Applicability of the New York State Department of Environmental Conservation (NYSDEC) Regulations to the Management of Navigational Dredged Material from the New York/New Jersey Harbor

by

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ABSTRACT

The New York/ New Jersey Harbor produces a large volume of navigational dredged material each year which contain pollutants that may cause adverse environmental impacts if mishandled. Previous options for managing navigational dredged material--such as disposal in the ocean or underground pits--have been largely foreclosed by the new federal and state laws or regulations.

On July 24, 1996, the United States Environmental Protection Agency (USEPA) announced the closure of the main ocean disposal site for New York/New Jersey Harbor contaminated dredged material. This off-shore location, known as the "Mud Dump Site" has been closed to dredged material disposal on September 1, 1997. After that date, only uncontaminated dredged material can be disposed of in this site.

Thus, other alternative methods to manage the dredged material in acceptable manners are to be explored. There are a number of approaches that can be used for the management of contaminated sediment from the NY/NJ harbor. Some of the disposal options include upland disposal in landfills, containment island, subaqueous borrow pits, quarries, mines etc., and

decontamination followed by beneficial reuse. This project was authorized and funded by Congress under the Water Resources Development Acts (WRDA) of 1992 and 1996. The goal is to demonstrate the feasibility of decontamination sediment from the NY/NJ harbor.

Consequently, the New York State Department of Environmental (NYSDEC) has taken initiative to promulgate appropriate guidance and regulations for the management of dredged material within the State. Currently, the Department is in the process of developing a guidance " *NYSDEC dredged material assessment and management guidance*" which will be the guidance for managing dredged material in an acceptable manner in New York State. Since this guidance is still in the draft form, other applicable guidance related to contaminated sediments and soil are discussed in this paper.

As a result of a combined effort by several Agencies and Departments to find an alternative management method(s), proposals were invited for an acceptable remedy. Seven treatability studies have been proposed in order to reduce the contaminants in the dredged material so that the resulting sediment can be used for unrestricted use or for beneficial uses. A variety of beneficial uses are proposed for the dredged material, for both raw and treated materials, and these may be approved by the New York State Department of Environmental Conservation (NYSDEC) on a case- by- case basis upon evaluation pursuant to Part 360 regulations. Landfill cover, aggregate, asphalt, and cement manufacturing are some of the proposed beneficial uses for the dredged material. Since the dredged material (both raw and treated) contain contaminants in excess of the existing NYSDEC guidance values, the proposed beneficial uses and disposal options are restricted and efforts should be focused either to improve decontamination or to find other alternate disposal options of the dredged material. In addition, the NYSDEC should promulgate adequate guidance in order to achieve proper management of dredged material within the State.

Chapter 1

INTRODUCTION

1.1 History and Background

The Port of New York and New Jersey handles about $55 billion in cargo annually. Commerce is dependent on Federal Navigation Channels, since ships need up to 45 feet of water. Harbor bay areas are naturally shallow(<20 feet) and sediment is continually transpired in by rivers. Constant dredging is needed to keep these channels open. Approximately 4,000,000 cubic meters of sediments need to be dredged each year. Historically, the dredged materials were disposed in the ocean. However, ocean disposal has been restricted due to greater regulatory restrictions on contaminant concentrations in the dredged sediments. The sediments normally contain elevated levels of metals, PCBs, chlorinated pesticides and herbicides, dioxins, and furans. If the dredging required to keep the Federal Navigation Channels open is to be continued, other ways of managing these sediments are needed.

Current proposals to solve the problem include continued ocean disposal of uncontaminated materials, use of confined disposal facilities, borrow pits, upland disposal and decontamination for contaminated materials. A combination of these may be the most viable alternative. Decontamination of the dredged material is attractive since it can be realized on a shorter time scale than some other alternatives. Further, it can reduce the magnitude of contamination and may provide a treated product with a beneficial reuse, thus simplifying disposal and possibly reducing the overall cost of treatment.

Based on the analysis of representative samples of the dredged materials, it was found that the raw sediment passed the Toxicity Characteristic Leaching Procedures(TCLP) tests and hence were acceptable for upland disposal as a non hazardous waste (Table 7-1). However, they contain elevated levels of metals, PCBs,

Table 1-1

Summary of contaminants in select New York-New Jersey Harbor Sediments (Stern, 1998, Chen 1994)

Contaminant	Newark Bay	Arthur Kill	Newtown Creek
2,3,7,8 TCDD (ppt)	130	39	9.9
OCDD (ppt)	5,494	3,016	15,369
TCDD/TCDF TEQ (ppt)	197	61	224
Total PCBs (ppm)[a]	0.92	1.16	2.86
Anthracene (ppb)	1,400	880	5,820
Benzo(a) anthracene	3,070	1,460	6,190
Chrysene (ppb)	3,100	1,630	6,050

Total PAHs (ppb)[a]	32,550	19,120	59,380
Total Herbicides and DDT (ppb)[a]	145	1,219	420
Arsenic (ppm)	9-17	17-25	5-33
Cadmium (ppm)	1-2	1.5-3	1-20
Chromium(ppm)	175	161	305
Copper (ppm)	105-131	178-304	61-770
Lead (ppm)	109-136	111-261	68-554
Mercury (ppm) total	2-3	2-4	1-3
Nickel (ppm)	33-40	20-60	12-140
Silver (ppm)	2-4	2-5	2-3
Zinc (ppm)	188-244	230-403	104-1,260

[a] National Oceanic Atmospheric Administration

chlorinated pesticides and herbicides and hence were not suitable for ocean disposal (Table 7-1). As an example, measurements of the concentrations of contaminants found in the Port of New York-New Jersey have been made in three locations: Newark Bay and Arthur Kill in New Jersey, and Newtown Creek, a small tributary of the East River between Brooklyn and Queens in the City of New York. The results of the measurements of the surface concentrations are shown in Table 1-1. When we compare these values with the Table 2-2 "Sediment screening parameters for Dredging, Riparian or In-Water Disposal"(Division of Water, 1994) it is clear that these dredged materials belong to category 3 material and hence in-water disposal is prohibited. Thus an alternate solution has to be established to manage the dredged material from the NY/NJ harbor. As part of this initiative, proposals to remediate this problem were invited. Out of several treatment/disposal methods submitted, seven proposals were selected for further evaluation by conducting bench scale and pilot scale studies.

The technologies investigated include several types of thermal destruction, solidification/stabilization, sediment washing, and chemical treatment and extraction methods. The treated sediment may be used in beneficial uses in landfill closure as barrier protection layer, grading fill or for daily cover of a landfill to name a few. The results of the abovementioned study will be interpreted in Chapters 4 through 7. This study is to find a suitable method for the management of the dredged material without having any adverse impact on the environment. Chapter 4 gives a summary of all seven treatment technologies selected for bench and pilot scale studies.

1.2 NYSDEC Regulations

For the past few years the New York State Department of Environmental Conservation (NYSDEC) has been in the process of developing regulations applicable to the dredging operations, which include excavation and disposal of the dredged material. In 1994, the *Division of Water* proposed an *Interim guidance for Freshwater Navigational Dredging*, which was intended for the dredging operations in general. This interim guidance has been used as the basis for all dredging activities in both freshwater and saltwater of the State. Chapter 2 explains the major elements of this guidance which includes classification of the dredged material in to categories A, B and C and their corresponding management options.

Meanwhile, in 1996, the *Division of Solid Waste* proposed certain revisions to 6NYCRR Part 360 regulations to include dredging operations under the Part 360 regulations. A new Subpart 360-18 has been proposed to regulate upland disposal, treatment, storage, and transfer of navigational dredged material. This new Subpart has allowed the dredged material to be used in certain beneficial uses (e.g. aggregate substitute in concrete or concrete products, aggregate for road base, construction backfill, alternative grading material, barrier protection layer in landfill etc.). For the purpose of this new subpart the dredged material has been

divided in to three types(type 1, type 2, and type 3) depending on its contaminant concentration. This classification is very similar to the classification in Interim Guidance for Freshwater Navigational Dredging categories A, B and C. The management of each type of dredged material is restricted based on the concentrations of the contaminants in that specific type. However, the Department recently abandoned this effort to revise the Part 360 regulations to include type 1, 2 and 3 categories of dredged materials due to lack of scientific evidence for characterization of the dredged material. Therefore, this proposed revision will not be discussed any further in this paper.

The *Division of Environmental Remediation* uses a *Technical and Administrative Guidance Manual (TAGM 4046)* that dictates the soil clean up levels for contaminated soils. This TAGM outlines recommended cleanup levels for soil and ground water for contaminated sites. This TAGM may be used if the dredged material is to be considered as a clean sediment and to be managed for any unrestricted use. A comparison study of both raw and treated sediment with the New York State cleanup objective is given in Chapter 6. When the raw or treated sediments meet these recommended levels, the soil will be considered clean and it can be used for unrestricted uses. Thus, the dredged material decontaminated to TAGM 4046 contaminant concentrations or less may be used or disposed as clean soil.

Also, NYSDEC has been reviewing specifications for fill materials specifically developed for the closure of Pennsylvania and Fountain Avenue Landfills located in Brooklyn, New York. The purpose is to set preliminary chemical and geotechnical specifications for grading fill (below the cap) and barrier protection layer (above the cap). These specifications were developed by New York City Department of Environmental Protection (DEP)'s consultant URS, and have not been approved by the DEC yet. Chapter 7 discusses whether the dredged material can be used as fill material in the landfill closure based on the assumption

that the above-mentioned specification will be approved .

Finally, the Division of Solid Waste is developing a guidance " *NYSDEC dredged material assessment and management guidance"* for the management of the dredged material in New York State. Currently, this guidance is in the preliminary draft form and is not available for public review. This guidance will be available in the near future and once finalized, will be used to regulate dredging activities which include transfer, storage, disposal and other beneficial uses.

1.3 Summary of Discussion

In Chapter 3, the requirements for beneficial use determinations are summarized. Dredged material may be used as a commodity to produce other products. A beneficial Use Determination (BUD) must be obtained from the New York State Department of Environmental Conservation (NYSDEC) for each use.

Chapter 4 discusses all treatability studies selected for the bench and pilot scale studies. This includes description of the process, raw materials used, equipment, and the resulting products and their properties.

Chapter 5 compares the dredged material with the Interim Guidance criteria. The Interim Guidance is offered by the Division of Water and is currently used by other programs as well.

In Chapter 6, a comparison of dredged material with the NYSDEC cleanup objectives has been provided. The clean up objective was promulgated by the Division of Environmental Remediation in their Technical and Administrative Guidance Memorandum(TAGM) 4046

In Chapter 7, a comparison of analysis results of both raw and treated sediments with the landfill closure specification criteria is given. The specification criteria have been developed for the Pennsylvania and Fountain Ave landfills in Brooklyn by the New York City consultant.

The management of dredged material in New York and New Jersey is briefly explained in Chapter 8. Dredged material from other states can be managed in New York provided the management meets the New York's regulatory requirements.

A discussion of all findings is provided in Chapter 9. This discussion will be based on the bench scale studies and the NYSDEC current regulations and guidance for the dredging activities.

Chapter 2

APPLICABLE NYSDEC REGULATIONS

This Chapter provides a summary of all the NYSDEC applicable guidance and regulations to carry out the dredging activities in New York State. Although there are several guidance available through different Divisions of the Department, there is no prescribed regulation to regulate the dredging activities which include treatment, storage, transfer and disposal of dredged materials in the State. The Division of Solid and Hazardous Materials is in the process of developing a new guidance "*NYSDEC dredged material assessment*,

management guidance" and currently is not available for public review.

2.1 Interim Guidance for Freshwater Navigational Dredging

The Division of Water in 1994 proposed an *"Interim Guidance for Freshwater Navigational Dredging"* (Division of water, 1994) to serve as a guidance for dredging activities. This guidance is a reasonable approach to both environmental protection and navigational maintenance. Although originally proposed for freshwater navigational dredging, it has been used for both freshwater and saltwater dredging operations and by the Division of Solid Waste as well.

This guidance limits the sediment screening parameters and parameter scans to nineteen, to require only one kind of test--total sediment analysis-- and to use it for determining the level of contamination and best management practices for the excavated dredged material. The thresholds for the dredged material differ from the cleanup standards used in Superfund and Resource Conservation and Recovery Act (RCRA) Subtitle C Corrective Action standards since the dredged material are generated in large quantities, contain diversified industrial pollutants, and the contaminants have a wide and complex range of biotic and abiotic effects. Although the guidance explains all the required steps in order for technical review of dredging projects, this section addresses only the parameters, evaluation of results, upland management of dredged materials.

2.1.1 Chemical Selection

For the development of this guidance, the Department focused on chemicals known to be both toxic and pervasive in the environment.

The first concern was impairment to aquatic and human health by in-place sediments. Yet, the Department found that the selected chemicals can often cause both aquatic and land disposal problems.

The original screen included all chemicals implicated in fish flesh consumption advisories in New York. This include: PCB, chlordane, DDT and its metabolites, mercury, dioxin, cadmium, and mirex.

