II	6 / 7	9.8	0.0340	51.7	MW-06-02	2 / 2	0.59	0.300	0.880	MW-08-02	MW-06-02	Deep Overburden
Total Organic Carbon (mg/L)	0.50		9.3	12.7	4 / 4	31	7.9	55.0 J	MW-II	7 / 7	48	9.7	99.5	OW-27	2 / 2	87	24.0	150	MW-07-02	MW-07-02	Bedrock
Biochemical Oxygen Demand (mg/L)	1.0		--	2.2	2 / 3	6.3	4.9	13.4 J	MW-II	5 / 5	17	1.0	31.5 J	OW-30	2 / 2	2.6	1.6	3.7	MW-07-02	OW-30	Deep Overburden
Hardness (mg/L)	NA		41	41	4 / 4	44	26	62	MW-II	7 / 7	100	18	257	MW-06-02	2 / 2	94	81	106	MW-07-02	MW-06-02	Deep Overburden
pH	NA		7.7	8.4	4 / 4	6.3	5.9	6.6	MW-II	7 / 7	6.5	6.2	6.7	MW-08-01	2 / 2	9.4	7.1	11.7	MW-07-02	MW-06-01	Shallow Overburden
Specific Conductance (μmhos/cm)	NA		100	150	4 / 4	860	78	2500	MW-06-01	7 / 7	360	77	730	MW-06-02	2 / 2	620	200	1050	MW-07-02	MW-07-02	Bedrock

NOTES:

1. Analytical data is presented in Appendix D.
2. If all sample detection limits are the same, a single detection limit is presented.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.
5. The actual highest concentration for this chemical was detected in a background sample.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

-- Analyte was not detected in samples.

TABLE 13 SUMMARY OF CHEMICALS DETECTED IN RESIDENTIAL WELLS, JUNE 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	MAXIMUM	FREQUENCY OF DETECTION (3)	ARITHMETIC AVERAGE	RANGE OF CONCENTRATIONS (4) MINIMUM	MAXIMUM	MAXIMUM LOCATION
VOLATILE ORGANICS (µg/L)							
Ethylbenzene	1.0		1 / 9	0.60	1.4		RES#3
o-Xylene	1.0		1 / 9	0.53	0.8 J		RES#3
Trichloroethene	5		1 / 9	2.0	2 J		RES#9
1,1-Dichloroethane	1.0		1 / 9	0.79	3.1		RES#3
Chloroethane	1.0		1 / 9	0.56	1.0		RES#3
Carbon Disulfide	1.0		1 / 9	1.8	12.0		RES#3
SEMIVOLATILE ORGANICS							
None Detected							
PESTICIDES/PCBs							
None Detected							
METALS - UNFILTERED (µg/L)							
Aluminum	10	27	2 / 9	100	294 J	470 J	RES#3
Iron	7	18	5 / 9	9,300	180 J	81,000 J	RES#3
Calcium	7	28	9 / 9	8,500	4,670	17,800	RES#3
Magnesium	13	33	9 / 9	2,000	1,190	4,580	RES#3
Sodium	22	30	9 / 9	12,000	5,890	31,400	RES#7
Potassium	42	251	9 / 9	2,000	619	7,470	RES#4
Barium	1	2	6 / 9	12	5.8	44.3	RES#4
Copper	3	11	2 / 9	14	11 J	58.6	RES#9
Manganese	1	9	6 / 9	1,200	21.4 J	3,100 J	RES#3
METALS - FILTERED (µg/L)							
Aluminum	10	27	1 / 9	41	175		RES#4
Iron	7	18	2 / 9	3,400	774	30,000	RES#3
Calcium	7	28	9 / 9	8,700	4,890	18,500	RES#3
Magnesium	13	33	9 / 9	2,000	1,030	4,890	RES#3
Sodium	22	30	9 / 9	13,000	5,320	32,500	RES#7
Potassium	42	251	9 / 9	2,000	491	7,420	RES#4
Antimony	11	17	3 / 9	8.2	8.6 J	14.1	RES#6
Barium	1	2	3 / 9	11	18.6	41.2	RES#4
Copper	3	11	3 / 9	8.5	7.7	29.6	RES#4
Manganese	1	9	7 / 9	1,100	11.6	3,100	RES#1
Nickel	4	6	2 / 9	3.4	6.9	8.0	RES#9
Zinc	3	8	1 / 9	13	57.3		RES#2
WATER QUALITY PARAMETERS							
Sulfide (mg/L)	0.05		9 / 9	1.6	0.45	3.70	RES#3
Cyanide	Not Detected						
Total Organic Carbon (mg/L)	1.0		1 / 9	1.1	5.6 J		RES#3
Biochemical Oxygen Demand	Not Detected						
Hardness (mg/L)	NA		9 / 9	29	17	63	RES#3
pH	NA		9 / 9	6.4	5.9	7.8	RES#7
Specific Conductance (µmhos/cm)	NA		9 / 9	240	95	520	RES#4

NOTES:

1. Analytical data is presented in Appendix D.
2. If all sample detection limits are the same, a single detection limit is presented.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

--- Analyte was not detected in samples.

TABLE 14 SUMMARY OF CHEMICALS DETECTED IN RESIDENTIAL WELLS, SEPTEMBER/OCTOBER 1991 (1)

CHEMICAL	DETECTION LIMIT	FREQUENCY OF DETECTION (2)	ARITHMETIC AVERAGE	RANGE OF CONCENTRATIONS (3) MINIMUM	MAXIMUM	MAXIMUM LOCATION
VOLATILE ORGANICS - 524 (µg/L)						
Benzene	1	1 / 9	0.53	0.8 J		RES#3
Toluene	1	2 / 9	0.91	0.6 J	4.1 J	RES#7
Ethylbenzene	1	1 / 9	0.46 *	0.1 J		RES#7
Trichloroethene	1	2 / 9	0.62	0.6 J	1.5	RES#2
trans-1,2-Dichloroethene	1	1 / 9	0.48 *	0.3 J		RES#4
1,1-Dichloroethane	1	1 / 9	0.66	1.9		RES#3
WATER SOLUBLE ORGANICS (µg/L)						
N,N-DMF	50	2 / 9	21 *	1.9 J	14 J	RES#3
SEMIVOLATILE ORGANICS (µg/L)						
4-Methylphenol	10	1 / 9	11	63		RES#3
PESTICIDES/PCBs						
None Detected						
METALS - UNFILTERED (µg/L)						
Aluminum	13	1 / 9	94	552 J		RES#3
Iron	6	6 / 9	7,000	160	41,700	RES#2
Calcium	20	9 / 9	11,000	3,220	23,400	RES#4
Magnesium	26	9 / 9	2,000	708	4,520	RES#3
Sodium	13	9 / 9	11,000	7,110	17,700	RES#9
Potassium	442	1 / 9	860	4,010		RES#3
Barium	1	2 / 9	5.5	15.2	20.7	RES#5
Copper	4	2 / 9	16	51.8	58.4	RES#2
Manganese	2	7 / 9	810	2.6	3,100	RES#1
METALS - FILTERED (µg/L)						
Iron	6	4 / 9	230	117	1,050	RES#1
Calcium	20	9 / 9	11,000	3,210	23,000	RES#4
Magnesium	26	9 / 9	2,100	757	4,550	RES#3
Sodium	13	9 / 9	11,000	6,870	16,800	RES#9
Potassium	442	1 / 9	920	3,880		RES#3
Antimony	25	2 / 9	18	28.4	32.4	RES#9
Arsenic	1	1 / 9	0.56	1.0		RES#3
Barium	1	1 / 9	3.9	19.7		RES#5
Manganese	2	6 / 9	780	8.4	3,160	RES#1
WATER QUALITY PARAMETERS						
Sulfide	Not Detected					
Cyanide	Not Detected					
Total Organic Carbon (mg/L)	0.5	7 / 9	3.5	0.8	17.7 J	RES#3
Biochemical Oxygen Demand (mg/L)	1.0	1 / 9	3.0	22.0		RES#3
Hardness (mg/L)	NA	9 / 9	35	11	67	RES#4
pH	NA	9 / 9	6.7	5.8	7.5	RES#7
Specific Conductance (µmhos/cm)	NA	9 / 9	120	55	180	RES#3

NOTES:

1. Analytical data is presented in Appendix D.
2. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
3. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

--- Analyte was not detected in samples.

TABLE 15 SUMMARY OF CHEMICALS DETECTED IN RESIDENTIAL WELLS, JANUARY/FEBRUARY 1992 (1)

CHEMICAL	DETECTION LIMITS	FREQUENCY OF DETECTION (2)	ARITHMETIC AVERAGE	RANGE OF CONCENTRATIONS (3) MINIMUM	MAXIMUM	MAXIMUM LOCATION
VOLATILE ORGANICS – (µg/L)						
Acetone	5.0	1 / 3	1.9 *	0.6 J		RES#8
WATER SOLUBLE ORGANICS						
None Detected						
SEMIVOLATILE ORGANICS						
None Detected						
PESTICIDES (µg/L)						
Dieldrin	0.10	1 / 3	0.03 *	0.002 J		RES#7
Endrin Aldehyde	0.10	1 / 3	0.07	0.10 J		RES#7
Endrin Ketone	0.10	1 / 3	0.07	0.10 J		RES#7
PCBs						
None Detected						
METALS – UNFILTERED (µg/L)						
Aluminum	20	2 / 3	22	20.0	36.6	RES#10
Iron	11	1 / 3	260	742		RES#8
Calcium	39	3 / 3	12,000	7,390	14,400	RES#10
Magnesium	49	3 / 3	2,200	2,110	2,220	RES#10
Sodium	38	3 / 3	310,000	12,300	891,000	RES#10
Potassium	130	3 / 3	910	572	1,220	RES#8
Manganese	1	2 / 3	330	4.1	978	RES#8
Mercury	0.2	1 / 1	0.46	0.46 J		RES#10
Zinc	4	1 / 3	56	165		RES#10
METALS – FILTERED (µg/L)						
Iron	35	2 / 3	87	94.2 J	149 J	RES#8
Calcium	92	3 / 3	12,000	7,310	15,300	RES#10
Magnesium	69	3 / 3	2,100	1,970	2,240	RES#10
Sodium	34	3 / 3	20,000	12,300	24,900	RES#7
Potassium	76	3 / 3	900	724	1,220	RES#8
Manganese	1	1 / 3	310	932		RES#8
Zinc	11	1 / 3	8.7	15.1		RES#8
WATER QUALITY PARAMETERS						
Sulfide	Not Detected					
Cyanide	Not Detected					
Total Organic Carbon (mg/L)	0.50	3 / 3	9.8	8.3	12	RES#7
Biochemical Oxygen Demand – Not Detected						
Hardness (mg/L)	NA	3 / 3	38	27	45	RES#10
pH	NA	2 / 2	7.2	6.1	8.3	RES#10
Specific Conductance (µmhos/cm)	NA	3 / 3	190	165	220	RES#10

NOTES:

1. Analytical data is presented in Appendix D.
2. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
3. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred. * The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

--- Analyte was not detected in samples.

TABLE 16 SUMMARY OF CHEMICALS DETECTED IN RESIDENTIAL WELLS, SEPTEMBER 1993 (1)

CHEMICAL	DETECTION LIMITS	FREQUENCY OF DETECTION (2)	ARITHMETIC AVERAGE	RANGE OF CONCENTRATIONS (3) MINIMUM	MAXIMUM	MAXIMUM LOCATION
VOLATILE ORGANICS - 524 (μg/L)						
Bromodichloromethane	1.0	3 / 3	1.0	1.0 J		RES#7
WATER SOLUBLE ORGANICS						
None Detected						
SEMIVOLATILE ORGANICS						
None Detected						
PESTICIDES (μg/L)						
None Detected						
PCBs						
None Detected						
METALS - UNFILTERED (μg/L) (4)						
Aluminum	31	1 / 7	49	90.6		RES#11
Iron	8.0	1 / 7	120	203		RES#11
Calcium	200	1 / 7	4,712 *	3,520		RES#11
Magnesium	114	1 / 7	1,124	1,450		RES#11
Sodium	183	1 / 7	7,977 *	7,030		RES#11
Potassium	796	1 / 7	708	1,140		RES#11
Barium	6.0	1 / 7	4.3	8.5		RES#11
Copper	3.0	1 / 7	34	142		RES#11
Lead	3.0	1 / 7	2.3	7.0		RES#9
Manganese	2.0	3 / 7	461	30	2,120	RES#6
Zinc	7.0	1 / 7	4.4	10.1		RES#9
METALS - FILTERED (μg/L) (4)						
Calcium	200	1 / 7	4,770 *	3,455		RES#11
Magnesium	114	1 / 7	1,114	1,415		RES#11
Potassium	796	1 / 7	677	1,130		RES#11
Arsenic	3.0	1 / 7	1.8	3.6		RES#5
Barium	6.0	1 / 7	4.4	7.6		RES#11
Copper	3.0	1 / 7	26	116.5 J		RES#11
Manganese	2.0	3 / 7	454	30	2,070	RES#6
WATER QUALITY PARAMETERS						
pH	NA	7 / 7	6.6	5.70	8.24	RES#7
Specific Conductance (μmhos/cm)	NA	7 / 7	108	66	150	RES#10

NOTES:

1. Analytical data is presented in Appendix D.
2. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
3. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred. * The calculated average is greater than the maximum value.
4. Includes analysis of antimony at lower detection limit.

NA = Not Applicable

* = The calculated average is greater than the maximum value.

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

TABLE 17 SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER, JUNE 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	RANGE OF DETECTION LIMITS (2) MAXIMUM	SAUGATUCKET RIVER FREQUENCY OF DETECTION (3)	SAUGATUCKET RIVER ARITHMETIC AVERAGE	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (4) MINIMUM	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (4) MAXIMUM	SAUGATUCKET RIVER MAXIMUM LOCATION	MITCHELL BROOK FREQUENCY OF DETECTION (3)	MITCHELL BROOK ARITHMETIC AVERAGE	MITCHELL BROOK RANGE OF CONCENTRATIONS (4) MINIMUM	MITCHELL BROOK RANGE OF CONCENTRATIONS (4) MAXIMUM	MITCHELL BROOK MAXIMUM LOCATION	UNNAMED BROOK FREQUENCY OF DETECTION (3)	UNNAMED BROOK CONCEN-TRATIONS	UNNAMED BROOK LOCATION	UNNAMED TRIBUTARY FREQUENCY OF DETECTION (3)	UNNAMED TRIBUTARY CONCEN-TRATIONS	UNNAMED TRIBUTARY LOCATION	OVERALL MAXIMUM LOCATION	WATER BODY ASSOC. WITH OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/L)																				
Benzene		5	0 / 6	—	—	—	—	1 / 6	2.6	3 J		SW-12	0 / 1	—	—	0 / 1	—	—	SW-12	Mitchell Brook
Total Xylenes		5	1 / 6	3.6	9		SW-05	1 / 6	3.4	8		SW-07	0 / 1	—	—	0 / 1	—	—	SW-05	Saugatucket
Chlorobenzene		5	0 / 6	—	—	—	—	1 / 6	2.4 *	2 J		SW-12	0 / 1	—	—	0 / 1	—	—	SW-12	Mitchell Brook
1,2-Dichloroethene(total)		5	0 / 6	—	—	—	—	1 / 6	2.8	4 J		SW-14	0 / 1	—	—	0 / 1	—	—	SW-14	Mitchell Brook
Chloroethane		10	0 / 6	—	—	—	—	1 / 6	5.2	6 J		SW-12	0 / 1	—	—	0 / 1	—	—	SW-12	Mitchell Brook
Carbon Disulfide		5	4 / 6	4.5	4 J	10 J	SW-08	1 / 6	2.2 *	1 J		SW-09	0 / 1	—	—	0 / 1	—	—	SW-08	Saugatucket
SEMIVOLATILE ORGANICS (µg/L)																				
bis(2-Ethylhexyl)phthalate		10	0 / 6	—	—	—	—	1 / 6	5.5	8 J		SW-09	0 / 1	—	—	0 / 1	—	—	SW-09	Mitchell Brook
PESTICIDES/PCBs																				
None Detected																				
METALS - UNFILTERED (µg/L)																				
Aluminum	10	27	1 / 6	39	88.5 J		SW-02	5 / 6	480	177 J	968 J	SW-12	0 / 1	—	—	1 / 1	272 J	SW-01	SW-12	Mitchell Brook
Iron	7	18	6 / 6	6,500	234	34,600	SW-05	6 / 6	14,000	547 J	65,000 J	SW-12	1 / 1	5,140 J	SW-10	1 / 1	3,250 J	SW-01	SW-12	Mitchell Brook
Calcium	7	28	6 / 6	8,500	3,950	27,100	SW-05	6 / 6	7,000	2,430	23,200	SW-12	1 / 1	11,100	SW-10	1 / 1	2,980	SW-01	SW-05	Saugatucket
Magnesium	13	33	6 / 6	3,500	1,270	12,900	SW-05	6 / 6	2,300	960	7,380	SW-12	1 / 1	2,680	SW-10	1 / 1	1,070	SW-01	SW-05	Saugatucket
Sodium	22	30	6 / 6	17,000	7,900	59,900	SW-05	6 / 6	12,000	6,550	35,300	SW-12	1 / 1	9,930	SW-10	1 / 1	6,840	SW-01	SW-05	Saugatucket
Potassium	42	251	6 / 6	8,500	777	45,000	SW-05	6 / 6	3,000	650	11,600	SW-12	1 / 1	2,970	SW-10	1 / 1	1,050	SW-01	SW-05	Saugatucket
Arsenic	2	4	1 / 6	2.2	4.1		SW-05	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SW-05	Saugatucket
Barium	1	2	5 / 6	52	5.3	279	SW-05	3 / 6	37	10.6	173	SW-12	1 / 1	31.6	SW-10	0 / 1	—	—	SW-05	Saugatucket
Manganese	1	9	6 / 6	530	22.2 J	2,030	SW-05	6 / 6	570	29.6	1,610 J	SW-12	1 / 1	1,690	SW-10	1 / 1	161	SW-01	SW-05	Saugatucket
Nickel	4	6	0 / 6	—	—	—	—	0 / 6	—	—	—	—	0 / 1	—	—	1 / 1	5.0	SW-01	SW-01	Unnamed trib.
Zinc	3	8	0 / 6	—	—	—	—	2 / 6	11	20.5	22.8	SW-12	0 / 1	—	—	0 / 1	—	—	SW-12	Mitchell Brook
METALS - FILTERED (µg/L)																				
Aluminum	10	27	1 / 6	41	116 J		SW-05	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SW-05	Saugatucket
Iron	7	18	4 / 6	570	361 J	1,520 J	SW-05	6 / 6	1,500	194 J	4,890	SW-12	1 / 1	3,620 J	SW-10	1 / 1	787 J	SW-01	SW-12	Mitchell Brook
Calcium	7	28	6 / 6	5,000	4,130	7,140	SW-08	6 / 6	6,500	2,430	20,100	SW-12	1 / 1	11,300	SW-10	1 / 1	2,970	SW-01	SW-12	Mitchell Brook
Magnesium	13	33	6 / 6	1,600	1,370	2,180	SW-08	6 / 6	2,100	873	6,320	SW-12	1 / 1	2,800	SW-10	1 / 1	1,020	SW-01	SW-12	Mitchell Brook
Sodium	22	30	6 / 6	10,000	8,310	12,350	SW-08	6 / 6	13,000	8,090	31,700	SW-12	1 / 1	12,100	SW-10	1 / 1	9,010	SW-01	SW-12	Mitchell Brook
Potassium	42	251	6 / 6	1,200	859	2,025	SW-08	6 / 6	2,800	684	9,840	SW-12	1 / 1	3,170	SW-10	1 / 1	1,120	SW-01	SW-12	Mitchell Brook
Antimony	11	17	1 / 6	7.9	10.7 J		SW-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SW-08	Saugatucket
Barium	1	2	1 / 6	3.9	6.6		SW-05	2 / 6	22	24.1	92.9	SW-12	1 / 1	30.2	SW-10	0 / 1	—	—	SW-12	Mitchell Brook
Lead	1	2	0 / 6	—	—	—	—	1 / 6	1.8	3.3		SW-09	0 / 1	—	—	0 / 1	—	—	SW-09	Mitchell Brook
Manganese	1	9	6 / 6	240	17.6	550	SW-08	6 / 6	520	16.4 J	1,450	SW-12	1 / 1	1,740 J	SW-10	1 / 1	134 J	SW-01	SW-10	Unnamed brook
Nickel	4	6	0 / 6	—	—	—	—	1 / 6	2.8	5.0 J		SW-09	0 / 1	—	—	0 / 1	—	—	SW-09	Mitchell Brook
Silver	2	4	1 / 6	1.6	1.8 J		SW-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SW-08	Saugatucket
WATER QUALITY PARAMETERS																				
Sulfide (mg/L)	0.05		6 / 6	1.4	0.64	2.2	SW-02	6 / 6	1.4	0.32	1.90	SW-14	1 / 1	1.90	SW-10	1 / 1	0.80	SW-01	SW-02	Saugatucket
Cyanide	Not Detected																			
Total Organic Carbon	Not Detected																			
Hardness (mg/L)	NA		6 / 6	36	15.1	121	SW-05	6 / 6	27	10	88	SW-12	1 / 1	39	SW-10	1 / 1	11.8	SW-01	SW-05	Saugatucket
pH	NA		6 / 6	5.9	5.77	6.02	SW-06	6 / 6	5.8	5.52	6.18	SW-07	1 / 1	7.2	SW-10	1 / 1	5.52	SW-01	SW-10	Unnamed brook
Specific Conductance (µmhos/cm)	NA		6 / 6	93	77	133	SW-08	6 / 6	270	55	1,200	SW-12	1 / 1	26	SW-10	1 / 1	73	SW-01	SW-12	Mitchell Brook
Dissolved Oxygen (mg/L)	NA		6 / 6	8.7	6.62	9.66	SW-03	6 / 6	6.6	1.85	8.40	SW-07	1 / 1	6.48	SW-10	1 / 1	1.9	SW-01	SW-03	Saugatucket
Biochemical Oxygen Demand (mg/L)	2.4		0 / 6	—	—	—	—	0 / 6	—	—	—	—	0 / 1	—	—	1 / 1	2.8 J	SW-01	SW-01	Unnamed trib.

NOTES:

1. Analytical data is presented in Appendix D.
2. If all sample detection limits are the same, a single detection limit is presented.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

— Analyte was not detected in samples.

TABLE 18 SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER, SEPTEMBER/OCTOBER 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	RANGE OF DETECTION LIMITS (2) MAXIMUM	SAUGATUCKET RIVER FREQUENCY OF DETECTION (3)	SAUGATUCKET RIVER ARITHMETIC AVERAGE	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (4) MINIMUM	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (4) MAXIMUM	SAUGATUCKET RIVER MAXIMUM LOCATION	MITCHELL BROOK FREQUENCY OF DETECTION (3)	MITCHELL BROOK ARITHMETIC AVERAGE	MITCHELL BROOK RANGE OF CONCENTRATIONS (4) MINIMUM	MITCHELL BROOK RANGE OF CONCENTRATIONS (4) MAXIMUM	MITCHELL BROOK MAXIMUM LOCATION	UNNAMED BROOK FREQUENCY OF DETECTION (3)	UNNAMED BROOK CONCEN-TRATIONS	UNNAMED BROOK LOCATION	UNNAMED TRIBUTARY FREQUENCY OF DETECTION (3)	UNNAMED TRIBUTARY CONCEN-TRATIONS	UNNAMED TRIBUTARY LOCATION	OVERALL MAXIMUM LOCATION	WATER BODY ASSOC. WITH OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/L)																				
Toluene		10	1 / 7	4.6 *	2 J		SW-05	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SW-05	Saugatucket
Carbon Disulfide		10	4 / 7	5.9	3 J	14	SW-03	1 / 6	4.5 *	2 J		SW-12	0 / 1	—	—	0 / 1	—	—	SW-03	Saugatucket
WATER SOLUBLE ORGANICS (µg/L)																				
Acrylamide		200	0 / 7	—	—	—	—	1 / 6	130	272 J		SW-12	0 / 1	—	—	0 / 1	—	—	SW-12	Mitchell Brook
N,N-DMF		50	0 / 7	—	—	—	—	0 / 6	—	—	—	—	1 / 1	5 J	SW-10	0 / 1	—	—	SW-10	Unnamed brook
SEMIVOLATILE ORGANICS (µg/L)																				
None Detected																				
PESTICIDES (µg/L)																				
gamma-BHC(Lindane)		0.050	0 / 7	—	—	—	—	0 / 6	—	—	—	—	1 / 1	0.002 J	SW-10	0 / 1	—	—	SW-10	Unnamed brook
PCBs																				
None Detected																				
METALS - UNFILTERED (µg/L)																				
Aluminum	13	31	3 / 7	130	121 J	331 J	SW-04	0 / 6	—	—	—	—	0 / 1	—	—	1 / 1	573 J	SW-01	SW-01	Unnamed trib.
Iron	6	12	5 / 7	1,000	882 J	1,825 J	SW-08	3 / 6	1,600	292 J	5,000 J	SW-07	1 / 1	6,160 J	SW-10	1 / 1	1,360 J	SW-01	SW-10	Unnamed brook
Calcium	15	20	7 / 7	5,200	4,010	6,740	SW-08	6 / 6	5,200	3,650 J	10,000	SW-12	1 / 1	9,110	SW-10	1 / 1	2,500	SW-01	SW-12	Mitchell Brook
Magnesium	26	46	7 / 7	1,700	1,460	2,075	SW-08	6 / 6	1,700	1,210 J	3,260	SW-12	1 / 1	2,060	SW-10	1 / 1	975	SW-01	SW-12	Mitchell Brook
Sodium	13	57	7 / 7	11,000	9,640	12,500	SW-08	6 / 6	13,000	10,800	18,800	SW-12	1 / 1	9,545	SW-10	1 / 1	4,620	SW-01	SW-12	Mitchell Brook
Potassium	133	442	0 / 7	—	—	—	—	1 / 6	1,100	4,220		SW-12	0 / 1	—	—	0 / 1	—	—	SW-12	Mitchell Brook
Antimony	25	47	1 / 7	14	25.0		SW-04	1 / 6	15	28.8		SW-07	0 / 1	—	—	0 / 1	—	—	SW-07	Mitchell Brook
Arsenic	1	2	1 / 7	0.57	1		SW-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SW-08	Saugatucket
Barium	1	2	2 / 7	6.1	9.1	13.2	SW-06	4 / 6	13	9.1	28.4	SW-12	1 / 1	24.9	SW-10	0 / 1	—	—	SW-12	Mitchell Brook
Copper	4	5	1 / 7	5.6	11.6		SW-04	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SW-04	Saugatucket
Manganese	2		7 / 7	270	42.3	470	SW-08	4 / 6	220	10.2	708	SW-12	1 / 1	1,410	SW-10	1 / 1	155	SW-01	SW-10	Unnamed brook
Zinc	6	7	0 / 7	—	—	—	—	1 / 6	9.1	17.9 J		SW-09	0 / 1	—	—	0 / 1	—	—	SW-09	Mitchell Brook
METAL - FILTERED (µg/L)																				
Aluminum	13	17	4 / 7	190	132 J	620	SW-03	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SW-03	Saugatucket
Iron	6	7	6 / 7	530	241 J	997	SW-03	2 / 6	890	1,950	3,160	SW-12	1 / 1	3,325 *	SW-10	1 / 1	440	SW-01	SW-10	Unnamed brook
Calcium	8	20	7 / 7	5,600	4,390	7,170 J	SW-11	6 / 6	5,200	3,790 J	9,830	SW-12	1 / 1	9,530 *	SW-10	1 / 1	2,530	SW-01	SW-12	Mitchell Brook
Magnesium	14	26	7 / 7	1,800	1,480	2,160 J	SW-11	6 / 6	1,700	1,220 J	3,120	SW-12	1 / 1	2,430	SW-10	1 / 1	904	SW-01	SW-12	Mitchell Brook
Sodium	13	38	7 / 7	12,000	11,400	14,800	SW-11	6 / 6	14,000	10,600	20,200	SW-12	1 / 1	10,900	SW-10	0 / 1	—	—	SW-12	Mitchell Brook
Potassium	73	442	0 / 7	—	—	—	—	1 / 6	1,000	3,810		SW-12	0 / 1	—	—	0 / 1	—	—	SW-12	Mitchell Brook
Barium	1		3 / 7	7.7	8.5	13.2	SW-05	4 / 6	9.8	4.0	25.2	SW-12	1 / 1	22.7	SW-10	0 / 1	—	—	SW-12	Mitchell Brook
Chromium	2	8	2 / 7	7.0	13.1	13.5	SW-05	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SW-05	Saugatucket
Copper	2	4	3 / 7	12	9.8	29.8	SW-05	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SW-05	Saugatucket
Manganese	1	2	6 / 7	300	136	547	SW-03	4 / 6	200	9.4	690	SW-12	1 / 1	1,295	SW-10	1 / 1	102	SW-01	SW-10	Unnamed brook
Zinc	5	6	0 / 7	—	—	—	—	1 / 6	15	36.6 J		SW-09	0 / 1	—	—	0 / 1	—	—	SW-09	Mitchell Brook
WATER QUALITY PARAMETERS																				
Sulfide	Not Detected																			
Cyanide (µg/L)		10	1 / 7	5.7	10.2 J		SW-04	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SW-04	Saugatucket
Total Organic Carbon (mg/L)		0.5	7 / 7	5.8	4.9 J	7.2 J	SW-02	6 / 6	4.5	3.2 J	5.4 J	SW-12	1 / 1	3.4 J	SW-10	1 / 1	9.9 J	SW-01	SW-01	Unnamed trib.
Hardness (mg/L)		NA	7 / 7	20	16	25	SW-08	6 / 6	20	14 J	38.4	SW-12	1 / 1	31	SW-10	1 / 1	10	SW-01	SW-12	Mitchell Brook
pH		NA	7 / 7	6.2	5.7	6.5	SW-05	6 / 6	5.9	5.3	7.0	SW-12	1 / 1	5.9	SW-10	1 / 1	4.4	SW-01	SW-12	Mitchell Brook
Specific Conductance (µmhos/cm)		NA	7 / 7	120	91	170	SW-05	6 / 6	100	29	222	SW-12	1 / 1	146	SW-10	1 / 1	50	SW-01	SW-12	Mitchell Brook
Dissolved Oxygen (mg/L)		NA	7 / 7	9.0	7.7	10.2	SW-02	6 / 6	9.0	8.6	9.5	SW-13	1 / 1	8.4	SW-10	1 / 1	8	SW-01	SW-02	Saugatucket
Biochemical Oxygen Demand (mg/L)		1.0	2 / 4	0.82	1.1	1.2 J	SW-08	1 / 3	0.70	1.1		SW-12	1 / 1	0.9 J	SW-10	0 / 1	—	—	SW-08	Saugatucket

NOTES:

1. Analytical data is presented in Appendix D.
2. If all sample detection limits are the same, a single detection limit is presented.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

— Analyte was not detected in samples.

