Commercial Metal Recovery Systems and Capacities
(Basi: 1993 BRS - Form PS)

Facility	Facility Name	System Code	Maximum RCRA Capacity	Utilized RCRA Capacity
NYD981182769	KBF POLLUTION MANAGEMENT INC	M019	4,035,363	1,757
CAD008488025	PHIBRO-TECH, INC.	M014	2,322,554	608,199
PAD002395887	HORSEHEAD RESOURCE DEVELOPMENT CO INC	M011	300,000	270,000
PAD990753089	GENERAL BATTERY CORP - READING COMPLEX	M013	83,600	3,894
MND006148092	GOPHER SMELTING & REFINING COMPANY	M013	48,000	60,251
ILD984766279	RECONTEK INC	M014	48,000	357
CAD069124717	MICRO METALLICS CORPORATION	M011	28,050	39
ALD046481032	SANDERS LEAD COMPANY, INC.	M013	25,000	5,200
PAD981038227	WORLD RESOURCES COMPANY	M014	24,250	20,446
MOD059200089	DOE RUN CO BUICK SMELTER	M013	21,175	1,339
PAD981110570	HORSEHEAD RESOURCE DEVELOPEMENT CO INC	M011	20,000	1,216
CAD088504881	KINSBURSKY BROTHERS INC.	M014	15,980	10,500
MND981098478	U.S. FILTER RECOVERY SERVICES, INC.	M014	8,655	418
CAD070148432	DREW RESOURCE CORPORATION	M014	8,501	3,346
CAD069124717	MICRO METALLICS CORPORATION	M014	5,976	31
MND985746569	RECYCLIGHTS, INC.	M014	5,622	610
LAD057109449	UOP - SHREVEPORT PLANT	M014	2,600	726
ILD005087630	UNITED REFINING & SMELTING CO	M011	2,500	126
IND093219012	HERITAGE ENVIRONMENTAL SERVICES, INC	M014	2,105	6
CAD001968361	LEARONAL INC	M014	1,142	100
NYD001325661	LEARONAL, INC.	M014	1,004	46
LAD981152903	NEW ORLEANS SILVERSMITHS	M014	890	157
FLD984217877	CHEMICAL POLLUTION CONTROL INC	M019	842	683
MID985567114	CYANO CORPORATION OF MICHIGAN INC.	M014	788	190
NYD048148175	MERCURY REFINING COMPANY INC	M012	510	311
PAD002390961	BETHLEHEM APPARATUS CO INC	M012	375	350
PAD987367216	ADVANCED ENVIRONMENTAL RECYCLING CORP	M012	345	172
OHD061614673	DAYTON WATER SYSTEMS	M014	259	197
CAD981689953	LESHER COMMUNICATIONS INC.	M014	209	23
ILD005087630	UNITED REFINING & SMELTING CO	M014	209	5
CAD982440273	BAY PHOTO LAB INC.	M014	186	80
CAD069138899	J&B ENTERPRISES	M014	133	53
NYD001325661	LEARONAL, INC.	M011	125	6
ILD000675249	AMERICAN CHEMICAL & REFINING	M014	104	52
KS1571924140	MCCONNELL AIR FORCE BASE	M014	104	-
LAD087029872	ALFRED'S PROCESSOR SALES/SERVICE	M014	100	39
PAD089352983	FEDERATED-FRY METALS	M013	83	83
MND981002470	ELECTROCHEMICALS, INC	M014	78	64
MAD000650051	WINDFIELD ALLOY INC.	M014	38	1
NYD086225596	AT&T NASSAU PLACE	M014	38	29
CAD981424732	QUICKSILVER RECYCLING INC	M019	36	32
IND005226949	REMOTE CONTROLS INC.	M014	27	27
NYD086225596	AT&T NASSAU PLACE	M011	25	12
RID001200609	PEASE & CURREN INC	M019	22	7
AZT050010685	ALLIED PRECIOUS METALS RECYCLING CO.	M013	20	60
CAD981424732	QUICKSILVER RECYCLING INC	M014	5	-
RID001200252	TECHNIC INC	M011	5	4
MAD000650051	WINDFIELD ALLOY INC.	M013	3	0

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RID001200252	TECHNIC INC	M019	2	84
NYD071600100	STATE UNIVERSITY OF NY AT BINGHAMTON	M014	1	0
CAD069138899	J&B ENTERPRISES	M011	0	0
NYD030485288	REVERE SMELTING & REFINING CORPORATION	M013	-	114,362
CAD981160948	PHIBRO-TECH, INC. AKA ENTECH RECOVERY, I	M014	-	560
PAD087561015	INMETCO INC	M011	-	40,168
CAD982411993	MERCURY TECHNOLOGIES INTERNATIONAL	M012	-	-
IND000199653	QUEMETCO, INC.	M013	-	148,548
RID981886104	GANNON & SCOTT INC	M013	-	6
COD983788688	ENVIROSERVE INC.	M014	-	-
IND984891994	BOLIDEN METECH, INC	M014	-	64
MID985619824	NORTRU INCORPORATED	M014	-	-
RID063890214	BOLIDEN METECH INC	M014	-	153
RID981886104	GANNON & SCOTT INC	M014	-	32
IND000718130	REFINED METALS CORPORATION	M013	-	-
MOD030712822	SCHUYLKILL METALS CORPORATION	M013	-	-
CAD981978752	PASADENA CITY COLLEGE	M014	-	-
CAD982523102	PHOTOTEK	M014	-	-
TXD084281575	TEXAS INSTRUMENTS, INC.	M014	-	-
TXD981514383	ALPHA OMEGA RECYCLING, INC.	M014	-	-
TXD988079307	FUJI TRUCOLOR	M014	-	-
TX6213820529	LONGHORN ARMY AMMUNITION PLANT	M014	-	-
	TOTAL QUANTITY FOR COMMERCIAL FACILITIES		7,015,635	1,295,222

Non Commercial Metal Recovery Systems and Capacities
(Basis: 1993 BRS- Form PS)