The Department accepted all of these chemicals, save chlordane, as important to sediment evaluation. With minor exceptions, chlordane contaminated sediments are limited to several Long Island lakes. Chlordane was used to protect structures on Long Island sandy soils from termites.

Analysis and evaluation of copper, dioxin and mirex are recommended for those waters known or suspected to have sediment contamination by those chemicals. This determination is made at the discretion of regional staff.

Table 2-1

Summary of Analytical Information (Division of Water, 1994)

Parameter Sediment/soil	"A" No appreciable Contamination(ppm)*	Practical Quant. Limits(ug/g)**
Hg	<.1	0.02

Cd	<.6	0.5
Pb	<30	0.3
Cu	<16	2.5
DDT	<.005	0.0033
3 DDT + DDE + DDD	<.005	0.01
Dieldrin	<.003	0.0033
PCB	<.1	0.033
3 PAH	<1	5.6
Anthracene	<.1	0.33
Benzo(a)anthracene	<.04	0.33
Chrysene	<.4	0.33
2-Butanone(MEK)	<1	0.1
Trichloroethylene	<.1	0.005
3BTX	<.05	0.015
Benzene	<.014	0.005
Ammonia	<40	1.2
Mirex	<.002	0.016
Dioxin	<.0000045	0.000002

* ppm- parts per million

ug/g- Micrograms/gram

Of the chemicals listed above and selected for interim guidance, mercury and cadmium appear in the EPA toxicity guidance with most stringent regulatory levels. In the aquatic environment, the compound listed can bioaccumulate to substantial levels. Fish consumption is

the primary exposure path for humans and wildlife. Upland, leaching to groundwater or surface water- followed by possible human ingestion of contaminated water- is the pathway of concern. Other substances selected for testing are: BTX (the sum of benzene, toluene and xylene), Benzene, Lead, Copper, Dieldrin, Total Polycyclic Aromatic Hydrocarbons (PAH) and Toxic PAHs; PAHs (Anthracene, Benzanthracene, and chrysene), Ammonia, Trichloroethylene, and Methylethylketone (2-Butanone).

Table 2-1 shown above gives a summary of analytical information of the contaminants of concern in the dredged material. If the concentration of each parameter is less than the corresponding criterion in column 2, that indicates there is no appreciable contamination present in the dredged material. Third column gives the practical quantification limit to meet for each laboratory method used for analysis.

2.1.2 Evaluation of Results

For each contaminant, the Department established three classes of sediment quality thresholds, with associated dredging and disposal options or best management practices (Table 2-2)(Division of Water, 1994).

Class A- No Appreciable Contamination

If sediment chemistry is found to be at or below the chemical concentrations which define this class, dredging and disposal can generally proceed under multiple options with minimal restrictions.

Class B- Moderate Contamination

Dredging and disposal can be conducted within several restrictions. These restrictions can be applied considering site-specific concerns and knowledge, coupled with sediment evaluation.

Table 2-2

Sediment screening parameters for Dredging, Riparian or In-Water Disposal

(Division of Water, 1994)

parameter	class		
	A	B	C
Hg	<.1	.1 to 4	>4
Cd	<.6	.6 to 10	>10
Pb	<30	30 to 100	>100
Cu*	<16	16 to 110	>110
DDT,DDE,DDD	<.005	.005 to .6	>.6
Dieldrin	<.003	.003 to .044	>.015
Mirex*	<.002	.002 to 0.2	>.2
PCB (total)	<.1	.1 to 10	>10
2,3,7,8 TCDD* or sum of toxic equivalents	<.0000045	.0000045 to .00005	>.00005
PAH(total)	<1	1 to 35	>35
Anthracene	<.1	.1 to 1	>1
Benzo(a)anthracene	<.04	.04 to .22	>.22
Chrysene	<.4	.4 to 2.8	>2.8
BTX	<.05	.05 to 10	>10
Benzene	<.014	.014 to 10	>10
MEK	<1	1 to 100	>100
Trichloroethylene	<.1	.1 to 10	>10
Ammonia	<40	40 to 200	>200

Notes 1. Threshold values are in ppm

2. * indicates case specific parameter

3. Threshold values lower than minimum quantification level are superseded by quantification level

4. Class C sediments may require additional testing if not destined for a Part 373 site(Hazardous waste site)

Class C- High Contamination

Disposal requirements, particularly, can be stringent and require handling of the material as hazardous waste.

If one or more samples exceed Class A (no appreciable contamination) sediment screening thresholds, then sediments are presumptively to be managed as Class B (moderate contamination) material. However, judgement should be applied in interpreting the results. For example, failure of only one sample may be an anomaly. Failure of two or three samples within a reasonable range of statistical, analytical variability may also not warrant special attention.

If one or more samples exceed Class C (high contamination) thresholds for sediment screening, then Regional Hazardous Substance Regulation/ Hazardous Waste Remediation staff should be consulted to determine further site characterization needs and to assess disposal options, i.e., Part 373 site or other facility.

The Class A, B and C categories are explained in Table 2-2.

For special case of on-land management of navigational dredge material, this alternative sediment quality categories, placement categories 1 through 3, were developed. The following section explain these categories.

2.1.3 Upland Management of Dredged Material

This section discusses on-land management and provides placement options for navigational dredged material based upon the level of contamination (Division of Water, 1994). The dredged material is classified as Category 1, 2 and 3 based on the contaminants concentration (Table 2-3). These levels are derived specifically for on-land scenarios, where ground and surface water contamination are the prime concern. Thus the levels are not always equivalent to those of categories 1 through 3 for in water and riparian disposal.

Generally, navigational dredged material for upland management can be placed into one of three categories for management options. Dredged material that exhibits no appreciable contamination after extensive analysis of sediment screening parameters, total sulfur, priority pollutant metals and organic fit into category 1. They are deemed to be innocuous and, assuming its physical properties are appropriate, may be widely used for a variety of purposes. Category 2 includes moderately contaminated dredged material that may have some beneficial uses or can be land filled in Department-authorized facilities. Dredged material that are highly contaminated, and may be hazardous if they fail tests specified by federal and state law, fit into category 3 and require a high level of containment to prevent the release of contaminants to the environment.

Category 1, which encompasses clean dredged material with the lowest concentrations of contaminants, is equivalent to Class A, except that it requires enhanced testing and analysis (Table 2-3) to ensure that its sediments are sufficiently uncontaminated for any probable use. Since Category 1 includes materials which can be sold and will entirely drop out of the regulatory system, it is essential that the Department has adequate assurance that there are no other contaminants in the dredged material, such as priority-pollutant organic, which can be of

environmental or health concern.

Dredged materials in category 2 are too elevated in pollutants to be widely dispersed in the environment, but do not necessitate complete containment. This category, therefore, allows management of dredged material (Table 2-4) in settings which provide protection from direct exposure to humans and wildlife, and where ground or surface water contamination should not result. Category 3 dredged material, which are significantly contaminated and present the greatest possibility of contravening State ground and surface water standards, require containment in a lined landfill either as solid waste or used as daily cover.

When navigational dredged materials exhibit levels at the concentrations enclosed by parentheses in Table 2-3, category 3, they are presumed to be either characteristic hazardous wastes or to contain listed hazardous wastes and must be managed as hazardous wastes. Unless shown to be nonhazardous through appropriate investigation and testing (e.g. the TCLP analysis, EPA Method 1311), they are not to be used in any nonhazardous waste landfill except as provided for by the Department's hazardous waste regulations, 6NYCRR Parts 370 through 373-2.

Tables 2-3 and 2-4 identify the various categories of dredged material, special testing for Category 1 and, generally, management options available for each category.

In identifying Category 1, several sources were consulted to set the upper limits for metals concentrations. In general, this value was set at the level of average concentration reported for uncontaminated soils in the scientific literature. In the case of zinc, department test data justified higher values. Where the average soil background levels were higher than the recommended cleanup levels specified in *Technical and Administrative Guidance Memorandum (TAGM) 4046*, (Division of Environmental Remediation, 1994) the later value

was used. The TAGM's level were taken as definitive to ensure consistency between the requirements governing site cleanups and those which would allow placement of navigational dredged material on virgin sites. Background metals values higher than the TAGMs may, in thallium, where adequate

Table 2-3

Contaminants and thresholds for on-land management of sediments

(Division of Water, 1994)

Placement Category(D)	1 Unrestricted sale,use,placement or disposal(ppm)	2 Restricted use or disposal (A)(ppm)	3 Disposal in permitted, lined landfills (B)(ppm)
Hg	<.1	.1 to .5	>.5 (4)
Cd	<.6	.6 to 3.0	>3.0(20)
Pb	<30	30 to 100	>100
Cu	<16	16 to 110	>110
DDT,DDE,DDD	<.005	.005 to .025	>.025
Dieldrin	<.003	.003 to .015	>.015
Mirex	<.002	.002 to .01	>.01
PCB	<.1	.1 to 1.0(c)	>1.0 (50) (C)
2,3,7,8 TCDD or sum of toxic equivalents	<.0000045	.0000045 to .00005	>.00005
PAH(total)	<1	1 to 5	>5

Anthracene	<.1	.1 to 1	>1
Benzo(a)anthracene	<.04	.04 to .22	>.22
Chrysene	<.4	.4 to 2.8	>2.8
BTX	<.05	.05 to .25	>.25
Placement Category(D)	1 Unrestricted sale,use,placement or disposal(ppm)	2 Restricted use or disposal (A)(ppm)	3 Disposal in permitted, lined landfills (B)(ppm)
Benzene	<.014	.014 to .07	>.07(10)
MEK	<1.0	1.0 to 5.0	>5.0(4000)(F)
Trichloroethylene	<.1	.1 to .5	>.5(10)

Priority Pollutant (PP) metals as follow Sb As Be Cr Ni Se Ag Tl Zn	 <1.0 <5.0 <.16 <10.0 <13.0 <2.0 <1.0 <.08 <40.0	No additional testing unless required by the Department	
Placement Category(D)	1 Unrestricted sale,use,placement or disposal(ppm)	2 Restricted use or disposal (A)(ppm)	3 Disposal in permitted, lined landfills (B)(ppm)

Priority Pollutant (PP) Organic (40 CFR Part 136)	Total PP organic not to exceed 2.0 ppm; No individual organic to exceed 20 times its Class GA groundwater standard or guidance value in 6NYCRR Part 703 or 1.0 ppm, whichever is less.	No additional testing unless required by the Department(E)	
Total Sulfur	<0.5%	No additional testing unless required by the Department (E)	

Note A: Category 2 contaminant thresholds are set at a conservative default criterion of five times category 1 contaminants thresholds, except for lead and PCBs. For all sediment screening parameters, category 1 contaminant thresholds equal Class A thresholds.

Note B: Dredged material determined to be hazardous in accordance with 6 NYCRR Part 371 must be disposed of pursuant to New York State's Hazardous Waste regulations, 6NYCRR Parts 370 through 373-2. Dredged material with sediment screening parameter levels in parentheses- for example, mercury at 4 ppm- are presumed to be characteristic hazardous waste. Unless TCLP or

other authorized test reveals the Dredged material to be nonhazardous, then it must be managed in accordance with Parts 370 to 373-2.

Note C: Consistent with Division of Solid Waste TAGM SW-93-5003, dredged material containing up to 10 ppm PCBs may be received at any Department-authorized landfill. Dredged material with greater than 10 ppm PCBs must go to a permitted landfill or to one with an administrative order to upgrade that has leachate containment and collection capability. Dredged material with more than 50 ppm PCBs must be disposed of pursuant to 6 NYCRR Parts 370 through 373-2 and 15 U.S.C., Subsection 2601 et.seq.

Note D: Threshold values are in ppm. Threshold values lower than the minimum quantification level are superseded by quantification level.

Note E: the department may require testing of priority pollutant metals, organic, and total sulfur in addition to the 17 sediment screening parameters for certain beneficial uses.

Note F: Concentrations of MEK below the maximum threshold of 4000 ppm may still have to be managed at hazardous waste levels of contaminant if associated with listed waste.

Table 2-4

On-Land Placement options for Navigational Dredged Material

Category 1 Unrestricted Use, Placement or Disposal	Category 2 Restricted Use or disposal	Category 3 Disposal in Permitted, Lined Landfills(3)
No adverse human health or environmental impacts presumed unless otherwise inconsistent with federal or state law, onsite or off-site sale, use placement or disposal of material is unrestricted.	Potential for adverse human health or environmental impacts unless material is managed as recommended. Disposal of material is restricted to such purposes as: Substitute for conventional aggregate in asphalt, concrete or foundation subgrade (1) limited backfilling at a site known to be significantly more contaminated with Category 2 contaminants (1) daily cover at a 6NYCRR Part 360 "authorized" landfill with prior written approval by the Department (2); etc	Significant potential for adverse human health or environmental impacts unless material is managed as recommended. Unless otherwise inconsistent with federal or state law, on-site or off-site disposal in lined landfills with leachate containment and collection permitted pursuant to Part 360:

(1) This option only for dredged material with one part per million of PCBs or less. " Limited backfilling" means fill placement as described in *Part 360-1.15(b)(8)*.

(2) An authorized landfill has a Part 360 Permit or administrative or court order to operate.