TABLE 19 SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER, JANUARY/FEBRUARY 1992 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	RANGE OF DETECTION LIMITS (2) MAXIMUM	SAUGATUCKET RIVER FREQUENCY OF DETECTION (3)	SAUGATUCKET RIVER ARITHMETIC AVERAGE	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (4) MINIMUM	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (4) MAXIMUM	SAUGATUCKET RIVER MAXIMUM LOCATION	MITCHELL BROOK FREQUENCY OF DETECTION (3)	MITCHELL BROOK ARITHMETIC AVERAGE	MITCHELL BROOK RANGE OF CONCENTRATIONS (4) MINIMUM	MITCHELL BROOK RANGE OF CONCENTRATIONS (4) MAXIMUM	MITCHELL BROOK MAXIMUM LOCATION	UNNAMED BROOK FREQUENCY OF DETECTION (3)	UNNAMED BROOK CONCEN-TRATIONS	UNNAMED BROOK LOCATION	OVERALL MAXIMUM LOCATION	WATER BODY ASSOC. WITH OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/L)																	
Carbon Disulfide		10	1 / 4	4.2 *	2 J		SW-05	2 / 3	5.0	1 J	9 J	SW-12	1 / 1	6 J	SW-10	SW-12	Mitchell Brook
WATER SOLUBLE ORGANICS																	
None Detected																	
SEMIVOLATILE ORGANICS (µg/L)																	
Dimethylphthalate	10	250	1 / 4	34 *	1 J		SW-04	0 / 3	—	—	—	—	0 / 1	—	—	SW-04	Saugatucket
Diethylphthalate	10	250	0 / 4	—	—	—	—	1 / 3	4.0 *	2 J		SW-12	0 / 1	—	—	SW-12	Mitchell Brook
Di-n-butylphthalate	10	250	0 / 4	—	—	—	—	1 / 3	4.3 *	3 J		SW-12	0 / 1	—	—	SW-12	Mitchell Brook
PESTICIDES (µg/L)																	
4,4'-DDD		0.10	1 / 4	0.04 *	0.00 J		SW-11	0 / 3	—	—	—	—	0 / 1	—	—	SW-11	Saugatucket
Methoxychlor		0.50	1 / 4	0.19 *	0.01 J		SW-11	0 / 3	—	—	—	—	0 / 1	—	—	SW-11	Saugatucket
PCBs																	
None Detected																	
METALS - UNFILTERED (µg/L)																	
Aluminum		66	4 / 4	110	105	140	SW-04	3 / 3	130	109	147	SW-09	1 / 1	160	SW-10	SW-10	Unnamed brook
Iron		35	4 / 4	660	108	1360	SW-05	3 / 3	740	280	1,105	SW-12	1 / 1	6,500	SW-10	SW-10	Unnamed brook
Calcium		92	4 / 4	3,600	3,030	4,060	SW-11	3 / 3	3,200	2,810	3,660	SW-12	1 / 1	8,110	SW-10	SW-10	Unnamed brook
Magnesium		69	4 / 4	1,400	1,250	1,510	SW-11	3 / 3	1,200	1,070	1,335	SW-12	1 / 1	2,160	SW-10	SW-10	Unnamed brook
Sodium		34	4 / 4	9,500	9,290	10,100	SW-11	3 / 3	8,700	8,080	9,330	SW-12	1 / 1	7,910	SW-10	SW-11	Saugatucket
Potassium		76	4 / 4	870	612	1,090	SW-11	3 / 3	680	472	889	SW-12	1 / 1	2,350	SW-10	SW-10	Unnamed brook
Barium		1	0 / 4	—	—	—	—	1 / 3	6.9	10.8		SW-12	1 / 1	25.2	SW-10	SW-10	Unnamed brook
Manganese		1	4 / 4	150	62.5 J	195	SW-05	3 / 3	120	53.4 J	173	SW-12	1 / 1	905	SW-10	SW-10	Unnamed brook
Zinc		11	0 / 4	—	—	—	—	0 / 3	—	—	—	—	1 / 1	17.2 J	SW-10	SW-10	Unnamed brook
METALS - FILTERED (µg/L)																	
Aluminum		66	4 / 4	95	89.2	102	SW-06	3 / 3	120	114	126	SW-09	0 / 1	—	—	SW-09	Mitchell Brook
Iron		35	4 / 4	430	82.1 J	702 J	SW-05	3 / 3	620	232 J	940 J	SW-12	1 / 1	3,660 J	SW-10	SW-10	Unnamed brook
Calcium		92	4 / 4	3,700	3,270	4,210	SW-11	3 / 3	3,500	3,160	3,770	SW-12	1 / 1	7,850	SW-10	SW-10	Unnamed brook
Magnesium		69	4 / 4	1,300	1,240	1,460	SW-11	3 / 3	1,200	1,100	1,325	SW-12	1 / 1	2,080	SW-10	SW-10	Unnamed brook
Sodium		34	4 / 4	11,000	10,700	11,300	SW-11	3 / 3	11,000	10,100	11,500	SW-07	1 / 1	7,490	SW-10	SW-07	Mitchell Brook
Potassium		76	4 / 4	910	701	1,130	SW-11	3 / 3	830	603	999	SW-12	1 / 1	2,140	SW-10	SW-10	Unnamed brook
Barium		1	0 / 4	—	—	—	—	0 / 3	—	—	—	—	1 / 1	24.7	SW-10	SW-10	Unnamed brook
Manganese		1	4 / 4	130	56.0	172	SW-11	3 / 3	110	52.7	166	SW-12	1 / 1	789	SW-10	SW-10	Unnamed brook
Zinc		11	0 / 4	—	—	—	—	1 / 3	9.6	17.9		SW-07	1 / 1	14.9	SW-10	SW-07	Mitchell Brook
WATER QUALITY PARAMETERS																	
Sulfide	Not Detected																
Cyanide	Not Detected																
Total Organic Carbon (mg/L)		0.5	4 / 4	6.0	5.0	7.0	SW-11	3 / 3	4.5	3.3	5.7	SW-12	1 / 1	11	SW-10	SW-10	Unnamed brook
Hardness (mg/L)		NA	4 / 4	15	13	16	SW-11	3 / 3	13	11	15	SW-12	1 / 1	29	SW-10	SW-10	Unnamed brook
pH		NA	4 / 4	6.2	6.0	6.5	SW-06	3 / 3	6.0	5.4	6.4	SW-12	1 / 1	6.4	SW-10	SW-06	Saugatucket
Specific Conductance (µmhos/cm)		NA	4 / 4	300	90	900	SW-04	3 / 3	83	80	90	SW-12	1 / 1	130	SW-10	SW-04	Saugatucket
Dissolved Oxygen (mg/L)		NA	2 / 2	13	12.5	13.2	SW-05	NA	—	—	—	—	NA	—	—	SW-05	Saugatucket
Biochemical Oxygen Demand																	
Not Detected																	

NOTES:

1. Analytical data is presented in Appendix D.
2. If all sample detection limits are the same, a single detection limit is presented.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detect.on limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

— Analyte was not detected in samples.

TABLE 20 SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER, APRIL 1992 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	RANGE OF DETECTION LIMITS (2) MAXIMUM	SAUGATUCKET RIVER FREQUENCY OF DETECTION (3)	SAUGATUCKET RIVER ARITHMETIC AVERAGE	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (4) MINIMUM	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (4) MAXIMUM	SAUGATUCKET RIVER MAXIMUM LOCATION	MITCHELL BROOK FREQUENCY OF DETECTION (3)	MITCHELL BROOK ARITHMETIC AVERAGE	MITCHELL BROOK RANGE OF CONCENTRATIONS (4) MINIMUM	MITCHELL BROOK RANGE OF CONCENTRATIONS (4) MAXIMUM	MITCHELL BROOK MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	WATER BODY ASSOC. WITH OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/L)														
Carbon Disulfide		10	1 / 5	4.2 *	1 J		SW-04	0 / 3	—	—	—	—	SW-04	Saugatucket
WATER SOLUBLE ORGANICS														
None Detected														
SEMIVOLATILE ORGANICS														
None Detected														
PESTICIDES/PCBs														
None Detected														
METALS UNFILTERED (µg/L)														
Iron		23	3 / 5	500	636 J	861 J	SW-11	2 / 3	920	1,300	1,310	SW-07	SW-07	Mitchell Brook
Calcium		34	5 / 5	3,700	3,240	4,690	SW-11	3 / 3	3,500	2,870	4,260	SW-12	SW-11	Saugatucket
Magnesium		22	5 / 5	1,300	1,210	1,590	SW-11	3 / 3	1,300	1,050	1,500	SW-12	SW-11	Saugatucket
Sodium		67	5 / 5	8,800	8,285	9,790	SW-11	3 / 3	9,200	8,150	10,400	SW-12	SW-12	Mitchell Brook
Potassium		82	5 / 5	860	624	1,190	SW-11	3 / 3	910	590	1,320	SW-12	SW-12	Mitchell Brook
Antimony		16	1 / 5	10	19.8		SW-11	1 / 3	14	24.8		SW-09	SW-09	Mitchell Brook
Barium		1	2 / 5	5.8	8.6 J	8.85 J	SW-04	2 / 3	11	12.6 J	15.7 J	SW-12	SW-12	Mitchell Brook
Chromium		3	0 / 5	—	—	—	—	1 / 3	2.1	3.2		SW-12	SW-12	Mitchell Brook
Manganese		1	5 / 5	140	20.6	237	SW-11	3 / 3	140	51.1	212	SW-12	SW-11	Saugatucket
METALS FILTERED (µg/L)														
Iron	23	25	1 / 5	310	866		SW-05	2 / 3	790	1,050	1,170	SW-07	SW-07	Mitchell Brook
Calcium	28	34	5 / 5	4,100	3,510	5,050	SW-11	2 / 3	3,200	3,300	4,570	SW-12	SW-11	Saugatucket
Magnesium	22	55	5 / 5	1,400	1,250	1,640	SW-11	3 / 3	1,300	1,100	1,540	SW-12	SW-11	Saugatucket
Sodium	34	67	5 / 5	10,000	9,380	10,500	SW-06	3 / 3	11,000	9,070	12,500	SW-12	SW-12	Mitchell Brook
Potassium	82	194	5 / 5	980	729	1,320	SW-11	3 / 3	970	654	1,350	SW-12	SW-12	Mitchell Brook
Manganese		1	5 / 5	140	20.2	245	SW-11	3 / 3	140	52.8	207	SW-12	SW-11	Saugatucket
Zinc	8	11	1 / 5	10	31.3 J		SW-05	0 / 3	—	—	—	—	SW-05	Saugatucket
WATER QUALITY PARAMETERS														
Cyanide	Not Detected													
Ammonia (mg/L)	0.0300		5 / 5	0.32	0.042	0.640	SW-06	2 / 3	0.23	0.220	0.460	SW-12	SW-06	Saugatucket
Total Organic Carbon (mg/L)	0.50		5 / 5	6.2	5.4	7.9	SW-11	3 / 3	5.0	4.5	5.7	SW-12	SW-11	Saugatucket
Hardness (mg/L)	NA		5 / 5	15	13	18	SW-11	3 / 3	14	11	17	SW-12	SW-11	Saugatucket
pH	NA		5 / 5	6.0	5.7	6.08	SW-11	3 / 3	6.0	5.75	6.25	SW-12	SW-12	Mitchell Brook
Specific Conductance (µmhos/cm)	NA		5 / 5	83	74	98	SW-11	3 / 3	95	74	125	SW-12	SW-12	Mitchell Brook
Dissolved Oxygen (mg/L)	NA		5 / 5	11	10.21	11.45	SW-11	3 / 3	11	10.42	11.38	SW-07	SW-04	Saugatucket
Biochemical Oxygen Demand (mg/L)	1.0		2 / 2	1.3	1.1	1.5	SW-02	2 / 2	1.4	1.0 J	1.7 J	SW-12	SW-12	Mitchell Brook

NOTES:

1. Analytical data is presented in Appendix D.
2. If all sample detection limits are the same, a single detection limit is presented.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

— Analyte was not detected in samples.

TABLE 21 SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER, MAY 1992 (1)

CHEMICAL	RANGE OF DETECTION LIMITS MINIMUM	RANGE OF DETECTION LIMITS MAXIMUM	SAUGATUCKET RIVER FREQUENCY OF DETECTION (2)	SAUGATUCKET RIVER ARITHMETIC AVERAGE	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (3) MINIMUM	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (3) MAXIMUM	SAUGATUCKET RIVER MAXIMUM LOCATION	MITCHELL BROOK FREQUENCY OF DETECTION (2)	MITCHELL BROOK ARITHMETIC AVERAGE	MITCHELL BROOK RANGE OF CONCENTRATIONS (3) MINIMUM	MITCHELL BROOK RANGE OF CONCENTRATIONS (3) MAXIMUM	MITCHELL BROOK MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	WATER BODY ASSOC. WITH OVERALL MAX. LOC.
VOLATILE ORGANICS														
None Detected														
SEMIVOLATILE ORGANICS														
None Detected														
PESTICIDES/PCBs														
None Detected														
METALS - UNFILTERED (µg/L)														
Aluminum	100	100	7 / 7	240	153	424	SW-18	4 / 4	440	132	1,140	SW-16	SW-16	Mitchell Brook
Iron	10	10	7 / 7	980	234	1,640	SW-06	4 / 4	3,600	403	6,760	SW-07	SW-07	Mitchell Brook
Calcium	20	20	7 / 7	4,200	3,230	5,950	SW-11	4 / 4	4,400	2,990	6,330	SW-12	SW-12	Mitchell Brook
Magnesium	20	20	7 / 7	1,400	1,110	1,920	SW-11	4 / 4	1,500	1,100	2,170	SW-12	SW-12	Mitchell Brook
Sodium	300	300	7 / 7	8,600	7,040	10,800	SW-11	4 / 4	9,700	7,905	12,500	SW-12	SW-12	Mitchell Brook
Barium	1	1	7 / 7	7.0	4.9	9.9	SW-11	4 / 4	14	8.2	17.4	SW-12	SW-12	Mitchell Brook
Copper	2	2	2 / 7	1.3	2.1	2.1	SW-02	3 / 4	2.0	2.2	2.5	SW-07	SW-07	Mitchell Brook
Lead	2	2	0 / 7	—	—	—	—	1 / 4	1.7	3.7		SW-16	SW-16	Mitchell Brook
Manganese	1	1	7 / 7	200	21.2	373	SW-11	4 / 4	300	58.65	443	SW-07	SW-07	Mitchell Brook
Zinc	2	2	7 / 7	4.5	2.8	8.2	SW-18	4 / 4	6.3	3.2	12.1	SW-16	SW-16	Mitchell Brook
METALS - FILTERED (µg/L)														
Aluminum	100	100	7 / 7	190	120	348	SW-18	4 / 4	200	104	437	SW-16	SW-16	Mitchell Brook
Iron	10	10	5 / 7	460	356	830	SW-11	3 / 4	970	662	1,710	SW-12	SW-12	Mitchell Brook
Calcium	20	20	7 / 7	4,300	3,460	6,050	SW-11	4 / 4	4,400	2,950	6,310	SW-12	SW-12	Mitchell Brook
Magnesium	20	20	7 / 7	1,400	1,120	1,910	SW-11	4 / 4	1,400	1,060	2,130	SW-12	SW-12	Mitchell Brook
Sodium	300	300	0 / 7	—	—	—	—	1 / 4	6,900	13,000		SW-12	SW-12	Mitchell Brook
Barium	1	1	1 / 7	3.5	5.0		SW-04	1 / 4	8.5	16.9		SW-12	SW-12	Mitchell Brook
Lead	1	1	0 / 7	—	—	—	—	1 / 4	0.68	1.2		SW-16	SW-16	Mitchell Brook
Manganese	1	1	7 / 7	170	19.0	369	SW-11	4 / 4	260	54.2	417	SW-12	SW-12	Mitchell Brook
Mercury	0.1	0.1	0 / 7	—	—	—	—	1 / 4	0.07	0.115 J		SW-09	SW-09	Mitchell Brook
WATER QUALITY PARAMETERS														
Cyanide (µg/L)	10	10	0 / 7	—	—	—	—	2 / 4	61	25 J	210 J	SW-07	SW-07	Mitchell Brook
Ammonia (mg/L)	0.0300	0.0300	6 / 7	0.36	0.0700	1.43	SW-11	4 / 4	1.2	0.033	3.53	SW-12	SW-12	Mitchell Brook
Hardness (mg/L)	NA		7 / 7	16	12	23	SW-11	4 / 4	17	12	25	SW-12	SW-12	Mitchell Brook
pH	NA		7 / 7	5.8	5.56	6.35	SW-11	4 / 4	6.1	5.72	6.27	SW-12	SW-11	Saugatucket
Specific Conductance (µmhos/cm)	NA		7 / 7	81	64	112	SW-11	4 / 4	95	68	141	SW-12	SW-12	Mitchell Brook
Dissolved Oxygen (mg/L)	NA		7 / 7	9.3	8.93	10.21	SW-02	4 / 4	9.6	8.93	9.97	SW-09	SW-02	Saugatucket

NOTES:
1. Analytical data is presented in Appendix D.
2. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
3. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.
NA = Not Applicable
J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.
— Analyte was not detected in samples.

TABLE 22 SUMMARY OF CHEMICALS DETECTED IN SEDIMENT, JUNE 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS MINIMUM	RANGE OF DETECTION LIMITS MAXIMUM	SAUGATUCKET RIVER FREQUENCY OF DETECTION (2)	SAUGATUCKET RIVER ARITHMETIC AVERAGE	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (3) MINIMUM	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (3) MAXIMUM	SAUGATUCKET RIVER MAXIMUM LOCATION	MITCHELL BROOK FREQUENCY OF DETECTION (2)	MITCHELL BROOK ARITHMETIC AVERAGE	MITCHELL BROOK RANGE OF CONCENTRATIONS (3) MINIMUM	MITCHELL BROOK RANGE OF CONCENTRATIONS (3) MAXIMUM	MITCHELL BROOK MAXIMUM LOCATION	UNNAMED BROOK FREQUENCY OF DETECTION (2)	UNNAMED BROOK CONCEN-TRATIONS	UNNAMED BROOK LOCATION	UNNAMED TRIBUTARY FREQUENCY OF DETECTION (2)	UNNAMED TRIBUTARY CONCEN-TRATIONS	UNNAMED TRIBUTARY LOCATION	OVERALL MAXIMUM LOCATION	WATER BODY ASSOC. WITH OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/kg)																				
Ethylbenzene	6	10	1 / 6	4.8		8 J	SD-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-08	Saugatucket
Total Xylenes	6	10	2 / 6	16	10 J	67 J	SD-08	2 / 6	4.9	7 J	8	SD-07	0 / 1	—	—	0 / 1	—	—	SD-08	Saugatucket
Trichloroethene	6	10	3 / 6	30	7 J	150 J	SD-08	3 / 6	5.4	6 J	9 J	SD-09	0 / 1	—	—	0 / 1	—	—	SD-08	Saugatucket
1,2-Dichloroethene(total)	6	10	1 / 6	4.3		5 J	SD-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-08	Saugatucket
Carbon Disulfide	6	10	1 / 6	5.0		9 J	SD-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-08	Saugatucket
SEMIVOLATILE ORGANICS (µg/kg)																				
Phenanthrene	820	1,400	1 / 6	500 *		220 J	SD-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-08	Saugatucket
Fluoranthene	820	1,400	1 / 6	520 *		330 J	SD-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-08	Saugatucket
Pyrene	820	1,400	1 / 6	510 *		280 J	SD-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-08	Saugatucket
Chrysene	820	1,400	1 / 6	500 *		180 J	SD-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-08	Saugatucket
Benzo(b)fluoranthene	820	1,400	1 / 6	490 *		130 J	SD-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-08	Saugatucket
Benzo(k)fluoranthene	820	1,400	1 / 6	490 *		130 J	SD-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-08	Saugatucket
Benzo(a)pyrene	820	1,400	1 / 6	490 *		140 J	SD-08	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-08	Saugatucket
Butylbenzylphthalate	820	1,400	1 / 6	530 *		440 J	SD-06	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-06	Saugatucket
PESTICIDES/PCBs																				
None Detected																				
METALS (mg/kg)																				
Aluminum	2.26	10.64	6 / 6	3,300	749	6,280	SD-05	6 / 6	3,300	1,360	5,640	SD-14	1 / 1	3,210	SD-10	1 / 1	6,050	SD-01	SD-05	Saugatucket
Iron	1.58	7.09	6 / 6	5,000	780	1,600	SD-04	6 / 6	4,400	2,750	6,490	SD-07	1 / 1	113,000	SD-10	1 / 1	7,530	SD-01	SD-10	Unnamed brook
Calcium	1.58	11.03	4 / 6	640	547	1,270	SD-03	3 / 6	350	339	921	SD-13	1 / 1	1,070	SD-10	1 / 1	378	SD-01	SD-03	Saugatucket
Magnesium	2.94	13.00	3 / 6	490	488	1,040	SD-05	4 / 6	470	506	764	SD-14	1 / 1	597	SD-10	1 / 1	1,100	SD-01	SD-01	Unnamed trib.
Sodium	4.98	11.82	1 / 6	44	115		SD-06	3 / 6	40	38.1	82.3	SD-13	1 / 1	84.6	SD-10	1 / 1	47.1	SD-01	SD-06	Saugatucket
Potassium	9.50	98.91	1 / 6	96	191		SD-06	3 / 6	170	191	308	SD-14	1 / 1	415	SD-10	1 / 1	549	SD-01	SD-01	Unnamed trib.
Arsenic	0.47	1.46	3 / 6	0.97	0.79	2.1	SD-05	2 / 6	0.60	0.52	1.1	SD-07	1 / 1	2.0	SD-10	0 / 1	—	—	SD-05	Saugatucket
Barium	0.23	0.79	6 / 6	12	2.7	26.2	SD-04	6 / 6	12	7.0	22.2	SD-13	1 / 1	64.6	SD-10	1 / 1	13.6	SD-01	SD-10	Unnamed brook
Beryllium	0.23	0.39	5 / 6	0.78	0.40	2.0	SD-04	5 / 6	0.59	0.29	1.3	SD-14	1 / 1	1.2	SD-10	0 / 1	—	—	SD-04	Saugatucket
Chromium	0.45	2.76	3 / 6	3.9	1.9 J	8.7	SD-04	3 / 6	2.1	2.5	3.6	SD-14	0 / 1	—	—	1 / 1	4.4	SD-01	SD-04	Saugatucket
Cobalt	0.45	1.58	3 / 6	2.2	3.4 J	4.2	SD-05	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-05	Saugatucket
Copper	0.68	4.33	0 / 6	—	—	—	—	1 / 6	2.2	4.2		SD-14	0 / 1	—	—	1 / 1	3.3	SD-01	SD-14	Mitchell Brook
Lead	0.24	0.39	1 / 6	5.1	10.9		SD-06	3 / 6	8.6	5.2	21.7	SD-14	1 / 1	7.4	SD-10	1 / 1	10.8	SD-01	SD-14	Mitchell Brook
Manganese	0.23	3.55	6 / 6	110	13.5	193	SD-06	6 / 6	54	36.3	84.0	SD-13	1 / 1	1,150 J	SD-10	1 / 1	74.4	SD-01	SD-10	Unnamed brook
Nickel	0.90	2.36	5 / 6	3.5	1.4	9.5	SD-05	6 / 6	2.2	1.4 J	3.0	SD-14	1 / 1	3.0	SD-10	1 / 1	4.1	SD-01	SD-05	Saugatucket
Selenium	0.95	1.55	1 / 6	0.85	2.1 J		SD-05	0 / 6	—	—	—	—	0 / 1	—	—	0 / 1	—	—	SD-05	Saugatucket
Vanadium	0.45	1.18	5 / 6	7.7	4.1	14.2	SD-05	5 / 6	4.7	3.5	7.6	SD-13	1 / 1	15.2	SD-10	1 / 1	10.8	SD-01	SD-10	Unnamed brook
Zinc	0.68	3.15	1 / 6	14	20.5		SD-06	3 / 6	16	17.3	30.6	SD-13	1 / 1	236	SD-10	1 / 1	25.2	SD-01	SD-10	Unnamed brook
SOIL QUALITY PARAMETERS																				
Sulfide (mg/kg)	0.04	0.07	6 / 6	48	15.0	129.0	SD-06	6 / 6	19	3.70	34.0	SD-07	1 / 1	25.00	SD-10	1 / 1	8.70	SD-01	SD-06	Saugatucket
Cyanide - Not Detected																				
TOTAL COMBUSTIBLE ORGANICS (%)																				
Organic Content	NA		6 / 6	5.5	1.0	14.7	SD-03	6 / 6	3.4	0.8	7.0	SD-13	1 / 1	4.7	SD-10	1 / 1	2.8	SD-01	SD-03	Saugatucket
Solids Content	NA		6 / 6	56	33.6	74.1	SD-02	6 / 6	67	54.1	80.5	SD-12	1 / 1	53.2	SD-10	1 / 1	68.1	SD-01	SD-12	Mitchell Brook
Moisture Content	NA		6 / 6	44	25.9	66.3	SD-03	6 / 6	29	15.6	45.9	SD-13	1 / 1	46.7	SD-10	1 / 1	31.9	SD-01	SD-03	Saugatucket
GRAIN SIZE (%)																				
Clay	NA		6 / 6	4.1	0.4	11.8	SD-04	6 / 6	1.4	0	3.6	SD-14	1 / 1	10.4	SD-10	1 / 1	2.9	SD-01	SD-04	Saugatucket
Gravel	NA		6 / 6	1.7	0.3	2.9	SD-05	6 / 6	5.6	1	13.8	SD-13	1 / 1	3	SD-10	1 / 1	6.6	SD-01	SD-13	Mitchell Brook
Sand	NA		6 / 6	72	37.7	95	SD-02	6 / 6	79	57.3	97	SD-12	1 / 1	67.7	SD-10	1 / 1	56.9	SD-01	SD-12	Mitchell Brook
Silt	NA		6 / 6	22	3.8	48.5	SD-04	6 / 6	14	1.6	26.5	SD-13	1 / 1	18.8	SD-10	1 / 1	33.5	SD-01	SD-04	Saugatucket

NOTES:

1. Analytical data is presented in Appendix D.
2. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
3. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

— Analyte was not detected in samples.