Facility	Facility Name	System Code	Maximum RCRA Capacity	Utilized RCRA Capacity
LAD008184137	SCHUYLKILL METALS CORP	M013	350,000	6,417
IND000717959	GENERAL BATTTERY/EXIDE CORPORATION	M013	240,000	132,923
CAD008344285	DICEON ELECTRONICS INC	M014	127,284	58,687
MAD990886301	ALTRON INCORPORATED	M014	123,853	82,877
CAD980816763	VELIE CIRCUITS INC.	M014	114,679	110,509
MND050730175	HARD CHROME INC	M014	112,594	170,898
CAD983601360	SOUTH BAY CIRCUITS INC	M014	107,381	76,755
PAD990753089	GENERAL BATTERY CORP - READING COMPLEX	M013	106,400	4,956
IAD984568204	UNIVERSAL CIRCUITS INCORPORATED	M014	106,255	38,729
MID006409387	PLASTIC PLATE I	M014	92,160	43,536
MNT280010257	NICO PRODUCTS INC	M014	85,488	54,712
MND980700900	BUREAU OF ENGRAVING, INC - INDUSTRIAL DV	M014	84,762	42,400
CAD008492951	HUGHES MISSILE SYSTEMS CO	M014	72,448	130
MND045976107	PRO-TECH INC	M014	72,195	28,731
MND116224288	PROFESSIONAL PLATING INC	M014	45,872	19,187
PAD005031448	ERIE PLATING COMPANY	M014	45,746	45,746
NJD011417516	PLASTI CLAD METAL PRODUCTS INC	M014	43,853	6,649
MND981089832	UNIVERSAL CIRCUITS, INC.	M014	43,716	25,761
MID981090509	LACKS, AIRLANE	M014	42,952	42,952
FLD004092839	GULF COAST RECYCLING INC	M013	41,000	27,513
CAD983654633	TRUST PRINTED CIRCUITS	M014	33,361	17,608
MND980681589	AVTEC FINISHING SYSTEMS INC	M014	30,901	10,587
MND006481287	JOYNER'S SILVER AND ELECTROPLATING	M014	29,633	15,638
IND980898522	CUSTOM CIRCUITCRAFT, INC.	M014	26,022	15,613
CT4170022020	US NAVAL SUBMARINE BASE	M014	25,500	23
GAD070330576	GNB BATTERY TECHNOLOGIES	M013	25,200	24,010
RID059735761	ADVANCED CHEMICAL COMPANY	M014	18,657	827
ARD981908890	NUCOR YAMATO STEEL	M011	17,000	12,427
CAD009680232	GRAPHIC RESEARCH INC	M014	16,971	2,286
MND006219232	MICOM CORP	M014	13,136	11,259
NYD001273242	QUEENS PLATING COMPANY INC	M014	7,500	1,088
NHD982202673	ABC FABRICATORS INC	M014	6,844	3,332
PAD002116994	TORPEDO WIRE & STRIP INC	M014	4,918	624
MND053422762	UNIVERSAL CIRCUITS INC	M014	4,170	3,963
NYD041293127	R D SPECIALTIES INC	M014	3,753	4
AZD980896310	CONTINENTAL CIRCUITS	M014	3,700	751
MND085114890	TELEX COMMUNICATION INC	M014	3,508	718
AZD980816276	TALLEY DEFENSE SYS	M014	3,123	0
IND075954222	DIVERSFIELD SYSTEM INC.	M014	2,752	440
MAD001411081	RAYTHEON COMPANY	M014	2,717	1,368
MND006253801	SUPERIOR PLATING INC	M014	2,365	647
NYD052782497	NEWSDAY, INC.	M014	2,180	3
MND079731519	UNISYS CORPORATION	M014	1,719	3
CAD982519423	SAN JOSE MERCURY NEWS	M014	1,344	-
MND980615496	ROSEMOUNT AEROSPACE INC.	M014	1,043	518
AZD063274609	CONTINENTAL CIRCUITS CORP	M014	1,000	216
KYD985083625	APPALACHIAN REGIONAL MEDICAL CENTER	M014	957	11
CAD982436172	MULTILAYER TECHNOLOGY, INC.	M014	911	193

Non Commercial Metal Recovery Systems and Capacities
(Basis: 1993 BRS- Form PS)

KYD074047556	GE AIRCRAFT ENGINES	M014	822	21
CAD983600339	KAISER FOUNDATION HOSPITALS	M014	651	580
DED003913266	OCCIDENTAL CHEMICAL CORPORATION	M012	600	153
GAD980847479	HITACHI CHEMICAL ELECTRO-PRODUCTS INC	M014	506	404
KYD130399363	HUMANA HOSPITAL-UNIVERSITY OF LOUISVILLE	M014	450	24
MOD985801380	MONSANTOA COMPANY	M014	436	108
KYD074051202	LEXINGTON CLINIC	M014	420	24
CAD063110605	CHEVRON PETROLEUM TECH. CO.	M014	415	9
CAD071557029	THE GRASS VALLEY GROUP, INC.	M014	410	98
ALD008163388	OCCIDENTAL CHEMICAL CORPORATION	M012	400	120
MAD981063001	CPC INCORPORATED	M014	375	129
MND981089790	WEST PUBLISHING COMPANY	M014	365	123
MND985668227	PRECISION DIVERSIFIED IND., INC.	M014	311	217
CA2170023152	USNAVY CHINA LAKE NAVAL AIR WPNS STN	M014	288	288
MND083467688	MAYO FOUNDATION	M019	280	240
OKD055943286	GRAPHIC ELECTRONICS	M014	271	-
PAD134752583	BURNDY CORP	M014	258	67
PAD980554570	OSRAM SYLVANIA INC - WARREN	M014	252	39
NHD986466688	CIRCUIT CONNECT INC	M014	250	188
FL2800016121	USAF CAPE CANAVERAL STATION	M014	218	37
NYD045201688	AMERICAN BOARD CO	M014	209	197
MAD001014174	AGFA DIVISION, MILES INC,	M014	204	33
ALD004019642	OCCIDENTAL ELECTROCHEMICALS CORP.	M012	200	88
MDD121338297	CARROLL COUNTY ITEMS	M014	163	16
NYD082788126	GEOMETRIC CIRCUITS, INC.	M014	150	83
PAD003004587	ATOTECH USA INC - STATE COLLEGE	M014	133	21
CAD108148958	SAINT JOSEPH MEDICAL CENTER	M014	125	63
NYD045606480	3M PRINTING & PUBLISHING	M014	125	11
CAD047784574	KETEMA A&E	M014	119	3
LAD062666540	PIONEER CHLOR ALKALI COMPANY	M014	115	33
CAD008314908	SOLAR TURBINES INC-HARBOR DRIVE FACILITY	M019	110	22
CTD983876814	COMPONENT TECHNOLOGIES, INC.	M019	92	64
CAD047297593	NATIONAL SMELTING & REFINING	M014	91	-
NYD002241982	HADCO CORPORATION	M014	87	15
OHD004174827	R.R. DONNELLEY & SONS COMPANY	M014	87	46
MND058330473	ADVANCED FLEX, INC. - PLANT 1	M014	87	13
MAD086538394	RAYTHEON COMPANY	M014	78	9
MNT280010414	UNIVERSITY OF MINN MPLS CAMPUS	M014	66	59
KYD981854987	ST. JOSEPH HOSPITAL	M014	65	32
KYD045739471	AMERICAN GREETINGS CORPORATION	M014	62	3
MND000819268	ALLIANT TECHSYSTEMS, INC T.C. AMMUN.	M014	60	20
NYD049838568	EXCEL PRECISION, INC.	M014	59	14
AKD000643239	BP EXPLORATIOIN ALASKA INC PRUDHOE BAY	M014	58	55
CTD001183763	CIRCUIT WISE INC	M014	54	2
KYD068324037	LEXINGTON HERALD LEADER COMPANY	M014	50	17
NYD987000759	COLOR DATA EAST	M014	50	9
MND982425589	STAR TRIBUNE NEWSPAPER	M014	48	5
CAD076243815	TELEDYNE AIRCRAFT PRODS-CAST PRODS OPS	M014	44	37
NHD081255788	ADVANCED CIRCUIT TECHNOLOGY	M014	42	31
KYD985085166	OUR LADY BELLEFONTE HOSPITAL	M014	40	34