(3) While some limited case specific beneficial uses of category 3 material may exist, disposal in lined landfills with efficient leachate containment and collection is the presumed placement option.

background data was absent for soils and sediment, a conservative value was derived by multiplying the thallium guidance value from TOGs 1.1.1 by 20, the dilution factor inherent in the TCLP extraction.

Dredged material determined to be hazardous in accordance with 6NYCRR Part 371 must be disposed of pursuant to New York State's Hazardous Waste regulations, 6NYCRR Part 370 through 372-2.

2.2 New York State Soil Clean Up Objective TAGM 4046

Division of Hazardous Waste Remediation uses a Technical and Administrative Guidance Memorandum (TAGM) 4046 (Division of Environmental Remediation, 1994) to provide basis and procedure to determine soil cleanup levels primarily at Superfund sites. This TAGM outlines recommended cleanup levels for soil and ground water, which are based on several scientific calculations. The following are some of the alternative bases used to determine soil clean up objectives:

(a) Human health based levels that correspond to excess lifetime cancer risks of one in a million for Class A and B carcinogens, or one in 100,000 for Class C carcinogens. These levels are contained in United State Environmental Protection Agency (USEPA)'s Health Effects Assessment Summary Tables (HEASTs) which are compiled and updated quarterly by the New York State Department of Environmental Conservation (NYSDEC)'s Division of Hazardous Substances Regulation;

(b) Human health based levels for systemic toxicant, calculated from Reference Doses (RfDs). RfDs are an estimate of the daily exposure an individual can experience without

appreciable risk of health effects during a lifetime.

(c) Environmental concentrations which are protective of groundwater/drinking water quality; based on promulgated or proposed New York State Standards;

(d) Background values for contaminants; and

(e) Detection limits.

A recommendation on the appropriate cleanup objective is based on the criterion that produces the most stringent cleanup level using a, b, and c for organic chemicals, and criteria a, b, and d for heavy metals. If criteria a and/or b are below criterion d for a contaminant, its background value should be used as the cleanup objective. However, cleanup objectives developed using this approach must be, at a minimum, above the method detection limit (MDL) and it is preferable to have the soil cleanup objectives above Contract Required Quantitation Limit (CRQL) as defined by NYSDEC.

Soil cleanup objectives are limited to the following maximum values. These values are consistent with approach promulgated by the States of Washington and Michigan.

1) Total VOCs # 10 ppm

2) Total Semi VOCS # 500 ppm

3) Individual Semi VOCs # 50 ppm

4) Total Pesticides # 10 ppm

Recommended soil cleanup objectives that have been calculated by the Department's Technology Section are presented in Table 2-5. These objectives are based on a soil organic carbon content of 1% and should be adjusted for the actual organic carbon content if it is known.

Table 2-5

Recommended Soil Cleanup Objectives (mg/kg or ppm)

(Division of Environmental Remediation, 1994)

Contaminant	CRQL*(ppm)	Rec. Soil cleanup objective(ppm)
VOCs		
Acetone	10	0.2
Benzene	5	0.06
Benzoic Acid	5	2.7
2-Butanone	10	0.3
Carbon Disulfide	5	2.7
Carbon tetrachloride	5	0.6
Chlorobenzene	5	1.7
Chloroethane	10	1.9
Chlorofrom	5	0.3
Dibromochloromethane	5	N/A
1,2-Dichlorobenzene	330	7.9
1,3-Dichlorobenzene	330	1.6
1,4-Dichlorobenzene	330	8.5
1,1 Dichloroethane	5	0.2
1,2 Dichloroethane	5	0.1
1,1 Dichloroethene	5	0.4
1,2 Dichloroethene(trans)	5	0.3
1,3-Dichloro propane	5	0.3
Ethylbenzene	5	5.5

Contaminant	CRQL*(ppm)	Rec. Soil cleanup objective(ppm)
113 Freon(1,1,2 Trichloro1,2,2 trifluoroethane)	5	6.0
Methylene Chloride	5	0.1
4-Methyl-2-Pentanone	10	1.0
Tetrachloroethene	5	1.4
1,1,1-Trichloroethane	5	0.8
1,1,2,2-tetrachloroethane	5	0.6
1,2,3-trichloropropane	5	0.4
1,2,4-trichlorobenzene	330	3.4
Toluene	5	1.5
Trichloroethene	5	0.7
Vinyl Chloride	10	0.2
Xylenes	-	1.2
SVOCs		
Acenaphthene	330	50.0
Acenaphthalene	330	41.0
Aniline	330	0.1
Anthracene	330	50.0
Benzo(a)anthracene	330	0.224 or MDL
Benzo(a)pyrene	330	0.061 or MDL
Benzo(b)flouranthene	330	1.1
Benzo(g,h,i)perylene	330	50.0

Benzo(k)flouranthene	330	1.1
Contaminant	CRQL*(ppm)	Rec. Soil cleanup objective(ppm)
Bis(2-ethylhexyl)phthalate	330	50.0
Butylbenzylphthalate	330	50.0
Chrysene	330	0.4
4-Chloroaniline	330	0.220 or MDL
4-chloro-3-methylphenol	330	0.240 or MDL
2-Chlorophenol	330	0.8
Dibenzofuran	330	6.2
Dibenzo(a,h)anthracene	330	0.014 or MDL
3,3'-Dichlorobenzidine	N/A	N/A
2,4-Dichlorophenol	330	0.4
2,4-Dinitrophenol	1,600	0.200 or MDL
2,6-Dinitrotluene	330	1.0
Diethylphthalate	330	7.1
Dimethylphthalate	330	2.0
Di-n-butylphthalate	330	8.1
Di-n-Octylphthalate	330	50.0
Flouranthene	330	50.0
Flourene	330	50.0
Hexachlorobenzene	330	0.41
Indeno(1,2,3-cd)pyrene	330	3.2
Isophorone	330	4.4
2-Methylnaphthalene	330	36.4

2-methylphenol	330	0.100 or MDL
4-Methylphenol	330	0.9
Naphthalene	330	13.0
Contaminant	CRQL*(ppm)	Rec. Soil cleanup objective(ppm)
Nitrobenzene	330	0.200 or MDL
2-Nitroaniline	1,600	0.430 or MDL
2-nitrophenol	330	0.330 or MDL
4-Nitrophenol	1,600	0.100 or MDL
3-nitroaniline	1,600	0.500 or MDL
Pentachlorophenol	1,600	1.0 or MDL
Phenanthrene	330	50.0
Phenol	330	0.03 or MDL
Pyrene	330	50.0
2,4,5 Trichlorophenol	330	0.1
Organic Pesticides/Herbicides and PCBs		
Aldrin	8	0.041
Alpha-BHC	8	0.11
Beta-BHC	8	0.2
Delta-BHC	8	0.3
Chlordane	80	0.54
2,4-D	800	0.5

4,4'-DDD	16	2.9
4,4'-DDE	16	2.1
4,4'-DDT	16	2.1
Contaminant	CRQL*(ppm)	Rec. Soil cleanup objective(ppm)
Dibenzo-p-dioxins(PCDD)2,3,7,8 TCDD	N/A	N/A
Dieldrin	16	0.044
Endosulfan I	16	0.9
Endosulfan II	16	0.9
Endosulfan Sulfate	16	1.0
Endrin	8	0.10
Endrin Ketone	N/A	N/A
gamma-BHC(Lindane)	8	0.06
Gamma Chlordane	80	0.54
Heptachlor	8	0.10
Heptachlor epoxide	8	0.02
Methoxychlor	80	***
Mitotane	N/A	N/A
Parathion	8	1.2
PCBs	160	1.0(surface) 10(subsurface)

Polychlorinated dibenzo furans(PCDF)	N/A	N/A
Silvex	330	0.7
2,4,5 T	330	1.9
Malathion	330	2.0
Dursban	330	15
Contaminant	CRQL*(ppm)	Rec. Soil cleanup objective(ppm)
Carbaryl	330	16
Metals		
Aluminum	2.0	SB
Antimony	0.6	SB
Arsenic	0.1	7.5 or SB
Barium	2.0	300 or SB
Beryllium	0.05	0.16(HEAST) or SB
Cadmium	0.05	1 or SB
Calcium	50.0	SB
Chromium	0.1	10 or SB
Cobalt	0.5	30 or SB
Copper	0.25	25 or SB
Cyanide	0.1	***
Iron	1.0	2,000 or SB
Lead	0.03	SB
Magnesium	50.0	SB

Manganese	0.15	SB
Mercury	0.002	0.1
Nickel	0.4	13 or SB
potassium	50.0	SB
Selenium	0.05	2 or SB
Silver	0.1	SB
Sodium	50.0	SB
Contaminant	CRQL*(ppm)	Rec. Soil cleanup objective(ppm)
Thallium	0.1	SB
Vanadium	0.5	150 or SB
Zinc	0.2	20 or SB

* CRQL - Contract Required Quantitation Limit

MDL- Method Detection Level

SB- Site Background

2.3 Landfill Closure Specifications

Specifications were developed for fill materials for the closure of two Brooklyn Landfills namely, Pennsylvania and Fountain Ave Landfills by a New York City Department of Environmental Protection (NYCDEP)'s consultant (Appendix A). These specifications are not approved by the NYSDEC yet. The specifications are for using the fill material for closure of landfills as grading fill, barrier protection layer or as off site borrow pits. The chemical and geotechnical specifications are analyzed more detail in Chapter 7, and compares the dredged material with those specifications.

Chapter 3

NYSDEC BENEFICIAL USE DETERMINATION CRITERIA

A Beneficial Use Determination (BUD) is a jurisdictional determination by New York State Department of Environmental Conservation (NYSDEC) that a material that would otherwise be a solid waste is no longer regulated as such, when it is suitably incorporated in to a product or a manufacturing process instead of virgin material or otherwise used in a beneficial manner that is not in the nature of disposal (Division of Solid Waste, 1996). Once the NYSDEC (Department) grants a BUD, the waste material ceases to be defined as a solid waste for regulatory purposes under 6 NYCRR Part 360 Solid Waste Regulations (Part 360). A generator or potential user of a solid waste that proposes a use of a solid waste material may petition the Department, in writing, for a jurisdictional determination that the solid waste under consideration in the petition may be beneficially used as proposed and, thus, should no longer be regulated as solid waste under Part 360. The NYSDEC determines on a case-by-case basis whether the proposal constitutes a beneficial use based on a showing that (1) the essential

nature of the proposed use of the material constitutes reuse rather than disposal (2) the proposal is consistent with the State's solid waste management policy, (3) the material under review will function or serve as an effective substitute for an analogous raw material or fuel, (4) for a material that is proposed for incorporation in to a manufacturing process, the material must not be required to be decontaminated or otherwise specially handled or processed before such incorporation in order to minimize loss of material or to provide adequate protection, as needed, of public health, safety, or welfare, the environment, or natural resources, and (5) whether a market is existing or is reasonably certain to be developed for the proposed use of the material under review or the product in to which the solid waste under review is proposed to be incorporated. This evaluation of the petition will include a review of the required elements outlined in subdivision Part 360-1.15(d) and an evaluation of whether the petition proposes a bonafide beneficial use.

3.1 Requirements for BUD Petitions

Dredged material can be used in a variety of engineered applications. However, each application will implicitly determine material specifications and necessary engineering controls. Sometimes, the physical or chemical properties of the dredged material will control where and how the material can be used; however, in other projects, additional considerations such as distance to groundwater, contaminant transport mechanisms, and/or slope stability may present unique project restrictions.

As mentioned earlier, a BUD should contain that information required by paragraph 360-1.15(d)(1) which states that "*the generator or proposed user of a solid waste may petition the department, in writing, for a determination that the solid waste under review in the petition may be beneficially used in a manufacturing process to make a product or*

as an effective substitute for a commercial product" and will be evaluated against the criteria in paragraph Part 360-1.15(d)(2), the essential elements of the criteria is listed below. For reuse of dredged materials, a BUD petition should include, but not be limited to the following sections.

3.1.1 Chemical and Physical Characterization

Subparagraph 360-1.15(d)(1)(ii) requires the petitioner to chemically and physically characterize materials and proposed products. This characterization allows potential materials and products to be evaluated against feed stocks, background soils, and minimum market standards and specifications. The chemical and physical characteristics will be evaluated to assess how the materials can be used, considering pathways of exposure, potential impacts to humans and/or the environment, and the stability of the material. With the dredged materials' physical properties and the potential contaminant pathways considered, engineering controls and location criteria can be developed to minimize all potential exposure scenarios.

3.1.2 Market Description

Subparagraph 360-1.15(d)(iii) requires petitioners to demonstrate that the proposed material will have a reasonable market for its proposed end use. Market studies should demonstrate that dredged materials proposed for beneficial use have positive market values and positive market demands.

Clause 360-1.15(d)(1)(iii)(c) further requires petitioners to demonstrate that the proposed products comply with industry and specifications. Applicants should classify products using the American Association of State Highway and Transportation Officials (AASHTO) soil classification system, the Public Roads Administration (PRA) Soil Classification System, or compare the product with New York State Department of

Transportation (NYSDOT) Materials Specifications (NYSDOT, 1990), an applicable American Society for Testing and Materials (ASTM) standard, or another practical, comparable, accepted industrial standard.