TABLE 23 SUMMARY OF CHEMICALS DETECTED IN SEDIMENT, SEPTEMBER 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS MINIMUM	RANGE OF DETECTION LIMITS MAXIMUM	SAUGATUCKET RIVER FREQUENCY OF DETECTION (2)	SAUGATUCKET RIVER ARITHMETIC AVERAGE	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (3) MINIMUM	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (3) MAXIMUM	SAUGATUCKET RIVER MAXIMUM LOCATION	MITCHELL BROOK FREQUENCY OF DETECTION (2)	MITCHELL BROOK ARITHMETIC AVERAGE	MITCHELL BROOK RANGE OF CONCENTRATIONS (3) MINIMUM	MITCHELL BROOK RANGE OF CONCENTRATIONS (3) MAXIMUM	MITCHELL BROOK MAXIMUM LOCATION	UNNAMED BROOK FREQUENCY OF DETECTION (2)	UNNAMED BROOK CONCEN-TRATIONS	UNNAMED BROOK LOCATION	UNNAMED TRIBUTARY FREQUENCY OF DETECTION (2)	UNNAMED TRIBUTARY CONCEN-TRATIONS	UNNAMED TRIBUTARY LOCATION	OVERALL MAXIMUM LOCATION	WATER BODY ASSOC. WITH OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/kg)																				
Benzene	12	24	0 / 7	--	--	--	--	1 / 5	7.2 *	1 J		SD-12	0 / 1	--	--	0 / 1	--	--	SD-12	Mitchell Brook
Ethylbenzene	12	24	1 / 7	7.9 *	3 J		SD-05	0 / 6	--	--	--	--	0 / 1	--	--	0 / 1	--	--	SD-05	Saugatucket
Total Xylenes	12	24	1 / 7	8.6 *	8 J		SD-05	0 / 6	--	--	--	--	0 / 1	--	--	0 / 1	--	--	SD-05	Saugatucket
Acetone	12	24	3 / 7	92	42 J	215 J	SD-08	2 / 6	73	190	200	SD-09	0 / 1	--	--	0 / 1	--	--	SD-08	Saugatucket
2-Butanone	12	24	1 / 7	12	28 J		SD-08	1 / 6	16	46		SD-07	0 / 1	--	--	0 / 1	--	--	SD-07	Mitchell Brook
4-Methyl-2-pentanone	12	24	0 / 7	--	--	--	--	0 / 6	--	--	--	--	1 / 1	3 J	SD-10	0 / 1	--	--	SD-10	Unnamed brook
Tetrachloroethene	12	24	1 / 7	8.3 *	4 J		SD-08	2 / 6	5.8 *	2 J	3 J	SD-14	0 / 1	--	--	0 / 1	--	--	SD-08	Saugatucket
Chloroform	12	24	0 / 7	--	--	--	--	1 / 6	7.8 *	5 J		SD-15	0 / 1	--	--	0 / 1	--	--	SD-15	Mitchell Brook
Carbon Disulfide	12	24	1 / 7	11	22 J		SD-08	0 / 6	--	--	--	--	0 / 1	--	--	0 / 1	--	--	SD-08	Saugatucket
SEMIVOLATILE ORGANICS (µg/kg)																				
Fluoranthene	400	800	0 / 7	--	--	--	--	3 / 6	140 *	31 J	34 J	SD-09	NA	R		0 / 1	--	--	SD-09	Mitchell Brook
Pyrene	400	800	1 / 7	260 *	39 J		SD-03	3 / 6	150 *	35 J	40 J	SD-15	NA	R		0 / 1	--	--	SD-15	Mitchell Brook
Di-n-butylphthalate	400	800	0 / 7	--	--	--	--	1 / 6	330	650 J		SD-09	NA	R		0 / 1	--	--	SD-09	Mitchell Brook
PESTICIDES (µg/kg)																				
delta-BHC	2.1	3.7	0 / 4	--	--	--	--	0 / 6	--	--	--	--	1 / 1	0.5 J	SD-10	0 / 1	--	--	SD-10	Unnamed brook
4,4'-DDE	4.0	7.1	0 / 4	--	--	--	--	2 / 6	2.8	1.6 J	4.9 J	SD-09	1 / 1	0.65 J	SD-10	0 / 1	--	--	SD-09	Mitchell Brook
4,4'-DDD	4.0	7.1	0 / 4	--	--	--	--	1 / 6	3.6	8.2		SD-09	0 / 1	--	--	0 / 1	--	--	SD-09	Mitchell Brook
4,4'-DDT	4.0	7.1	0 / 4	--	--	--	--	0 / 6	--	--	--	--	1 / 1	0.90 J	SD-10	0 / 1	--	--	SD-10	Unnamed brook
Methoxychlor	21.0	37	0 / 4	--	--	--	--	0 / 6	--	--	--	--	1 / 1	2.6 J	SD-10	0 / 1	--	--	SD-10	Unnamed brook
Endosulfan II	4.0	7.1	0 / 4	--	--	--	--	0 / 6	--	--	--	--	1 / 1	0.31 J	SD-10	0 / 1	--	--	SD-10	Unnamed brook
Dieldrin	4.0	7.1	0 / 4	--	--	--	--	0 / 6	--	--	--	--	1 / 1	1.3 J	SD-10	0 / 1	--	--	SD-10	Unnamed brook
gamma-Chlordane	2.1	3.7	0 / 4	--	--	--	--	0 / 6	--	--	--	--	1 / 1	0.23 J	SD-10	0 / 1	--	--	SD-10	Unnamed brook
PCBs																				
None Detected																				
METALS (mg/kg)																				
Aluminum	3.1	12.08	7 / 7	3,800	1,260	8,420	SD-05	6 / 6	4,400	1,660	6,080	SD-13	1 / 1	4,000	SD-10	1 / 1	8,650	SD-01	SD-01	Unnamed trib.
Iron	1.4	4.68	7 / 7	5,600	1,020	16,400	SD-04	6 / 6	7,300	5,010	14,600	SD-07	1 / 1	85,500	SD-10	1 / 1	10,500	SD-01	SD-10	Unnamed brook
Calcium	4.8	11.3	7 / 7	910	350 J	1,760 J	SD-03	6 / 6	580	290	949	SD-07	1 / 1	1,125	SD-10	1 / 1	751 J	SD-01	SD-03	Saugatucket
Magnesium	6.2	17.93	7 / 7	980	362	2,560	SD-06	6 / 6	700	350	933	SD-07	1 / 1	816	SD-10	1 / 1	1,550	SD-01	SD-06	Saugatucket
Sodium	3.1	22.22	2 / 7	41	59.6	63.2	SD-08	5 / 6	49	31.5	67.4	SD-07	0 / 1	--	--	0 / 1	--	--	SD-07	Mitchell Brook
Potassium	51.8	250	4 / 7	200	111 J	488	SD-05	6 / 6	340	230	583	SD-07	1 / 1	654	SD-10	1 / 1	775	SD-01	SD-01	Unnamed trib.
Antimony	6.0	18.32	0 / 7	--	--	--	--	0 / 6	--	--	--	--	1 / 1	62.1 J	SD-10	0 / 1	--	--	SD-10	Unnamed brook
Arsenic	0.24	0.75	3 / 7	0.47	0.43	1.2	SD-05	4 / 6	0.44	0.35 J	0.7	SD-09	1 / 1	4.6	SD-10	1 / 1	1.2	SD-01	SD-10	Unnamed brook
Barium	0.24	0.78	7 / 7	13	3.1	30.5	SD-04	6 / 6	17	9.3	25.6	SD-13	1 / 1	46.8 J	SD-10	1 / 1	21.5	SD-01	SD-10	Unnamed brook
Beryllium	0.24	0.56	1 / 7	0.56	2.3		SD-04	0 / 6	--	--	--	--	1 / 1	1.2	SD-10	0 / 1	--	--	SD-04	Saugatucket
Cadmium	0.72	1.7	0 / 7	--	--	--	--	1 / 6	0.60	1.3 J		SD-13	0 / 1	--	--	0 / 1	--	--	SD-13	Mitchell Brook
Chromium	1.9	4.5	4 / 7	8.5	11.4	18.1	SD-06	0 / 6	--	--	--	--	0 / 1	--	--	1 / 1	11.1	SD-01	SD-06	Saugatucket
Cobalt	1.4	3.4	4 / 7	2.9	1.9	6.5	SD-05	4 / 6	2.3	2.0	4.4	SD-13	1 / 1	5.7	SD-10	1 / 1	5.0	SD-01	SD-05	Saugatucket
Copper	1.0	2.3	0 / 7	--	--	--	--	0 / 6	--	--	--	--	1 / 1	56.1 J	SD-10	0 / 1	--	--	SD-10	Unnamed brook
Lead	0.24	0.75	7 / 7	9.8	4.3 J	24.2 J	SD-03	6 / 6	13	3.5 J	27.7 J	SD-13	1 / 1	243.4 J	SD-10	1 / 1	12.2 J	SD-01	SD-10	Unnamed brook
Manganese	0.48	1.1	7 / 7	97	20.4	207	SD-05	6 / 6	91	41.1	222	SD-07	1 / 1	530 J	SD-10	1 / 1	113	SD-01	SD-10	Unnamed brook
Nickel	3.51	9.0	2 / 7	6.9	12.8	20.5	SD-06	0 / 6	--	--	--	--	1 / 1	3.4	SD-10	1 / 1	7.3	SD-01	SD-06	Saugatucket
Selenium	0.24	1.5	3 / 7	0.46	0.37 J	1.3 J	SD-05	0 / 6	--	--	--	--	0 / 1	--	--	0 / 1	--	--	SD-05	Saugatucket
Thallium	0.24	0.56	0 / 7	--	--	--	--	2 / 6	0.22	0.37	0.37	SD-15	0 / 1	--	--	0 / 1	--	--	SD-15	Mitchell Brook
Vanadium	0.72	1.95	7 / 7	8.3	2.0	17.7	SD-05	5 / 6	7.7	6.0	11.5	SD-13	1 / 1	12.4	SD-10	1 / 1	16.8	SD-01	SD-05	Saugatucket
Zinc	1.4	3.4	2 / 7	20	43.6	49.8	SD-05	2 / 6	20	33.6 J	43.9 J	SD-15	1 / 1	229 J	SD-10	1 / 1	33.7	SD-01	SD-10	Unnamed brook
SOIL QUALITY PARAMETERS																				
Sulfide (mg/kg)	10	17	0 / 7	--	--	--	--	1 / 6	150	850 J		SD-12	0 / 1	--	--	0 / 1	--	--	SD-12	Mitchell Brook
Cyanide - Not Detected																				
TOTAL COMBUSTIBLE ORGANICS (%)																				
Organic Content	NA		7 / 7	5.6	1.8	9.3	SD-03	6 / 6	4.2	0.8	7.6	SD-13	1 / 1	6.0	SD-10	1 / 1	4.7	SD-01	SD-03	Saugatucket
Solids Content	NA		7 / 7	57	43.2	68.9	SD-04	6 / 6	68	53.3	81.8	SD-12	1 / 1	52.3	SD-10	1 / 1	62.9	SD-01	SD-12	Mitchell Brook
Moisture Content	NA		7 / 7	43	31.0	56.7	SD-11	6 / 6	32	18.2	46.6	SD-09	1 / 1	47.8	SD-10	1 / 1	37.2	SD-01	SD-11	Saugatucket
GRAIN SIZE (%)																				
Clay	NA		7 / 7	4.0	0	11.6	SD-04	6 / 6	1.1	0	3.2	SD-13	1 / 1	7.8	SD-10	1 / 1	7.5	SD-01	SD-04	Saugatucket
Gravel	NA		7 / 7	1.7	0.1	4.2	SD-05	6 / 6	7.0	0.2	12.9	SD-14	1 / 1	0.9	SD-10	1 / 1	1.8	SD-01	SD-14	Mitchell Brook
Sand	NA		7 / 7	71	31.1	93.4	SD-06	6 / 6	76	57	97.3	SD-12	1 / 1	64.0	SD-10	1 / 1	51.2	SD-01	SD-12	Mitchell Brook
Silt	NA		7 / 7	23	5	54.2	SD-04	6 / 6	16	2.2	29.1	SD-13	1 / 1	27.4	SD-10	1 / 1	39.5	SD-01	SD-04	Saugatucket

NOTES:

1. Analytical data is presented in Appendix D.
2. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
3. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

R = All sample values were rejected.

-- Analyte was not detected in samples.

TABLE 24 SUMMARY OF CHEMICALS DETECTED IN SEDIMENT , MAY 1992 (1)

CHEMICAL	RANGE OF DETECTION LIMITS MINIMUM	RANGE OF DETECTION LIMITS MAXIMUM	SAUGATUCKET RIVER FREQUENCY OF DETECTION (2)	SAUGATUCKET RIVER ARITHMETIC AVERAGE	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (3) MINIMUM	SAUGATUCKET RIVER RANGE OF CONCENTRATIONS (3) MAXIMUM	SAUGATUCKET RIVER MAXIMUM LOCATION	MITCHELL BROOK FREQUENCY OF DETECTION (2)	MITCHELL BROOK ARITHMETIC AVERAGE	MITCHELL BROOK RANGE OF CONCENTRATIONS (3) MINIMUM	MITCHELL BROOK RANGE OF CONCENTRATIONS (3) MAXIMUM	MITCHELL BROOK MAXIMUM LOCATION	OVERALL MAXIMUM LOCATION	WATER BODY ASSOC. WITH OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/kg)														
None Detected														
SEMIVOLATILE ORGANICS (µg/kg)														
Phenanthrene	350	500	1 / 7	180 *	57 J		SD-11	0 / 4	—	—	—	—	SD-11	Saugatucket
Anthracene	350	500	1 / 7	190 *	64 J		SD-11	0 / 4	—	—	—	—	SD-11	Saugatucket
Fluoranthene	350	500	1 / 7	190 *	81 J		SD-11	0 / 4	—	—	—	—	SD-11	Saugatucket
Pyrene	350	500	1 / 7	180 *	39 J		SD-11	0 / 4	—	—	—	—	SD-11	Saugatucket
PESTICIDES (µg/kg)														
delta-BHC	1.9	2.7	6 / 7	0.78	0.46 J	1.3 J	SD-11	4 / 4	0.64	0.57 J	0.73 J	SD-12	SD-11	Saugatucket
4,4'-DDE	3.6	5.3	2 / 7	2.2	1.2 J	4.3 J	SD-11	0 / 4	—	—	—	—	SD-11	Saugatucket
4,4'-DDD	3.6	5.3	1 / 7	2.9	8.0		SD-11	0 / 4	—	—	—	—	SD-11	Saugatucket
PCBs														
None Detected														
METALS (mg/kg)														
Aluminum	10.9	18.8	7 / 7	1,500	836	1,860	SD-11	4 / 4	2,100	1,860	2,640	SD-07	SD-07	Mitchell Brook
Iron	1.1	1.9	7 / 7	7,700	885	25,900	SD-05	4 / 4	8,700	3,985	12,400	SD-07	SD-05	Saugatucket
Calcium	2.2	3.8	5 / 7	280	258	555	SD-11	4 / 4	210	176.5	242	SD-16	SD-11	Saugatucket
Magnesium	2.2	3.8	7 / 7	260	114	489	SD-17	4 / 4	490	388	613	SD-07	SD-07	Mitchell Brook
Arsenic	0.19	0.41	2 / 7	1.2	2.0 J	6.1	SD-05	4 / 4	0.72	0.31 J	1.1	SD-12	SD-05	Saugatucket
Barium	0.11	0.19	7 / 7	7.2	2.9	13.7 J	SD-05	4 / 4	9.2	6.2	11.5	SD-07	SD-05	Saugatucket
Beryllium	0.11	0.19	2 / 7	0.20	0.25	0.79	SD-06	3 / 4	0.25	0.27	0.42	SD-07	SD-06	Saugatucket
Chromium	0.44	0.75	7 / 7	1.7	1.1	2.5	SD-18	4 / 4	1.9	1.35	2.5	SD-07	SD-07	Mitchell Brook
Cobalt	0.33	0.56	4 / 7	0.76	0.91	1.4	SD-06	4 / 4	1.1	0.59 J	1.8	SD-07	SD-07	Mitchell Brook
Lead	0.09	0.21	7 / 7	6.5	3.7	13.5	SD-18	4 / 4	3.1	2.3	4.1	SD-16	SD-18	Saugatucket
Manganese	0.11	0.19	7 / 7	110	22.6	200	SD-04	4 / 4	110	57.8	241	SD-07	SD-07	Mitchell Brook
Nickel	2.2	3.8	1 / 7	1.8	4.7		SD-06	1 / 4	1.8	3.8		SD-12	SD-06	Saugatucket
Selenium	0.19	0.41	2 / 7	0.24	0.43	0.58	SD-18	0 / 4	—	—	—	—	SD-18	Saugatucket
Vanadium	0.22	0.38	1 / 7	1.9	3.4 J		SD-05	1 / 4	3.2	6.4		SD-07	SD-07	Mitchell Brook
Zinc	0.22	0.38	1 / 7	5.9	11.2		SD-05	0 / 4	—	—	—	—	SD-05	Saugatucket
SOIL QUALITY PARAMETERS														
Cyanide - Not Detected														
Ammonia (mg/kg)	0.980	1.37	3 / 7	1.4	2.01	3.17	SD-05	2 / 4	7.7	4.36	25.6	SD-12	SD-12	Mitchell Brook
TOTAL COMBUSTIBLE ORGANICS (%)														
Organic Content	NA		7 / 7	2.4	1.3	5.6	SD-11	4 / 4	1.3	1.1	1.8	SD-16	SD-11	Saugatucket
Solids Content	NA		7 / 7	71	50.5	78.3	SD-04	4 / 4	80	76.05	85.5	SD-12	SD-12	Mitchell Brook
Moisture Content	NA		7 / 7	43	27.7	97.9	SD-11	4 / 4	25	16.9	31.5	SD-09	SD-11	Saugatucket
GRAIN SIZE (%)														
Clay	NA		7 / 7	0	0	0	SD-11	4 / 4	0	0	0	SD-12	SD-12	Mitchell Brook
Gravel	NA		7 / 7	14	0.7	33.2	SD-05	4 / 4	6.8	0.9	10.65	SD-09	SD-05	Saugatucket
Sand	NA		7 / 7	82	64.6	95.8	SD-06	4 / 4	91	86.45	95.7	SD-16	SD-06	Saugatucket
Silt	NA		7 / 7	3.9	1.8	6.2	SD-11	4 / 4	2.4	1.5	3.4	SD-16	SD-11	Saugatucket

NOTES:

1. Analytical data is presented in Appendix D.
2. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was reje cted.
3. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

— Analyte was not detected in samples.

TABLE 25 SUMMARY OF CHEMICALS DETECTED IN LEACHATE, JUNE 1991 (1)

CHEMICAL	RANGE OF DETECTION LIMITS (2) MINIMUM	MAXIMUM	SAUGATUCKET RIVER FREQUENCY OF DETECTION (3)	ARITHMETIC AVERAGE	RANGE OF CONCENTRATIONS (4) MINIMUM	MAXIMUM	MAXIMUM LOCATION	MITCHELL BROOK FREQUENCY OF DETECTION (3)	CONCENTRATION	OVERALL MAXIMUM LOCATION	WATER BODY ASSOC. WITH OVERALL MAX. LOC.
VOLATILE ORGANICS - (µg/L)											
Toluene		5	3 / 5	22	27 J	50	LE-03	0 / 1	—	LE-03	Saugatucket
Chlorobenzene		5	3 / 5	2.2 *	2 J	2 J	LE-03	0 / 1	—	LE-03	Saugatucket
Trichloroethene		5	0 / 4	—	—	—	—	1 / 1	4 J	LE-01	Mitchell Brook
1,2-Dichloroethene(total)		5	0 / 4	—	—	—	—	1 / 1	44	LE-01	Mitchell Brook
1,1-Dichloroethane		5	3 / 5	2.2 *	2 J	2 J	LE-03	0 / 1	—	LE-03	Saugatucket
Chloroethane		10	3 / 5	5.8	5 J	8 J	LE-03	0 / 1	—	LE-03	Saugatucket
Vinyl Chloride		10	0 / 4	—	—	—	—	1 / 1	1 J	LE-01	Mitchell Brook
Carbon Disulfide		5	1 / 4	2.6	3 J		LE-02	1 / 1	12	LE-01	Mitchell Brook
SEMIVOLATILE ORGANICS (µg/L)											
bis(2-Ethylhexyl)phthalate		10	1 / 5	50	230 J		LE-06	0 / 1	—	LE-06	Saugatucket
PESTICIDES/PCBs											
None Detected											
METALS - UNFILTERED (µg/L)											
Aluminum	10	27	4 / 5	2,100	184 J	9,220 J	LE-02	1 / 1	60,500 J	LE-01	Mitchell Brook
Iron	7	18	5 / 5	370,000	15,200 J	1,370,000 J	LE-02	1 / 1	133,000 J	LE-02	Saugatucket
Calcium	7	28	5 / 5	27,000	10,000	59,000	LE-02	1 / 1	14,900	LE-02	Saugatucket
Magnesium	13	33	5 / 5	7,500	2,420	16,100	LE-02	1 / 1	5,610	LE-02	Saugatucket
Sodium	22	30	5 / 5	23,000	5,560	55,400	LE-02	1 / 1	9,300 J	LE-02	Saugatucket
Potassium	42	251	5 / 5	16,000	2,000	44,800	LE-02	1 / 1	3,620	LE-02	Saugatucket
Arsenic	2	4	0 / 4	—	—	—	—	1 / 1	3.7	LE-01	Mitchell Brook
Barium	1	2	5 / 5	550	22.2	2,120	LE-02	1 / 1	328 J	LE-02	Saugatucket
Beryllium	1		1 / 5	2.3	8.7		LE-02	1 / 1	11.2	LE-01	Mitchell Brook
Chromium	2	7	0 / 5	—	—	—	—	1 / 1	23.9	LE-01	Mitchell Brook
Cobalt	2	4	4 / 5	63	5.6	295	LE-02	0 / 1	—	LE-02	Saugatucket
Copper	3	11	0 / 5	—	—	—	—	1 / 1	37.8 J	LE-01	Mitchell Brook
Lead	1	2	1 / 5	37	174 J		LE-02	1 / 1	150	LE-02	Saugatucket
Manganese	1	9	5 / 5	8,300	2,490 J	14,700 J	LE-02	1 / 1	814	LE-02	Saugatucket
Nickel	4	6	2 / 5	5.3	4 J	13.6	LE-02	1 / 1	15.8	LE-01	Mitchell Brook
Vanadium	2	3	2 / 5	18	22.2	65.2	LE-02	1 / 1	49.8	LE-02	Saugatucket
Zinc	3	8	2 / 4	260 *	34.3	133 J	LE-02	1 / 1	209 J	LE-01	Mitchell Brook
METALS - FILTERED (µg/L)											
Iron	7	18	5 / 5	29,000	743	64,100 J	LE-03	1 / 1	1,260 J	LE-03	Saugatucket
Calcium	7	28	5 / 5	16,000	4,500	41,500	LE-05	1 / 1	4,400	LE-05	Saugatucket
Magnesium	13	33	5 / 5	4,800	1,420	11,500	LE-05	1 / 1	1,360	LE-05	Saugatucket
Sodium	22	30	5 / 5	16,000	7,095	42,600	LE-05	1 / 1	11,600	LE-05	Saugatucket
Potassium	42	251	5 / 5	7,200	1,000	26,700	LE-05	1 / 1	1,440	LE-05	Saugatucket
Barium	1	2	4 / 5	57	22.5	143	LE-05	1 / 1	21.5	LE-05	Saugatucket
Cobalt	2	4	1 / 5	2.5	3.5 J		LE-04	0 / 1	—	LE-04	Saugatucket
Manganese	1	9	5 / 5	5,100	246	9,700 J	LE-03	1 / 1	184 J	LE-03	Saugatucket
WATER QUALITY PARAMETERS											
Cyanide (mg/L)	2		2 / 5	19	36.1	41.7	LE-06	0 / 1	—	LE-06	Saugatucket
Total Organic Carbon (mg/L)	1.0		3 / 5	18	18 J	48 J	LE-02	1 / 1	8.4 J	LE-02	Saugatucket
Biochemical Oxygen Demand (mg/L)	2.4		2 / 5	15	7.5	51	LE-02	0 / 1	—	LE-02	Saugatucket
Hardness (mg/L)	NA		5 / 5	99	35	214	LE-02	1 / 1	60	LE-02	Saugatucket
pH	NA		5 / 5	6.5	6.2	7.1	LE-02	1 / 1	5.4	LE-02	Saugatucket
Specific Conductance (µmhos/cm)	NA		5 / 5	750	250	1,800	LE-05	1 / 1	100	LE-05	Saugatucket

NOTES:

1. Analytical data is presented in Appendix D.
2. If all sample detection limits are the same, a single detection limit is presented.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

— Analyte was not detected in samples.