Non Commercial Metal Recovery Systems and Capacities
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KY6210020479	USAARMC AND FORT KNOX	M014	38	28
KYD144303864	HARDIN MEMORIAL HOSPITAL	M014	35	25
MND982639775	T.R.C. CIRCUITS INC.	M014	34	7
COD981549413	SAS CIRCUITS INC	M014	33	18
CTD001159557	COMBUSTION ENGINEERING, INC.	M014	32	1
KYD006383665	GATEWAY PRESS INC.	M014	30	12
PA0890090004	US DOE - BETTIS ATOMIC POWER LAB	M014	30	0
MND006147102	QUEBECOR PRINTING INC.	M014	30	15
MAD991289505	CHILDREN'S HOSPITAL CORP.	M014	28	17
CAT080031461	CSUF	M014	25	1
CAD983576760	PROGRESSIVE CIRCUIT PROD	M014	25	1
GA7360015450	VA MEDICAL CENTER	M014	23	8
KYD068135516	HIGHLANDS REGIONAL MEDICAL CENTER	M014	23	23
MD3750832062	FREDERICK CANCER RESEARCH AND DEVELOPN	M014	22	1
MND048166672	INSTANT WEB, INC	M014	22	12
CAD080129000	GENENTECH INC	M014	21	2
FL6800014585	USNASA KENNEDY SPACE CENTER	M014	21	15
NYD033490640	ANDIN INTERNATIONAL	M014	20	7
FLD060240207	MARTIN MARIETTA MISSILE SYSTEMS	M014	18	5
CAT000618603	CHEVRON RESEARCH & TECHNOLOGY	M014	18	1
CA2890012584	LAWRENCE LIVERMORE NATIONAL LABORATOR	M014	18	1
CAD009220898	TELEDYNE RYAN AERONAUTICAL	M014	18	0
COD085270270	BALL AEROSPACE & COMMUNICATIONS GROUP	M014	16	2
FLD004100152	E-SYSTEMS ECI DIV	M014	16	0
UTD980959191	HERCULES AEROSPACE	M014	15	6
MND081138604	ALLIANT TECHSYSTEMS PROVING GROUND	M019	15	0
MND981536006	LITHO SPECIALTIES, INC.	M014	14	12
MED037719846	US DEPRTMENT OF VETERAN AFFAIRS	M014	13	1
CA7170024528	USNAVY NAVAL WEAPONS STN CONCORD	M014	13	1
MND980826457	MCF-STILLWATER	M014	12	0
CTD001183763	CIRCUIT WISE INC	M019	12	1
FLD980841746	MARTIN MARIETTA ELECTRONIC SYSTEMS	M014	12	1
MS6210809871	WATERWAYS EXPERIMENT STATION	M014	11	1
KYD980844757	RIVERPORT IMAGING	M014	10	3
KY5170024173	NAVAL ORDNANCE STATION	M014	10	2
MND985703024	SOURCE, INCORPORATED	M019	10	7
CAT000617597	USC HEALTH SCIENCES CAMPUS	M014	10	8
NYD043835081	AIR TECHNIQUES INC	M014	10	3
FL2570024404	USAF PATRICK	M014	10	7
MDD050793926	TOWSON STATE UNIVERSITY	M014	9	1
VAD000820712	UNIVERSITY OF VIRGINIA	M014	9	5
ME8170022018	US NAVAL AIR STATION	M014	9	1
MND985684620	IMPRESSIONS INC.	M014	8	5
CAD075301390	TELEDYNE AIRCRAFT PRODUCTS	M014	8	7
FLD984225821	HEALTHSOUTH DOCTORS'HOSPITAL	M019	8	6
MND041786930	ADVANCED FLEX, INC. - PLANT 2	M014	8	6
MND985667047	QUEBECOR PRINTING ST. CLOUD, INC.	M014	7	6
FLD004104105	HONEYWELL INC	M014	7	1
KYD985095140	GOOD SAMARITAN HOSPITAL	M014	6	3
MOD071999783	UMSL DANGEROUS CHEMICALS STORAGE BLDG	M014	6	1