3.1.3 Effective Substitution

Beneficially used materials must demonstrate that they play a complimentary role to the manufactured product and can successfully replace a raw material. While certain activities such as dewatering are essential to prepare dredged material for reuse, only dredged material that can be used without further processing or decontamination will be considered to meet the effective substitute's criteria. This criterion is crucial as it established the point at which the Department determines dredged material to be beneficially used. This determination rests on whether the dredged material is commodity like; that is, does the dredged material have value as a raw material/product?

3.1.4 Decontamination and process modifications

Subparagraph 360-1.1.15(d)(2)(iv) requires that materials incorporated into manufacturing processes not be decontaminated or otherwise specially handled or processed before such incorporation. This requirement was promulgated to minimize the loss of material or to provide adequate protection, as needed, of public health, safety or welfare, the environment or natural resources.

If the contaminants in the waste material do not serve any purpose in the manufacturing process or the end product, or if the levels of contaminants exceed the levels of contaminants in the raw material intended to be replaced, the use of the waste material would also seem more like disposal rather than that of a proper substitution. Although the use of the material may be beneficial to the petitioner, the use would not be a proper one if the high levels of harmful

contaminants pose a potential harm to the public health or the environment. The Department will not grant a case specific BUD for feedstock materials where the contaminants requiring treatment are not necessary ingredients in the manufacturing of the proposed product and have no other useful purpose when added to the product. The Department will conclude that these manufacturing processes constitute a form of disposal and are subject to the permit requirements of Part 360. However, the product produced from the manufacturing process may qualify for a beneficial use based on a showing that the product can function as an effective substitute.

3.1.5 Contaminant Transport and Pathways of Exposure

All materials go through chemical reactions to attain a state of equilibrium with their environment. Contaminated waste materials are no different and tend to leach contaminants at rates depending upon which chemical and/or physical processes are dominant. The rate at which each contaminant can dissolve and migrate needs to be evaluated before considering the viability of any material in a potential BUD.

Exposure scenarios examine the processes by which a contaminant moves through the environment, the contaminant's ultimate fate, and how the contaminant can impact humans and wildlife. In general, the term "exposed" or "exposure" is used to describe how a contaminant can enter a receptor, be it human, wildlife, or microbial. The important ways through which receptors are exposed to contaminants include:

- ingestion of contaminated water;
- inhalation of contaminated bound to fugitive particles;
- inhalation of gaseous contaminants;
- direct dermal contact or direct consumption of contaminants; or

- ingestion of contaminants that have moved through the food chain.

To be exposed to a contaminant, a receptor has to contact an environmental media. Environmental mediae, be they soil, air, or water are typically referred to as pathways of exposure. Five distinct pathways of exposure exist for the exposure scenarios as following:

- groundwater pathway;
- surface water pathway;
- soil pathway;
- air or atmospheric pathway; and
- food chain pathway (bioaccumulation)

Through the development of a worst case scenario, engineers can design systems to account for all important exposure pathways and intrinsically design in safety factors that can mitigate the transport of contaminants.

A variety of exposure scenarios is presented in Table 3-1 which illustrates which pathways can impact human health and the environment. As can be seen from this table, not all exposure pathways are relevant to all of the presented beneficial use scenarios. Each scenario represents the worst case scenario and it is through an exploration of each scenario that extremely conservative results can be obtained.

Table 3-1

POTENTIAL EXPOSURE PATHWAYS FOR DREDGED MATERIALS						
Exposure Pathway	Exposure Beneficial Use Scenario					
	Raw Waste storage Pile	constructio n aggregate	Upland Habitat creation	Agronomic Application	road deicing/Tra ction Media	stabilized Backfill

Groundwater	x	x	x	x	x	x
surface water	x	x	x	x	x	x
Soil	x	x	x	x	x	x
Air	x	minimized	x	x	x	minimized
Dermal Contact bioaccumula-tion	x	minimized	x	x	minimized	minimized

3.1.6 Quality Control and Assurances

Each upland application for dredged material will have minimum mechanical, physical, and chemical criteria that will restrict the types, quality, and quantity of useable dredged material. Quality control and quality assurances need to be considered for each potential upland application to ensure the safety of the public and environment to satisfy clauses 360-1.15(d)(iii)(c) which states that a demonstration that the proposed product complies with industry standards and specifications for that product (e.g. ASTM /NYSDOT)and (d) which require that other documentation that a market for the proposed product or use exists.

Chapter 4

TREATABILITY STUDIES PERFORMED AS PER WATER RESOURCE DEVELOPMENT ACT OF 1992 AND 1996 AND BENEFICIAL USES

4.1 Treatability Studies

As described earlier, seven proposals to treat/dispose were selected for further evaluation by performing bench and pilot scale studies. These technologies include chemical and /or physical treatment. A summary of each study is described in this section.

4.1.1 Metcalf and Eddy

Metcalf and Eddy's bench scale test were to demonstrate the feasibility of decontaminating the dredged estuarine sediments to produce useful, recyclable end products and to optimize and to determine process information for the operation of a pilot plant and generate design information for operating and capital costs for large scale production plants

(Metcalf and Eddy, 1996). There are three sequential Integrated Sediment Decontamination technologies used:

1) HYDRO-SEP: a soil washing process to produce clean, larger-size fractions and reduce the quantity to be treated by downstream operations
2) ORG-X: a solvent extraction process to remove organic contaminants; the process uses three countercurrent solvent extraction stages
3) SOLFIX: a solidification/stabilization process for reducing the leaching properties for inorganic contaminants and for improving strength and erosion properties of the end products

The M&E process includes a pretreatment with water decanting, coarse scalping/screening with a special separator and the HYDRO-SEP process to separate the coarse from the fine fractions. Water washing using a trammel is sufficient to clean the gravels/sands for reuse as construction aggregates. If the gravels/sands cannot be cleaned of organics/metals using water, the oversize will require crushing for subsequent ISDS processing.

Based on the grain size data for the raw sediments, 25-50% of the total solids are made of gravel/sand fraction. The gravel fraction is very insignificant and the sand fraction is left in the sediments. This sand in the sediment will improve the organic extraction.

<u>ORG-X process</u>: A proprietary solvent is used to extract the organic contaminants (oils, PCBs, dioxin, pesticides etc.) which are strongly attached to the sediment. After several stages of extraction "organic free" sediment be produced. This organic free sediment may be partially dried to make a soil blend product to achieve an acceptable levels of metals or to proceed to the next SOLFIX process to fix the metals.

<u>The SOLFIX stabilization/solidification process</u>: In order to reduce leaching of heavy metals

(lead, cadmium, arsenic etc) the sediment is reacted with cement, pozzolanic materials and other special additives. The mix is "cured" wherein the heavy metals are chemically immobilized in to insoluble forms, as well as micro encapsulated in to a concrete like solid. The curing also binds free water in to a hydrated solid, and alters sediment properties by increasing compressive strength, increasing erosion resistance and reducing permeability. The inert end product can be returned to ocean as marine structure or can be crushed for beneficial uses as construction materials, fill, possibly road base, or landfill cover.

A comparison study of raw sediments and treated material is given as Table 7-1. The data given for the M&E treated material is for the ORG-X product. Once the material become solidified it is no longer be used in landfill closures. The ORG-X product is soil like and can be beneficially used.

4.1.2 Biosafe

Biosafe FBT process uses fluidized bed steam cracking to totally destroy any organic materials such as dioxins (Biosafe, 1996). It is a continuous process and the final product is a contaminant free solid product. A process flow diagram is shown in Figure 4-1. It uses two stages or fluid beds in series. The feed material is conveyed continuously in to the first fluidized bed using a commercially available transport device. The unit is indirectly heated that heats the processed material to a temperature in the range of 1200 to 1400 degrees Fahrenheit. The fluid bed is heated by tubes immersed in the bed of bubbling solids. Heat is supplied by burning a fuel such as natural gas and then passing the hot combustion gasses through the tubes immersed in the bed. Combustion gases do not come in to contact with the material being treated. The volatile organic materials in the feed have boiling points in the range of 180 to 1200^0F and volatilized (steam stripped). The organic vapor is then cracked at a temperature of

about 2200^0F in a second fluidized bed to yield carbon monoxide, hydrogen and methane. The hot gases exit the fluidized bed with the steam and vaporized water. The ash/inert are removed from the bottom of the fluidized bed and cooled with water to a temperature of 100^0F with a moisture content of around 3% to reduce dusting. Ash/inert could be used as a clean fill, concrete aggregate cover material, agricultural material or beach nourishment. The vapor from the outlet of the first fluidized bed (organic vapor, water and dust) enters a cyclonic separator where large particulate are collected. Following this separation, the hot gas passes though a baghouse/filter where small particulate less than one micron are collected. These collected solids are mixed with the ash/inert and disposed of. The gas then enters the second atmospheric fluid bed where they are "cracked" at about 2200^0F to yield the components of the LoBTU gas. The steam is also processed to remove any entrained solids, cooled and the water fraction condensed and collected. The organic portion which remains a vapor is the LoBTU gas (heating value ~ 400-500 Btu/scf) which can be recycled as fuel and burned along with natural gas in the combustion system which supplies heat to the tubes immersed in the fluidized bed.

The bench scale processed about 100 pounds of sediment in two test runs. Samples were collected and returned to BNL for analysis. The results demonstrate that in nearly all cases greater than 90% of the component is removed from the sediment. Table 7-1 shows the analysis results for this product.

There are still areas of concern for this process. A screw conveyor is not effective in transporting the material in to the bed since the unit could process sediment without dewatering the fluid bed. A progressive cavity pump can be used instead of a screw conveyor to feed the material. Nitrogen is used instead of steam as the fluidizing medium. Biosafe is working to use

steam as the fluidizing medium.

4.1.3 IT Corporation

The treatment includes a three stage process vs, dewatering the sediment, removing organic contaminants by thermal desorption, followed by cement based solidification/stabilization of thermally treated sediment (IT Corp, 1996). Two waste forms designed to meet different disposal options were investigated. The first waste form was a monolithic, high-strength block of treated material suitable for ocean disposal. The second waste form was a thermally treated, dry soil like material that was treated to reduce leachability of metals. This product is suitable for fill or road base construction.

The treatment train by IT as shown in figure 4-2 comprised of four primary unit operations.

1. Thermal drying of the dredged sediment
2. Thermal desorption to remove the organic contaminants from the dewatered sediment solids.
3. Treatment of the contaminants in the off-gas from the thermal desorber in the flameless thermal oxidizer. And
4. Stabilization of the thermally desorbed sediments to render the metals nonleachable and to produce a dry soil like waste form suitable for use as road or fill base construction.

It is a multistep operation that involves the drying of the sediments for 34 to 70 % solids in a direct contact rotary drier, followed by thermal treatment at 1032^0F in an indirectly fired calciner. This process includes treatment of all process residuals and destruction of desorbed organic contaminants in a thermatrix Flameless Oxidizer.

Sweep gas(nitrogen or inert gas) will be used to purge the organic from the tube in to

the calciner off gas treatment system, which will include a hot, ceramic fiber baghouse, to remove contaminated solids, and a thermatrix flameless oxidizer. Air will be added to the thermatrix unit to support oxidation of the organics.

The thermally treated sediment contains leachable cadmium, copper and zinc at levels that are below the TC criteria but too high for beneficial use. The stabilization process will reduce the metals leachability to acceptable levels be mixing the material with lime, fly ash and condensate from the rotary drier system. Based on the bench scale work 5 percent lime 10 percent fly ash will be required.

4.1.4 Biogenesis

This is a sediment washing process. The process includes treating the sediment with proprietary reagents SN2 and SN3 (Biogenesis, 1997, 1998). The sediment is mixed with the reagents in a pretreatment tank and agitated for about two hours. The mixing allow any inorganic contaminants to mobilize. The mixed slurry is then pumped in to a Collision Chamber. After two minutes, the slurry was returned to the slurry tank where some anti foaming agent were added. The cycle was repeated and was returned to the pretreatment tank for post treatment consisting of defoaming, dewatering and water treatment. The product is clean soil and clean sediment.

S-N2 makes a strong, complex hydrogen bond with organic petroleum based materials. The affinity of the chemical for halogenated organic material such as PCBs, dioxins etc is much greater than the sediment's affinity for such products. Because of the greater affinity of S-N2 to the contaminants than the soil, S-N2 is able to clean soil and sediments by "pulling" the organic materials out of the soil matrix.

The process diagram is shown in Figure 4-3. S-N3 is a complex organic acid which is

able to form very stable complexes with mono, di and trivalence cations. It is quite similar to the humate acidic substances which occur naturally to control heavy metal mobilization.

There are four end products from this process. Clean soil, clean sediment, inorganic contaminated wash water and organic contaminated wash water. The clean soil is from washing of oversized material(>6mm size). The clean sediment does not have any petroleum odor and have a pleasant, organic based odor and a dark, humate color. The oily, grey sheen present in the raw sediment is no longer present.