TABLE 26 SUMMARY OF CHEMICALS DETECTED IN LEACHATE, APRIL 1992 (1)

CHEMICAL	RANGE OF DETECTION LIMITS MINIMUM	AXIMUM	SAUGATUCKET RIVER FREQUENCY OF DETECTION (2)	ARITHMETIC AVERAGE	RANGE OF CONCENTRATIONS (3) MINIMUM	MAXIMUM
VOLATILE ORGANICS - (μg/L)						
Ethylbenzene	10		3 / 3	1.7	1 J	2 J
Total Xylenes	10		2 / 3	3.3 *	2 J	3 J
1,2-Dichloroethene(total)	10		1 / 3	3.7 *	1 J	
Chloroethane	10		1 / 3	4.0 *	2 J	
WATER SOLUBLE ORGANICS						
None Detected						
SEMIVOLATILE ORGANICS (μg/L)						
Naphthalene	10		3 / 3	0.77	0.7 J	0.9 J
Diethylphthalate	10		3 / 3	6.3	4 J	11
PESTICIDES/PCBs						
None Detected						
METALS - UNFILTERED (μg/L)						
Aluminum	21	22	2 / 3	310	238.75 J	623
Iron	23	25	3 / 3	140,000	49,800	283,000
Calcium	28	34	3 / 3	20,000	16,700	23,000
Magnesium	22	55	3 / 3	6,600	5,710	7,220
Sodium	34	67	3 / 3	23,000	20,800	24,700 J
Potassium	82	194	3 / 3	14,000	12,000	15,200
Barium	1	5	3 / 3	180	97.4 J	293 J
Chromium	3	5	1 / 3	2.6	4.85 J	
Lead	1		1 / 3	5.0	10.5 J	
Manganese	1		3 / 3	1,900	1,490	2,410
Mercury	0.2		1 / 3	0.13	0.2	
Zinc	8	11	1 / 2	6.8	8.1 J	
METALS - FILTERED (μg/L)						
Iron	23	25	3 / 3	20,000	13,800	27,500
Calcium	28	34	3 / 3	20,000	17,100	21,800
Magnesium	22	55	3 / 3	6,800	5,730	7,530
Sodium	34	67	3 / 3	25,000	22,900	27,700
Potassium	82	194	3 / 3	15,000	12,200	16,100
Barium	1	5	3 / 3	81	80.3	82.5
Manganese	1		3 / 3	1,500	1,410	1,570
WATER QUALITY PARAMETERS						
Cyanide	Not Detected					
Ammonia (mg/L)	0.0300		3 / 3	13	5.06	21.75
Total Organic Carbon (mg/L)	0.5		3 / 3	41	30.9	49.9
Biochemical Oxygen Demand (mg/L)	1.0		3 / 3	3.2	1.5	4.1 J
Hardness (mg/L)	NA		3 / 3	78	65	87
pH	NA		1 / 1	NA	6.5	
Specific Conductance (μmhos/cm)	NA		1 / 1	NA	412	

NOTES:

1. Analytical data is presented in Appendix D. Data is summarized for one sample, LE-05, collected on three consecutive days.
2. If all sample detection limits are the same, a single detection limit is presented.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample detection limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample detection limits are also included. A single concentration is presented when only one positive detection occurred.

* The calculated average is greater than the maximum value.

NA = Not Applicable

J = Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

--- Analyte was not detected in samples.

TABLE 27

POTENTIAL RISK FROM INGESTION OF SITE GROUNDWATER WITHIN THE SOLID WASTE AREA (AS DRINKING WATER)
AVERAGE CONCENTRATIONS USED FOR AN ADULT EXPOSURE (a)

Analyte	Average Concentration (ug/L)	Exposure Dose Chronic (b) (mg/kg/day)	Oral Reference Dose (RfD) (mg/kg/day)	Hazard Quotient (c)	Exposure Dose Lifetime (b) (mg/kg/day)	Oral Slope Factor /(mg/kg/day)	Cancer Risk (d)
Benzene	11	3.0E-04	na	—	1.3E-04	0.029	3.7E-06
1,1-Dichloroethane	14	3.8E-04	0.1	3.8E-03	1.6E-04	na	—
1,2-Dichloroethene (e)	34	9.3E-04	0.01	9.3E-02	4.0E-04	na	—
Vinyl Chloride	34	9.3E-04	na	—	4.0E-04	1.9	7.6E-04
Pentachlorophenol	3	8.2E-05	0.03	2.7E-03	3.5E-05	0.12	4.2E-06
bis(2-Ethylhexyl)phthalate	5.6	1.5E-04	0.02	7.7E-03	6.6E-05	0.014	9.2E-07
Acrylamide	160	4.4E-03	0.0002	2.2E+01	1.9E-03	4.5	8.5E-03
N,N-DMF	200	5.5E-03	0.1	5.5E-02	2.3E-03	na	—
Antimony	nd	—	0.0004	—	—	na	—
Arsenic	2.7	7.4E-05	0.0003	2.5E-01	3.2E-05	1.5	4.8E-05
Barium	170	4.7E-03	0.07	6.7E-02	2.0E-03	na	—
Beryllium	1.7	4.7E-05	0.002	2.3E-02	2.0E-05	na	—
Cadmium (f)	4.4	1.2E-04	0.0005	2.4E-01	5.2E-05	na	—
Chromium (e)	24	6.6E-04	0.005	1.3E-01	2.8E-04	na	—
Manganese (h)	1900	5.2E-02	0.024	2.2E+00	2.2E-02	na	—
Nickel	26	7.1E-04	0.02	3.6E-02	3.1E-04	na	—
Vanadium	21	5.8E-04	0.007	8.2E-02	2.5E-04	na	—
Zinc	680	1.9E-02	0.3	6.2E-02	8.0E-03	na	—
		Total Hazard Index =		2.3E+01	Total Risk =		9.3E-03
		Hazard Index (liver toxins)=		0.07			
		Hazard Index (nervous system toxins)=		24.09			
		Hazard Index (kidney toxins)=		0.24			
		Hazard Index (red blood cell effects)=		0.16			

NOTES:

(a) This table does not include groundwater chemicals of concern for which no reference dose or slope factor exists.
(chloroethane,2-methylnapthalene, 4-chloro-3-methylphenol, aluminum, cobalt, copper, lead, sulfide and ammonia)

(b) Calculation for exposure dose :

INGESTION EXPOSURE DOSE	= Conc. x Conc.	Ingestion Rate 2 L/day	x Exposure Frequency 350 days/yr	x Exposure Duration 30 years	/ Body Weight 70 kg	Averaging Time (g) years	x Conversion Factor 365 days/year x 1E+03 ug/mg

(c) Hazard quotient = chronic exposure dose / RfD
(d) Cancer Risk = lifetime exposure dose x slope factor
(e) Dose-response data for cis-1,2-dichloroethene and chromium VI were used.
(f) Reference Dose for cadmium in water was used.
(g) Averaging times of 30 years for chronic doses and 70 years for lifetime doses were used.
(h) The reference dose for manganese is based on total allowable intake (10 mg/day) minus the background intake (5 mg/day).
The remaining intake (5 mg/day) was normalized for body weight (70 kg) and an additional uncertainty factor of 3 applied for water exposures.

nd = chemical not detected
na = toxicity value not available
— = not calculated due to absence of data

TABLE 28

POTENTIAL RISK FROM INGESTION OF SITE GROUNDWATER WITHIN THE SOLID WASTE AREA (AS DRINKING WATER)
MAXIMUM CONCENTRATIONS USED FOR AN ADULT EXPOSURE (a)

Analyte	Maximum Concentration (ug/L)	Exposure Dose Chronic (b) (mg/kg/day)	Oral Reference Dose (RfD) (mg/kg/day)	Hazard Quotient (c)		Exposure Dose Lifetime (b) (mg/kg/day)	Oral Slope Factor /(mg/kg/day)	Cancer Risk (d)
Benzene	31	8.5E-04	na	—		3.6E-04	0.029	1.1E-05
1,1-Dichloroethane	220	6.0E-03	0.1	—		2.6E-03	na	—
1,2-Dichloroethene (e)	730	2.0E-02	0.01	2.0E+00		8.6E-03	na	—
Vinyl Chloride	690	1.9E-02	na	—		8.1E-03	1.9	1.5E-02
Pentachlorophenol	3	8.2E-05	0.03	2.7E-03		3.5E-05	0.12	4.2E-06
bis(2-Ethylhexyl)phthalate	36	9.9E-04	0.02	4.9E-02		4.2E-04	0.014	5.9E-06
Acrylamide	229	6.3E-03	0.0002	3.1E+01		2.7E-03	4.5	1.2E-02
N,N-DMF	1440	3.9E-02	0.1	3.9E-01		1.7E-02	na	—
Antimony	nd	—	0.0004	—		—	na	—
Arsenic	9.7	2.7E-04	0.0003	8.9E-01		1.1E-04	1.5	1.7E-04
Barium	508	1.4E-02	0.07	2.0E-01		6.0E-03	na	—
Beryllium	13.7	3.8E-04	0.002	1.9E-01		1.6E-04	na	—
Cadmium (f)	40	1.1E-03	0.0005	2.2E+00		4.7E-04	na	—
Chromium (e)	154	4.2E-03	0.005	8.4E-01		1.8E-03	na	—
Manganese (h)	9790	2.7E-01	0.024	1.1E+01		1.1E-01	na	—
Nickel	125	3.4E-03	0.02	1.7E-01		1.5E-03	na	—
Vanadium	142	3.9E-03	0.007	5.6E-01		1.7E-03	na	—
Zinc	7360	2.0E-01	0.3	6.7E-01		8.6E-02	na	—
		Total Hazard Index =		5.1E+01		Total Risk =		2.8E-02
		Hazard Index (liver toxins)=		0.45				
		Hazard Index (nervous system toxins)=		42.55				
		Hazard Index (kidney toxins)=		2.19				
		Hazard Index (red blood cell effects)=		2.67				

NOTES:

(a) This table does not include groundwater chemicals of concern for which no reference dose or slope factor exists.
(chloroethane,2-methylnapthalene, 4-chloro-3-methylphenol, aluminum, cobalt, copper, lead, sulfide and ammonia)

(b) Calculation for exposure dose :

INGESTION	= Conc. x	Ingestion	x Exposure	x Exposure	/	Body	Averaging	x	Conversion
EXPOSURE		Rate	Frequency	Duration		Weight	Time		Factor
DOSE	Conc.	2	350	30		70	(g)		365 x 1E+03
		L/day	days/yr	years		kg	years		days/year ug/mg

(c) Hazard quotient = chronic exposure dose / RfD

(d) Cancer Risk = lifetime exposure dose x slope factor

(e) Dose-response data for cis-1,2-dichloroethene and chromium VI were used.

(f) Reference Dose for cadmium in water was used.

(g) Averaging times of 30 years for chronic doses and 70 years for lifetime doses were used.

(h) The reference dose for manganese is based on total allowable intake (10 mg/day) minus the background intake (5 mg/day).
The remaining intake (5 mg/day) was normalized for body weight (70 kg) and an additional uncertainty factor of 3 applied for water exposures.

nd = chemical not detected
na = toxicity value not available
— = not calculated due to absence of data

TABLE 29

POTENTIAL RISK OF INGESTION OF SITE GROUNDWATER WITHIN THE BULKY WASTE AREA (AS DRINKING WATER)
AVERAGE CONCENTRATIONS USED FOR AN ADULT EXPOSURE (a)

Analyte	Average Concentration (ug/L)	Exposure Dose Chronic (b) (mg/kg/day)	Oral Reference Dose (RfD) (mg/kg/day)	Hazard Quotient (c)	Exposure Dose Lifetime (b) (mg/kg/day)	Oral Slope Factor /(mg/kg/day)	Cancer Risk (d)
Benzene	1	2.7E-05	na	—	1.2E-05	0.029	3.4E-07
1,1-Dichloroethane	5	1.4E-04	0.1	1.4E-03	5.9E-05	na	—
1,2-Dichloroethene (e)	5	1.4E-04	0.01	1.4E-02	5.9E-05	na	—
Vinyl Chloride	nd	—	na	—	—	1.9	—
Pentachlorophenol	nd	—	0.03	—	—	0.12	—
bis(2-Ethylhexyl)phthalate	nd	—	0.02	—	—	0.014	—
Acrylamide	nd	—	0.0002	—	—	4.5	—
N,N-DMF	33	9.0E-04	0.1	9.0E-03	3.9E-04	na	—
Antimony	19	5.2E-04	0.0004	1.3E+00	2.2E-04	na	—
Arsenic	0.84	2.3E-05	0.0003	7.7E-02	9.9E-06	1.5	1.5E-05
Barium	81	2.2E-03	0.07	—	9.5E-04	na	—
Beryllium	2	5.5E-05	0.002	2.7E-02	2.3E-05	na	—
Cadmium (f)	nd	—	0.0005	—	—	na	—
Chromium (e)	9.9	2.7E-04	0.005	5.4E-02	1.2E-04	na	—
Manganese (h)	1600	4.4E-02	0.024	1.8E+00	1.9E-02	na	—
Nickel	13	3.6E-04	0.02	1.8E-02	1.5E-04	na	—
Vanadium	15	4.1E-04	0.007	5.9E-02	1.8E-04	na	—
Zinc	61	1.7E-03	0.3	5.6E-03	7.2E-04	na	—
		Total Hazard Index =		3.4E+00	Total Risk =		1.5E-05
		Hazard Index (liver toxins)=		0.01			
		Hazard Index (nervous system toxins)=		1.83			
		Hazard Index (kidney toxins)=		0.00			
		Hazard Index (red blood cell effects)=		0.02			
		Hazard Index (longevity)=		1.30			

NOTES:

(a) This table does not include groundwater chemicals of concern for which no reference dose or slope factor exists.
(chloroethane,2-methylnapthalene, 4-chloro-3-methylphenol, aluminum, cobalt, copper, lead, sulfide and ammonia)

(b) Calculation for exposure dose :

INGESTION EXPOSURE DOSE	= Conc. x Conc.	Ingestion Rate 2 L/day	x Exposure Frequency 350 days/yr	x Exposure Duration 30 years	/ Body Weight 70 kg	Averaging Time (g) years	x Conversion Factor 365 days/year x 1E+03 ug/mg

(c) Hazard quotient = chronic exposure dose / RfD
(d) Cancer Risk = lifetime exposure dose x slope factor
(e) Dose-response data for cis-1,2-dichloroethene and chromium VI were used.
(f) Reference Dose for cadmium in water was used.
(g) Averaging times of 30 years for chronic doses and 70 years for lifetime doses were used.
(h) The reference dose for manganese is based on total allowable intake (10 mg/day) minus the background intake (5 mg/day).
The remaining intake (5 mg/day) was normalized for body weight (70 kg) and an additional uncertainty factor of 3 applied for water exposures.

nd = chemical not detected
na = toxicity value not available
— = not calculated due to absence of data

TABLE 30

POTENTIAL RISK OF INGESTION OF SITE GROUNDWATER WITHIN THE BULKY WASTE AREA (AS DRINKING WATER)
MAXIMUM CONCENTRATIONS USED FOR AN ADULT EXPOSURE (a)

Analyte	Maximum Concentration (ug/L)	Exposure Dose Chronic (b) (mg/kg/day)	Oral Reference Dose (RfD) (mg/kg/day)	Hazard Quotient (c)	Exposure Dose Lifetime (b) (mg/kg/day)	Oral Slope Factor /(mg/kg/day)	Cancer Risk (d)
Benzene	1	2.7E-05	na	—	1.2E-05	0.029	3.4E-07
1,1-Dichloroethane	5	1.4E-04	0.1	1.4E-03	5.9E-05	na	—
1,2-Dichloroethene (e)	5	1.4E-04	0.01	1.4E-02	5.9E-05	na	—
Vinyl Chloride	nd	—	na	—	—	1.9	—
Pentachlorophenol	nd	—	0.03	—	—	0.12	—
bis(2-Ethylhexyl)phthalate	nd	—	0.02	—	—	0.014	—
Acrylamide	nd	—	0.0002	—	—	4.5	—
N,N-DMF	183	5.0E-03	0.1	5.0E-02	2.1E-03	na	—
Antimony	104.9	2.9E-03	0.0004	7.2E+00	1.2E-03	na	—
Arsenic	2.3	6.3E-05	0.0003	2.1E-01	2.7E-05	1.5	4.1E-05
Barium	430	1.2E-02	0.07	—	5.0E-03	na	—
Beryllium	10.5	2.9E-04	0.002	1.4E-01	1.2E-04	na	—
Cadmium (f)	nd	—	0.0005	—	—	na	—
Chromium (e)	66.6	1.8E-03	0.005	3.6E-01	7.8E-04	na	—
Manganese (h)	9995	2.7E-01	0.024	1.1E+01	1.2E-01	na	—
Nickel	71.3	2.0E-03	0.02	9.8E-02	8.4E-04	na	—
Vanadium	91	2.5E-03	0.007	3.6E-01	1.1E-03	na	—
Zinc	215	5.9E-03	0.3	2.0E-02	2.5E-03	na	—
		Total Hazard Index =		2.0E+01	Total Risk =		4.1E-05
		Hazard Index (liver toxins)=		0.05			
		Hazard Index (nervous system toxins)=		11.41			
		Hazard Index (kidney toxins)=		0.00			
		Hazard Index (red blood cell effects)=		0.03			
		Hazard Index (longevity)=		7.18			

NOTES:

(a) This table does not include groundwater chemicals of concern for which no reference dose or slope factor exists.
(chloroethane,2-methylnapthalene, 4-chloro-3-methylphenol, aluminum, cobalt, copper, lead, sulfide and ammonia)

(b) Calculation for exposure dose :

INGESTION EXPOSURE DOSE	= Conc. x Conc.	Ingestion Rate 2 L/day	x Exposure Frequency 350 days/yr	x Exposure Duration 30 years	/ Body Weight 70 kg	Averaging Time (g) years	x Conversion Factor 365 days/year x 1E+03 ug/mg

(c) Hazard quotient = chronic exposure dose / RfD

(d) Cancer Risk = lifetime exposure dose x slope factor

(e) Dose-response data for cis-1,2-dichloroethene and chromium VI were used.

(f) Reference Dose for cadmium in water was used.

(g) Averaging times of 30 years for chronic doses and 70 years for lifetime doses were used.

(h) The reference dose for manganese is based on total allowable intake (10 mg/day) minus the background intake (5 mg/day).
The remaining intake (5 mg/day) was normalized for body weight (70 kg) and an additional uncertainty factor of 3 applied for water exposures.

nd = chemical not detected
na = toxicity value not available
— = not calculated due to absence of data

TABLE 31

POTENTIAL RISK FROM INGESTION OF SITE GROUNDWATER WITHIN THE SEWAGE SLUDGE AREA (AS DRINKING WATER)
AVERAGE CONCENTRATIONS USED FOR AN ADULT EXPOSURE (a)

Analyte	Average Concentration (ug/L)	Exposure Dose Chronic (b) (mg/kg/day)	Oral Reference Dose (RfD) (mg/kg/day)	Hazard Quotient (c)	Exposure Dose Lifetime (b) (mg/kg/day)	Oral Slope Factor /(mg/kg/day)	Cancer Risk (d)
Benzene	nd	---	na	---	---	0.029	---
1,1-Dichloroethane	nd	---	0.1	---	---	na	---
1,2-Dichloroethene (e)	nd	---	0.01	---	---	na	---
Vinyl Chloride	nd	---	na	---	---	1.9	---
Pentachlorophenol	nd	---	0.03	---	---	0.12	---
bis(2-Ethylhexyl)phthalate	nd	---	0.02	---	---	0.014	---
Acrylamide	nd	---	0.0002	---	---	4.5	---
N,N-DMF	nd	---	0.1	---	---	na	---
Antimony	17	4.7E-04	0.0004	1.2E+00	2.0E-04	na	---
Arsenic	1.8	4.9E-05	0.0003	1.6E-01	2.1E-05	1.5	3.2E-05
Barium	97	2.7E-03	0.07	---	1.1E-03	na	---
Beryllium	1.7	4.7E-05	0.002	2.3E-02	2.0E-05	na	---
Cadmium (f)	3.3	9.0E-05	0.0005	1.8E-01	3.9E-05	na	---
Chromium (e)	14	3.8E-04	0.005	7.7E-02	1.6E-04	na	---
Manganese (h)	2500	6.8E-02	0.024	2.9E+00	2.9E-02	na	---
Nickel	33	9.0E-04	0.02	4.5E-02	3.9E-04	na	---
Vanadium	22	6.0E-04	0.007	8.6E-02	2.6E-04	na	---
Zinc	140	3.8E-03	0.3	1.3E-02	1.6E-03	na	---
		Total Hazard Index =		4.6E+00	Total Risk =		3.2E-05
		Hazard Index (liver toxins)=		0.00			
		Hazard Index (nervous system toxins)=		2.85			
		Hazard Index (kidney toxins)=		0.18			
		Hazard Index (red blood cell effects)=		0.01			
		Hazard Index (longevity)=		1.16			

NOTES:

(a) This table does not include groundwater chemicals of concern for which no reference dose or slope factor exists.
(chloroethane,2-methylnapthalene, 4-chloro-3-methylphenol, aluminum, cobalt, copper, lead, sulfide and ammonia)

(b) Calculation for exposure dose :

INGESTION EXPOSURE DOSE	= Conc. x	Ingestion Rate	x Exposure Frequency	x Exposure Duration	/ Body Weight	Averaging Time	x Conversion Factor
	Conc.	2	350	30	70	(g)	365 x 1E+03
		L/day	days/yr	years	kg	years	days/year ug/mg

(c) Hazard quotient = chronic exposure dose / RfD

(d) Cancer Risk = lifetime exposure dose x slope factor

(e) Dose-response data for cis-1,2-dichloroethene and chromium VI were used.

(f) Reference Dose for cadmium in water was used.

(g) Averaging times of 30 years for chronic doses and 70 years for lifetime doses were used.

(h) The reference dose for manganese is based on total allowable intake (10 mg/day) minus the background intake (5 mg/day).
The remaining intake (5 mg/day) was normalized for body weight (70 kg) and an additional uncertainty factor of 3 applied for water exposures.

nd = chemical not detected
na = toxicity value not available
--- = not calculated due to absence of data

TABLE 32

POTENTIAL RISK FROM INGESTION OF SITE GROUNDWATER WITHIN THE SEWAGE SLUDGE AREA (AS DRINKING WATER)
MAXIMUM CONCENTRATIONS USED FOR AN ADULT EXPOSURE (a)

Analyte	Maximum Concentration (ug/L)	Exposure Dose Chronic (b) (mg/kg/day)	Oral Reference Dose (RfD) (mg/kg/day)	Hazard Quotient (c)	Exposure Dose Lifetime (b) (mg/kg/day)	Oral Slope Factor /(mg/kg/day)	Cancer Risk (d)
Benzene	nd	—	na	—	—	0.029	—
1,1-Dichloroethane	nd	—	0.1	—	—	na	—
1,2-Dichloroethene (e)	nd	—	0.01	—	—	na	—
Vinyl Chloride	nd	—	na	—	—	1.9	—
Pentachlorophenol	nd	—	0.03	—	—	0.12	—
bis(2-Ethylhexyl)phthalate	nd	—	0.02	—	—	0.014	—
Acrylamide	nd	—	0.0002	—	—	4.5	—
N,N-DMF	nd	—	0.1	—	—	na	—
Antimony	74.2	2.0E-03	0.0004	5.1E+00	8.7E-04	na	—
Arsenic	5.5	1.5E-04	0.0003	5.0E-01	6.5E-05	1.5	9.7E-05
Barium	284	7.8E-03	0.07	1.1E-01	3.3E-03	na	—
Beryllium	3.4	9.3E-05	0.002	4.7E-02	4.0E-05	na	—
Cadmium (f)	19.4	5.3E-04	0.0005	1.1E+00	2.3E-04	na	—
Chromium (e)	54.5	1.5E-03	0.005	3.0E-01	6.4E-04	na	—
Manganese (h)	6230	1.7E-01	0.024	7.1E+00	7.3E-02	na	—
Nickel	76.6	2.1E-03	0.02	1.0E-01	9.0E-04	na	—
Vanadium	101	2.8E-03	0.007	4.0E-01	1.2E-03	na	—
Zinc	362	9.9E-03	0.3	3.3E-02	4.3E-03	na	—
		Total Hazard Index =		1.5E+01	*Total Risk =*		9.7E-05
		Hazard Index (liver toxins)=		0.00			
		Hazard Index (nervous system toxins)=		7.11			
		Hazard Index (kidney toxins)=		1.06			
		Hazard Index (red blood cell effects)=		0.03			
		Hazard Index (longevity)=		5.08			

NOTES:

(a) This table does not include groundwater chemicals of concern for which no reference dose or slope factor exists.
(chloroethane,2-methylnapthalene, 4-chloro-3-methylphenol, aluminum, cobalt, copper, lead, sulfide and ammonia)

(b) Calculation for exposure dose :

INGESTION EXPOSURE DOSE	= Conc.	x	Ingestion Rate	x Exposure Frequency	x Exposure Duration	/	Body Weight	Averaging Time	x	Conversion Factor
	Conc.		2	350	30		70	(g)		365 x 1E+03
			L/day	days/yr	years		kg	years		days/year ug/mg

(c) Hazard quotient = chronic exposure dose / RfD
(d) Cancer Risk = lifetime exposure dose x slope factor
(e) Dose-response data for cis-1,2-dichloroethene and chromium VI were used.
(f) Reference Dose for cadmium in water was used.
(g) Averaging times of 30 years for chronic doses and 70 years for lifetime doses were used.
(h) The reference dose for manganese is based on total allowable intake (10 mg/day) minus the background intake (5 mg/day).
The remaining intake (5 mg/day) was normalized for body weight (70 kg) and an additional uncertainty factor of 3 applied for water exposures.

nd = chemical not detected
na = toxicity value not available
--- = not calculated due to absence of data

TABLE 33

POTENTIAL RISK FROM INGESTION OF GROUNDWATER FROM RESIDENTIAL WELLS
AVERAGE CONCENTRATIONS USED FOR AN ADULT EXPOSURE

Analyte	Average Concentration (ug/L)	Exposure Dose Chronic (a) (mg/kg/day)	Oral Reference Dose (RfD) (mg/kg/day)	Hazard Quotient (b)	Exposure Dose Lifetime (a) (mg/kg/day)	Oral Slope Factor /(mg/kg/day)	Cancer Risk (c)
Benzene	0.52	1.4E-05	na	—	6.1E-06	0.029	1.8E-07
Chloroethane	0.53	1.5E-05	na	—	6.2E-06	na	—
Trichloroethene	0.56	1.5E-05	na	—	6.6E-06	0.011	7.2E-08
4-Methylphenol	7.9	2.2E-04	0.005	4.3E-02	9.3E-05	na	—
N,N-DMF	14	3.8E-04	0.1	3.8E-03	1.6E-04	na	—
Dieldrin	0.0024	6.6E-08	0.00005	1.3E-03	2.8E-08	16	4.5E-07
Aluminum	90	2.5E-03	na	—	1.1E-03	na	—
Barium	8.3	2.3E-04	0.07	3.2E-03	9.7E-05	na	—
Copper	14	3.8E-04	na	—	1.6E-04	na	—
Manganese (d)	890	2.4E-02	0.024	1.0E+00	1.0E-02	na	—
Mercury	0.14	3.8E-06	0.0003	1.3E-02	1.6E-06	na	—
Zinc	24	6.6E-04	0.3	2.2E-03	2.8E-04	na	—
Sulfide	1600	4.4E-02	na	—	1.9E-02	na	—
		Total Hazard Index =		1.1E+00	Total Risk =		7.0E-07
		Hazard Index (liver toxins) =		0.01			
		Hazard Index (nervous system toxins) =		1.06			

NOTES:

(a) Calculation for exposure dose :

INGESTION EXPOSURE DOSE	= Conc. x Conc.	Ingestion Rate 2 L/day	x Exposure Frequency 350 days/yr	x Exposure Duration 30 years	/ Body Weight 70 kg	Averaging Time (e) years	x	Conversion Factor 365 days/year x 1E+03 ug/mg

(b) Hazard quotient = chronic exposure dose / RfD

(c) Cancer Risk = lifetime exposure dose x slope factor

(d) The reference dose for manganese is based on total allowable intake (10 mg/day) minus the background intake (5 mg/day).
The remaining intake (5 mg/day) was normalized for body weight (70 kg) and an additional uncertainty factor of 3 applied for water exposures.