ME9570024522	US AIR FORCE BASE - LORING	M014	5	2
NYD002235182	MARTIN MARIETTA CORP AIR FORCE PLNT#59	M014	5	1
NYD981875461	PEPSI-COLA COMPANY	M014	5	8
MND985677210	CONTAINER GRAPHICS CORP	M014	4	2
MAD041710609	TECH-ETCH, INC.	M014	4	1
NMD041358904	NEW MEXICO INST. OF MINING & TECHNOLOGY	M014	4	2
CAT000613372	KCA ELECTRONICS INC.	M014	3	1
KSD980852669	UNIVERSITY OF KANSAS	M014	3	1
CAD099457061	MAGNAVOX ELECTRONIC SYSTEMS CO	M014	3	0
CA1800005034	USNASA AMES RESEARCH CENTER	M014	3	177
CAT000617589	USC UNIV PARK CAMPUS	M014	3	2
MND000819292	ADVANCED FLEX, INC. - PLANT 3	M014	2	1
FL8170023792	USN COASTAL SYSTEMS CENTER	M014	2	0
CAT080033392	CALIFORNIA STATE UNIVERSITY NORTHRIDGE	M014	2	-
MND980792642	MANKATO STATE UNIV	M014	2	1
CAD072518517	BECKMAN INSTRUMENTS INC	M014	2	2
VAD046960449	BABCOCK & WILCOX CO N N F D	M014	1	1
ME7170022019	PORTSMOUTH NAVAL SHIPYARD	M019	1	1
CAD079622569	AEROJET ELECTRONIC SYSTEMS PLANT	M014	1	-
MAD001027325	GARE INCORPORATED	M014	1	0
FLD064824030	MCDONNELL DOUGLAS MISSILE PRODUCTION	M014	1	0
MAD001423631	NORTHEASTERN UNIVERSITY	M014	1	0
NYD000810986	CORNELL UNIVERSITY LIFE SAFETY	M014	1	0
CAD009587700	TELEDYNE ELECTRONIC TECHNOLOGIES	M014	0	0
CAD047791421	CARPENTER TECH. CORP. -SPECIAL PROD. DIV	M014	0	0
MO4213820489	LAKE CITY ARMY AMMUNITION PLANT	M014	0	0
MID041793589	PARLIN INDUSTRIES INCORPORATED	M014	0	0
CTD010174613	KLOCK CO DIV OF WICKES CO INC	M014	0	0
CA1170090020	USNAVY PT LOMA NAVAL COMPLEX	M014	0	0
NYD000799239	SYRACUSE UNIVERSITY (QUAD)	M014	0	2
KSD007233323	KANSAS PLATING INC	M014	0	0
NY6360010312	VAMC - NORTHPORT	M014	0	0
MAD071723563	NEW ENGLAND DEACONESS HOSPITAL	M014	0	0
NHD073976904	GENCORP POLYMER PRODUCTS	M014	0	0
CAD066233966	QUEMETCO, INC.	M013	-	1,609
PAD002330165	EAST PENN MFG CO	M013	-	146
CAD000628032	AIRCRAFT X-RAY LABORATORIES, INC	M014	-	3
CAD001425206	RAYTHEON COMPANY ESD	M014	-	-
CAD008319089	CHROMALLOY ADV TURBINOLOGY	M014	-	-
CAD020530846	GDE SYSTEMS INC	M014	-	-
CAD028878015	STANFORD UNIVERSITY HOSPITAL	M014	-	-
CAD069130995	HEWLETT-PACKARD COMPANY	M014	-	-
CAD980673347	U.S. CIRCUIT, INC.	M014	-	-
CAD980737837	SACRAMENTO BEE	M014	-	-
CAD980885941	ALLERGAN MEDICAL OPTICS	M014	-	-
CAD981385958	AMBITECH, INC	M014	-	-
CAD982417172	NAPA PIPE CORP	M014	-	-
CAD982484826	UNIVERSAL CIRCUITS	M014	-	-
CAD990843716	ILC TECHNOLOGY	M014	-	-
CAT000646257	FLIGHT ACCESSORY SERVICE DIV. OF HAWKER	M014	-	-

Non Commercial Metal Recovery Systems and Capacities
(Basis: 1993 BRS- Form PS)

COD082657420	SCHLAGE LOCK COMPANY	M014	-	-
CTD018695999	AEROSPACE METALS	M014	-	-
DED002337806	NVF COMPANY	M014	-	34
KSD116030909	COLT TECHNOLOGY CORPORATION	M014	-	-
MAD001032358	GLOBE NEWSPAPER CO.	M014	-	14
MID047153077	PRODUCTION PLATED PLASTICS INCORPORATEI	M014	-	-
MND006159149	THE JOHN ROBERTS COMPANY	M014	-	6
MND006258115	JAPS-OLSON CO.	M014	-	5
MND985667807	ADVANCED FLEX, INC. - PLANT 2	M014	-	-
NED007281728	LINCOLN PLATING COMPANY	M014	-	-
NED986387041	SUPRA COLOR LABS INCORPORATED	M014	-	-
NYD986875326	HERAEUS PMR	M014	-	39
PAD005031497	AMERICAN TINNING & GALVANIZING CO	M014	-	-
PAD014299523	WEINSTOCK CONESTOGA INC	M014	-	1
PAD987377504	INTERNATIONAL ENVELOPE CO	M014	-	-
VTD001075886	MERIDEN STINEHOUR PRESS	M014	-	-
ALD000826958	AUBURN UNIVERSITY	M019	-	0
CAD009584210	CALIF INSTITUTE OF TECHNOLOGY	M019	-	-
CAD982324154	COMPOSITE STRUCTURES	M019	-	-
CTD002592020	BEAVER BROOK CIRCUITS INC.	M019	-	-
CTD023869423	COMPONENTS TECHNOLOGIES, INC	M019	-	-
CTD099762015	INTERMAGNETICS GENERAL CORP	M019	-	-
CT0572826873	CT ARMY NATIONAL GUARD BRADLEY BASE	M019	-	-
DED003930799	E.I. DUPONT CHESTNUT RUN	M019	-	1
MIT270012198	GRAND HAVEN BRASS FOUNDRY	M019	-	-
MND985668227	PRECISION DIVERSIFIED IND. INC.	M019	-	-
GU9170090022	USNAVY NAVAL HOSPITAL COMPLEX	M014	-	-
KSD007237241	BOEING COMPANY, THE	M014	-	-
	TOTAL QUANTITY FOR NON-COMMERCIAL FACILITIES		2,361,290	1,150,491

ES FOCUS HAZMAT MANAGEMENT

Chemical fixation increases options for hazardous waste treatment

THE HAZARDOUS AND SOLID WASTE AMENDMENTS (HSWA) to the Resource Conservation and Recovery Act (RCRA) govern the manner in which hazardous materials are managed. Disposing RCRA hazardous wastes on or in the land is no longer an accepted remedial option. This land disposal restriction requires that all listed and characteristic hazardous wastes (as defined by RCRA) must be treated according to specified standards before they are disposed [*40 CFR 268.40*]. These treatment standards define technologies and concentration limits. Hazardous wastes that do not meet the standards are prohibited from being disposed on land, such as in landfills, surface impoundments, land treatment units, injection wells, and mines or caves.

BY GREGORY J. INDELICATO AND GARY A. TIPTON

The Environmental Protection Agency (EPA) permits land disposal of some hazardous waste streams provided the toxicity or mobility of the specific hazardous constituents has been reduced to required treatment standard concentrations. Such is the case with hazardous wastes exhibiting toxicity characteristics (TCs) as identified in *40 CFR 261.24*. Specifically, wastes contaminated with arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver — known as the RCRA metals — fall under the standard.

Given these TC concentration limits, EPA gives generators the ability to choose from several treatment technologies. The standard to which the effectiveness of other treatment technologies for a specific waste is composed is called the best demonstrated available technology.