4.1.5 Institute of Gas Technology (IGT)

The technology used is a cement lock treatment to decontaminate the dredged sediment (IGT, 1995). Reagents such as Calcium Oxide, Alumina, Aluminum Oxide etc are added to the sediment. The reagents are blended and then placed in to a high temperature furnace. Organic contaminants are completely destroyed in this process. Inorganic contaminants are mobilized and the resultant solid residue from the treatment can be put to a beneficial use. The technology is capable of simultaneously handling the fixation of heavy metal and the destruction of PAHs and organo chlorines such as dioxins, furans, PCBs, Chlorinated pesticides and herbicides.

Cement-Lock is a thermo-chemical process(Figure 4-4) in which contaminated sediments are reacted in a submerged combustion melter with calcined limestone. The combustion melter can be operated at temperatures up to about 1650^0C, or temperatures sufficient to melt the sediment additive mixture. At this temperature organic contaminants originally present in the sediments are completely destroyed in the presence of oxygen and converted to carbon dioxide and water. Further, chlorine present in some of the organic compound (dioxins, furans, PCBs) is converted to Hydrogen Chloride(HCl) which can be

readily scrubbed from the flue gas by using solid media such as CaO or a liquid media such as water.

Heavy metals present in the dredged sediment are locked in to the cement matrix to completely immobilize them. The melt containing immobilized metals is rapidly quenched to prevent crystallization by being drawn in to fibers. The fibers are then easily pulverized and blended with an additives to yield cement as a byproduct for beneficial use in the construction industry. Mercury and arsenic, highly volatile heavy metals are removed from the off gas by amalgamating them with affinity metals distributed over a filter element.

The Cement -Lock process can be operated under reducing instead of oxidizing conditions, thereby eliminating the formation of aromatic hydrocarbons, such as dioxins and furans.

4.1.6 Marcor

Marcor uses a proprietary treatment technology to decontaminate the dredged sediment (Marcor, 1996). The treatment is a chemical stabilization technology known as Advanced Chemical Treatment (ACT) designed to treat organic and inorganic contaminants in a single application process. The process consists of adding ACT reagent with water to the sediment and blend the mixture. The mixture is then allow to cure for several days. The bench scale testing performed used both seven day and thirty day cure products.

Figure 4-5 is a schematic of the treatment process and the components of the system. The dredged sediment will be transferred to a dewatering filter container. Decanted water will be temporarily stored on site pending sampling/ characterization. The dewatered sediment is thoroughly mixed with a slurry mixture of the ACT reagent and placed in a lined roll off container for curing. The only side stream generated from the ACT treatment process is the water decanted from the sediment. This water may be treated on site or discharged in to a

POTW with proper permits. The treated sediment may be cured for any fixed number of days, for example, 7 days, 15 days or 30 days.

4.1.7 Westinghouse Plasma Vitrification Process

This process is a vitrification process in a plasma melter (Westinghouse, 1996). The sediment is melted in a plasma melter using glass former to produce a target glass product. The molten glass can be generated to produce a glass aggregate or directly fed to glass manufacturing equipment to produce a salable commercial glass product. In the plasma melter, all organic are dissociated in to elemental species which form clean gases that meet environmental release standards. Hazardous metals are incorporated in the product glass where they are environmentally benign. The system is designed to minimize all process residuals and ensure that they are environmentally sound. A pretreatment of the sediment is desired to optimize the treatment technology and control of the quality of glass product.

Figure 4-6 shows basic operation of the integrated plasma vitrification process. The central engine of the pretreatment train is the plasma melter. The other major component of the treatment train (ie. Sediment pretreatment, glass manufacture, and waste stream processing) need to be designed in synergy with the plasma melter in order to provide a cost effective solution that minimizes the production of any waste from the integrated plasma vitrification system.

The as dredged sediment will be initially screened to remove large particles with minimal contamination, rinsed and partially dewatered to improve process economics and then vitrified in the plasma melter to destroy the hazardous organics, and convert the contaminated fines to a low leachability glass product suitable for reuse for construction aggregate, roofing granules, or glass fiber insulation material. Process off gas are treated with lime desulfurization and wet scrubbing to remove contaminants before discharge. The major operation in the integrated system are "sediment size segregation". The as Dredged sediment will be screened to

remove large particles and debris. The oversized material, about 1-3% of the feed is stored for batch vitrification in to a low quality glass or slag. This material is normally oil coated. The remaining sediment is processed as follows.

Salt rinsing and dewatering:

Although the plasma melter could accept the sediment as is, process economics improve by desalinating and dewatering the sediment. This technique will be implemented in further study by Westinghouse Plasma vitrification.

Plasma Vitrification:

The dewatered sediment is injected in to the plasma melter along with glassformers, to produce a molten glass stream and off-gas.

Glass product Manufacture:

The molten glass is feed directly in to a glass manufacturing system or quenched to produce a simple glass aggregate.

Glass Cleaning:

The gases are cleaned to remove entrained particulate, sulfur and some trace metals that are too volatile to be captured in the molten glass. Clean gases are released to the atmosphere.

Scrubber water Treatment:

Water from the gas cleaning system is treated by commercial process such as ion exchange to remove any metals before discharge. Mercury is the primary metal expected in the scrubber water.

Oversize Material Processing:

Oversized materials and debris from the feed sediment screening step can be vitrified to

produce a low grade glass or slag. To obtain the most controllable glass products it is better not feed oversized material with the bulk sediment.

Rinse water Treatment:

Rinse water from the feed sediment desalination and dewatering step is not expected to require any treatment. If treatment is required to remove suspended solids or any organics, the steps will be defined after the pilot study.

The process raw materials are soda ash and lime, along with the feed sediment to make commercial glass product.

All these treatment technologies are somewhat succeeded to decontaminate the sediment. However, most technologies failed to produce a product acceptable to dispose in a monofill. Each technology has its own merit and disadvantages. The raw sediment itself cannot be disposed in a monofill or be used for a beneficial use such as grading fill in a landfill closure.

4. 2 BUD Alternatives for Dredged Materials

At present the Division of Solid Waste is using the Interim Guidance standards for regulating the dredged material (Division of Water, 1994). As per those standards the material is divided in to three classes (Class A, B and C) depending on its characteristics as explained in Chapter 2. For Class A and B dredged material there are many options for beneficial use, however, for Class C material, the options are restricted. The following are certain predetermined BUDs for the navigational dredged material for Class A and B material.

- aggregate substitute in concrete or concrete products
- aggregate for road base, subbase, or other pavement structures
- raw feed in manufacture of cement
- structural fill in building foundations and construction backfill (when placed above seasonal high ground water table)

- alternative grading material, barrier protection material, or topsoil in landfill closure projects
- alternative daily cover at an approved landfill (This applies to Class C dredged material as well)

Some of this and other beneficial uses are discussed below. Any BUD that is not predetermined is available on a case-specific basis as provided for in existing section 360-1.15(d).

4.2.1 Aggregates

There are two types of aggregates, fine and coarse, depending on the particle size and other properties of the material. The properties in determining the aggregate includes but not limited to, magnesium sulfate content, organic plate property, maximum percent loss by weight after a certain number of weeks, etc. The specifications are discussed in the NYSDOT *Standard Specifications Construction and Materials* guidance manual. Dredged material may be used to produce these aggregates by first dewatering and then by treating the sediments appropriately. These aggregates may be used as construction material with the cement. A brief description about the two types are given below.

4.2.1.1 Fine Aggregate

Fine aggregate consists of natural or manufactured sand. All fine aggregate consists of hard, strong, durable particles which are free from a coating or any uniform material and injurious amount of clay, loam or other deleterious substances. In addition, it should not contain substances, when mixed in Portland cement concrete, produce an unacceptable level of chloride ions in the final product. Hence salt content should be removed for the aggregate preparation. Also the fine cohesive fraction is not acceptable and therefore must be removed using an appropriate separation method. Fine aggregate from more than one source may be blended. The fine aggregate must also meet the DOT requirements to be used in the New York State

construction projects(*NYSDOT, 1990).*

Acceptance of the source is determined on the basis of tests performed by the Materials Bureau on samples representing the sources, review of Geologic Source Reports and Plant Flow information, petrographic information and other geologic studies, and performance histories where applicable.

4.2.1.2 Coarse Aggregate

Coarse aggregate shall consists of crushed stone, crushed gravel, screened gravel or crushed air cooled blast furnace slag, conforming to the requirements of the specifications. The material must meet the specifications for the coarse aggregate as per the *Standard Specifications Construction and Materials (NYSDOT, 1990)*

Acceptance of sources is determined on the basis of tests performed by the Materials Bureau on samples representing the source, review of quarry reports, geologic source reports and plant flow information, petrographic examination and other geologic studies and performance history where applicable.

Dredged material may be used as aggregates if it meets the specifications required by the *Standard Specifications Construction and Materials (NYSDOT, 1990).* Raw sediment may not meet the requirements for the aggregate preparation. Some treatment may be needed to produce aggregate meeting the specifications for construction purposes. Bench scale studies showed that some treatment can produce aggregates meeting the DOT specifications. Even if the treatment fails to produce sediment meeting the specifications, a BUD may be made on a case by case basis to be used as an aggregate. Biogenesis is one of the candidate for aggregate manufacturing since it meets the Class A and B criteria for most of the parameters. More studies are needed to carry out to see whether the treated materials meet the above mentioned specifications.

4.2.2 Asphalt Manufacturing

Although there is no predetermined BUD made for the asphalt manufacturing, navigational dredged material may qualify for this beneficial use determination. First, the material should be dewatered or otherwise treated to reduce the salt content to an acceptable level. The manufactured asphalt must meet the specifications in accordance with the *New York State Department of Transportation. Standard Specifications; Construction and Materials.* The product asphalt has to meet the required physical properties including, but are not limited to viscocity, flash point etc. A BUD may be easy to obtain if the material is a Class A or B as described in Section 1. However, if the material is Class C, a beneficial use determination may be made on a case by case basis.

There are different types of asphalt mix available for different uses. A specific composition is needed for a specific use. There is asphalt cement for paving and miscellaneous asphalt cement. The asphalt cement shall be homogeneous, free from water and shall not foam when heated to 347^0F. All NYSDOT specifications must be met for the material.

The asphalt manufactured from the dredged material should meet the specification criteria provided in the *NYSDOT Standard Specifications construction and Materials*. An air permit may be required for the emissions from the asphalt manufacturing process as per USEPA's 40 CFR Part 60.90. Emissions from the asphalt plant may not contain particulate matter in excess of 90 mg/dscm (0.04gr/dscf). Also, the emissions should not exhibit an opacity of 20% or greater. In addition emissions of VOCs and other hazardous air pollutants may be regulated as well. Also depending on the BUD determination a solid waste management unit/transfer station permit may be required form the Division of Solid Waste. A Beneficial Use Determination may be made on this by submitting an application to the New York State Department of Environmental Conservation (NYSDEC), Beneficial Use Determination Section of the Solid Waste Division (*Appendix C*).

4.2.3 Cement Manufacturing

Navigational dredged material may be used to produce cement by treating the sediment to decontaminate and to obtain specific properties of the cement. Institute of Gas Technology evaluated the sediment for producing pozzolan by melting, to partially replace Portland cement for construction purpose (IGT, 1995). A number of formulations were designed and melted. In one formulation 80% of the sediment and 20% of other additives were required to generate a pozzolan of adequate reactivity. It also produced cement with compressive strengths comparable to that of ASTM C 595 specifications. With 40% Portland cement replaced with pozzolan in the blended cement, it generated 3 and 7 day compressive strengths comparable to those identified for general purpose concrete, and exceeded the levels required for moderate early strength concrete.

This technique also helps lock the heavy metals to immobilize them. The melt containing immobilized metals is rapidly quenched and to prevent crystallization, drawn into fibers. The fibers are then easily pulverized and blended with an additive to yield cement as a by product. According to the Institute of Gas Technology, this technology has the following advantages.

- It destroys harmful organic contaminants in the sediment and immobilizes the inorganic contaminants present in the sediments.
- A valuable by product can be produced
- The technology will help defray the costs of sediment clean up whereby the resources could be deployed elsewhere.
- No harmful pollutants will be discharged
- The final product is also safe environmentally
- The technology offers superior destruction of the organic contaminants than any known incineration technology.

The resultant cement should meet the specification prescribed for the cement for respective uses. Although IGT's product is not "Portland" cement, it produces cement comparable in properties to Portland cement. As per NYSDOT's *Standard Specifications, Construction Materials (NYSDOT,1990)*, the following are different types of Portland cement.

Type 1- For use in general concrete construction where low heat of hydration is not required and where no sulfate action is anticipated.

Type 2- For use in general concrete construction

Type 3- For use when high early strength is required

Type 5- For use when high sulfate resistance is required

Type 6- For use in white concrete or white mortar

Portland cement Types 1,2,3 and 5 shall conform to the chemical and physical requirements of those respective types as contained in ASTM C 150 Portland Cement. Type 6 should conform to the requirements of ASTM C150 Type 1 except that the color shall be white. For all types, any cement possessing an alkali content in excess of 0.7% may be either accepted, rejected or have use limitations imposed as directed by the Materials Bureau.