(e) Averaging times of 30 years for chronic doses and 70 years for lifetime doses were used.

nd = chemical not detected
na = toxicity value not available
— = not calculated due to absence of data

TABLE 34

POTENTIAL RISK FROM INGESTION OF GROUNDWATER FROM RESIDENTIAL WELLS
MAXIMUM CONCENTRATIONS USED FOR AN ADULT EXPOSURE

Analyte	Maximum Concentration (ug/L)	Exposure Dose Chronic (a) (mg/kg/day)	Oral Reference Dose (RfD) (mg/kg/day)	Hazard Quotient (b)	Exposure Dose Lifetime (a) (mg/kg/day)	Oral Slope Factor /(mg/kg/day)	Cancer Risk (c)
Benzene	0.8	2.2E-05	na	—	9.4E-06	0.029	2.7E-07
Chloroethane	1	2.7E-05	na	—	1.2E-05	na	—
Trichloroethene	2	5.5E-05	na	—	2.3E-05	0.011	2.6E-07
4-Methylphenol	63	1.7E-03	0.005	3.5E-01	7.4E-04	na	—
N,N-DMF	14	3.8E-04	0.1	3.8E-03	1.6E-04	na	—
Dieldrin	0.0024	6.6E-08	0.00005	1.3E-03	2.8E-08	16	4.5E-07
Aluminum	552	1.5E-02	na	—	6.5E-03	na	—
Barium	44.3	1.2E-03	0.07	1.7E-02	5.2E-04	na	—
Copper	58.6	1.6E-03	na	—	6.9E-04	na	—
Manganese (d)	3100	8.5E-02	0.024	3.5E+00	3.6E-02	na	—
Mercury	0.46	1.3E-05	0.0003	4.2E-02	5.4E-06	na	—
Zinc	165	4.5E-03	0.3	1.5E-02	1.9E-03	na	—
Sulfide	3700	1.0E-01	na	—	4.3E-02	na	—
		Total Hazard Index =		4.0E+00	Total Risk =		9.8E-07
		Hazard Index (liver toxins) =		0.01			
		Hazard Index (nervous system toxins) =		3.88			

NOTES:

(a) Calculation for exposure dose :

INGESTION EXPOSURE DOSE	=	Conc. x	Ingestion Rate	x Exposure Frequency	x Exposure Duration	/ Body Weight	Averaging Time	x	Conversion Factor
		Conc.	2	350	30	70	(e)		365 x 1E+03
			L/day	days/yr	years	kg	years		days/year ug/mg

(b) Hazard quotient = chronic exposure dose / RfD

(c) Cancer Risk = lifetime exposure dose x slope factor

(d) The reference dose for manganese is based on total allowable intake (10 mg/day) minus the background intake (5 mg/day).
The remaining intake (5 mg/day) was normalized for body weight (70 kg) and an additional uncertainty factor of 3 applied for water exposures.

(e) Averaging times of 30 years for chronic doses and 70 years for lifetime doses were used.

nd = chemical not detected

na = toxicity value not available

— = not calculated due to absence of data

TABLE 35

POTENTIAL RISK FROM INHALATION OF OUTDOOR AIR BY ADULTS IN THE SOLID WASTE AREA
AVERAGE CONCENTRATIONS USED BASED ON SOIL GAS CONTAMINATION COLLECTED BY SUMMA CANISTERS

ANALYTE	Avg. Soil Gas Conc. (mg/m^3)	Estimated Emission Rate (mg/sec)(a)	Modeled Air Concentration (mg/m^3)(b)	Annualized Avg. Conc. (mg/m^3)(c)	RfC (mg/m^3)	Inhalation Unit Risk /(ug/m^3)	Hazard Quotient (d)	Cancer Risk (e)
Acetone	0	0	0	0	na	na	na	---
Benzene	8.0	0.23	4.6E-04	3.1E-05	0.006	8.3E-06	5.2E-03	1.1E-07
Carbon Disulfide	0.87	0.02	5.0E-05	3.4E-06	0.7	nd	4.9E-06	---
1,1-Dichloroethane	61	1.72	3.5E-03	2.4E-04	0.5	nd	4.8E-04	---
1,1-Dichloroethene	17	0.48	9.7E-04	6.7E-05	na	5.0E-05	na	1.4E-06
cis-1,2-Dichloroethene	9800	276.36	5.6E-01	3.8E-02	na	na	na	---
trans-1,2-Dichloroethene	11	0.31	6.3E-04	4.3E-05	na	nd	na	---
Dichlorodifluoromethane	51	1.44	2.9E-03	2.0E-04	0.2	nd	1.0E-03	---
Ethylbenzene	25	0.71	1.4E-03	9.8E-05	1	na	9.8E-05	---
4-Methyl-2-pentanone	6.5	0.18	3.7E-04	2.5E-05	0.08	nd	3.2E-04	---
Methylene Chloride	26	0.73	1.5E-03	1.0E-04	3	4.7E-07	3.4E-05	2.1E-08
Toluene	100	2.82	5.7E-03	3.9E-04	0.4	na	9.8E-04	---
1,2,4-Trichlorobenzene	0	0	0	0	0.2	na	---	---
1,2,4-Trimethylbenzene	2	0.06	1.1E-04	7.8E-06	0.006	na	1.3E-03	---
1,3,5-Trimethylbenzene	4.3	0.12	2.5E-04	1.7E-05	0.006	na	2.8E-03	---
Trichloroethene	31	0.87	1.8E-03	1.2E-04	na	1.7E-06	na	8.8E-08
Vinyl Chloride	1400	39.48	8.0E-02	5.5E-03	na	8.4E-05	na	2.0E-04
m,p-Xylene	41	1.16	2.3E-03	1.6E-04	na	nd	na	---
					Total Hazard Index =		1.2E-02	
						Total Cancer Risk =		2.0E-04

NOTES:

(a) Soil gas concentration x gas generation rate (60 cfm, or 0.0282 m^3/sec, calculated in M&E FS, 1998)

(b) Emission rate x Disposal area length in prevailing wind direction (NW)/ Surface area x Breathing zone height x Windspeed.
[(Emission rate x 450 m) / (110950 m^2 x 2 m x 1 m/sec)]

(c) Annualized Air Concentration = Modeled Air Concentration (mg/m^3) x 4 hrs/24 hrs x 150 days / 365 days

(d) Hazard quotient = Annualized Air Concentration / RfC

(e) Cancer Risk = Annualized Air Concentration (mg/m^3) x 1000 ug/mg x Unit Risk /(ug/m^3) x 30 yrs / 70 yrs

na - not available

nd - not determined

-- - not calculated due to absence of data

TABLE 36

POTENTIAL RISK FROM INHALATION OF OUTDOOR AIR BY ADULTS IN THE SOLID WASTE AREA
MAXIMUM CONCENTRATIONS USED BASED ON SOIL GAS CONTAMINATION COLLECTED BY SUMMA CANISTERS

ANALYTE	Max. Soil Gas Conc. (mg/m^3)	Estimated Emission Rate (mg/sec)(a)	Modeled Air Concentration (mg/m^3)(b)	Annualized Avg. Conc. (mg/m^3)(c)	RfC (mg/m^3)	Inhalation Unit Risk /(ug/m^3)	Hazard Quotient (d)	Cancer Risk (e)
Acetone	0	0	0	0	na	na	na	---
Benzene	8.0	0.23	4.6E-04	3.1E-05	0.006	8.3E-06	5.2E-03	1.1E-07
Carbon Disulfide	0.87	0.02	5.0E-05	3.4E-06	0.7	nd	4.9E-06	---
1,1-Dichloroethane	140	3.95	8.0E-03	5.5E-04	0.5	nd	1.1E-03	---
1,1-Dichloroethene	32	0.90	1.8E-03	1.3E-04	na	5.0E-05	na	2.7E-06
cis-1,2-Dichloroethene	23000	648.60	1.3E+00	9.0E-02	na	na	na	---
trans-1,2-Dichloroethene	27	0.76	1.5E-03	1.1E-04	na	nd	na	---
Dichlorodifluoromethane	100	2.82	5.7E-03	3.9E-04	0.2	nd	2.0E-03	---
Ethylbenzene	25	0.71	1.4E-03	9.8E-05	1	na	9.8E-05	---
4-Methyl-2-pentanone	6.5	0.18	3.7E-04	2.5E-05	0.08	nd	3.2E-04	---
Methylene Chloride	66	1.86	3.8E-03	2.6E-04	3	4.7E-07	8.6E-05	5.2E-08
Toluene	230	6.49	1.3E-02	9.0E-04	0.4	na	2.3E-03	---
1,2,4-Trichlorobenzene	0	0	0	0	0.2	na	---	---
1,2,4-Trimethylbenzene	2	0.06	1.1E-04	7.8E-06	0.006	na	1.3E-03	---
1,3,5-Trimethylbenzene	4.3	0.12	2.5E-04	1.7E-05	0.006	na	2.8E-03	---
Trichloroethene	31	0.87	1.8E-03	1.2E-04	na	1.7E-06	na	8.8E-08
Vinyl Chloride	3100	87.42	1.8E-01	1.2E-02	na	8.4E-05	na	4.4E-04
m,p-Xylene	41	1.16	2.3E-03	1.6E-04	na	nd	na	---
					Total Hazard Index =		1.5E-02	
						Total Cancer Risk =		4.4E-04

NOTES:

(a) Soil gas concentration x gas generation rate (60 cfm, or 0.0282 m^3/sec, calculated in M&E FS, 1998)

(b) Emission rate x Disposal area length in prevailing wind direction (NW)/ Surface area x Breathing zone height x Windspeed.
[(Emission rate x 450 m) / (110950 m^2 x 2 m x 1 m/sec)]

(c) Annualized Air Concentration = Modeled Air Concentration (mg/m^3) x 4 hrs/24 hrs x 150 days / 365 days

(d) Hazard quotient = Annualized Air Concentration / RfC

(e) Cancer Risk = Annualized Air Concentration (mg/m^3) x 1000 ug/mg x Unit Risk /(ug/m^3) x 30 yrs / 70 yrs

na - not available

nd - not determined

--- - not calculated due to absence of data

TABLE 37

POTENTIAL RISK FROM INHALATION OF AMBIENT AIR BY NEARBY RESIDENTS
AVERAGE CONCENTRATIONS USED FOR AN ADULT EXPOSURE

ANALYTE	Ambient Air Concentration (mg/m^3)	Annualized Avg. Conc. (mg/m^3)(a)	RfC (mg/m^3)	Inhalation Unit Risk /(ug/m^3)	Hazard Quotient (b)	Cancer Risk (c)
Benzene	2.4E-02	2.3E-02	0.006	8.3E-06	3.8E+00	8.2E-05
Ethylbenzene	2.0E-03	1.9E-03	1	na	1.9E-03	na
Methylene Chloride	1.0E-03	9.6E-04	3	4.7E-07	3.2E-04	1.9E-07
1,1,2,2-Tetrachloroethane	4.0E-03	3.8E-03	na	5.8E-05	na	9.5E-05
Toluene	1.0E-03	9.6E-04	0.4	na	2.4E-03	na
1,1,1-Trichloroethane	2.0E-03	1.9E-03	1	na	1.9E-03	na
Vinyl Chloride	1.0E-03	9.6E-04	na	8.4E-05	na	3.5E-05
m,p-Xylene	4.0E-03	3.8E-03	na	na	na	na
o-Xylene	5.0E-03	4.8E-03	na	na	na	na
			Total Hazard Index =		3.8E+00	
				Total Cancer Risk =		2.1E-04

NOTES:

(a) Annualized Air Concentration = Ambient Air Concentration (mg/m^3) x 350 days / 365 days

(b) Hazard quotient = Annualized Air Concentration / RfC

(c) Cancer Risk = Annualized Air Concentration (mg/m^3) x 1000 ug/mg x Unit Risk /(ug/m^3) x 30 yrs / 70 yrs

na - not available

nd - not determined

TABLE 38

POTENTIAL RISK FROM INHALATION OF AMBIENT AIR BY NEARBY RESIDENTS
MAXIMUM CONCENTRATIONS USED FOR AN ADULT EXPOSURE

ANALYTE	Ambient Air Concentration (mg/m^3)	Annualized Avg. Conc. (mg/m^3)(a)	RfC (mg/m^3)	Inhalation Unit Risk /(ug/m^3)	Hazard Quotient (b)	Cancer Risk (c)
Benzene	7.5E-02	7.2E-02	0.006	8.3E-06	1.2E+01	2.6E-04
Ethylbenzene	2.0E-03	1.9E-03	1	na	1.9E-03	na
Methylene Chloride	1.0E-03	9.6E-04	3	4.7E-07	3.2E-04	1.9E-07
1,1,2,2-Tetrachloroethane	4.0E-03	3.8E-03	na	5.8E-05	na	9.5E-05
Toluene	2.0E-03	1.9E-03	0.4	na	4.8E-03	na
1,1,1-Trichloroethane	2.0E-03	1.9E-03	1	na	1.9E-03	na
Vinyl Chloride	4.0E-03	3.8E-03	na	8.4E-05	na	1.4E-04
m,p-Xylene	7.0E-03	6.7E-03	na	na	na	na
o-Xylene	7.0E-03	6.7E-03	na	na	na	na
			Total Hazard Index =		1.2E+01	
				Total Cancer Risk =		4.9E-04

NOTES:

(a) Annualized Air Concentration = Ambient Air Concentration (mg/m^3) x 350 days / 365 days

(b) Hazard quotient = Annualized Air Concentration / RfC

(c) Cancer Risk = Annualized Air Concentration (mg/m^3) x 1000 ug/mg x Unit Risk /(ug/m^3) x 30 yrs / 70 yrs

na - not available

nd - not determined

TABLE 39

POTENTIAL FUTURE RISK FROM INHALATION OF INDOOR AIR BY NEARBY RESIDENTS
AVERAGE CONCENTRATION OF VINYL CHLORIDE USED FOR AN ADULT EXPOSURE

ANALYTE	Indoor Air Concentration (mg/m^3)	Annualized Avg. Conc. (mg/m^3)(a)	RfC (mg/m^3)	Inhalation Unit Risk /(ug/m^3)	Hazard Quotient (b)	Cancer Risk (c)
Vinyl Chloride	2.3E-02	2.2E-02	na	8.4E-05	na	7.9E-04
			Total Hazard Index =		na	
				Total Cancer Risk =		7.9E-04

NOTES:

(a) Annualized Air Concentration = Indoor Air Concentration (mg/m^3) x 350 days / 365 days

(b) Hazard quotient = Annualized Air Concentration / RfC

(c) Cancer Risk = Annualized Air Concentration (mg/m^3) x 1000 ug/mg x Unit Risk /(ug/m^3) x 30 yrs / 70 yrs

na - not available

nd - not determined

TABLE 40

POTENTIAL FUTURE RISK FROM INHALATION OF INDOOR AIR BY NEARBY RESIDENTS
MAXIMUM CONCENTRATION OF VINYL CHLORIDE USED FOR AN ADULT EXPOSURE

ANALYTE	Indoor Air Concentration (mg/m^3)	Annualized Avg. Conc. (mg/m^3)(a)	RfC (mg/m^3)	Inhalation Unit Risk /(ug/m^3)	Hazard Quotient (b)	Cancer Risk (c)
Vinyl Chloride	5.6E-02	5.4E-02	na	8.4E-05	na	1.9E-03
			Total Hazard Index =		na	
				Total Cancer Risk =		1.9E-03

NOTES:
(a) Annualized Air Concentration = Indoor Air Concentration (mg/m^3) x 350 days / 365 days
(b) Hazard quotient = Annualized Air Concentration / RfC
(c) Cancer Risk = Annualized Air Concentration (mg/m^3) x 1000 ug/mg x Unit Risk /(ug/m^3) x 30 yrs / 70 yrs

na - not available
nd - not determined

TABLE 41

POTENTIAL CENTRAL TENDENCY RISKS FOR A CURRENT/FUTURE SITE VISITOR TO THE SOLID WASTE AREA, FROM INHALATION OF AMBIENT AIR, ESTIMATED FROM SUMMA CANISTER SAMPLES OF LANDFILL GAS AND BOX DISPERSION MODEL

ANALYTE	Avg. Landfill Gas Conc. (mg/m^3)(a)	Estimated Emission Rate (mg/sec)(b)	Modeled Air Concentration (mg/m^3)(c)	Annualized Avg. Conc. (mg/m^3)(d)	RfC (mg/m^3)	Inhalation Unit Risk /(ug/m^3)	Hazard Quotient (e)	Cancer Risk (f)
Acetone	nd	nd	nd	nd	na	na	nd	---
Benzene	4.2	0.12	2.4E-04	1.7E-05	0.006	8.3E-06	2.8E-03	5.9E-08
Carbon disulfide	0.87	0.02	5.0E-05	3.4E-06	0.7	na	4.9E-06	---
Dichlorodifluoromethane	44	1.24	2.5E-03	1.7E-04	0.2	nd	8.7E-04	nd
1,1-Dichloroethane	43	1.21	2.5E-03	1.7E-04	0.5	nd	3.4E-04	nd
1,1-Dichloroethene	14	0.39	8.1E-04	5.5E-05	na	5.0E-05	nd	1.2E-06
cis-1,2-Dichloroethene	7800	220	4.5E-01	3.1E-02	na	na	nd	---
trans-1,2-Dichloroethene	8.2	0.23	4.7E-04	3.2E-05	na	nd	nd	---
Ethylbenzene	25	0.71	1.4E-03	9.9E-05	1	na	9.9E-05	---
4-Methyl-2-pentanone	3.5	0.10	2.0E-04	1.4E-05	0.08	na	1.7E-04	---
Methylene chloride	19	0.54	1.1E-03	7.5E-05	3	4.7E-07	2.5E-05	1.5E-08
1,1,2,2-Tetrachloroethane	nd	nd	nd	nd	na	5.8E-05	nd	---
Toluene	83	2.34	4.8E-03	3.3E-04	0.4	na	8.2E-04	---
1,2,4-Trichlorobenzene	nd	nd	nd	nd	0.2	na	nd	---
1,1,1-Trichloroethane	4.0	0.11	2.3E-04	1.6E-05	1	na	1.6E-05	---
Trichloroethene	15	0.42	8.6E-04	5.9E-05	na	1.7E-06	nd	4.3E-08
1,2,4-Trimethylbenzene	2.5	0.07	1.4E-04	9.9E-06	0.006	na	1.6E-03	---
1,3,5-Trimethylbenzene	2.0	0.06	1.2E-04	7.9E-06	0.006	na	1.3E-03	---
Vinyl chloride	1100	31	6.3E-02	4.3E-03	na	8.4E-05	nd	1.6E-04
m,p-Xylene	41	1.16	2.4E-03	1.6E-04	na	na	nd	---
o-Xylene	11	0.31	6.3E-04	4.3E-05	na	na	nd	---
					Total Hazard Index =		8.1E-03	
						Total Cancer Risk =		1.6E-04

NOTES:

(a) Average concentration among three SUMMA canister locations, or substitute value, as specified in Table 5

(b) Soil gas concentration x gas generation rate (0.0282 m^3/sec, calculated in FS: M&E, 1998)

(c) Emission rate x Disposal area length in prevailing wind direction (NW)/ Surface area x Breathing zone height x Windspeed

[(Emission rate x 370 m) / (90,580 m^2 x 2 m x 1 m/sec)]

(d) Annualized Air Concentration = Modeled Air Concentration (mg/m^3) x 4 hrs/24 hrs x 150 days / 365 days

(e) Hazard quotient = Annualized Air Concentration (mg/m^3) / Chronic RfC (mg/m^3)

(f) Cancer Risk = Annualized Air Concentration (mg/m^3) x 1000 ug/mg x Unit Risk (m^3/ug) x 30 yrs / 70 yrs

na not available or not applicable

nd not detected or not determined

--- minimal risk from compounds that were not detected or that are not considered carcinogenic

TABLE 42

POTENTIAL RME RISKS FOR A CURRENT/FUTURE SITE VISITOR TO THE SOLID WASTE AREA, FROM INHALATION OF AMBIENT AIR, ESTIMATED FROM SUMMA CANISTER SAMPLES OF LANDFILL GAS AND BOX DISPERSION MODEL

ANALYTE	Max. Landfill Gas Conc. (mg/m^3)(a)	Estimated Emission Rate (mg/sec)(b)	Modeled Air Concentration (mg/m^3)(c)	Annualized Avg. Conc. (mg/m^3)(d)	RfC (mg/m^3)	Inhalation Unit Risk /(ug/m^3)	Hazard Quotient (e)	Cancer Risk (f)
Acetone	nd	nd	nd	nd	na	na	nd	---
Benzene	8.0	0.23	4.6E-04	3.2E-05	0.006	8.3E-06	5.3E-03	1.1E-07
Carbon disulfide	0.87	0.02	5.0E-05	3.4E-06	0.7	na	4.9E-06	---
Dichlorodifluoromethane	110	3.10	6.3E-03	4.3E-04	0.2	nd	2.2E-03	nd
1,1-Dichloroethane	140	3.95	8.1E-03	5.5E-04	0.5	nd	1.1E-03	nd
1,1-Dichloroethene	32	0.90	1.8E-03	1.3E-04	na	5.0E-05	nd	2.7E-06
cis-1,2-Dichloroethene	23000	649	1.3E+00	9.1E-02	na	na	nd	---
trans-1,2-Dichloroethene	27	0.76	1.6E-03	1.1E-04	na	nd	nd	---
Ethylbenzene	25	0.71	1.4E-03	9.9E-05	1	na	9.9E-05	---
4-Methyl-2-pentanone	6.6	0.19	3.8E-04	2.6E-05	0.08	na	3.3E-04	---
Methylene chloride	66	1.86	3.8E-03	2.6E-04	3	4.7E-07	8.7E-05	5.2E-08
1,1,2,2-Tetrachloroethane	nd	nd	nd	nd	na	5.8E-05	nd	---
Toluene	230	6.49	1.3E-02	9.1E-04	0.4	na	2.3E-03	---
1,2,4-Trichlorobenzene	nd	nd	nd	nd	0.2	na	nd	---
1,1,1-Trichloroethane	10	0.28	5.8E-04	3.9E-05	1	na	3.9E-05	---
Trichloroethene	31	0.87	1.8E-03	1.2E-04	na	1.7E-06	nd	8.9E-08
1,2,4-Trimethylbenzene	2.5	0.07	1.4E-04	9.9E-06	0.006	na	1.6E-03	---
1,3,5-Trimethylbenzene	4.3	0.12	2.5E-04	1.7E-05	0.006	na	2.8E-03	---
Vinyl chloride	3100	87	1.8E-01	1.2E-02	na	8.4E-05	nd	4.4E-04
m,p-Xylene	41	1.16	2.4E-03	1.6E-04	na	na	nd	---
o-Xylene	11	0.31	6.3E-04	4.3E-05	na	na	nd	---
					Total Hazard Index =		1.6E-02	
						Total Cancer Risk =		4.4E-04

NOTES:

(a) Maximum concentration among three SUMMA canister locations, or substitute value, as specified in Table 5

(b) Soil gas concentration x gas generation rate (0.0282 m^3/sec, calculated in FS: M&E, 1998)

(c) Emission rate x Disposal area length in prevailing wind direction (NW)/ Surface area x Breathing zone height x Windspeed
[(Emission rate x 370 m) / (90,580 m^2 x 2 m x 1 m/sec)]

(d) Annualized Air Concentration = Modeled Air Concentration (mg/m^3) x 4 hrs/24 hrs x 150 days / 365 days

(e) Hazard quotient = Annualized Air Concentration (mg/m^3) / Chronic RfC (mg/m^3)

(f) Cancer Risk = Annualized Air Concentration (mg/m^3) x 1000 ug/mg x Unit Risk (m^3/ug) x 30 yrs / 70 yrs

na not available or not applicable

nd not detected or not determined

--- minimal risk from compounds that were not detected or that are not considered carcinogenic

TABLE 43

POTENTIAL CENTRAL TENDENCY RISKS FOR A CURRENT/FUTURE RESIDENT, FROM INHALATION OF AMBIENT AND INDOOR AIR, ESTIMATED FROM SUMMA CANISTER SAMPLES OF RESIDENTIAL AREA AMBIENT AIR

ANALYTE	Measured Air Concentration (mg/m^3)(a)	Annualized Avg. Conc. (mg/m^3)(b)	RfC (mg/m^3)	Inhalation Unit Risk /(ug/m^3)	Hazard Quotient (c)	Cancer Risk (d)
Benzene	0.024	2.3E-02	0.006	8.3E-06	3.8E+00	8.2E-05
Ethylbenzene	0.0017	1.6E-03	1	na	1.6E-03	---
Methylene chloride	0.0010	9.6E-04	3	4.7E-07	3.2E-04	1.9E-07
1,1,2,2-Tetrachloroethane	0.0021	2.0E-03	na	5.8E-05	nd	5.0E-05
Toluene	0.0011	1.1E-03	0.4	na	2.6E-03	---
1,1,1-Trichloroethane	0.0014	1.3E-03	1	na	1.3E-03	---
Vinyl chloride	0.0011	1.1E-03	na	8.4E-05	nd	3.8E-05
m,p-Xylene	0.0045	4.3E-03	na	na	nd	---
o-Xylene	0.0055	5.3E-03	na	na	nd	---
			Total Hazard Index =		3.8E+00	
				Total Cancer Risk =		1.7E-04

NOTES:

(a) Average concentration among valid outdoor SUMMA canister samples, as specified in Table 6

(b) Annualized Air Concentration = Modeled Air Concentration (mg/m^3) x 24 hrs/24 hrs x 350 days / 365 days

(c) Hazard quotient = Annualized Air Concentration (mg/m^3) / Chronic RfC (mg/m^3)

(d) Cancer Risk = Annualized Air Concentration (mg/m^3) x Unit Risk (m^3/ug) x 1000 ug/mg x 30 yrs / 70 yrs

na not available or not applicable

nd *not detected or not determined*

--- minimal risk from compounds that were not detected or that are not considered carcinogenic

TABLE 44

POTENTIAL RME RISKS FOR A CURRENT/FUTURE RESIDENT, FROM INHALATION OF AMBIENT AND INDOOR AIR, ESTIMATED FROM SUMMA CANISTER SAMPLES OF RESIDENTIAL AREA AMBIENT AIR

ANALYTE	Measured Air Concentration (mg/m^3)(a)	Annualized Avg. Conc. (mg/m^3)(b)	RfC (mg/m^3)	Inhalation Unit Risk /(ug/m^3)	Hazard Quotient (c)	Cancer Risk (d)
Benzene	0.075	7.2E-02	0.006	8.3E-06	1.2E+01	2.6E-04
Ethylbenzene	0.0017	1.6E-03	1	na	1.6E-03	---
Methylene chloride	0.0014	1.3E-03	3	4.7E-07	4.5E-04	2.7E-07
1,1,2,2-Tetrachloroethane	0.0021	2.0E-03	na	5.8E-05	nd	5.0E-05
Toluene	0.0015	1.4E-03	0.4	na	3.6E-03	---
1,1,1-Trichloroethane	0.0016	1.5E-03	1	na	1.5E-03	---
Vinyl chloride	0.0043	4.1E-03	na	8.4E-05	nd	1.5E-04
m,p-Xylene	0.0069	6.6E-03	na	na	nd	---
o-Xylene	0.0069	6.6E-03	na	na	nd	---
			Total Hazard Index =		1.2E+01	
				Total Cancer Risk =		4.5E-04

NOTES:

(a) Maximum concentration among valid outdoor SUMMA canister samples, as specified in Table 6

(b) Annualized Air Concentration = Modeled Air Concentration (mg/m^3) x 24 hrs/24 hrs x 350 days / 365 days

(c) Hazard quotient = Annualized Air Concentration (mg/m^3) / Chronic RfC (mg/m^3)

(d) Cancer Risk = Annualized Air Concentration (mg/m^3) x Unit Risk (m^3/ug) x 1000 ug/mg x 30 yrs / 70 yrs

na not available or not applicable

nd not detected or not determined

--- minimal risk from compounds that were not detected or that are not considered carcinogenic

TABLE 45

SUMMARY STATISTICS FOR SOLID WASTE AREA LANDFILL GAS

(Units: mg/m^3)

Ambient Air Chemical of Concern	Frequency of Detection, per Sample (a)	Frequency of Detection, per Location (b)	Range of Detection Limits (c)	Range of Detected Concentrations (d)	Calculated Arithmetic Mean (e)	Selected Landfill Gas Concentrations RME Case (f)	Selected Landfill Gas Concentrations Average Case (g)
Acetone	0 / 4	0 / 3	0.4 - 300	ND	ND	ND	ND
Benzene	3 / 4	3 / 3	400	2.0 - 8.0	4.20	8.0	4.2
Carbon disulfide	2 / 4	2 / 3	100 - 400	0.12 - 0.87	21.08	0.87	0.87
Dichlorodifluoromethane	4 / 4	3 / 3	-	1.0 - 110	43.53	110	44
1,1-Dichloroethane	4 / 4	3 / 3	-	0.21 - 140	43.13	140	43
1,1-Dichloroethene	4 / 4	3 / 3	-	0.040 - 32	14.10	32	14
cis-1,2-Dichloroethane	4 / 4	3 / 3	-	1.5 - 23000	7803	23000	7800
trans-1,2-Dichloroethane	4 / 4	3 / 3	-	0.087 - 27	8.16	27	8.2
Ethylbenzene	2 / 4	2 / 3	200 - 600	13 - 25	41.70	25	25
4-Methyl-2-pentanone	1 / 4	1 / 3	0.7 - 600	6.6	3.52	6.6	3.5
Methylene Chloride	4 / 4	3 / 3	-	0.69 - 66	18.64	66	19
1,1,2,2-Tetrachloroethane	0 / 4	0 / 3	1 - 1000	ND	ND	ND	ND
Toluene	4 / 4	3 / 3	-	21 - 230	83.50	230	83
1,2,4-Trichlorobenzene	0 / 4	0 / 3	1 - 1000	ND	ND	ND	ND
1,1,1-Trichloroethane	2 / 4	2 / 3	0.9 - 800	1.3 - 10	4.02	10	4.0
Trichloroethene	3 / 4	3 / 3	800	0.45 - 31	15.20	31	15
1,2,4-Trimethylbenzene	2 / 4	2 / 3	200 - 700	1.1 - 2.5	33.95	2.5	2.5
1,3,5-Trimethylbenzene	3 / 4	3 / 3	700	0.74 - 4.3	2.02	4.3	2.0
Vinyl Chloride	4 / 4	3 / 3	-	3.1 - 3100	1062	3100	1100
m,p-Xylene	2 / 4	2 / 3	200 - 600	24 - 41	50.67	41	41
o-Xylene	2 / 4	2 / 3	200 - 600	4.3 - 11	34.02	11	11

NOTES:

Units converted from reported units of ppbv, using molecular weights and a conversion factor of 24.45 liters/mole (molar volume at 1 atm, 25 C)

a. This is the ratio of the number of samples in which the chemical was detected to the total number of valid samples, among SUMMA canister samples of Solid Waste Area land

b. This is the ratio of the number of locations where the chemical was detected to the total number of locations with valid samples.

c. Range of detection limits among non-detected samples

d. Range of concentrations among detected samples

e. The arithmetic mean among three locations is listed. The two samples from sampling location SW(03+300) are considered together, for averaging purposes. The mean was calculated using 1/2 of the detection limit for samples that were non-detect for a specific analyte, if the analyte was detected at other locations.

f. The landfill gas concentration used to derive the exposure point concentration for "Reasonable Maximum Exposure" is the maximum detected among four samples.

g. The landfill gas concentration used to derive average case exposure point concentrations is the arithmetic mean (note e) or the maximum detected (note f), whichever is lower.