Remedial options. Treatment generally is the only option for metal-containing listed wastes and wastes that include any RCRA metals in concentrations exceeding the TC treatment standard. There are several non-treatment methods; however, their applicability is limited. These include:

- *Reclassification of the material, followed by disposal.* This involves obtaining a variance to classify the waste as hazardous and dispose it as non-hazardous. Although reclassification is an inexpensive alternative, it is being phased out as variances expire and are not renewed.
- *Disposal in a permitted hazardous waste facility.* The waste is transported as hazardous waste to a hazardous-waste disposal facility, where it is treated and disposed. The advantage of this method is that the waste can be removed from the site quickly. However, the waste still must be treated to meet pre-disposal treatment standards; in addition, transportation, and offsite treatment and disposal of hazardous waste can be costly and increase the generator's risk of exposure to liability.
- *Reclamation and recycling.* As long as the waste contains specific metals in concentrations high enough for recovery, recycling is an attractive option, eliminating long-term liability and reducing the volume of waste generated. However, this method may not be viable if concentrations are not at threshold levels.

Thus, generators usually are forced to treat metal-contaminated waste using an accepted treatment technology, such as solidification and stabilization processes, thermal decomposition, sorbents, osmotic and ion-exchange methods, and flocculation and precipitation.

Solidification/stabilization. This common process treats waste by physically or chemically immobilizing the constituents, diminishing their effective mobility and toxicity. Many solidification and stabilization processes use cementing or encapsulation to immobilize contaminants. A variety of materials — such as portland cement and other calcium-based cements, silicates and other siliceous materials, and even asphaltics and waxess — are used as binders to stabilize the metals, or surround or incorporate the metals in a matrix.

In cement-based approaches, wastes are mixed directly with cement or similar setting materials; the metals then are incorporated and bound in the cement. The pH increases as the cement cures, and most multivalent cations are converted into insoluble hydroxides or carbonates. However, metal hydroxides and carbonates are insoluble only over a narrow pH range; as the curing process continues and pH increases, the solubility of these metal compounds will increase as well.

Another approach is to add a siliceous material with lime, cement, gypsum and other suitable setting agents. Siliceous material includes fly ash, blast furnace slag, and calcium, sodium or potassium silicates. Portland cement and lime are the most commonly used setting agents. Under proper conditions, a reaction will take place between the silica-rich material and the polyvalent metal ions, yielding a weakly bonded metal-silica material.

Various materials generally present in typical waste streams can inhibit the effectiveness of solidification/stabilization; these materials include sulfates, organics (oil and solvents, for example) and many of the metals being treated. The materials prevent or retard the curing process, reducing the strength and durability of the treated waste and increasing the susceptibility for leaching of the contaminants.

Treated wastes also are highly susceptible to changing chemical conditions, such as lower pH. Simple cemented wastes are subject to leaching in the presence of even mildly acidic solutions such as rainwater, thereby rendering the process ineffective for immobilizing the metals. As the matrix breaks down, the encapsulated material will begin to leach. Similarly, the matrix, if not processed properly, can retain a large amount of water that is not chemically bound. This can structurally weaken the final product, making it susceptible to leaching. Over time, the water will migrate out of the treated waste material and. in the process, leach out the metals.

Other solidification processes vary in applicability and effectiveness. Many of the thermoplastic processes — such as asphaltic, bitumen and paraffin-based methods — are costly and have limited compatibility with many waste streams.

These methodologies are enhanced if the contaminants can be chemically stabilized or "fixed" in the molecular structure of the solidified product. The applicability and effectiveness of the various chemical fixation protocols available depend on the nature of the contaminants, their concentrations, the matrix, other metal interactions and interferences, and physical and chemical parameters. These factors must be understood fully to maximize treatment effectiveness.

Chemical fixation. Chemical fixation is a treatment process that employs reagents

CONTINUED

C A S E S T U D Y

Chemical fixation of dewatered sludge from an electronics/specialty parts manufacturer

Parameter	Untreated waste (mg/kg)	Treated waste (TCLP: mg/l)	Treatment standards (TCLP: mg/l)
Aluminum	2,610.00	0.70	—
Arsenic	2.93	<0.01	5.00
Barium	12.00	<1.00	100.00
Cadmium	<0.40	<0.01	1.00
Chromium	51,800.00	1.90	5.00
Copper	20,300.00	<0.01	—
Lead	20,900.00	<0.01	5.00
Magnesium	292.00	0.15	—
Mercury	<0.03	0.003	0.20
Nickel	1,510.00	0.12	—
Selenium	1.70	<0.01	—
Silver	206.00	<0.01	—
Tin	643,000.00	3.20	—
Zinc	116.00	0.07	—

Note: Volume increase was less than 20%.

designed for the specific contaminant or contaminants in the waste stream. Using the pozzolanic material as a silica source, the metal-affected waste is remineralized as non-leachable metal silicates. The physicochemical reaction process, which involves hydration, sorption, molecular cross-linking and other reactions, ultimately produces a monolithic, calcium-metal silicate material with potentially high structural strength.

Chemical fixation uses predetermined treatment protocols based on the contaminants in the waste stream. The protocols specify the volumes, concentrations and proper sequencing of proprietary reagents, and emphasize appropriate mixing and reaction times for each step. Special attention is given to matrix interferences and interactions involving metal solubility, such as ionic strength, valence state, redox potential, pH and competing ions. It may be necessary to reduce the toxicity of specific contaminants (for example, hexavalent chromium or cyanide) before chemical fixation takes place. In other cases, the chemical activity of such specific metals as cadmium, mercury and arsenic may need to be stabilized or modified: this is especially true for metals that complex with organics.

Reaction kinetics must be optimized to ensure effective fixation of the contaminants in the waste stream. Several types of reagents can be added to induce and facilitate the chemical fixation process. These include:

- Mixing agents, which facilitate the dispersion of organics and help incorporate the metal(s) into the mixture;
- Inhibitors, which are used to slow hydration reactions so the slower silicate complexing reactions can occur;
- Complexing agents, which facilitate reactions between amorphous silica and the metal contaminants; and
- Accelerators, which increase the rate of the silicate reactions as the inhibitors are consumed.

Series of reactions. When properly combined, the metals-affected waste, fixing agents and proprietary chemicals (as determined by the appropriate protocol) produce a series of reactions. First, calcium silicates from the pozzolanic material begin to decompose, releasing calcium oxide and silica. Then, the calcium hydroxide is precipitated with the hydrated calcium silica gel under conditions that allow silica complexes to form.