Normally, for the purpose of rigid pavement in New York State, Type 1 and type 2 are acceptable. In addition the concrete mixture also should meet certain specification requirements of the State DOT Materials Bureau.

4.2.4 Glass Aggregates

The Westinghouse vitrification process produces glass aggregates which can be used in the manufacture of glasses of different varieties (Westinghouse, 1996). Although the market is unknown at this time for the manufactured glass, Westinghouse is confident their product will have a good market. This will definitely depend on the quality of the glasses produced.

4.2.5 Manufactured Soil

Another proposal is using a mixture of 30% dredged material with compost and manure to sell as a product (Biogenesis, 1997). This may be used as a plant soil, or landfill cover or other uses. If the mixture meets the specification for the intended use, it may be used for that particular use. For example using the mixture as a landfill cover is acceptable if the mixture meets the Class A or B criteria and the landfill is operated according to the 360-2 regulations (or Municipal Solid Waste landfill). If the mixture meets the Class A criteria, it may be used as a

landfill cover for other solid waste landfill as well.

4.2.6 Beach Nourishment

Dredged material can be used in coast protection (Burt T N, 1996). This can be achieved by direct replacement of eroded beach material, or developing a new coast line with addition of proper dredged material. Beaches may be recharged with appropriate grade dredged material. One of the basic characteristic to use dredged material in beach nourishment is its grading. Generally recharge material should be at least as coarse as the existing beach material. The material should also be clean and non toxic. Also the material must be reliable and consistent. No specification is available by the NYSDEC for the use of dredged material in beach nourishment. However, a Class A material is a candidate for this purpose. A beneficial use determination may be required in order to use any other type of dredged materials.

4.2.7 Artificial Reefs

This can be made from the dredged material by appropriate treatment. Normally high temperature treatment and producing a pozzolan material can form reefs with adequate strength and stability. High temperature treatment removes all the organics and even some heavy metals as well. The remaining heavy metals can be encapsulated using a solidification/stabilization process. The final product may be used as artificial reef. One of the concerns regarding the removal of contaminants is the presence of leachable metals. If a TCLP test verify that acceptable levels of metals and other contaminants are present, it can be used for artificial reef. A case by case beneficial use determination is required for the use of artificial reef. This is considered as a viable beneficial use for the dredged material and more research is needed in this topic.

Chapter 5

COMPARISON WITH INTERIM GUIDANCE- DIVISION OF WATER

Chapter 2 discussed the Interim Guidance for Freshwater Navigational Dredging and classification of the dredged material based on the contaminants and their concentrations. For each contaminant the NYSDEC established three classes of sediment quality threshold, with associated dredging and disposal options or best management practices. Table 5-1 shows a comparison of the raw and treated sediments with the Interim Guidance parameters for dredging, riparian and In-water disposal. The Class A category is the most stringent and neither raw or treated sediment meet this criteria. Heavy metals are the primary contaminant of concern for the treated sediment. Out of all the seven treated samples, Biogenesis has the least number of exceedances with three contaminants namely PCBs, beryllium, and thallium. All other sediments belong to Class C category with a number of contaminants.

In addition to the above categories, there is an alternative sediment quality categories

for the purpose of on-land management of navigational dredge materials. These are also discussed in Chapter 2 and are divided in to categories 1, 2, and 3. In this chapter we will compare the raw and treated sediments with the Interim guidance standards under this categories for the purpose of on-land management. Table 5-2 gives a summary of the findings.

The category 1 criteria is the most stringent of all classes and both raw and treated sediment fail to meet this criteria. Of all the parameters, metals seem to be present in high concentrations in the sediments. Biogenesis is the only treated sample with only 3 elevated concentrations (PCBs, beryllium and thallium). All other treated samples failed for several parameters, mostly metals, to meet the Category 3 criteria. Sediments meeting the Category 3 criteria will be subject to restricted use or disposal.

5.1 Dredged Material as Landfill Cover- Category 1, 2 and 3 Criteria

5.1.1 Raw Sediment- Landfill without Treatment

As per the proposed Interim guidance regulations for the management of navigational dredged material, the dredged material from the NY/NJ harbor meets the criteria of Category 3 navigational dredged material. Metals such as mercury, cadmium, lead and copper are found in higher levels than the category 3 criteria. Shaded boxes in table 5-2 indicate that the concentration exceed the category 3 criteria. It also exceeds the category 3 levels for DDE, DDD and Dieldrin. Anthracene, benzo anthracene and chrysene are also present in higher concentration than the respective category 3 criterion.

Thus, in order to dispose the dredged material (whether it is category 2 or 3) in a landfill, it has to be authorized to operate pursuant to 360-2 or a monofill used solely for the purpose of disposing of navigational dredged material with double liner system.

5.1.2 Treated Sediment-Landfill

All treated sediments fall in to placement category 3. A higher concentration of PCB (2.9 ppm) makes the Biogenesis treated sediment to become a category 3 material. Whereas a higher concentration of cadmium (22.5 ppm) makes the Biosafe treated sediment to

become a category 3. These sediments would have otherwise qualify for category 2 sediments. For other treated sediments, however, there are more than one contaminant that is present in elevated concentration to make them category 3 sediments. Westinghouse sample has 4.4 ppm cadmium and 166 ppm copper (category 3 limits 3 and 160 ppm respectively). IGT treated sediment was not analyzed for VOCs, SVOCs, organic pesticides, PCBs, and heavy metals. Hence it is impossible to determine whether the IGT treated sediment meets category 1 criteria.

Hence all treated material meet the category 3 criteria and hence can be disposed in a monofill or landfill authorized to operate pursuant to 360-2.

5.1.3 Treated Sediment-landfill Cover:

If the material meets the category 1 material, it can be used as landfill cover. If the NYSDEC is using the criteria developed for the two Brooklyn landfills as described in Section 3 (*Appendix A*), then the material has to meet those specifications instead. The raw or treated sediments have not met the criteria and thus cannot be used as landfill cover unless further treatment is performed to meet those specifications.

5.1.4 Conclusion

Table 5-1 indicates that except the Biogenesis treated material all other treated and raw dredged material belong to Class C. Biogenesis, however, with only a few elevated contaminant concentration is a Class B material. From Table 5-2, we can see that the raw sediment belongs to category 3 material and cannot be disposed of in a landfill. Shaded boxes indicate that the concentration exceed category 3 criteria. However, it can be disposed of in a monofill or in a landfill authorized to operate under 360-2. When a sediment is determined to be a category 3 material, further determination should be made for its hazardous characteristics. If it is determined to be a hazardous waste as defined by 6 NYCRR Part 371, it has to be managed as a hazardous waste instead. The

treated sediment also belong to category 3 material and hence, the disposal option is similar to that of the raw sediment. A case-by-case beneficial use determination may be made by the NYSDEC if a treated sediment is to be considered for a specific beneficial use. Further discussion regarding the beneficial use determination is given in Chapter 3.

Table 5-1

Comparison of Raw and Treated Sediments with Interim Guidance Parameters for dredging, Riparian or In-water Disposal**

Parameter	Dredging Class*			Raw	M&E	Biosafe	Westing house	Marcor	Biogensis	IT Corp	IGT
	A	B	C								
Hg	0.1	.1 to 4	>4	1.29	3.06	0.04	0.07	1.5	0.103	0.086	ND
Cd	0.6	.6 to 10	>10	37	36.25	22.5	4.4	19	0.437	12.8	ND
Pb	30	30 to 100	>100	617	628	0.8	93.5	300	9.69	203	ND
Cu	16	16 to 110	>110	1171	1180	22.6	166	540	12.1	408	ND
DDD	0.005	.005 to .6	>.6	0.162	0.00918	0.0033	0.0033	0.11	ND	0.0068	ND
DDE	0.005	.005 to .6	>.6	0.15	0.0035	0.0033	0.0033	0.11	ND	0.0068	ND
DDT	0.005	.005 to .6	>.6	0.0289	0.0035	0.0033	0.0033	0.11	ND	0.0068	ND
Dieldrin	0.003	.003 to .044	>.044	0.0745	0.0035	0.0033	0.0033	0.11	ND	0.0068	ND
Mirex	0.00 2	.002 to .2	0.003	ND	ND	ND	ND	ND	ND	ND	ND
PCB	0.1	1 to 10	>10	5.25	0.57	0.0008	0.0013	4.73	2.9	0.00068	ND
2,3,7,8TCDD	0	0.00005	>.00005	ND	ND	ND	ND	ND	ND	ND	ND
PAH(total)	1	1 to 35	>35	ND	ND	ND	ND	ND	ND	ND	ND

ND- Not Determined *- Dredge material category according to Interim Guidance A- No appreciable contamination B- Moderate Contamination
C- High Contamination All Concentration are in ppm

Anthracene	0.1	.1 to 1	>1	3.7	1.1	0.0098	0.0452	1.1	0.034	0.0345	ND
Benzo(a)anthracene	0.04	0.04 to 0.22	>.22	4.48	1.31	0.0083	0.0203	1.6	0.044	0.0256	ND
Chrysene	0.4	.4 to 2.8	>2.8	4.56	1.886	0.009	0.0232	1.8	0.0479	0.0282	ND
BTEX	0.05	.05 to 10	>10	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	0.014	0.014 to 10	>10	ND	ND	ND	ND	0.024	ND	ND	ND
MEK	1	1 to 100	>100	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethylene	0.1	0.1 to 10	>10	ND	ND	ND	ND	ND	ND	ND	ND
	Dredging Class*										
Parameter	A	B	C	Raw	M&E	Biosafe	Westing house	Marcor	Biogensis	IT Corp	IGT
Ammonia	<40	40 to 200	>200	ND	ND	ND	ND	ND	ND	ND	ND
Category				C	C	C	C	C	B	C	ND

** data obtained from

Metcalf and Eddy, 1996

Biosafe, 1996

Westinghouse 1996

Marcor, 1996

Biogenesis, 1997

IT Corp, 1996

IGT, 1995

ND- Not Determined *- Dredge material category according to Interim Guidance A- No appreciable contamination B- Moderate Contamination
C- High Contamination All Concentration are in ppm

Table 5-2

Comparison of Raw and Treated Sediments with Interim Guidance Thresholds for On-land Management

Parameter	Placement Category*			Raw	M&E	Biosafe	Westing house	Marcor	Biog
	1	2	3						
Hg	0.1	0.5	>.5	1.29	3.06	0.04	0.07	1.5	0.10
Cd	0.6	3	>3	37	36.25	22.5	4.4	19	0.43
Pb	30	100	>100	617	628	0.8	93.5	300	9.69
Cu	16	110	>110	1171	1180	22.6	166	540	12.1
DDD	0.005	0.025	>.025	0.162	0.00918	0.0033	0.0033	0.11	ND
DDE	0.005	0.025	>.025	0.15	0.0035	0.0033	0.0033	0.11	ND
DDT	0.005	0.025	>.025	0.0289	0.0035	0.0033	0.0033	0.11	ND
Dieldrin	0.003	0.015	>.015	0.0745	0.0035	0.0033	0.0033	0.11	ND
Mirex	0.002	0.01	>.01	ND	ND	ND	ND	ND	ND
PCB	0.1	1	>1	5.25	0.57	0.0008	0.0013	4.73	2.9
2,3,7,8TCDD	0.0000045	0.00005	>.00005	ND	ND	ND	ND	ND	ND
PAH(total)	1	5	>5	ND	ND	ND	ND	ND	ND
Anthracene	0.1	1	>1	3.7	1.1	0.0098	0.0452	1.1	0.03
Benzo(a)anthracene	0.04	0.22	>.22	4.48	1.31	0.0083	0.0203	1.6	0.04
Chrysene	0.4	2.8	>2.8	4.56	1.886	0.009	0.0232	1.8	0.04
BTX	0.05	0.25	>.25	ND	ND	ND	ND	ND	ND
Benzene	0.014	0.07	>.07	ND	ND	ND	ND	0.024	ND
MEK	1	5	>5	ND	ND	ND	ND	ND	ND
Trichloroethylene	0.1	0.5	>.5	ND	ND	ND	ND	ND	ND
Sb	1			10.3	7.7	0.8	1.35	0.37	0.96
As	5			33.5	ND	1.9	5.18	0.38	3.01
Parameter	Placement Category*			Raw	M&E	Biosafe	Westing house	Marcor	Biog
	1	2	3						
Be	0.16			0.56	0.19	0.2	0.18	0.23	0.24
Cr	10			376	385	55	74	180	8.43
Ni	13			297	289	27	50	140	7.91

ND- Not Determined *- Placement category according to Interim Guidance 1- Unrestricted use, placement, or disposal 2- Restricted Use or Disposal
3- Disposal in Permitted, Lined Landfill All concentrations are in ppm

Se	2			3.24	2.72	1	0.89	0.14	0.72
Ag	1			18.4	ND	0.9	2.47	8.1	0.24
Tl	0.08			2.77	1.85	1	0.89	0.36	1.2
Zn	40			1725	1705	92.1	333	1300	41.3
sulfur	0.50%			ND	ND	ND	ND	ND	ND
Category				3	3	3	3	3	3

Chapter 6

COMPARISON OF DREDGED MATERIAL WITH NYSDEC CLEANUP OBJECTIVES

As discussed earlier in Chapter 1, the New York State Department of Environmental Conservation (NYSDEC) has promulgated clean up objectives for contaminated soil to protect the environment from contaminated sites. This clean up objective is detailed in Technical And Guidance Memorandum (TAGM) 4046 and has been described in Chapter 2 (Division of

Environmental Remediation, 1994). In this chapter we will compare this objective with the raw and treated sediments to find out whether either raw or treated sediment meet the specified criteria. Once the sediment meets the criteria, it will be considered as clean and may be used for unrestricted use such as placement of dredged material on virgin sites. Table 6-1 will give a summary of the comparison of both raw and treated sediments with the cleanup objective referred as per TAGM 4046.