SOURCE: REMEDIAL INVESTIGATION FINAL REPORT (M&E, May 1994)

TABLE 46

SUMMARY STATISTICS, AMBIENT AIR MEASUREMENTS NEAR RESIDENCES

(Units: mg/m^3)

Chemical Detected in Residential Area Ambient Air	Frequency of Detection, per Sample (a)	Frequency of Detection, per Location (b)	Detection Limit (c)	Range of Detected Concentrations (d)	Calculated Arithmetic Mean (e)	Selected Ambient Air Concentration Based on Direct Measurements RME Case (f)	Average Case (g)
Benzene (h)	4 / 4	4 / 4	-	0.0029 - 0.075	0.024	0.075	0.024
Ethylbenzene (h)	1 / 1	1 / 1	-	0.0017	0.0017	0.0017	0.0017
Methylene Chloride (h)	4 / 4	4 / 4	-	0.0007 - 0.0014	0.0010	0.0014	0.0010
1,1,2,2-Tetrachloroethane (h)	1 / 4	1 / 4	0.007	0.0021 - 0.0021	0.0031	0.0021	0.0021
Toluene (h)	4 / 4	4 / 4	-	0.0008 - 0.0015	0.0011	0.0015	0.0011
1,1,1-Trichloroethane (h)	4 / 4	4 / 4	-	0.0005 - 0.0016	0.0014	0.0016	0.0014
Vinyl Chloride (i)	6 / 11	3 / 4	0.0005	0.0007 - 0.0043	0.0011	0.0043	0.0011
m,p-Xylene (h)	4 / 4	4 / 4	-	0.0013 - 0.0069	0.0045	0.0069	0.0045
o-Xylene (h)	3 / 3	3 / 3	-	0.0043 - 0.0069	0.0055	0.0069	0.0055

NOTES:

Units converted from reported units of ppbv, using molecular weights and a conversion factor of 24.45 liters/mole (molar volume at 1 atm, 25 C)

a. This is the ratio of the number of samples in which the chemical was detected to the total number of valid samples. The total number of samples varies between chemicals due to rejected values and, in the case of vinyl chloride, reliance on a different set of data (see notes h and i).

b. This is the ratio of the number of locations where the chemical was detected to the total number of locations with valid samples; samples flagged "B" considered invalid.

c. Detection limit reported for non-detected samples only

d. Range of concentrations among detected samples

e. Arithmetic mean among all valid samples

f. The maximum detected is selected as the "Reasonable Maximum Exposure" case concentration based on direct measurements.

g. The arithmetic mean (note e) or maximum detected (note f), whichever is lower, is selected to represent the average case ambient air concentration based on direct measurements

h. Statistics for chemicals other than vinyl chloride are from the 24-hour period ending 5/27/93.

i. Statistics for vinyl chloride are from outdoor samples in residential areas collected in February and March 1993.

SOURCE: AIR QUALITY MODELING FINAL REPORT, Appendix E, Table 4 (EPA, August 1993)

TABLE 47 SUMMARY STATISTICS FOR INDOOR AIR FROM 220 ROSE HILL ROAD

(Units: mg/m3)

Chemical	Frequency of Detection/Location (1)	Frequency of Detection/Samples (2)	Detection Limit	Range of Concentrations	Calculated Arithmetic Mean (3)	Selected Ambient Air Concentrations RME Case (4)	Selected Ambient Air Concentrations Average Case (5)
Vinyl Chloride	1 / 1	8 / 8	0.001	0.004 - 0.056	0.023	0.056	0.023

NOTES:

1. This value represents the number of locations which had detected concentrations per the number of locations sampled. The number of locations sampled varies due to rejected values and locations not sampled.
2. This value represents the number of detected concentrations per the total sum of samples collected at all locations in the specific area. The total number of samples collected varies due to rejected values and locations not sampled.
3. When an analyte was not detected, the mean was calculated using 1/2 of the detection limit for that sample. Refer to section 6.1.3 for a detailed discussion of averaging.
4. Maximum detected is defined as the exposure point concentration for "Reasonable Maximum Exposure"
5. Exposure point concentration is maximum detected or arithmetic mean, whichever is lower.

gwsola

TABLE 48 SUMMARY STATISTICS FOR GROUNDWATER FROM THE SOLID WASTE AREA

(Units: μg/L)

Chemical	Frequency of Detection/Location (1)	Frequency of Detection/Samples (2)	Range of Detection Limits	Range of Concentration	Calculated Arithmetic Mean (3)	Selected Exposure Point Concentrations RME Case (4)	Average Case (5)
Benzene	9 / 10	25 / 40	5 - 40	2 - 31	10.575	31	11
Chloroethane	6 / 10	21 / 40	10 - 40	2 - 86	16.954	86	17
1,1-Dichloroethane	7 / 10	24 / 40	5 - 40	1 - 220	13.650	220	14
1,2-Dichloroethene(total)	8 / 10	21 / 40	5 - 40	1 - 730	33.767	730	34
Vinyl Chloride	5 / 10	11 / 40	10 - 40	3 - 690	34.154	690	34
Acrylamide	1 / 9	1 / 17	200 - 2000	229	160.556	229	160
N,N-DMF	5 / 9	12 / 37	50 - 500	50 - 1440	199.259	1440	200
4-Chloro-3-methylphenol	3 / 10	5 / 39	10	0.9 - 5	4.702	5	4.7
bis(2-Ethylhexyl)phthalat	2 / 10	2 / 40	10	0.9 - 36	5.581	36	5.6
2-Methylnaphthalene	2 / 10	4 / 40	10	1 - 5	4.796	5	4.8
Pentachlorophenol	1 / 10	1 / 39	25 - 50	3	13.746	3	3
Aluminum	10 / 10	37 / 40	13 - 66	228 - 110000	13886.190	110000	14000
Antimony	0 / 10	0 / 40	8 - 47	--	0.000	0	0
Arsenic	8 / 10	11 / 39	1 - 4	1.1 - 9.7	2.718	9.7	2.7
Barium	10 / 10	39 / 40	1 - 4	7.0 - 508	165.200	508	170
Beryllium	7 / 10	10 / 40	1	1.1 - 13.7	1.669	13.7	1.7
Cadmium	1 / 10	4 / 40	1 - 3	19.6 - 40.0	4.448	40.0	4.4
Chromium	7 / 10	17 / 40	2 - 8	4.2 - 154	23.967	154	24
Cobalt	9 / 10	21 / 40	3 - 8	3.2 - 53.8	14.587	53.8	15
Copper	8 / 10	15 / 40	2 - 11	16 - 367	41.675	367	42
Lead	9 / 10	14 / 40	1 - 5	7.8 - 181	39.773	181	40
Manganese	10 / 10	38 / 40	1 - 9	22.8 - 9790	1923.843	9790	1900
Nickel	9 / 10	21 / 40	3 - 16	3.6 - 125	26.202	125	26
Vanadium	8 / 10	22 / 40	2 - 5	3 - 142	21.273	142	21
Zinc	9 / 10	21 / 39	4 - 11	13.2 - 7360	680.242	7360	680
Ammonia	5 / 5	8 / 8	30.0	34.0 - 51700	8094.000	51700	8100
Sulfide	4 / 10	4 / 32	50 - 1000	1700 - 4940	815.000	4940	820

NOTES:

1. This value represents the number of locations which had detected concentrations per the number of locations sampled. The number of locations sampled varies due to rejected values and locations not sampled.
2. This value represents the number of detected concentrations per the total sum of samples collected at all locations in the specific area. The total number of samples collected varies due to rejected values and locations not sampled.
3. When an analyte was not detected, the mean was calculated using 1/2 of the detection limit for that sample. Refer to section 6.1.3 for a detailed discussion of averaging.
4. Maximum detected is defined as the exposure point concentration for "Reasonable Maximum Exposure"
5. Exposure point concentration is maximum detected or arithmetic mean, whichever is lower.

gwbulka

TABLE 49 SUMMARY STATISTICS FOR GROUNDWATER FROM THE BULKY WASTE AREA
(Units: µg/L)

Chemical	Frequency of Detection/Location (1)	Frequency of Detection/Samples (2)	Range of Detection Limits	Range of Concentration	Calculated Arithmetic Mean (3)	Selected Exposure Point Concentrations RME Case (4)	Selected Exposure Point Concentrations Average Case (5)
Benzene	1 / 5	1 / 17	5 - 50	1	6.550	1	1
Chloroethane	1 / 5	2 / 17	10 - 50	9 - 16	7.750	16	7.8
1,1-Dichloroethane	2 / 5	3 / 17	5 - 50	1 - 5	6.490	5	5
1,2-Dichloroethene(total)	2 / 5	4 / 17	5 - 50	1 - 5	6.225	5	5
Vinyl Chloride	0 / 5	0 / 17	10 - 50	--	0.000		0
Acrylamide	0 / 5	0 / 9	200	--	0.000	0	0
N,N-DMF	1 / 5	1 / 16	50	183	32.900	183	33
4-Chloro-3-methylphenol	0 / 5	0 / 17	10 - 20	--	0.000	0	0
bis(2-Ethylhexyl)phthalate	0 / 5	0 / 17	10 - 20	--	0.000	0	0
2-Methylnaphthalene	1 / 5	1 / 17	10 - 20	2	4.950	2	2
Pentachlorophenol	0 / 5	0 / 17	25 - 50	--	0.000	0	0
Aluminum	5 / 5	15 / 17	13 - 66	28.5 - 61000	12318.738	61000	12000
Antimony	2 / 5	2 / 17	8 - 47	17.5 - 104.9	18.663	104.9	19
Arsenic	1 / 5	2 / 16	1 - 2	1 - 2.3	0.837	2.3	0.84
Barium	5 / 5	14 / 17	1 - 4	9.1 - 430	81.428	430	81
Beryllium	3 / 5	4 / 17	1	2.6 - 10.5	1.988	10.5	2.0
Cadmium	0 / 5	0 / 17	1 - 3	--	0.000	0	0
Chromium	3 / 5	5 / 17	2 - 8	8.1 - 66.6	9.877	66.6	9.9
Cobalt	4 / 5	6 / 17	3 - 8	3.7 - 27.2	7.149	27.2	7.1
Copper	5 / 5	11 / 17	2 - 11	12.4 - 104	32.813	104	33
Lead	3 / 5	5 / 17	1 - 2	24 - 307	23.188	307	23
Manganese	5 / 5	17 / 17	1 - 9	43.3 - 9995	1637.850	9995	1600
Nickel	2 / 5	3 / 17	3 - 16	24.8 - 71.3	12.923	71.3	13
Vanadium	4 / 5	10 / 17	2 - 5	6.5 - 91.0	14.746	91.0	15
Zinc	4 / 5	9 / 16	4 - 11	48.4 - 215	60.713	215	61
Ammonia	1 / 2	2 / 4	30.0	500 - 6030	1640.000	6030	1600
Sulfide	2 / 5	2 / 13	50 - 1000	2400 - 32000	3670.000	32000	3700

NOTES:

1. This value represents the number of locations which had detected concentrations per the number of locations sampled. The number of locations sampled varies due to rejected values and locations not sampled.
2. This value represents the number of detected concentrations per the total sum of samples collected at all locations in the specific area. The total number of samples collected varies due to rejected values and locations not sampled.
3. When an analyte was not detected, the mean was calculated using 1/2 of the detection limit for that sample. Refer to section 6.1.3 for a detailed discussion of averaging.
4. Maximum detected is defined as the exposure point concentration for "Reasonable Maximum Exposure"
5. Exposure point concentration is maximum detected or arithmetic mean, whichever is lower.

gwsewa

TABLE 50 SUMMARY STATISTICS FOR GROUNDWATER FROM THE SEWAGE SLUDGE AREA

(Units: μg/L)

Chemical	Frequency of Detection/Location (1)	Frequency of Detection/Samples (2)	Range of Detection Limits	Range of Concentration	Calculated Arithmetic Mean (3)	Selected Exposure Point Concentrations RME Case (4)	Average Case (5)
Benzene	0 / 6	0 / 13	5 - 10	--	0.000	0	0
Chloroethane	0 / 6	0 / 13	10	--	0.000	0	0
1,1-Dichloroethane	0 / 6	0 / 13	5 - 10	--	0.000	0	0
1,2-Dichloroethene(total)	0 / 6	0 / 13	5 - 10	--	0.000	0	0
Vinyl Chloride	0 / 6	0 / 13	10	--	0.000	0	0
Acrylamide	0 / 6	0 / 6	200	--	0.000	0	0
N,N-DMF	0 / 6	0 / 9	50	--	0.000	0	0
4-Chloro-3-methylphenol	0 / 6	0 / 13	10	--	0.000	0	0
bis(2-Ethylhexyl)phthalate	0 / 6	0 / 13	10	--	0.000	0	0
2-Methylnaphthalene	0 / 6	0 / 13	10	--	0.000	0	0
Pentachlorophenol	0 / 6	0 / 13	25 - 50	--	0.000	0	0
Aluminum	6 / 6	13 / 13	10 - 66	627 - 55600	16422.306	55600	16000
Antimony	1 / 6	1 / 13	11 - 47	74.2	17.097	74.2	17
Arsenic	2 / 6	3 / 13	1 - 4	2.7 - 5.5	1.800	5.5	1.8
Barium	6 / 6	11 / 13	1 - 2	19.3 - 284	97.497	284	97
Beryllium	3 / 6	3 / 13	1	2.6 - 3.4	1.701	3.4	1.7
Cadmium	1 / 6	1 / 13	1 - 3	19.4	3.325	19.4	3.3
Chromium	3 / 6	3 / 13	2 - 8	23.0 - 54.5	14.451	54.5	14
Cobalt	5 / 6	8 / 13	2 - 8	10.0 - 45.0	20.560	45.0	21
Copper	5 / 6	9 / 13	2 - 11	15.3 - 123	58.178	123	58
Lead	5 / 6	8 / 13	1 - 2	10.9 - 82.4	26.542	82.4	27
Manganese	6 / 6	13 / 13	1 - 9	44.0 - 6230	2541.444	6230	2500
Nickel	6 / 6	11 / 13	3 - 16	5.4 - 76.6	32.851	76.6	33
Vanadium	5 / 6	8 / 13	2 - 5	6.5 - 101.0	22.019	101.0	22
Zinc	6 / 6	9 / 13	3 - 11	32.5 - 362	137.426	362	140
Ammonia	1 / 1	1 / 1	30.0	17100	17100.000	17100	17000
Sulfide	4 / 6	4 / 12	50 - 1000	640 - 2700	565.000	2700	560

NOTES:

1. This value represents the number of locations which had detected concentrations per the number of locations sampled. The number of locations sampled varies due to rejected values and locations not sampled.
2. This value represents the number of detected concentrations per the total sum of samples collected at all locations in the specific area. The total number of samples collected varies due to rejected values and locations not sampled.
3. When an analyte was not detected, the mean was calculated using 1/2 of the detection limit for that sample. Refer to section 6.1.3 for a detailed discussion of averaging.
4. Maximum detected is defined as the exposure point concentration for "Reasonable Maximum Exposure"
5. Exposure point concentration is maximum detected or arithmetic mean, whichever is lower.

gwres

TABLE 51 SUMMARY STATISTICS FOR GROUNDWATER FROM RESIDENTIAL WELLS

(Units: μg/L)

Chemical	Frequency of Detection/Location (1)	Frequency of Detection/Samples (2)	Range of Detection Limits	Range of Concentration	Calculated Arithmetic Mean (3)	Selected Exposure Point Concentrations RME Case (4)	Selected Exposure Point Concentrations Average Case (5)
Benzene	1 / 10	1 / 21	1	0.8 - 0.8	0.515	0.8	0.52
Chloroethane	1 / 10	1 / 21	1	1.0 - 1.0	0.525	1.0	0.53
Trichloroethene	2 / 10	2 / 21	1	0.6 - 2*	0.555	2*	0.56
N,N-DMF	2 / 10	2 / 12	50	1.9 - 14	22.745	14	14
4-Methylphenol	1 / 10	1 / 19	10	63	7.900	63	7.9
Dieldrin	1 / 10	1 / 21	0.10	0.0024	0.048	0.0024	0.0024
Aluminum	4 / 10	5 / 21	10 - 27	20.0 - 552	90.475	552	90
Barium	6 / 10	8 / 21	1 - 4	5.8 - 44.3	8.273	44.3	8.3
Copper	3 / 10	4 / 21	3 - 11	11 - 58.6	13.503	58.6	14
Manganese	9 / 10	15 / 21	1 - 9	2.6 - 3100	887.830	3100	890
Mercury	1 / 10	1 / 19	0.2	0.46	0.136	0.46	0.14
Zinc	1 / 10	1 / 21	3 - 8	165	24.204	165	24
Sulfide	9 / 10	9 / 21	50 - 1000	450 - 3700	1571.000	3700	1600

NOTES:

1. This value represents the number of locations which had detected concentrations per the number of locations sampled. The number of locations sampled varies due to rejected values and locations not sampled.
2. This value represents the number of detected concentrations per the total sum of samples collected at all locations in the specific area. The total number of samples collected varies due to rejected values and locations not sampled.
3. When an analyte was not detected, the mean was calculated using 1/2 of the detection limit for that sample. Refer to section 6.1.3 for a detailed discussion of averaging.
4. Maximum detected is defined as the exposure point concentration for "Reasonable Maximum Exposure"
5. Exposure point concentration is maximum detected or arithmetic mean, whichever is lower.

TABLE 52

RISK ASSESSMENT SUMMARY

REASONABLE MAXIMUM EXPOSURE

ROSE HILL REGIONAL LANDFILL SUPERFUND SITE

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Drinking Water	Solid Waste Area	Benzene	1.1E-05	--	--	1.1E-05	1,2-Dichloroethene	Liver	2.0E+00	--	--	2.0E+00
			Vinyl Chloride	1.5E-02	--	--	1.5E-02	Acrylamide	Nervous System	3.1E+01	--	--	3.1E+01
			Pentachlorophenol	4.2E-06	--	--	4.2E-06	Cadmium	Kidney	2.2E+00	--	--	2.2E+00
			Bis(2-Ethylhexyl)phthalate	5.9E-06	--	--	5.9E-06	Manganese	Nervous System	1.1E+01	--	--	1.1E+01
			Acrylamide	1.2E-02	--	--	1.2E-02						
			Arsenic	1.7E-04	--	--	1.7E-04						
			(Total)	2.7E-02	--	--	2.7E-02	(Total)		4.6E+01	--	--	4.6E+01

-- Not Evaluated

Total Risk Across All Media and All Exposure Routes: 2.7E-02

Total Hazard Index Across All Media and All Exposure Routes: 4.6E+01

Total Liver HI = 2.0E+00

Total Nervous System HI = 4.2E+01

Total Kidney HI = 2.2E+00

TABLE 53

RISK ASSESSMENT SUMMARY

REASONABLE MAXIMUM EXPOSURE

ROSE HILL REGIONAL LANDFILL SUPERFUND SITE

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Drinking Water	Sewage Sludge Area						Antimony	Blood	5.1E+00	- -	- -	5.1E+00
								Cadmium	Kidney	1.1E+00	- -	- -	1.1E+00
								Manganese	Nervous System	7.1E+00	- -	- -	7.1E+00
								(Total)		1.3E+01	- -	- -	1.3E+01

- - Not Evaluated

Total Risk Across All Media and All Exposure Routes: N/A

Total Hazard Index Across All Media and All Exposure Routes: 1.3E+01

Total Blood HI = 5.1E+00

Total Kidney HI = 1.1E+00

Total Nervous System HI = 7.1E+00

TABLE 54

RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE

ROSE HILL REGIONAL LANDFILL SUPERFUND SITE

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Drinking Water	Bulky Waste Area						Antimony	Blood	7.2E+00	--	--	7.2E+00
								Manganese	Nervous System	1.1E+01	--	--	1.1E+01
								(Total)		1.8E+01	--	--	1.8E+01
-- Not Evaluated			Total Risk Across All Media and All Exposure Routes				N/A		Total Hazard Index Across All Media and All Exposure Routes				1.8E+01

Total Blood HI = 7.2E+00
Total Nervous System HI = 1.1E+01

TABLE 55

RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE

ROSE HILL REGIONAL LANDFILL SUPERFUND SITE

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Drinking Water	Residential Wells						Manganese	Nervous System	3.5E+00	--	--	3.5E+00
								(Total)		3.5E+00	--	--	3.5E+00
-- Not Evaluated			Total Risk Across All Media and All Exposure Routes				N/A		Total Hazard Index Across All Media and All Exposure Routes				3.5E+00

Total Nervous System HI = 3.5E+00

TABLE 56

RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE

ROSE HILL REGIONAL LANDFILL SUPERFUND SITE

Scenario Timeframe: Current/Future
Receptor Population: Visitor
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Air	Outdoor Air (1)	Solid Waste Area	1,1-Dichloroethane	- -	2.7E-06	- -	2.7E-06						
			Vinyl Chloride	- -	4.4E-04	- -	4.4E-04						
			(Total)	- -	4.4E-04	- -	4.4E-04						
- - Not Evaluated			Total Risk Across All Media and All Exposure Routes				4.4E-04		Total Hazard Index Across All Media and All Exposure Routes				N/A

(1) Measured by SUMMA canister

TABLE 57

RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE

ROSE HILL REGIONAL LANDFILL SUPERFUND SITE

Scenario Timeframe: Current/Future
Receptor Population: Nearby Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Air	Ambient Air (1)	Nearby Residences	Benzene	- -	2.6E-04	- -	2.6E-04	Benzene	Blood	- -	1.2E+01	- -	1.2E+01
			1,1,2,2-Tetrachloroethane	- -	9.5E-05	- -	9.5E-05						
			Vinyl Chloride	- -	1.4E-04	- -	1.4E-04						
			(Total)	- -	5.0E-04	- -	5.0E-04	(Total)		- -	1.2E+01	- -	1.2E+01
- - Not Evaluated			Total Risk Across All Media and All Exposure Routes				5.0E-04		Total Hazard Index Across All Media and All Exposure Routes				1.2E+01

(1) Measured by SUMMA canister

Total Blood HI = 1.2E+01

TABLE 58

RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE

ROSE HILL REGIONAL LANDFILL SUPERFUND SITE

Scenario Timeframe: Current/Future
Receptor Population: Visitor
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Air	Ambient Air (1)	Solid Waste Area	1,1-Dichloroethane	--	2.7E-06	--	2.7E-06						
			Vinyl Chloride	--	4.4E-04	--	4.4E-04						
			(Total)	--	4.4E-04	--	4.4E-04						
-- Not Evaluated				Total Risk Across All Media and All Exposure Routes			4.4E-04		Total Hazard Index Across All Media and All Exposure Routes				N/A

(1) Concentrations based on landfill gas concentrations, a landfill gas emission rate, and simple box dispersion modeling.