Next, proprietary chemicals (selected based on the contaminants present) are added to the waste stream, increasing the viscosity of the mixture. This acts as an effective interparticule lubricant, which accelerates the homogenization of the mixture and simultaneously decelerates the diffusivity of other components in the cementation reaction.

At this point, the calcium oxide and calcium silicates hydrate while other chemicals dehydrate, generating cross-linkage among particles and dehydrated molecules. This helps prevent volume expansion in the solidified mixture. In this stage, the cementation reaction begins to accelerate.

Next, the hydrated calcium silica gel and crystals physically and chemically entrap the contaminants within the solidified matrix. Many of the metal components are incorporated into the crystalline structure through ion exchange, substitution, solid solution and complexing processes. Some fine inorganic particles are encapsulated physically within the macropores and micropores of the silicate matrix, while some metals are absorbed on the surface of the crystals and the particles of the fixing agent. Contaminant entrapment and encapsulation are enhanced naturally by the cage-like structure associated with the previously formed cross-linked molecules.

Finally, the dissolved or dispersed organic components are physically trapped and encapsulated in the macropores and micropores of the solidified mixture matrix, or are absorbed or chemisorbed on the surfaces of these pores through dipole-dipole interaction, London-force attraction or hydrogen bonding. Remaining components are incorporated chemically into the matrix through a variety of processes, which can include complex formation, chemical (covalent) bonding and cross-linkage formation. The process overcomes the tendency of organic waste components to inhibit the cementation reaction.

The solidified mixture produced by this process has much greater density and mechanical strength, which results in substantially lower leaching rates of the final waste product; 28-day, unconfined compressive strengths of more than 4,000 pounds per square inch (psi) have been achieved in some treated organic sludges, with as much as 12,000 psi in non-organic

CONTINUED

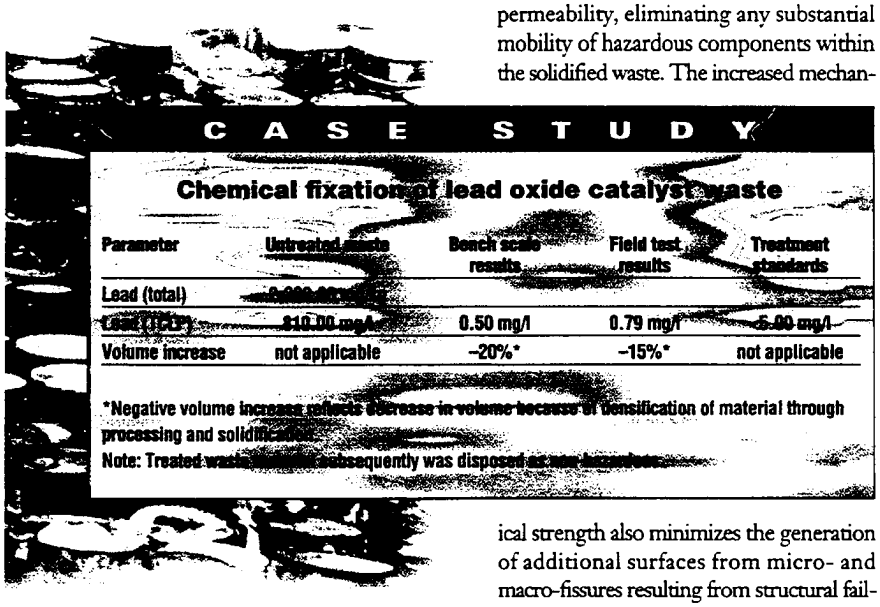
CASE STUDY

Chemical fixation of municipal incinerator ash

Metals	Ash mean* (ppm)	Treatment standard (TCLP: mg/l)	Field trial results 24-hour cure (mg/l) SW-A1	SW-A2	Field trial results 28-day cure (mg/l) SW-1	SW-2
Cadmium	19.65	1.00	ND	ND	ND	ND
Chromium	95.30	5.00	ND	ND	ND	ND
Lead	1,028.00	5.00	2.30	2.00	ND	ND
Nickel	185.00	20.00	ND	ND	ND	ND
Zinc	1,453.00	250.00	0.22	0.17	0.05	ND

ND = non-detectable
*The mean was calculated from samples taken on six different days.
SW-A1 and SW-1: mixture of 10% fly ash, 90% bottom ash, pozzolans, reagents
SW-A2 and SW-2: mixture of fly ash, pozzolans, reagents

Fixation



materials. Characteristically, an increase in the density of a solid indicates diminished permeability, eliminating any substantial mobility of hazardous components within the solidified waste. The increased mechanical strength also minimizes the generation of additional surfaces from micro- and macro-fissures resulting from structural failure. Water penetration and the subsequent transport of soluble metals constituents are, therefore, minimized.

Chemical fixation advantages. There are distinct advantages in using this proprietary chemical fixation process:

- It can be used to treat a wide range of waste streams;
- There is minimal increase in the volume of the treated waste; and
- The process is relatively inexpensive.

Unlike many conventional solidification processes, chemical fixation can treat a wide range of waste streams, including complex, multicontaminant inorganic wastes and the typically hard-to-treat, organically contaminated wastes. Waste streams treated successfully by this process include soils contaminated by heavy metals, organically contaminated soils, electroplating sludges, paint-sludge wastes, sandblasting grit contaminated by heavy metals, API separator oils and sludges, petroleum tank bottoms, wastes containing polychlorinated biphenyls (PCBs), asbestos wastes, and incineration ash.

Mix formulations can be modified to accommodate specific waste streams so that the waste takes an active role in the cementation phase of stabilization. Some wastes even function as chemical reagents, assisting in their own stabilization by contributing to physical hardening, thereby reducing or eliminating permeation and leaching concerns. Also, by altering the design of the mix, processed waste can be poured as a plastic solid similar to concrete and cast into blocks, super sacks, rolloff boxes and other forms suitable for disposal. The processed waste also can be stabilized into a final state with a soil-type texture. In either form, low solubility reduces the potential for leaching to a negligible degree. The resulting treated waste yields analytical results below EPA's TC leaching procedures.

Typical solidification/stabilization processes add cement to the micture, increasing the volume of the waste. Chemical fixation limits volume expansion of the resultant waste material. Because disposal charges at most landfills are based on volume, this translates into significant savings. In one test, a 65-percent organic oily waste sludge that was solidified showed an increase in volume of less than 50 percent. In another test, soil containing PCBs at 30 parts per million was treated with chemical fixation, with a resulting 15-percent volume reduction and a 28-day compressive strength of 3,250 psi. When compared to the costs for treatment and disposal of hazardous waste, treatment processes and subsequent disposal of non-hazardous waste is significantly less expensive.