As we can see in Table 6-1, many of the Volatile Organic Compounds (VOC)s were Not Determined (ND) for any of the raw or treated sediment. However, Marcor sample was analyzed for most of the VOCs. IGT sample was not analyzed for any of the parameters and therefore will not be discussed for comparison purpose. Raw sediment contains a few Semi-Volatile Organic Compounds (SVOC)s in high concentrations and will not meet the cleanup objective. M &E and Marcor samples also failed to meet the objective for a limited SVOCs as well (shaded boxes). Biosafe, Westinghouse, Biogenesis and IT Corp samples meet the soil cleanup criteria for all the parameters analyzed, although Biogenesis sample was not analyzed for all the SVOCs listed in the TAGM 4046. PCBs were detected in high concentration in Raw, Marcor and Biogenesis samples. All other treated samples have PCBs below the cleanup objective. Metals are to be compared with the Site Background (SB) concentration or a specified concentration, whichever is higher. Site background is the concentration of the metal found near a specific site to be remediated. Metals such as chromium and zinc were present in high concentrations in both raw and treated samples. All elevated concentrations are indicated by shaded boxes.

Table 6-1 gives a comparison of the bench scale result with the TAGM 4046 guidance values. As we can see, none of the raw or treated samples meet the clean soil criteria defined by the TAGM 4046. The shaded boxes indicate that the concentration is above that of the threshold values.

Table 6-1

NYSDEC

Recommended Soil Cleanup Objective (mg/kg or ppm) for VOCs, SVOCs, Organic Pesticides/Herbicides, PCBs and Metals

Contaminants	Rec. soil clean object(ppm)[1]	raw sedi	M &E	Biosafe	West.house	Marcor	Biogene	IT Corp	IGT
VOCs									
Acetone	0.2	ND	ND	ND	ND	0.11	ND	ND	ND
Benzene	0.06	ND	ND	ND	ND	0.024	ND	ND	ND
Benzoic acid	2.7	ND	ND	ND	ND	ND	ND	ND	ND
2- Butanone	0.3	ND	ND	ND	ND	0.667	ND	ND	ND
Carbon disulfide	2.7	ND	ND	ND	ND	0.024	ND	ND	ND
Carrbon tetrachloride	0.6	ND	ND	ND	ND	0.024	ND	ND	ND
Chlorobenzene	1.7	ND	ND	ND	ND	0.024	ND	ND	ND
Chloroethane	1.9	ND	ND	ND	ND	0.047	ND	ND	ND
Chloroform	0.3	ND	ND	ND	ND	0.024	ND	ND	ND
1,2 dichlorobenzene	7.9	0.57	0.058	0.0285	0.0751	ND	ND	0.0768	ND
1,3 dichlorobenzene	1.6	0.51	0.14	0.029	0.07	ND	ND	0.0687	ND
1,4 dichlorobenzene	8.5	0.52	0.566	0.0274	0.0679	ND	ND	0.07	ND
1,1 dichloroethane	0.2	ND	ND	ND	ND	0.024	ND	ND	ND
1,2, Dichloroethane	0.1	ND	ND	ND	ND	0.024	ND	ND	ND
1,1 Dichloroethane	0.4	ND	ND	ND	ND	0.024	ND	ND	ND
1,2 Dichloroethene(trans)	0.3	ND	ND	ND	ND	0.024	ND	ND	ND
1,3 Dichloropropane	0.3	ND	ND	ND	ND	0.024	ND	ND	ND
Ethylbenzene	5.5	ND	ND	ND	ND	0.012	ND	ND	ND
Contaminants	Rec. soil clean object(ppm)	raw sedi	M &E	Biosafe	West.house	Marcor	Biogene	IT Corp	IGT
113 Freon	6	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	0.1	ND	ND	ND	ND	0.19	ND	ND	ND
4Methyl 2Pentanone	1	ND	ND	ND	ND	0.023	ND	ND	ND

Tetrachloroethane	0.8	ND	ND	ND	ND	0.024	ND	ND	ND
1,1,1-trichloroethane	0.8	ND	ND	ND	ND	0.024	ND	ND	ND
1,1,2,2, tetrachloroethane	0.6	ND	ND	ND	ND	0.024	ND	ND	ND
1,2,3 Trichloropropane	0.4	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4 trichlorobenzene	3.4	0.623	0.209	0.029	0.072	ND	ND	0.0725	ND
Toluene	1.5	ND	ND	ND	ND	0.1	ND	ND	ND
Trichloroethene	0.7	ND	ND	ND	ND	0.047	ND	ND	ND
Vinyl chloride	0.2	ND	ND	ND	ND	0.047	ND	ND	ND
Xylenes	1.2	ND	ND	ND	ND	0.056	ND	ND	ND
SVOCs									
Acenaphthene	50	1.04	0.105	0.02	0.065	0.3	ND	0.0432	ND
Acenaphthalene	41	1.28	0.12	0.011	0.043	0.32	0.011	0.027	ND
Aniline	0.1	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	50	3.7	1.1	0.0098	0.0452	1.1	0.034	0.0345	ND
Benzo(a)anthracene	0.224 orMDL	4.48	1.31	0.0083	0.0203	1.6	0.044	0.0256	ND
Benzo(a)pyrene	0.224 orMDL	2.12	0.886	0.0116	0.022	1	0.027	0.039	ND
Benzo(b)flouranthene	1.1	2.92	1.55	0.0105	0.0207	1.3	0.039	0.0359	ND
Benzo(g,h,i)perylene	50	1.25	0.341	0.0157	0.0243	0.54	0.0171	0.0369	ND
Benzo(k)flouranthene	1.1	1.11	0.528	0.0115	0.0208	0.76	0.0162	0.0403	ND
bis(2-ethylhexyl)phthalate	50	48.6	5.88	0.02	0.044	ND	ND	6.2	ND
Butylbenzylphthalate	50	1.47	0.148	0.013	0.188	ND	ND	0.0275	ND
Chrysene	0.4	4.56	1.886	0.009	0.0232	1.8	0.0479	0.0282	ND
4-Chloroaniline	0.220 or MDL	1	0.121	0.029	0.0945	ND	ND	0.0634	ND
Contaminants	Rec. soil clean object(ppm)	raw sedi	M &E	Biosafe	West.house	Marcor	Biogene	IT Corp	IGT
4Chloro-3-methylphenol	0.240 or MDL	0.84	0.129	0.045	0.119	ND	ND	0.0639	ND
2-Chlorophenol	0.8	0.7	0.146	0.0354	0.0873	ND	ND	0.0761	ND
Dibenzofuran	6.2	1.17	0.388	0.0119	0.0491	0.22	ND	0.0308	ND

Dibenzo(a,h)anthracene	0.014	0.4	0.189	0.0181	0.0281	1.8	0.0089	0.0267	ND
2,4-dichlorophenol	0.4	0.68	0.162	0.0367	0.104	ND	ND	0.0823	ND
2,4 Dinitrophenol	0.2	2.5	0.617	0.1262	0.752	ND	ND	0.314	ND
2,6 Dinitrotoluene	1	1.4	0.292	0.06	0.297	ND	ND	0.171	ND
Diethylphthalate	7.1	0.276	0.103	0.012	0.054	ND	ND	0.0334	ND
Dimethylphthalate	2	0.31	0.066	0.0138	0.0605	ND	ND	0.037	ND
Di-n-butylphthalate	8.1	1.23	0.262	0.0568	0.0258	ND	ND	0.0187	ND
di-n-octylphthalate	50	ND	0.058	ND	0.0139	ND	ND	0.06	ND
Flouranthene	50	10.3	2.5	0.0075	0.0227	3.8	0.071	0.0253	ND
Flourene	50	1.4	0.337	0.0153	0.0651	ND	0.0175	0.0436	ND
Hexachlorobenzene	0.41	0.78	0.24	0.026	0.161	ND	ND	0.113	ND
Indeno(1,2,3-cd)pyrene	3.2	1.075	0.382	0.0133	0.0216	1.8	0.0102	0.0352	ND
Isophorone	4.4	0.334	0.63	0.02	0.039	ND	ND	0.032	ND
2-Methylnaphthalene	36.4	2.3	0.491	0.0181	0.047	0.32	ND	0.0251	ND
2-Methylphenol	0.1	0.875	0.148	0.0233	0.102	ND	ND	0.0788	ND
4 Methylphenol	0.9	1.4	0.253	0.0447	0.09	ND	ND	0.0702	ND
Naphthalene	13	2.73	0.75	0.013	0.032	0.33	0.0116	0.048	ND
Nitrobenzene	0.2	0.57	0.105	0.0325	0.0669	ND	ND	0.053	ND
2-Nitroaniline	0.43	1.1	0.19	0.055	0.275	ND	ND	0.114	ND
2-Nitrophenol	0.33	1.05	0.265	0.0524	0.155	ND	ND	0.131	ND
4-Nitrophenol	0.1	1.62	0.293	0.051	0.222	ND	ND	0.182	ND
3-Nitroaniline	0.5	1.35	0.291	0.0635	0.354	ND	ND	0.182	ND
Pentachlorophenol	1	1.038	0.35	0.0395	0.328	ND	ND	0.158	ND
Contaminants	Rec. soil clean object(ppm)	raw sedi	M &E	Biosafe	West.house	Marcor	Biogene	IT Corp	IGT
Phenanthrene	50	6.6	2.35	0.0099	0.043	ND	0.0294	0.0233	ND

Phenol	0.03	0.638	0.176	0.0391	0.07	ND	ND	0.022	ND
Pyrene	50	7.1	3.6	0.0068	0.023	3.4	0.0489	0.0233	ND
2,4,5 trichlorophenol	0.1	0.798	0.201	0.038	0.196	ND	ND	0.119	ND
Organic Pesticides and PCBS									
Aldrin	0.041	0.075	0.0018	0.0017	0.0017	0.053	ND	0.0034	ND
Alpha-BHC	0.11	0.0145	0.0018	0.0017	0.0017	0.035	ND	0.0034	ND
Beta-BHC	0.2	0.145	0.0018	0.0017	0.0017	0.053	ND	0.0034	ND
Delta-BHC	0.3	0.0148	0.0018	0.0017	0.0017	0.053	ND	0.0034	ND
Chlordane	0.54	0.0145	0.0018	0.0017	0.0017	0.053	ND	0.0034	ND
2,4-D	0.5	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	2.9	0.162	0.00918	0.0033	0.0033	0.11	ND	0.0068	ND
4,4'-DDE	2.1	0.15	0.0035	0.0033	0.0033	0.11	ND	0.0068	ND
4,4'-DDT	2.1	0.0289	0.0035	0.0033	0.0033	0.11	ND	0.0068	ND
Dieldrin	0.044	0.0745	0.0035	0.0033	0.0033	0.11	ND	0.0068	ND
Endosulfan I	0.9	0.0145	0.00177	0.0017	0.0017	0.053	ND	0.034	ND
EndosulfanII	0.9	0.0289	0.0035	0.0033	0.0033	0.11	ND	0.0068	ND
Endosulfan Sulfate	1	0.0289	0.0354	0.0033	0.0033	0.11	ND	0.0068	ND
Endrin	0.1	0.0289	0.00354	0.0033	0.0033	0.11	ND	0.0068	ND
Lindane	0.06	0.0145	0.00177	0.0017	0.0017	0.053	ND	0.0034	ND
GammaChlordane	0.54	0.0145	0.00177	0.0017	0.0017	0.053	ND	0.0034	ND
Heptachlor	0.1	0.0145	0.00177	0.0017	0.0017	0.053	ND	0.0034	ND
Heptachlor epoxide	0.02	0.0145	0.00177	0.0017	0.0017	0.053	ND	0.0034	ND
Contaminants	Rec. soil clean object(ppm)	raw sedi	M &E	Biosafe	West.house	Marcor	Biogene	IT Corp	IGT
Methoxychlor	***	0.144	0.0177	0.017	0.017	0.53	ND	0.034	ND
PCBs	1.0(sur)	5.25	0.57	0.0008	0.0013	4.73	2.9	0.00068	ND
	10(subsr)	5.25	0.57	0.0008	0.0013	4.73	2.9	0.00068	ND