TABLE 59

RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE

ROSE HILL REGIONAL LANDFILL SUPERFUND SITE

Scenario Timeframe: Current/Future
Receptor Population: Nearby Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Air	Ambient and Indoor Air (1)	Nearby Residences	Benzene	--	2.6E-04	--	2.6E-04	Benzene	Blood	--	1.2E+01	--	1.2E+01
			1,1,2,2-Tetrachloroethane	--	5.0E-05	--	5.0E-05						
			Vinyl Chloride	--	1.5E-04	--	1.5E-04						
			(Total)	--	4.6E-04	--	4.6E-04	(Total)		--	1.2E+01	--	1.2E+01
-- Not Evaluated				Total Risk Across All Media and All Exposure Routes			4.6E-04		Total Hazard Index Across All Media and All Exposure Routes				1.2E+01

(1) Concentrations based on landfill gas concentrations, a landfill gas emission rate, and ISCST3 dispersion modeling

Total Blood HI = 1.2E+01

TABLE 60

RISK ASSESSMENT SUMMARY
REASONABLE MAXIMUM EXPOSURE

ROSE HILL REGIONAL LANDFILL SUPERFUND SITE

Scenario Timeframe: Future
Receptor Population: Nearby Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Air	Indoor Air (1)	Nearby Residences	Vinyl Chloride	--	1.9E-03	--	1.9E-03						
			(Total)	--	1.9E-03	--	1.9E-03						

-- Not Evaluated

Total Risk Across All Media and All Exposure Routes: 1.9E-03

Total Hazard Index Across All Media and All Exposure Routes: N/A

(1) Measured concentrations at 220 Rose Hill Road

TABLE 61

ORAL DOSE-RESPONSE VALUES FOR CHEMICALS OF CONCERN

CHEMICAL (a)	CHRONIC RfD (mg/kg)	CRITICAL EFFECTS	ORAL RfD CONFIDENCE	REFERENCE FOR RfD	ORAL SLOPE FACTOR /(mg/kg/day)	WEIGHT OF EVIDENCE	REFERENCE FOR SLOPE FACTOR	NOTES
VOLATILE ORGANIC COMPOUNDS								
Acetone	0.10	increased liver weight	Low	IRIS 8/98	NA	NA	NA	
Benzene	NA	NA	NA	NA	2.9E-02	A	IRIS 8/98	
Chloroethane	NA	NA	NA	NA	NA	NA	NA	
1,1-Dichloroethane	0.10	kidney damage	Low	HEAST '97	NA	C	IRIS 8/98	
1,2-Dichloroethene	0.01	liver lesions	Low	HEAST '97	NA	NA	NA	
Trichloroethene	NA	NA	NA	NA	1.1E-02	B2 or C	NCEA	
Vinyl chloride	NA	NA	NA	NA	1.9E+00	A	HEAST '97	
Pentachlorophenol	0.03	liver/kidney damage	Med.	IRIS 8/98	1.2E-01	B2	IRIS 8/98	
bis(2-Ethylhexyl)phthalate	0.02	NOEL	Med.	IRIS 8/98	1.4E-02	B2	IRIS 8/98	
Acrylamide	0.0002	nerve damage	Med.	IRIS 8/98	4.5E+00	B2	IRIS 8/98	
4-Methylphenol	0.005	central nervous system	Low	HEAST '97	NA	NA	NA	
N,N-Dimethylformamide	0.10	liver effects	Med.	HEAST '97	NA	NA	NA	
Benzo(a)anthracene	NA	NA	NA	NA	7.3E-01	B2	IRIS 8/98	
Benzo(a)pyrene	NA	NA	NA	NA	7.3E+00	B2	IRIS 8/98	
Benzo(b)fluoranthene	NA	NA	NA	NA	7.3E-01	B2	IRIS 8/98	
Benzo(k)fluoranthene	NA	NA	NA	NA	7.3E-02	B2	IRIS 8/98	
Chrysene	NA	NA	NA	NA	7.3E-03	B2	IRIS 8/98	
Indeno(1,2,3-c,d)pyrene	NA	NA	NA	NA	7.3E-01	B2	IRIS 8/98	
Dieldrin	0.00005	liver effects	Med.	IRIS 8/98	1.6E+01	B2	IRIS 8/98	

TABLE 61 (continued).

ORAL DOSE-RESPONSE VALUES FOR CHEMICALS OF CONCERN

CHEMICAL (a)	CHRONIC RfD (mg/kg)	CRITICAL EFFECTS	ORAL RfD CONFIDENCE	REFERENCE FOR RfD	ORAL SLOPE FACTOR /(mg/kg/day)	WEIGHT OF EVIDENCE	REFERENCE FOR SLOPE FACTOR	NOTES
Aluminum	NA	NA	NA	NA	NA	NA	NA	
Antimony	0.0004	blood	Low	IRIS 8/98	NA	NA	NA	
Arsenic	0.0003	skin	Med.	IRIS 8/98	1.5	A	IRIS 8/98	
Barium	0.07	vascular	Med.	IRIS 8/98	NA	NA	IRIS 8/98	
Beryllium	0.002	NOEL	Med.	IRIS 8/98	NA	NA	IRIS 8/98	
Cadmium	0.0005	kidney damage	High	IRIS 8/98	NA	B1	IRIS 8/98	
Chromium	0.005	NOEL	Low	IRIS 8/98	NA	A	IRIS 8/98	b
Cobalt	NA	NA	NA	NA	NA	NA	NA	
Copper	NA	NA	NA	NA	NA	NA	NA	
Lead	NA	NA	NA	NA	NA	B2	IRIS 8/98	
Manganese	0.07	nervous system	Med.	IRIS 8/98	NA	D	IRIS 8/98	
Mercury	0.0003	nervous system	High	IRIS 8/98	NA	D	IRIS 8/98	
Nickel	0.02	decreased body/organ weights	Low	IRIS 8/98	NA	NA	NA	
Thallium	0.00008	NOEL	Med.	IRIS 8/98	NA	D	IRIS 8/98	
Vanadium	0.007	NOEL	Med.	HEAST '97	NA	D	IRIS 8/98	
Zinc	0.30	blood	High	IRIS 8/98	NA	D	IRIS 8/98	

FOOTNOTES:

a. This table includes chemicals detected in soil, sludge, leachate, and groundwater.

b. The RfD for Chromium VI was used.

REFERENCES:

IRIS. USEPA, 1998. Integrated Risk Information System. Database searched August 1998.

HEAST. USEPA, 1997. Health Effects Assessment Summary Tables, FY-1997 Annual.

NCEA. USEPA, 1996. National Center for Environmental Assessment, Superfund Health Risk Technical Support Center. Attachments to 21 August 1996 letter to D. Newton.

ABBREVIATIONS:

NA = Not available

NOEL=No Observed Effect Level

RfD = Reference concentration

TABLE 62

INHALATION DOSE-RESPONSE VALUES FOR AIR CHEMICALS OF CONCERN

CHEMICAL (a)	CHRONIC RfC (mg/m^3)	CRITICAL EFFECTS	INHALATION RfC CONFIDENCE	REFERENCE FOR RfC	INHALATION UNIT RISK /(ug/m^3)	WEIGHT OF EVIDENCE	REFERENCE FOR UNIT RISK	NOTES
VOLATILE ORGANIC COMPOUNDS								
Acetone	NA							
Benzene	0.006	damage to hematopoietic progenitor cells	medium	NCEA 3/96	8.3E-06	A	IRIS 8/98	b
Carbon disulfide	0.70	peripheral nervous system dysfunction	medium	IRIS 8/98				
Dichlorodifluoromethane	0.20	liver lesions		HEAST '97				c
1,1-Dichloroethane	0.50	kidney damage		HEAST '97		C	IRIS 8/98	c
1,1-Dichloroethene	NA				5.0E-05	C	IRIS 8/98	
cis-1,2-Dichloroethene	NA					D	IRIS 8/98	
trans-1,2-Dichloroethene	NA							
Ethylbenzene	1.0	developmental toxicity	low	IRIS 8/98		D	IRIS 8/98	
4-Methyl-2-pentanone (MIBK)	0.08	increased liver weight, kidney effects		HEAST '97				c
Methylene chloride	3.0	liver toxicity		HEAST '97	4.7E-07	B2	IRIS 8/98	
1,1,2,2-Tetrachloroethane	NA				5.8E-05	C	IRIS 8/98	

TABLE 62 (continued).
INHALATION DOSE-RESPONSE VALUES
FOR AMBIENT AIR CHEMICALS OF CONCERN

CHEMICAL (a)	CHRONIC RfC (mg/m^3)	CRITICAL EFFECTS	INHALATION RfC CONFIDENCE	REFERENCE FOR RfC	INHALATION UNIT RISK /(ug/m^3)	WEIGHT OF EVIDENCE	REFERENCE FOR UNIT RISK	NOTES
Toluene	0.40	neurological effects		IRIS 8/98		D	IRIS 8/98	
1,2,4-Trichlorobenzene	0.20	non-adverse weight changes		HEAST '97		D	IRIS 8/98	
1,1,1-Trichloroethane	1.00	brain damage	medium	NCEA 8/96		D	IRIS 8/98	b
Trichloroethene	NA				1.7E-06	B2 or C	NCEA	d
1,2,4-Trimethylbenzene	0.006	neurotoxicity, decreased body weight gain, testicular atrophy	low	NCEA 3/96				b
1,3,5-Trimethylbenzene	0.006	neurotoxicity, decreased body weight gain, testicular atrophy	low	NCEA 3/96				b
Vinyl chloride	NA				8.4E-05		HEAST '97	
m,p-Xylene	NA					D	IRIS 8/98	d
o-Xylene	NA					D	IRIS 8/98	d

FOOTNOTES:

a. This table includes chemicals selected in the RI as chemicals of concern in landfill gas that were detected in the solid waste landfill plus chemicals detected in residential area ambient air sampling in 1993.
b. The value listed as a chronic RfC is a draft, provisional value.
c. Chronic RfC is from the "Alternate Methods Table" of HEAST FY-1997.
d. RfCs for xylenes and the inhalation unit risk for trichloroethene were available on HEAST until 1991 but have since been withdrawn.

REFERENCES:

IRIS. USEPA, 1998. Integrated Risk Information System. Database searched August 1998.
HEAST. USEPA, 1997. Health Effects Assessment Summary Tables, FY-1997 Annual.
NCEA. USEPA, 1996. National Center for Environmental Assessment, Superfund Health Risk Technical Support Center. Attachments to 21 August 1996 letter to D. Newton.

ABBREVIATIONS:

NA = Not available
RfC = Reference concentration

TABLE 63 ROSE HILL REGIONAL LANDFILL ECOLOGICAL RISK ASSESSMENT - SURFACE WATER CONTAMINANT SCREENING

Compound	Frequency of Detection	Site Concentration Maximum	Mean 6/91	9/91	1/92	4/92	5/92	AWQC Chronic Criteria	AWQC Acute Criteria	Background Range
Volatile organics										
Benzene	1/56	3	2.5	—	—	—	—	5.9	265	U
Toluene	1/56	2	—	***	—	—	—	14	635	U
Total Xylenes	2/56	9	3.4	—	—	—	—	ND	ND	U
Chlorobenzene	1/56	2	***	—	—	—	—	18	795	U
1,2-Dichloroethene(total)	1/56	4	2.6	—	—	—	—	ND	ND	U
Chloroethane	1/56	6	5.1	—	—	—	—	ND	ND	U
Carbon Disulfide	15/56	14	3.2	5.2	4.8	***	—	ND	ND	4
Water soluble organics										
Acrylamide	1/15	272	NA	110	NA	—	NA	ND	ND	U
N,N-DMF	1/31	5	NA	***	—	—	NA	ND	ND	U
Semivolatile organics										
bis(2-ethylhexyl)phthalate	1/56	8	5.2	—	—	—	—	12	555	U
Diethylphthalate	2/56	2	—	***	***	—	—	58	2,605	U
Dimethylphthalate	1/56	1	—	—	***	—	—	37	1,650	U
Di-n-butylphthalate	1/56	3	—	—	***	—	—	ND	ND	U
Pesticides										
gamma-BHC(Lindane)	1/56	0.002	—	***	—	—	—	ND	ND	U
4,4'-DDD	1/56	0.0047	—	—	***	—	—	ND	ND	U
Methoxychlor	1/56	0.014	—	—	***	—	—	0.03	ND	U
Inorganics										
Aluminum	30/56	1,140	250	130	120	—	310	87	750	88.5 - 194
Antimony	4/56	28.8	—	15	—	12	—	10	450	U
Arsenic	2/56	4.1	1.7	0.57	—	—	—	1.2	52	U
Barium	33/56	279	40	10	7.8	7.7	9.5	ND	ND	U - 8.6
Calcium	56/56	27,100	7,700	5,300	4,000	3,700	4,300	ND	ND	3,240 - 4,070
Chromium	1/56	3.2	—	—	—	1.7	—	11	16	U
Copper	6/56	11.6	—	5.8	—	—	1.6	13.9 *	21.2 *	U - 2.1
Iron	48/56	65,000	9,500	1,600	1,400	660	1,900	1,000	ND	U - 250
Lead	1/56	3.7	—	—	—	—	1.2	4.0 *	104 *	U
Magnesium	56/56	12,900	2,700	1,700	1,400	1,300	1,500	ND	ND	1,210 - 1,460
Manganese	54/56	2,030	610	320	230	140	240	ND	ND	20.6 - 68.2
Nickel	1/56	5.0	2.7	—	—	—	—	185 *	1,664 *	U
Potassium	31/56	45,000	5,200	870	980	880	—	ND	ND	U - 777
Sodium	56/56	59,900	14,000	11,000	9,000	9,000	9,000	ND	ND	7,900 - 9,720
Zinc	15/56	22.8	8.3	9.4	7.0	—	5.2	124 *	137 *	U - 3.9
Ammonia	17/19	3.53	NA	NA	NA	0.29	0.65	2.2	24	U - 0.15
Cyanide	3/56	210	—	5.3	—	—	25	5.2	22	U
Sulfide	14/37	2.20	1.4	—	—	NA	NA	ND	ND	U - 2.20

NOTES

All concentrations in µg/L except ammonia and sulfide, which are in mg/L.

— Analyte was not detected in this round.

*** The calculated mean is greater than the maximum detect.

NA Analyte was not analyzed for in this round or all values were rejected.

ND Data not available.

* Criterion was calculated using the maximum value of unfiltered hardness (120.8 mg/L).

U This analyte was not detected in any of the background samples, or the non-detected value is the lowest concentration.

TABLE 64 ROSE HILL REGIONAL LANDFILL ECOLOGICAL RISK ASSESSMENT - LEACHATE CONTAMINANT SCREENING

Compound	Frequency of Detection	Site Concentration Maximum	Site Concentration Mean 6/91	Site Concentration Mean 4/92	AWQC Chronic Criteria	AWQC Acute Criteria
Volatile organics						
Toluene	3/9	50	19	—	14	635
Ethylbenzene	3/8	2	—	1.7	36	1,600
Total Xylenes	2/8	3	—	***	ND	ND
Chlorobenzene	3/9	2	***	—	18	795
Trichloroethene	1/8	4	2.8	—	43	1,950
1,2-Dichloroethene(total)	2/8	44	10.8	***	ND	ND
1,1-Dichloroethane	3/9	2	***	—	ND	ND
Chloroethane	4/9	8	5.7	***	ND	ND
Vinyl Chloride	1/8	1	***	—	ND	ND
Carbon Disulfide	2/8	12	4.5	—	ND	ND
Semivolatile organics						
Naphthalene	3/9	0.9	—	0.77	2.6	115
Diethylphthalate	3/9	11	—	6.3	58	2,605
bis(2-Ethylhexyl)phthalate	1/9	230	42.5	—	12	555
Inorganics						
Aluminum	7/9	60,500	12,000	310	87	750
Arsenic	1/8	3.7	1.9	—	1.2	52
Barium	9/9	2,120	510	180	ND	ND
Beryllium	2/9	11.2	3.8	—	0.17	7.5
Calcium	9/9	59,000	25,000	20,000	ND	ND
Chromium	2/9	23.9	6.1	2.6	11	16
Cobalt	4/9	295	53	—	ND	ND
Copper	1/9	37.8	9.6	—	22.6 *	36.2 *
Iron	9/9	1,370,000	330,000	140,000	1,000	ND
Lead	3/9	174	56	5.0	8.4 *	214 *
Manganese	9/9	14,700	7,100	1,900	ND	ND
Magnesium	9/9	16,100	7,200	6,600	ND	ND
Mercury	1/9	0.2	—	0.13	0.012	2.4
Nickel	3/8	15.8	7.0	—	300 *	2,700 *
Potassium	9/9	44,800	14,000	14,000	ND	ND
Sodium	9/9	55,400	21,000	23,000	ND	ND
Vanadium	3/9	65.2	23	—	ND	ND
Zinc	4/7	209	***	6.8	202 *	223 *
Ammonia	3/3	21.75	NA	13	2.2	24
Cyanide	2/9	41.7	16	—	5.2	22

NOTES

All concentrations in µg/L except ammonia, which is in mg/L.

— Analyte was not detected in this round.

*** The calculated mean is greater than the maximum detect.

NA Analyte was not analyzed for in this round or all values were rejected.

ND Data not available.

* The criterion is calculated using the maximum value of the unfiltered hardness (213.6 mg/L).

TABLE 65 ROSE HILL REGIONAL LANDFILL ECOLOGICAL RISK ASSESSMENT - SEDIMENT CONTAMINANT SCREENING

Compound	Frequency of Detection	Site Concentration Maximum	Mean 6/91	Mean 9/91	Mean 5/92	Sediment Criteria ERL-L	ERL-M	EPA	NYSDEC	Background Range		
Volatile organics (µg/kg)												
Benzene	1/39	1	—	***	—	ND	ND	ND	ND		U	
Ethylbenzene	2/40	8	4.1	***	—	ND	ND	ND	ND		U	
Total Xylenes	5/40	67	9.3	***	—	ND	ND	ND	ND		U	
Acetone	5/40	215	—	97	—	ND	ND	ND	ND	U	-	42
2-Butanone	2/40	46	—	13	—	ND	ND	ND	ND		U	
4-Methyl-2-pentanone	1/40	3	—	***	—	ND	ND	ND	ND		U	
Tetrachloroethene	3/40	4	—	***	—	ND	ND	ND	ND		U	
Trichloroethene	6/39	150	16	—	—	ND	ND	ND	ND		U	
1,2-Dichloroethene(total)	1/40	5	3.9	—	—	ND	ND	ND	ND		U	
Chloroform	1/40	5	—	***	—	ND	ND	ND	ND		U	
Carbon Disulfide	2/40	22	4.2	9.5	—	ND	ND	ND	ND		U	
Semivolatile organics (µg/kg)												
Phenanthrene	2/39	220	***	—	***	225	1,380	ND	ND		U	
Anthracene	1/39	64	—	—	***	85	960	ND	ND		U	
Flouranthene	5/39	330	***	***	***	600	3,600	ND	ND		U	
Pyrene	6/39	280	***	***	***	350	2,200	ND	ND		U	
Chrysene	1/39	180	***	—	—	400	2,800	ND	ND		U	
Benzo(b)fluoranthene	1/39	130	***	—	—	ND	ND	ND	ND		U	
Benzo(k)fluoranthene	1/39	130	***	—	—	ND	ND	ND	ND		U	
Benzo(a)pyrene	1/39	140	***	—	—	400	2,500	ND	ND		U	
Di-n-butylphthalate	1/39	650	—	310	—	ND	ND	ND	ND		U	
Butylbenzylphthalate	1/39	440	***	—	—	ND	ND	ND	ND		U	
Pesticides (µg/kg)												
delta-BHC	11/37	1.3	—	***	0.73	ND	ND	ND	ND		U	
4,4'-DDE	5/37	4.9	—	2.6	2.1	2.0	15	ND	ND		U	
4,4'-DDD	2/37	8.2	—	3.1	2.6	2.0	20	ND	ND		U	
4,4'-DDT	1/37	0.90	—	***	—	1.0	7	ND	ND		U	
Methoxychlor	1/37	2.6	—	***	—	ND	ND	ND	ND		U	
Endosulfan II	1/37	0.31	—	***	—	ND	ND	ND	ND		U	
Dieldrin	1/37	1.3	—	***	—	0.02	8	ND	ND		U	
gamma-Chlordane	1/37	0.23	—	***	—	0.5	6	ND	ND		U	
Inorganics (mg/kg)												
Aluminum	40/40	8,650	3,500	4,400	1,700	ND	ND	ND	ND	749	-	1,260
Antimony	1/40	62.1	—	8.1	—	2	25	ND	ND		U	
Arsenic	21/40	6.1	0.85	0.78	1.1	33	85	3	5		U	
Barium	40/40	64.6	16	17	7.9	ND	ND	20	ND	2.7	-	3.1
Beryllium	18/40	2.3	0.71	0.54	0.22	ND	ND	ND	ND		U	
Cadmium	1/40	1.3	—	0.56	—	5	9	ND	0.8		U	
Calcium	33/40	1,760	530	780	260	ND	ND	ND	ND	U	-	350
Chromium	23/40	18.1	3.0	5.7	1.7	80	145	25	26	U	-	1.6
Cobalt	21/40	6.5	1.5	3.0	0.90	ND	ND	ND	ND		U	
Copper	3/39	56.1	2.4	6.3	—	70	390	25	19		U	
Iron	40/40	113,000	13,000	12,000	8,100	ND	ND	17,000	24,000	780	-	1,020
Lead	32/40	243.4	7.2	27	5.2	35	110	40	27	U	-	7.2
Magnesium	35/40	2,560	530	890	340	ND	ND	ND	ND	U	-	373

TABLE 65 (Continued). ROSE HILL REGIONAL LANDFILL ECOLOGICAL RISK ASSMENT - SEDIMENT CONTAMINANT SCREENING

Compound	Frequency of Detection	Site Concentration Maximum	Site Concentration Mean 6/91	Site Concentration Mean 9/91	Site Concentration Mean 5/92	Sediment Criteria ERL-L	Sediment Criteria ERL-M	Sediment Criteria EPA	Sediment Criteria NYSDEC	Background Range		
Manganese	40/40	1,150	160	120	110	ND	ND	300	428	13.5	-	22.6
Nickel	19/40	20.5	2.9	5.0	1.8	30	50	20	22	U	-	1.4
Potassium	18/40	775	180	320	—	ND	ND	ND	ND		U	
Selenium	6/40	2.1	0.68	0.34	0.20	ND	ND	ND	ND	U	-	0.52
Sodium	13/39	115	45	44	—	ND	ND	ND	ND		U	
Thallium	2/40	0.37	—	0.20	—	ND	ND	ND	ND		U	
Vanadium	28/40	17.7	7.2	8.9	2.3	ND	ND	ND	ND	U	-	2.0
Zinc	13/40	236	31	35	6.0	120	270	90	85		U	
Ammonia	5/11	25.6	NA	NA	3.7	ND	ND	75	ND		U	
Sulfide	15/29	850	31	63	—	ND	ND	ND	ND	U	-	22.0

NOTES
— Analyte was not detected in this round.
*** The calculated mean is greater than the maximum detect.
NA Analyte was not analyzed for in this round.
ND Data is not available.
U This analyte was not detected in any of the background samples, or the non-detected value is the lowest concentration.
ER-L/ER-M Values presented by Long and Morgan (1990)
EPA Values presented by USEPA (1977)
NYSDEC Draft sediment criteria (NYSDEC 1989)

TABLE 66 **ECOLOGICAL RISK ASSESSMENT - SURFACE SOIL CONTAMINANT SCREENING**

Compound	Frequency of Detection	Site Concentration			Effect Level	Screening Status Code[2]
		Maximum	Mean[1]			
			9/91	4/92		
Volatile Organics - µg/kg						
1,1,1-Trichloroethane	1/24	8	6.8	---	100,000	SE
1,1-Dichloroethene	1/24	4	***	---	Unknown	SM
1,1-Dichloroethane	2/24	25	7.7	---	100,000	SE
1,2-Dichloroethene	4/24	2,400	266.7	---	100,000	SE
2-Butanone	7/24	830	130.8	8.5	10,000	SE
2-Hexanone	1/24	6	***	---	Unknown	SM
4-Methyl-2-Pentanone	1/24	3	***	---	Unknown	SM
Acetone	15/24	160,000	15,917	428.8	10,000,000	SE
Benzene	2/24	6	***	---	300	SE
Chloroform	4/24	3	***	---	100,000	SE
Ethylbenzene	5/24	21	8.5	7.6	1,000	SE
Tetrachloroethene	7/24	13	5.5	---	10,000	SE
Toluene	6/24	110	24.3	6.3	300	SE
Trichloroethene	1/24	2	***	---	Unknown	SM
Vinyl Chloride	2/24	250	25.0	---	10,000	SE
Total Xylenes	5/24	84	16.7	7.8	1,000	SE
Semivolatile Organics - µg/kg						
4-Chloroanaline	1/24	490	229.6	---	Unknown	SM

TABLE 66 **(Continued). ECOLOGICAL RISK ASSESSMENT - SURFACE SOIL CONTAMINANT SCREENING**

Compound	Frequency of Detection	Site Concentration			Effect Level	Screening Status Code[2]
		Maximum	Mean[1]			
			9/91	4/92		
Benzo(a)anthracene	4/24	78	***	***	1,000	SE
Benzo(a)pyrene	4/24	68	***	***	20	SM
Benzo(b)fluoranthene	5/24	76	***	***	19,000	SE
Benzo(k)fluoranthene	4/24	64	***	***	19,000	SE
Benzo(g,h,i)perylene	4/24	57	***	***	1,000	SE
Butylbenzylphthalate	3/24	120	***	---	10,000	SE
Chrysene	5/24	95	***	***	5,000	SE
Diethylphthalate	5/24	46	***	***	60	SE
Fluoranthene	7/24	160	149.2	***	10,000	SE
Indeno(1,2,3-cd)pyrene	3/24	52	***	---	1,000	SE
Naphthalene	1/24	35	---	***	5,000	SE
Phenanthrene	5/24	110	***	***	5,000	SE
Pyrene	9/24	170	126.5	***	10,000	SE
Pesticides - µg/kg						
Aldrin	1/24	0.6	***	---	Unknown	SM
alpha-Chlordane	1/24	3.7	1.3	---	Unknown	SM
Dieldrin	1/24	4.5	2.3	---	Unknown	SM
Endrin ketone	2/24	2.3	---	2.3	100	SE

TABLE 66 **(Continued). ECOLOGICAL RISK ASSESSMENT - SURFACE SOIL CONTAMINANT SCREENING**

Compound	Frequency of Detection	Site Concentration			Effect Level	Screening Status Code[2]
		Maximum	Mean[1]			
			9/91	4/92		
4,4-DDE	7/24	11.0	3.6	2.4	100	SE
4,4-DDD	2/24	5.2	2.9	***	100	SE
4,4-DDT	8/24	5.2	3.1	1.8	100	SE
Inorganics - mg/kg						
Aluminum	24/24	16,600	9,219	6,592	Unknown	SB
Antimony	1/24	79	9	---	8	SM
Arsenic	13/24	3.5	1.6	1.1	3.4	SM
Barium	24/24	86	20	24	400	SE
Beryllium	11/24	1.1	---	0.6	2.2	SE
Cadmium	1/24	0.6	0.4	---	3	SE
Calcium	24/24	1,870	626	502	Unknown	SB
Chromium	14/24	18	10	4	120	SE
Cobalt	14/24	12.8	3.9	3.3	25	SE
Copper	15/22	253	32	5	20	CC
Iron	24/24	149,000	11,285	26,124	Unknown	SM
Lead	24/24	124	11	21	20	CC
Magnesium	24/24	1,990	1,241	802	8,660	SB/SE

TABLE 66 **(Continued). ECOLOGICAL RISK ASSESSMENT - SURFACE SOIL CONTAMINANT SCREENING**

Compound	Frequency of Detection	Site Concentration			Effect Level	Screening Status Code[2]
		Maximum	Mean[1]			
			9/91	4/92		
Manganese	24/24	6,120	130	666	300	CC
Mercury	4/24	0.41	0.10	0.11	0.5	SE
Nickel	12/23	10.6	5.8	2.5	32	SE
Potassium	23/24	944	680	394	4,320	SB/SE
Selenium	1/24	5.9	---	1.1	2	SM
Silver	3/24	1.6	0.5	---	10	SE
Thallium	2/24	0.4	0.2	0.2	Unknown	SB
Vanadium	23/24	27	16	11	150	SE
Zinc	22/22	57	32	19	100	SE

1 Only calculated for compounds with at least one detection. Half of the detection limit was used at locations where a compound was below the detection limit when calculating means. The symbol *** indicates that the calculated mean exceeded the maximum value.