Chemical fixation can treat a wide range of waste streams, including multicontaminant inorganic and hard-to-treat organic wastes, at relatively low cost and with minimal volume increase.

Chemical fixation can be customized for a facility's specific hazardous waste treatment and disposal program. Years of development and application has resulted in an extensive data base of treatment reactions for metal-contaminated wastes. More than 700 waste streams have been evaluated and successfully treated. More than 400 waste streams have been treated successfully in bench-scale testing, and more than 100 waste streams have been treated in field applications. □

Gregory J. Indelicato is manager of emergency and remediation services for CURA Inc. (Dallas). Gary A. Tipton is an environmental consultant in Houston. Readers wishing to obtain further information on the chemical fixation process can contact Indelicato at 800/486-7117, ext. 220.

... Moore, Suzzane Wade

FROM: Stephen Schwartz

SUBJECT: Phone Calls to TSDs Who Stabilize D008 and Other TC-metal Hazardous Wastes

DATE: 13 May 96

At your request I contacted commercial Treatment, Storage, Disposal (TSD) facilities in EPA Regions 5 and 6 in order to determine if they perceived that there would be any problem to stabilize brass/bronze foundry TC-metal hazardous wastes to Universal Treatment Standard (UTS) levels. More specifically, I asked if they could use conventional stabilization technology to treat foundry sand-type D008 (TC for Lead), including the lead and all Underlying Hazardous Constituents (UHCs), to the UTS levels. Further, I requested any treatability data that the TSDs might have to support their contention that they could perform the required treatment. Attached is a list of the TSDs contacted. Also attached are the records of the telephone contacts, including the details of their telephone responses.

Nine TSDs were contacted, seven of which actually performed stabilization of TC-metal wastes, either on-site, or shipped to one of their facilities elsewhere in the country.

Of the two facilities that did not stabilize wastes, one is primarily a Deepwell disposer, and if they received such waste they would subcontract its treatment. The second of the two did not manage foundry-type wastes, or any other bulk solids, but mostly managed drummed waste.

In general, each of the seven facilities that performed the requested stabilization said that they manage foundry sand D008 wastes, or wastes that they believed were similar. Each said that they didn't believe that there were any significant problems in producing the necessary pozzolonic recipe to stabilize the waste in question to all applicable UTS levels, including the lead component. (Most seemed familiar with the UTS requirement for lead of 0.37 ppm TCLP, rather than the current D008 lead requirement of 5.0 ppm.) One facility said they do this type of stabilization to UTS levels routinely, and find no difficulty 90% of the time. (Initially they were only able to hit all UTS levels about 70% of the time, but have since improved.)

....., ADDRESS/PHONE OF FIRM: Chem. Waste Mgmt 318/582-2169
7170 John Brannon Rd.
Carlyss, LA 70663

CONTACT PERSON: Renée Denton DATE: 10 May

1 - Do you receive non-wastewater wastes from brass/bronze foundries? Do you receive similar wastes? If similar, why are they similar?
Typical foundry waste contains fine sand particles contaminated with a few percent lead, zinc, copper.

Yes, they receive Brass/Bronze foundry wastes & similar wastes

2 - If so, do you stabilize those wastes with pozzolonic-type stabilizing agents?

Yes they stabilize w/ cement/H₂O mixtures ↪ each tailored to the client.

3 - If so, what typical mix of water/stabilizer/waste do you use?

See above (2)

4- To what TCLP levels are you able to stabilize the BDAT/TC metals? CAN WE HAVE - DATA FOR UNTREATED/TREATED METAL CONSTITUENTS? They reach TC & UTS levels ↪ & she believes they can meet VHC levels for all metals, even the primary T.C. metals. Won't release data

5- Would you forsee problems in treating these wastes to TC/UTS levels?

See (4) above

--- NUCLEAR CONTAINMENT SERVICES (LA). INC.
P.O. Box 73877
BATON ROUGE, LA 70137 302/426-3168

CONTACT PERSON: FRED GURDESS — RICHARD GRONDIN COLORADO 970/386-2293 DATE: 10 MAY '96

1 - Do you receive non-wastewater wastes from brass/bronze foundries? Do you receive similar wastes? If similar, why are they similar?
Typical foundry waste contains fine sand particles contaminated with a few percent lead, zinc, copper.

OTHER/LANDFILL FOUNDRY WASTE IN COLORADO.

TALKED TO COLORADO — THEY DO STAB. BRASS/BRONZE FNDRY WASTES & OTHER D008's

2 - If so, do you stabilize those wastes with pozzolonic-type stabilizing agents?
YES USE CONVENTIONAL POZZOL. MIXTURES

3 - If so, what typical mix of water/stabilizer/waste do you use?
VARIOUS RECIPES —— NOT PROPRIETARY

4- To what TCLP levels are you able to stabilize the BDAT/TC metals? CAN WE HAVE DATA FOR UNTREATED/TREATED METAL CONSTITUENTS?
CAN MEET ALL METAL UTS LEVELS, EVEN LEAD, TYPICALLY LEAD IS NO PROBLEM. WON'T RELEASE DATA

5- Would you forsee problems in treating these wastes to TC/UTS levels?
NO PROBLEMS —— HE'LL PROVE IT IF WE SEND SAMPLE

NAME/ADDRESS/PHONE OF FIRM: ENVIRITE CORP
16455 S. Center Ave.
Harvey, IL 60426
708/596-7040

CONTACT PERSON: David Reyes DATE: 10 May 96

↳ He'll have someone call from York, PA

1 - Do you receive non-wastewater wastes from brass/bronze foundries? Do you receive similar wastes? If similar, why are they similar?
Typical foundry waste contains fine sand particles contaminated with a few percent lead, zinc, copper.

Yes — Get Brass foundry wastes.

2 - If so, do you stabilize those wastes with pozzolonic-type stabilizing agents? Yes, but somewhat proprietary

3 - If so, what typical mix of water/stabilizer/waste do you use?
See (2) above)

4- To what TCLP levels are you able to stabilize the BDAT/TC metals? CAN WE HAVE DATA FOR UNTREATED/TREATED METAL CONSTITUENTS? No problem — Get to detection levels — no data avail.