2 SB - Screened Out: Background Concentrations Only; SE - Screened Out: Media Concentration Below Effect/Criteria Level; SM - Screened Out: Miscellaneous (see text); CC - Chemical of Concern.

References for effect levels: USEPA (1985a), Eisler (1985; 1986; 1987a; 1987b; 1988a; 1988b), Bysshe (1988), Fitchko (1989), Beyer (1990), M&E (1992c), and Kappleman (1993).

TABLE 67 **ECOLOGICAL RISK ASSESSMENT - UNITED STATES SURFACE SOIL BACKGROUND LEVEL FOR METALS (MG/KG)**

Compound	Mean	Typical Range	Minimum	Maximum
Aluminum	66,000	30,000-100,000	700	> 100,000
Antimony	ND	ND	ND	ND
Arsenic	6	1-12	0.1	50
Barium	554	200-1,000	15	5,000
Beryllium	1	1-3	< 1	7
Cadmium	3.5	0.2-8.9	0.01	9
Calcium	24,000	8,000-18,000	< 150	400,000
Chromium	53	4-1,000	1	3,000
Cobalt	10	3-10	< 3	70
Copper	25	2-100	< 1	300
Iron	25,000	20,000-50,000	100	550,000
Lead	20	2-100	2	700
Magnesium	9,200	3,000-10,000	50	100,000
Manganese	560	500-700	< 1	7,000
Mercury	0.15	0.01-0.61	0.01	15
Nickel	20	1.5-28	< 5	5,000
Potassium	23,000	9,500-25,000	50	70,000
Selenium	0.5	0.1-2.0	0.1	38
Silver	ND	0.1-1.0	0.1	1.0

TABLE 67 **(Continued). ECOLOGICAL RISK ASSESSMENT - UNITED STATES SURFACE SOIL BACKGROUND LEVEL FOR METALS (MG/KG)**

Compound	Mean	Typical Range	Minimum	Maximum
Thallium	ND	0.5-2.0	0.5	2.0
Vanadium	76	30-70	<7	500
Zinc	54	10-300	<5	2,000

From: Bysshe (1988), Fitchko (1989), Beyer (1990), and M&E (1992c).
ND = No data.

TABLE 68 **SUMMARY OF THE ECOLOGICAL CHEMICALS OF CONCERN**

Compound	Surface Soil	Surface Water	Leachate	Surface Sediment
Aluminum		X	X	X
Copper	X			
Iron		X	X	X
Lead	X		X	
Manganese	X	X	X	

TABLE 69 **ASSESSMENT AND MEASUREMENT ENDPOINTS FOR SELECTED SPECIES GROUPS**

Species Group	Assessment Endpoint	Measurement Endpoint
Benthic Organisms	Abundance/Diversity	Comparison With Upstream Location, Toxicity Tests
Fish	Presence	Observed Use of Site, Water Quality Criteria, Toxicity Tests

TABLE 70 . **SUMMARY OF THE WEIGHT OF SURVIVING ORGANISMS IN 10-DAY *HYALELLA AZTECA* SEDIMENT TOXICITY TESTS**

Location	Mean Weight of Surviving Organisms (mg)
Lexington Pond Reference	0.107
Laboratory Control Water	0.078
Saugatucket River	
SE-02	0.129
SE-04	0.103
SE-05	0.086
SE-06	0.071
SE-11	0.130
Mitchell Brook	
SE-09	0.101
SE-07	0.074
SE-12	0.080

Note: No statistical difference in mean weight of surviving organisms was found between test samples and reference samples.

TABLE 71 . SURVIVAL RATE OF *CERIODAPHNIA DUBIA* IN 7-DAY STATIC RENEWAL SEDIMENT TOXICITY TESTS

Location	Percent Survival	
	Day 2	Day 7
Lexington Pond Reference	100	70
Laboratory Control Water	100	100
Saugatucket River		
SE-02	100	80
SE-04	100	100
SE-05	90	90
SE-06	90	80
SE-11	90	90
Mitchell Brook		
SE-09	90	80
SE-07	100	90
SE-12	90	90

TABLE 72 **SURVIVAL RATE OF *PIMEPHALES PROMELAS* IN 96-HOUR CHRONIC SEDIMENT TOXICITY TESTS**

Location	Percent Survival	
	48 hours	96 hours
Lexington Reference Pond	87.5	85
Saugatucket River		
SE-02	80.0	65.0
SE-04	97.5	90.0
SE-05	97.5	92.5
SE-06	87.5	85.0
SE-11	100	100
Mitchell Brook		
SE-09	97.5	92.5
SE-07	90.0	85.0
SE-12	90.0	75.0

Note: No significant statistical difference was found between the reference sample and any 48-hour or 96-hour test samples.

TABLE 73 . **SUMMARY OF LEACHATE TOXICITY TESTS**

Measurement Endpoint	*Ceriodaphnia dubia*	*Pimephales promelas*
Acute Test:		
48 hour LC_{50}	67.8%[a]	no samples with >50% observed mortality
NOAEL	25%	50%
Chronic Test:		
7-day LC_{50}	could not be determined	58.1% [b]
Survival NOEC	no effects observed	50%
Survival LOEC	no effects observed	100%
Reproductive NOEC	50%	--
Reproductive LOEC	100%	--
Growth NOEC	--	25%
Growth LOEC	--	50%
7-day IC_{25}-growth	--	33.8%
7-day IC_{50}-growth	--	56.8%

- indicates value not calculated for this test
(a) 95% confidence interval 101.0% to 45.5%
(b) 95% confidence interval 71.7% to 47.1%

'TABLE 74). **SUMMARY OF SURVIVAL RATES IN LEACHATE TOXICITY TESTS**

	Percent Survival			
	Ceriodaphnia dubia		*Pimephales promelas*	
Concentration of Leachate	48-hour	7-day	48-hour	7-day
Control (0%)	100	100	100	82.5
3.125%	100	90	100	80
6.25%	80	80	100	85
12.5%	90	90	97	82.5
25%	80	80	100	80
50%	70	60	100	72.5
100%	0	0	83	2.5

TABLE 75. COST SENSITIVITY ANALYSIS SUMMARY

VARIABLE		TOTAL ALTERNATIVE COSTS (in $1,000's)					
	ALT #	1	2	3a	3b	4a	4b
Discount Rate	5%	4,517	4,798	14,939	14,643	18,101	19,441
	7%	**3,568**	**3,845**	**13,425**	**13,187**	**16,064**	**18,041**
	9%	2,900	3,175	12,303	12,111	14,577	16,999
Total Capital Cost	-30%	3,534	3,736	11,499	11,220	13,893	14,633
	0%	**3,568**	**3,845**	**13,425**	**13,187**	**16,064**	**18,041**
	+50%	3,623	4,027	16,635	16,464	19,682	23,721
Total Annual Cost	-30%	2,531	2,801	11,324	11,197	13,415	16,037
	0%	**3,568**	**3,845**	**13,425**	**13,187**	**16,064**	**18,041**
	+50%	5,296	5,587	16,928	16,502	20,478	21,382
Contingency	15%	3,419	3,685	12,866	12,637	15,395	17,289
	20%	**3,568**	**3,845**	**13,425**	**13,187**	**16,064**	**18,041**
	25%	3,716	4,006	13,985	13,736	16,733	18,793
LFG Operation/ Air/Soil Gas Monitoring	5 years	3,374	3,636	11,219	11,206	13,858	15,862
	10 years	3,480	3,750	12,427	12,290	15,066	17,055
	15 years	**3,568**	**3,845**	**13,425**	**13,187**	**16,064**	**18,041**
Overall	Low	2,531	2,801	11,219	11,197	13,415	14,633
	Baseline	**3,568**	**3,845**	**13,425**	**13,187**	**16,064**	**18,041**
	High	5,296	5,587	16,928	16,502	20,478	23,721

Notes:

Boldface indicates base case conditions for the alternative

TABLE 76 **ACTION-SPECIFIC ARARS, CRITERIA AND GUIDANCE: ALTERNATIVE #4B**

Regulation	Status	Requirement	Action to be taken to attain ARARs
ACTION-SPECIFIC			
GROUNDWATER			
RCRA Groundwater Protection (40 CFR 264, Subpart F)	Implemented through RI regulations	Establishes requirements for solid waste management units (SWMUs) at RCRA regulated sites. Regulations include groundwater protection standard requirements for groundwater monitoring, detection monitoring and compliance monitoring and the corrective action program.	Because this is a source control remedy, groundwater cleanup will not be addressed and cleanup goals are not set; however, all alternatives will comply with the portions of the regulations which apply to installing groundwater monitoring wells and compliance monitoring.
Rhode Island Rules and Regulations for Hazardous Waste Management, RIDEM 4/92, Section 9.03	Applicable	Regulation outlines operation requirements for treatment, storage and disposal facilities, including a groundwater monitoring program.	Although this is a source control remedy which does not address groundwater, this alternative will comply with the regulations with respect to installation of groundwater monitoring wells and compliance monitoring.
RI Rules and Regs for Groundwater Quality, RIDEM 7/93, Sections 12.02 and 12.03.	Applicable	Regulations are designed to protect and restore the quality of the state's groundwater and include a groundwater monitoring program.	Although this is a source control remedy which does not address groundwater, this alternative will comply with the regulations with respect to installation of groundwater monitoring wells.

TABLE 76 **ACTION-SPECIFIC ARARS, CRITERIA AND GUIDANCE: ALTERNATIVE #4B**

Regulation	Status	Requirement	Action to be taken to attain ARARs
RI Rules and Regs for Underground Injection Control Program	Applicable	Regulations are designed to assure proper location, design, construction, maintenance and operation of injection wells and other subsurface disposal systems to prevent GW contamination.	The portions of this alternative which include on-site treatment of leachate, requiring discharge of treated water to GW recharge wells, will comply with UICP requirements.
Rhode Island Regs for Underground Storage Facilities used for Petroleum Products & Hazardous Material (USTs) (12-190-017)	Applicable	Establishes procedures & requirements for preventing, assessing and remediating releases from USTs.	Underground components of condensate collection system from flares will be installed and maintained in accordance with these requirements.
Draft Interim Final OSWER Monitored Natural Attenuation Policy (OSWER Dir.9200.4-17)(12/1/97)	To Be Considered	Provides guidance on how EPA will implement national policy on use of monitored natural attenuation.	Decisions on use and efficacy of monitored natural attenuation will be consistent with guidance.
<u>HAZARDOUS WASTE</u>			
RCRA-Hazardous Waste Identification, 40 CFR Part 261.	Implemented through RI regulations	Defines solid wastes that are subject to regulation as hazardous waste under 40 CFR Parts 262-265.	Requirements define RCRA regulated wastes. Acceptable management approaches for listed and characteristic hazardous waste will be met for this alternative.
RCRA-Closure and Post-Closure, 40 CFR Part 264, Subpart G	Implemented through RI regulations	Outlines the requirements for closure and post-closure care of hazardous waste management facilities.	Closure and post-closure care of the landfill will comply with these requirements.

TABLE 76 **ACTION-SPECIFIC ARARS, CRITERIA AND GUIDANCE: ALTERNATIVE #4B**

Regulation	Status	Requirement	Action to be taken to attain ARARs
RCRA Tank Systems Requirements, 40 CFR Part 264 Subpart J	Implemented through RI regulations	Sets standards for storage and treatment of hazardous waste in tanks, including pipes and ancillary equipment.	On-site treatment of leachate will comply with these standards.
RCRA-Standards for Permitted TSDFs; Thermal Treatment, 40 CFR Part 264, Subpart AA	Relevant & Appropriate	Air emission standards for process vents, closed vent systems and control devices at facilities that treat, store or dispose of hazardous wastes.	Alternatives which include on-site thermal treatment (enclosed flares) will meet these requirements.
EPA Technical Guidance for Final Covers on HW Landfills and Surface Impoundments, EPA/530-SW-047 (7/89)	To Be Considered	Guidance for landfill covers. Presents recommended technical specifications for multilayer landfill cover design.	Cap construction will be protective in accordance with the guidance.
EPA Technical Guidance memorandum regarding Alternative Cap Design for Unlined, Hazardous Waste Landfills in EPA Region I, From Dennis P. Gagne & Yoon-Jean Choi to OSRR, 9/30/97	To Be Considered	Guidance for landfill covers in EPA Region I. Presents recommended technical specifications for multilayer landfill cover design.	Cap construction will be protective in accordance with the guidance
EPA Technical Guidance on Management of Investigation-Derived Waste: Final covers on HW Landfills and surface Impoundments (EPA/530-SW-89-047)	To Be Considered	Guidance for landfill covers, recommending technical specifications for multi-layer landfill cover design.	Waste derived from cap construction will be managed in accordance with these standards.
RI Rules and Regs for HW Management, Section 8, RIDEM 4/92.	Applicable	Outlines requirements for treatment, disposal and storage of hazardous waste by TSDFs.	Management and treatment of on-site treatment residues and waste derived from cap construction will comply with these regulations.

TABLE 76 **ACTION-SPECIFIC ARARS, CRITERIA AND GUIDANCE: ALTERNATIVE #4B**

Regulation	Status	Requirement	Action to be taken to attain ARARs
RI Rules and Regs for HW Management, Sections 9 and 10.02, RIDEM 4/92.	Applicable	Outlines requirements for general waste analysis, security procedures, and management of hazardous waste. Sets design, construction and operational requirements for containers and tanks and closure requirements for hazardous waste facilities.	Identification and handling of hazardous waste and closure of hazardous waste landfill will comply with these requirements.
RI Guidelines on the Management of Investigation-Derived Waste	To Be Considered	Guidance on management and disposal of materials generated during environmental investigations. Specifies action levels for soils and liquids below which investigation-derived waste may be disposed of on-site.	All sampling activities performed on-site will comply with this guidance.
SURFACE WATER			
RI PDES Regulations (12-190-003) and RI Water Quality Regs for Water Pollution Control (12-190-001)	Relevant & Appropriate	Sets AWQC standards for water discharged to surface waters.	Because this is a source control remedy, surface water cleanup will not be addressed; AWQC standards will be used to measure effectiveness of remedy with respect to leachate outbreaks to streams and other discharges to onsite surface water.

TABLE 76 **ACTION-SPECIFIC ARARS, CRITERIA AND GUIDANCE: ALTERNATIVE #4B**

Regulation	Status	Requirement	Action to be taken to attain ARARs
CWA Ambient Water Quality Criteria (AWQC), 40 CFR 122.44	Relevant & Appropriate	Non-enforceable guidance used by states in conjunction with a designated use for a stream effluent to establish water quality standards. WQC levels for protection of human health from consuming fish and aquatic organisms have been developed for several contaminants. The standards are RA if there is no more stringent state rules for particular contaminants.	Because this is a source control remedy, surface water cleanup will not be addressed; WQC standards will be used to measure effectiveness of remedy with respect to leachate outbreaks to streams and other discharges to onsite surface water.
Proposed CWA Ambient Water Quality Criteria (AWQC), 40 CFR Part 120	To Be Considered	Remedial actions involving contaminated surface water or groundwater must consider the uses of the water and circumstances of release or threatened release.	Proposed AWQC for compounds detected onsite (Fe) were compared to observed concentrations in groundwater and used in developing PRGs for surface water; standards will be used to measure effectiveness of remedy with respect to leachate outbreaks to streams and other discharges to onsite surface water.
<u>AIR</u>			
Air Pollution Control Regs, RI Dept of Health, Div of Air Pollution Control, eff. 8/2/67, amended 5/20/91--Regulation No. 1 Visible Emissions	Applicable	Prohibits contaminant emissions for periods of more than 3 minutes in any one hour which are greater or equal to 20% opacity.	Air emissions from remedial actions will meet emission levels in regulations.
RI Air Pollution Control Reg No. 5--Fugitive Dust	Applicable	Requires reasonable precautions to prevent particulate matter from becoming airborne.	Operations will be performed in acc. with these rules.

TABLE 76 **ACTION-SPECIFIC ARARS, CRITERIA AND GUIDANCE: ALTERNATIVE #4B**

Regulation	Status	Requirement	Action to be taken to attain ARARs
RI Air Pollution Control Reg No. 7.1 and 7.2--Emission of Air Contaminants Detrimental to Person or Property	Applicable	Prohibits the emission of any contaminant which may be injurious to human, plant or animal life, or cause damage to property or interferes with the enjoyment of property.	Air emissions will meet all applicable standards, as set forth in RI Reg No. 22 and CAA NESHAPs, 40 CFR Part 61.
RI Air Pollution Control Reg No. 9--Permits	Applicable	Requires permitting for air pollution control systems and any new stationary sources which create an increase in pollutant emissions.	Air pollution control systems will be designed to meet all applicable standards, as set forth in RI Reg No. 22 and CAA NESHAPs, 40 CFR Part 61.
RI Air Pollution Control Reg No. 16--Operation of Air Pollution Control Systems	Applicable	Requires operation of air pollution control systems according to design specifications and defines malfunction reporting requirements.	Air pollution control systems will be operated and maintained in accordance with Operation and Maintenance Plan.
RI Air Pollution Control Reg No. 22--Air Toxics	Applicable	Prohibits the emission of specified contaminants at rates which would result in ground level concentrations greater than acceptable ambient levels in the reg.	Ambient air quality levels will be met for all technologies which emit air contaminants.
RI Guidance for Air Quality/Air Toxics Substances	To Be Considered	Provides guidelines for models and modeling procedures.	Guidance will be considered when modeling emissions from the LFG combustion stack.
CAA National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61).	Relevant & Appropriate	Establishes emission levels for certain hazardous air pollutants, including vinyl chloride and benzene.	This remedy will attain NESHAP emission limits for hazardous air pollutants that result from treatment processes.

TABLE 76 **ACTION-SPECIFIC ARARS, CRITERIA AND GUIDANCE: ALTERNATIVE #4B**

Regulation	Status	Requirement	Action to be taken to attain ARARs
CAA Standards of Performance for Municipal Solid Waste Landfills (40 CFR Part 60, Subpart WWW).	Relevant & Appropriate	Establishes air emission limits for municipal solid waste landfills (MSWLF) and standards of performance for MSWLF gas collection and control systems.	Landfill gas collection and control systems will meet relevant and applicable performance standards.
CHEMICAL-SPECIFIC			
EPA Human Health Assessment Cancer Slope Factors (CSFs)	To Be Considered	CSFs are developed by EPA for health effects assessments or evaluation by the Human Health Assessment Group.	The values present the most up-to-date cancer risk potency information. CSFs will be used to compute the individual cancer risk resulting from exposure to contaminants.
LOCATION-SPECIFIC			
CWA Section 404(b)(1); Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR Parts 230, 231)	Applicable	No activity that adversely affects a wetland is permitted if a practicable alternative with lesser effects is available. Controls discharges of dredged or fill material to protect aquatic ecosystems.	During the identification, screening and evaluation of the systems, the effects on wetlands will be considered, and no activity which adversely affects a wetland will be undertaken if a practicable alternative with lesser effects is available.
Executive Order 11990; Statement of Procedures on Wetlands Protection (40 CFR Part 6, App.A)	Applicable	Action to avoid, whenever possible, the long and short-term impacts on wetlands and to preserve and enhance wetlands. Plans for action in wetlands must be submitted for public review.	All practicable means will be used to minimize harm to the wetlands. Wetlands disturbed by remedial activities will be mitigated in accordance with requirements if no practicable alternative exists.

TABLE 76 ACTION-SPECIFIC ARARS, CRITERIA AND GUIDANCE: ALTERNATIVE #4B

Regulation	Status	Requirement	Action to be taken to attain ARARs
Fish and Wildlife Coordination Act; 16 U.S.C. 661, 40 CFR Section 6.302	Applicable	Any modification of a body of water requires consultation with US Fish and Wildlife Service and appropriate state wildlife agency to develop measures to prevent, mitigate or compensate for losses of fish and wildlife. This requirement is addressed under CWA Section 404 requirements.	Requires federal and state coordination on fish and wildlife matters. Will consult as required.
Executive Order 11988; Statement of Procedures on Floodplain Management (40 CFR Part 6, App. A)	Applicable	Action should avoid, whenever possible, the long and short-term impacts associated with occupancy and modifications of floodplains development, wherever there is a practicable alternative. Promotes preservation and restoration of floodplains so that their natural and beneficial value can be realized.	Remedial actions that involve construction in the floodplain areas will include all practicable means to minimize harm to and preserve beneficial values of floodplains. Floodplains disturbed by excavation will be restored to original conditions and utility.
Rules and Regulations governing administration and enforcement of Freshwater Wetlands Act (12-100-003)(8/90)	Applicable	Identifies and protects significant wetlands and their values and functions with the goal of no net loss.	Remedial actions will includes measures to mitigate adverse impacts on protected functions and achieve no net loss.
An Act Relating to Historic Cemeteries	Applicable	Restrictions on altering land within 25 feet of historical human cemeteries.	Plat 35 is a historic cemetery; actions must be coordinated with appropriate agencies such as RI Cemeteries Commission, town offices, and Historical Preservation Commission.

TABLE 76 **ACTION-SPECIFIC ARARS, CRITERIA AND GUIDANCE: ALTERNATIVE #4B**

Regulation	Status	Requirement	Action to be taken to attain ARARs
RI Endangered Species Act	Applicable	Actions must conserve identified local endangered or threatened species.	Consultation with RIDEM will ensure that remedial actions do not jeopardize the existence of endangered or threatened species or adversely modify or destroy critical habitat.

Note 1: Because the remedy is source control only, Safe Drinking Water Act, Maximum Contaminant Level Goals (MCLGs), 40 CFR Part 141, which are health goals for public water systems, are not ARARs for the alternative remedies at this site. Rather, they are used to measure performance of groundwater containment alternatives. The alternatives are expected to contain groundwater exceeding non-zero MCLGs within the compliance boundaries.

Note 2: RI Air Pollution Control Reg No. 17–Odors. RI Regulation No. 17, which prohibits emissions of air contaminants that create an objectionable odor beyond the property line, does not fall within the definition of an ARAR as set forth in the NCP, in EPA's view, because it falls within the category of nuisance laws rather than environmental cleanup or control standards. Therefore, it is not listed as an ARAR for this site. However, EPA views this rule to be a regulation which, like those promulgated under OSHA, must nonetheless be complied with in the performance of any remedy.

TABLE 77 **HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR GROUNDWATER**

Analyte Exceeding Preliminary Remediation Goal (PRG)	PRG (μg/L)	Basis
SOLID WASTE AREA [a]		
Benzene	5	Final MCL
1,2-Dichloroethene	70	Final MCL [b]
Vinyl chloride	2	Final MCL
Pentachlorophenol	1	Final MCL
bis(2-Ethylhexyl)phthalate	6	Final MCL
Acrylamide	0.02	Human Health Risk-Based
Beryllium	4	Final MCL
Cadmium	5	Final MCL
Chromium	100	Final MCL
Lead [c]	15	SDWA Action Level
Manganese [d]	840	Human Health Risk-Based
BULKY WASTE AREA		
Antimony [e]	6	Final MCL
Beryllium	4	Final MCL
Lead [c]	15	SDWA Action Level
Manganese [d]	840	Human Health Risk-Based
SEWAGE SLUDGE AREA		
Antimony [e]	6	Final MCL
Cadmium	5	Final MCL
Manganese [d]	840	Human Health Risk-Based

Note: These PRGs are determined for baseline conditions, which include an assumption of direct consumption of groundwater.
MCL: Maximum Contaminant Level under the Federal Safe Drinking Water Act (SDWA, U.S. EPA, 1996MCL).

Footnotes:

[a] Arsenic, which is listed on Table 2-1A, is not an anlyte exceeding the PRG since it was detected at concentrations lower than the SDWA MCL.

[b] The MCL for cis-1,2-DCE, 70 μg/L is selected; the MCL for trans-1,2-DCE is higher, 100 μg/L.

[c] The average concentration at a background location (MW-01-01) was 36.7 μg/L.

[d] The average concentration at a background location (MW-01-01) was 2,041 μg/L.

[e] There was one detection of antimony at a background location (RES#9) during the RI.

TABLE 78 **ECOLOGICAL PRELIMINARY REMEDIATION GOALS FOR SURFACE WATER**

Analyte Exceeding Preliminary Remediation Goal (PRG)	PRG (μg/l)	Basis
MITCHELL BROOK		
Aluminum	140	Background
Iron	1,000	AWQC
Manganese	45	Background
SAUGATUCKET RIVER		
Aluminum	140	Background
Iron	1,000	AWQC
Manganese	45	Background

TABLE 79 **HUMAN HEALTH PRELIMINARY REMEDIATION GOALS FOR AMBIENT AIR**

Analyte Exceeding Preliminary Remediation Goal (PRG)	PRG ($\mu g/m^3$)	Basis
SOLID WASTE AREA		
Vinyl chloride	0.2	Human Health Risk-Based
1,1-Dichloroethene	0.05	Human Health Risk-Based
RESIDENTIAL AREA		
Benzene	0.1	Rhode Island AAL [1]
1,1,2,2-Tetrachloroethane	0.04	Human Health Risk-Based
Vinyl chloride	0.03	Human Health Risk-Based

Notes:
[1] AAL - Acceptable Ambient Level as defined in Air Pollution Control Regulation No. 22

TABLE 80. COMPARISON OF COSTS FOR ALTERNATIVES #4a & #4b (OLD & CURRENT), ROSE HILL REGIONAL LANDFILL

May 12, 1999

CAPITAL COSTS (in $1,000's)			Old	Current
		4a	4b*	4b
1.0	GRADING & SITE PREP.: SOLID WASTE AREA	100	100	100
2.0	CAPPING: SOLID WASTE AREA	2,442	2,686	2,686
3.0	GRADING & SITE PREP.: BULKY WASTE AREA	48	46	46
4.0	CAPPING: BULKY WASTE AREA	864	0	0
5.0	LANDFILL MINING	0	1,452	3,812
6.0	PERIMETER WETLANDS MITIGATION	40	40	40
7.0	INTERNAL LF GAS COLLECTION SYSTEM	681	681	734
8.0	PERIMETER LF GAS COLLECTION SYSTEM	338	338	338
9.0	LF GAS TREATMENT PLANT	338	338	338
10.0	GW DEPRESSION SYSTEM: COLLECTION	0	0	0
11.0	LEACHATE COLLECTION SYSTEM	99	99	99
12.0	50 GPM WATER TREATMENT PLANT	0	0	0
13.0	5 GPM WATER TREATMENT PLANT	507	507	507
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST	94	94	94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA	50	50	50
16.0	INSTITUTIONAL CONTROLS +	88	88	88
	TOTAL DIRECT CAPITAL COST	5,689	6,517	8,930
	REMEDIAL DESIGN ALLOWANCE	341	391	536
	CONTINGENCY +	1,206	1,382	1,893
	TOTAL CAPITAL COSTS	$7,236	$8,290	$11,359
ANNUAL COSTS (Present Value in $1,000's)				
17.0	ENVIRONMENTAL MONITORING: ANNUAL	3,051	3,051	2,698
18.0	LANDFILL GAS COLLECTION AND TREATMENT	2,787	2,787	2,787
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM	0	0	0
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM	1,519	83	83
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS +	0	0	0
	TOTAL DIRECT ANNUAL COST	7,357	5,921	5,568
	CONTINGENCY	1,471	1,184	1,114
	TOTAL ANNUAL COSTS	$8,828	$7,105	$6,682
TOTAL COST OF ALTERNATIVE (in $1,000's)		$16,064	$15,395	$18,041

* Landfill mining costs are different than those presented in the FS and Proposed Plan due to a calculation correction.

Note that Old 4b and Current 4b estimates have the same dewatering allowance ($50,000). Further evaluation should be made to determine any increased costs for dewatering.