5- Would you forsee problems in treating these wastes to TC/UTS levels?
See (4) above

NAME OF FIRM: AETS/Chem. Waste Mngmnt
W124 N9451 Boundary Rd. 414/255-4645
Menomonee Falls, WI 53051

CONTACT PERSON: Alan Koumtz DATE: 10 may/96

1 - Do you receive non-wastewater wastes from brass/bronze foundries? Do you receive similar wastes? If similar, why are they similar?
Typical foundry waste contains fine sand particles contaminated with a few percent lead, zinc, copper.
Yes They Get Brass Foundry Wastes

2 - If so, do you stabilize those wastes with pozzolonic-type stabilizing agents? Stabilize w/ Conventional Agts. (CaO)

3 - If so, what typical mix of water/stabilizer/waste do you use?
/See (2) above

4- To what TCLP levels are you able to stabilize the BDAT/TC metals? CAN WE HAVE DATA FOR UNTREATED/TREATED METAL CONSTITUENTS? Currently that Does - Leads to <5 ppm TCL.
No Data Available

5- Would you forsee problems in treating these wastes to TC/UTS levels?
Doesn't think that treating to UTS is a problem.

NAME/ADDRESS/PHONE OF FIRM: HEALTHAGE ENVIRON. SERVICES.
7901 W. MORRIS ST.
INDIANAPOLIS, IN 46231 317/243-0811 x

CONTACT PERSON: DARCY RAY DATE: 10 MAY/96

1 - Do you receive non-wastewater wastes from brass/bronze foundries? Do you receive similar wastes? If similar, why are they similar?
Typical foundry waste contains fine sand particles contaminated with a few percent lead, zinc, copper.

BELIEVE THEY CAN HANDLE THIS — DON'T KNOW IF THEY ACTUALLY DO HANDLE FOUNDRIES.

2 - If so, do you stabilize those wastes with pozzolonic-type stabilizing agents? USE CEMENT TYPE STUFF — USE PUG-MILL

3 - If so, what typical mix of water/stabilizer/waste do you use?
CONVENTIONAL — SEPARATE TESTING

4- To what TCLP levels are you able to stabilize the BDAT/TC metals? CAN WE HAVE DATA FOR UNTREATED/TREATED METAL CONSTITUENTS?
TREAT TO F006 CODE LDR VALUES — BELIEVE THEY CAN TREAT — THEY HAVE A MODEL — NO DATA AVAIL

5- Would you forsee problems in treating these wastes to TC/UTS levels?
BELIEVE THEY CAN MEET STANDARDS FOR UTS.

NAME/ADDRESS/PHONE OF FIRM: GNI Group (Disposal Systems)
P.O. Box 1914
Deer Park, TX 77536

713/930-2538

CONTACT PERSON: Bob Griffith
Warren Norris

DATE: 10 MAY 96

1 - Do you receive non-wastewater wastes from brass/bronze foundries? Do you receive similar wastes? If similar, why are they similar?

Typical foundry waste contains fine sand particles contaminated with a few percent lead, zinc, copper.

NOT MUCH FOUNDRY WASTE, BUT DO HAVE SAND BLAST Pb DEPAINTING WASTE.

THEY'RE A LOCAL OUTFIT, SHIP STABILIZED STUFF TO CHEM. WASTE MNGMN'T.

2 - If so, do you stabilize those wastes with pozzolonic-type stabilizing agents? YES

3 - If so, what typical mix of water/stabilizer/waste do you use?

CONVENTIONAL POZZOLANES (FLY ASH, LIME KILN DUST, CEMENT DUST, [illegible], [illegible], POLYMERS)

4- To what TCLP levels are you able to stabilize the BDAT/TC metals? CAN WE HAVE DATA FOR UNTREATED/TREATED METAL CONSTITUENTS?

CAN TREAT — BUT DON'T HAVE DATA TO GIVE.

5- Would you forsee problems in treating these wastes to TC/UTS levels?

BELIEVE THEY CAN TREAT ALL STUFF TO UTS LEVELS PASS 90% OF TIME.

NAME/ADDRESS/PHONE OF FIRM: Clean Harbors of Chicago
11800 Stony Island Ave.
Chicago, IL 60617
312/646-6202

CONTACT PERSON: CNE Doran (Craig) Tim Getteloff DATE: 10 May 96

1 - Do you receive non-wastewater wastes from brass/bronze foundries? Do you receive similar wastes? If similar, why are they similar?
Typical foundry waste contains fine sand particles contaminated with a few percent lead, zinc, copper.
Would [illegible] in Cincinnati — still have someone call me.
Yes, they [illegible] foundry [illegible]
(although sand is not TC [illegible])

2 - If so, do you stabilize those wastes with pozzolonic-type stabilizing agents? Yes

3 - If so, what typical mix of water/stabilizer/waste do you use?
Whatever recipe works.

4- To what TCLP levels are you able to stabilize the BDAT/TC metals? CAN WE HAVE DATA FOR UNTREATED/TREATED METAL CONSTITUENTS? Whatever client needs, they can meet — but
No data available

5- Would you forsee problems in treating these wastes to TC/UTS levels?
No

[illegible], STORAGE, AND DISPOSAL FACILITIES CONTACTED

1 - GNI Group (Disposal Systems)
P.O. Box 1914
Deer Park, TX 77536

Mr. Warren Norris - 713/930-2588

2 - Clean Harbors of Chicago
11800 Stoney Island Avenue
Chicago, IL 60617

Mr. Tim Getzloff - 312/646-6202

3 - AETS/Chemical Waste Management
W124 N9451 Boundary Road
Menomonee Falls, WI 53051

Mr. Alan Koumtz - 414/255-6655

4 - Heritage Environmental Services
7901 W. Morris Street
Indianapolis, IN 46231

Ms. Darcy Ray - 317/243-0811 ext.1483

5 - Envirite Corp.
16435 S. Center Avenue
Harvey, IL 60426

Mr. David Reyes - 708/596-7040

6 - Rollins Environmental Services (LA), Inc.
P.O. Box 73877
Baton Rouge, LA 74137

Fred Gurdess - 302/426-3168 &
Richard Grondan - 970/386-2293 (Colorado facility)

7 - Chemical Waste Management
7170 John Brannon Road
Carlyss, LA 70663

Ms. Renee Dillion - 318/583-2169

8 - Treatment One
5743 Cheswood
Houston, TX 77087

Ms. Shiela Armstrong - 502/327-8860 (Louisville, KY facility)

THEY DO NOT HANDLE BULK SOLIDS, INCL. FOUNDRY SAND WASTES.

[illegible] Company
P.O. Box 709
Texas City, TX 77592

Ms. Tracy Holister - 409/945-3301

DEEPWELL FACILITY. THEY WOULD SUBCONTR
NONWASTEWATERS.