Sivex	0.7	ND	ND	ND	ND	ND	ND
2,4,5 T	1.9	ND	ND	ND	ND	ND	ND
Malathion	2	ND	ND	ND	ND	ND	ND
Dursban	15	ND	ND	ND	ND	ND	ND
Carbaryl	16	ND	ND	ND	ND	ND	ND
metals							
Aluminum	SB	ND	ND	ND	ND	14,000	ND
Antimony	SB	10.29	7.69	0.8	1.35	0.37	0.962
Arsenic	7.5 or SB	33.5	ND	1.9	5.18	0.38	3.01
Barium	300 or SB	ND	ND	ND	ND	180	ND
Beryllium	0.16 or SB	0.56	0.19	0.2	0.18	0.23	0.241
Cadmium	1 or SB	37	36.25	22.5	4.4	19	0.437
Calcium	SB	ND	ND	ND	ND	95000	ND
Chromium	10 or SB	376	385	55	74	180	8.43
Cobalt	30 or SB	ND	ND	ND	ND	10	ND
Copper	25 or SB	1171	1180	22.6	166	540	12.1
Cyanide	***	ND	ND	ND	ND	ND	ND
Iron	2,000 or SB	ND	ND	ND	ND	23000	ND
Lead	SB	617	628	0.8	93.5	300	9.69
Magnesium	SB	ND	ND	ND	ND	12000	ND
Manganese	SB	ND	ND	ND	ND	730	ND
Mercury	0.1	1.29	3.06	0.04	0.07	1.5	0.103
Nickel	13 or SB	297	289	27	50	140	7.91
Potassium	SB	ND	ND	ND	ND	3000	ND
Contaminants	Rec. soil clean object(ppm)	raw sedi	M &E	Biosafe	West.house	Marcor	Biog
Selenium	2 or SB	3.24	2.72	1	0.89	0.14	0.722
Silver	SB	18.4	ND	0.9	2.47	8.1	0.241
Sodium	SB	ND	ND	ND	ND	10000	ND
Thallium	SB	2.77	1.85	1	0.89	0.36	1.2
Vanadium	150 or SB	ND	ND	ND	ND	51	ND
Zinc	20 or SB	1725	1705	92.1	333	1300	41.3

1 TAGM 4046, (Division of Remediation, 1994)

Chapter 7

COMPARISON STUDY OF DREDGED MATERIAL TO USE IN LANDFILL CLOSURE

The New York State Department of Environmental Conservation (NYSDEC) has promulgated specifications for the use of dredged material in landfill closure, specifically for the Pennsylvania and Fountain Ave landfills located in Brooklyn, New York (*Appendix A. Section 02210; Grading fill, Barrier protective Layer and Structural Fill dated 12/17/1996*). The material may be used as offsite borrow material, grading fill, barrier protection layer, structural fill or trench backfill. These preliminary specifications are developed by a New York City's consultant and are not final yet.

Table 7-1 gives an overview of the raw sediment and the treated sediment in comparison with the NYSDEC specification to use the sediment in landfill closure. As the data indicates, the raw sediment does not meet the NYSDEC specifications to be used in a landfill closure. The treated sediments, however, meet most of the criteria to be used in landfill closure. However, there are parameters those were not analyzed for the raw and treated

sediments and a few parameters, such as certain heavy metals, which are analyzed contain elevated concentrations of contaminants to be used as barrier protection layer in a land fill closure(Table 7-1). From the data it is clear that the sediment must be treated to meet the criteria to use in landfill closure or for other beneficial use purposes. Following is a summary of findings based on the studies. The comparison is based on the NYSDEC soil clean up criteria (*Appendix B*) and the specifications developed for the two Brooklyn landfills. Elevated concentrations are indicated by shaded boxes in Table 7-1.

7.1 Offsite Borrow Materials

Dredged sediment may be used as offsite borrow materials for a landfill closure if the material meet certain criteria. Each criterion is analyzed here to find out whether the raw and treated sediments are suitable for this use (refer Table 7-2).

Size

The dredged sediment usually does not contain any roots, frozen materials or stones which is greater than 6 inches in any dimensions. The raw sediment analysis showed that there is 0.18% of material greater than 4.75 mm size (~0.2 inches).

Odor:

All treated materials have either no odors or have pleasant organic odor unlike the untreated material which has an oily foul odor. Hence treated sediments are acceptable to
landfill as offsite borrow material.

Organic Content:

The organic content criterion is 5% by weight. The raw sediment has 7.32% organic content. However, this varies among the treated materials. The M&E treated sediment has 6%, which is slightly higher than the 5% criterion. Biosafe, Westinghouse, Marcor and IT Corp samples all have acceptable levels of organic 0.4%, 0.05%, 0.88% and 3.4% respectively. However, Biogenesis sample

is not provided with an exact organic content. It was only referred as having an organic content of <7.3%. IGT sample is not analyzed for its organic content. M&E process may be modified to reduce its organic content from 6% to less than 5% so that it may be useful as an offsite borrow material.

Table 7-1

Comparison study of Dredged Material from different processes for the usage in Landfill Closure

	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT
I	**Offsite Borrow Materials**									

1-Org X results(M&E,1996) 3-Product glass(Westhouse, 1996) 5-Sediment washing technology(triangle lab analysis) 7-Total organic Carbon
2-BNL analysis(FBT process) 4-Marcor 1996, 30 day cured product 6-Thermally treated DES(BNL analysis) 8-Org X process
ND-Not Determined
**- New York City Landfill Closure Specifications for fill materials
***- BNL analysis results

1	free from roots, frozen material, stones >6 inches in any dimension, debris, contaminants and any other objectionable material	<6 inches	<0.18% (>4.75mm)	0%	0%	0%(for glass aggregate)	0%	0%	0%	0%
2	odor	no odor	oily foul odor	no odor	no odor	no odor	no odor	pleasant organic odor	no odor	no odor
3	organic content[7]	<5% by wt	7.32%	6%	0.4%	0.05%	0.88%	12.3%	3.4%	0.1%
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

1-Org X results(M&E,1996) 3-Product glass(Westhouse, 1996) 5-Sediment washing technology(triangle lab analysis) 7-Total organic Carbon
2-BNL analysis(FBT process) 4-Marcor 1996, 30 day cured product 6-Thermally treated DES(BNL analysis) 8-Org X process
ND-Not Determined
**- New York City Landfill Closure Specifications for fill materials
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4	moisture content < +7% of the standard proctor optimum moisture content	<+7% of Std. Proct.opt. Moist. Cont	67%	3%	ND	0.3%	24.5%	ND	30%	ND
5	No solid waste or hazardous waste present	as described	OK	OK	OK	OK	OK	OK	OK	OK
6	Plasticity Index(PI) For Cohesive soils <12, except for slopes <20%(1V:5H) where PI < 50	as described	ND	ND	ND	ND	ND	ND	ND	ND
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

1-Org X results(M&E,1996) 3-Product glass(Westhouse, 1996) 5-Sediment washing technology(triangle lab analysis) 7-Total organic Carbon
2-BNL analysis(FBT process) 4-Marcor 1996, 30 day cured product 6-Thermally treated DES(BNL analysis) 8-Org X process
ND-Not Determined
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7	Shall meet the interface friction requirement as per testing in section 01410	as described	ND	ND	ND	ND	ND	ND	ND	ND
II	**Grading Fill**									
1	Organic content	< 15% by wt	7.32%	6%	0.4%	0.05%	0.88%	12.3%	3.4%	0.1%
2	fill is non hazardous under RCRA	nonhazardous	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
3	Waste Characteristics									
	Ignitability	>140 deg F	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	Corrosivity	2<pH.12.5	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	Reactivity(cyanide)	<250 ppm reactive	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

1-Org X results(M&E,1996) 3-Product glass(Westhouse, 1996) 5-Sediment washing technology(triangle lab analysis) 7-Total organic Carbon
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**- New York City Landfill Closure Specifications for fill materials
***- BNL analysis results

	Reactivity(Sulfide)	<500ppm reactive	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
	TCLP waste chara in ppm									
	Arsenic	<5.0	<0.1	<0.1	<0.1	<0.1	<0.23	0.4	<0.1	0.1
	Barium	<100	<0.5	0.5	<0.5	<0.5	0.28	0.5	<0.5	0.5
	Benzene	<0.5	<0.2	<0.2	<0.2	<0.2	<0.005	0.2	<0.02	0.2
	Cadmium	<1.0	<0.01	0.525	<0.04	<0.01	<0.02	0.37	<0.01	0.01
	Carbon tetra chloride	<0.5	<0.2	<0.2	<0.2	<0.2	<0.005	0.2	<0.2	0.2
	Chlordane	<0.03	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	0.005
	Chlorobenzene	<100	<0.2	<0.2	<0.2	<0.2	<0.005	0.2	<0.2	0.2
	Chloroform	<6.0	<0.2	<0.2	<0.2	<0.2	<0.001	0.2	<0.2	0.2
	Chromium	<5.0	0.028	0.05	<0.01	<0.01	0.01	0.57	<0.01	0.21
	o-Cresol	<200	<0.1	<0.1	<0.1	ERR	ND	0.1	<0.1	0.1
	m-Cresol	<200	<0.1	<0.1	<0.1	ERR	ND	0.1	<0.1	0.1
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

1-Org X results(M&E,1996) 3-Product glass(Westhouse, 1996) 5-Sediment washing technology(triangle lab analysis) 7-Total organic Carbon
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ND-Not Determined
**- New York City Landfill Closure Specifications for fill materials
***- BNL analysis results

	p-Cresol	<200	<0.1	<0.1	<0.1	ERR	ND	0.1	<0.1	0.1
	1,4 Dichlorobenzene	<7.5	<0.2	<0.2	<0.2	<0.2	<0.0067	0.2	<0.2	0.2
	1,2Dichloroethane	<0.5	<0.2	<0.2	<0.2	<0.2	<0.005	0.2	<0.2	0.2
	1,1Dichloroethylene	<0.7	<0.2	<0.2	<0.2	<0.2	<0.005	0.2	<0.2	0.2
	2,4,Dinitroluene	<0.13	<0.1	<0.1	<0.1	ND	<0.0067	0.1	<0.1	0.1
	Endrin	<0.02	<0.0005	<0.0005	<0.0005	<0.0005	<0.00027	0.0005	0.0005	0.0005
	Heptchlor	<0.008	<0.0005	<0.0005	<0.0005	<0.0005	<0.00013	0.0005	0.0005	0.0005
	Hexchlorobenzene	<0.13	<0.1	<0.1	<0.1	ERR	<0.0067	0.1	<0.1	0.1
	Hexchloro1,3,butdiene	<0.5	<0.1	<0.1	<0.1	ND	<0.0067	0.1	<0.1	0.1
	Hexchloroethane	<3.0	<0.1	<0.1	<0.1	ND	<0.0067	0.1	<0.1	0.1
	Lead	<5.0	<0.05	0.095	<0.11	0.14	<0.17	7.9	<0.05	0.05
	Lindane	<0.4	<0.0005	<0.0005	ND	<0.0005	<0.00013	0.0005	0.0005	0.0005
	mercury	<0.2	<0.001	0.001	<0.0005	<0.001	0.006	0.001	<0.001	0.001
	Methoxychlor	<10	<0.001	<0.001	<0.001	<0.001	<0.0013	0.001	0.001	0.001
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

1-Org X results(M&E,1996) 3-Product glass(Westhouse, 1996) 5-Sediment washing technology(triangle lab analysis) 7-Total organic Carbon
2-BNL analysis(FBT process) 4-Marcor 1996, 30 day cured product 6-Thermally treated DES(BNL analysis) 8-Org X process
ND-Not Determined
**- New York City Landfill Closure Specifications for fill materials
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	MEK	<200	<5	<5	<5	<5	0.046	5	<5	5
	Nitrobenzene	<2.0	<0.1	<0.1	<0.1	ND	<0.0067	0.1	<0.1	0.1
	Pentchlorophenol	<100	<0.25	<0.25	<0.25	ND	<0.0067	0.25	<0.25	0.25
	Pyridine	<5.0	<0.25	<0.25	<0.25	ND	<0.0067	0.25	<0.25	0.25
	Selenium	<1.0	<0.1	<0.1	<0.1	<0.1	<0.15	0.1	<0.1	0.1
	Silver	<5.0	<0.01	0.01	<0.01	<0.01	0.08	0.01	<0.01	0.01
	tetrachloroethylene	<0.7	<0.2	<0.2	<0.2	<0.2	<0.0005	0.2	<0.2	0.2
	Toxaphene	<0.5	<0.01	<0.01	<0.01	<0.01	<0.0067	0.01	0.01	0.01
	Trichloroethylene	<0.5	<0.2	<0.2	<0.2	<0.2	<0.01	0.2	<0.2	0.2
	2,4,5Trichlorophenol	<400	<0.1	<0.1	<0.1	ND	<0.0067	0.1	<0.1	0.1
	2,4,6 trichlorophenol	< 2.0	<0.1	<0.1	<0.1	ND	<0.0067	0.1	<0.1	0.1
	2,4,5TP	<1.0	<0.01	<0.01	<0.01	<0.01	<0.0001	0.01	<0.01	0.01
	vinyl chloride	<0.2	<0.1	<0.1	<0.1	<0.1	<0.01	0.1	<0.1	0.1
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

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	Waste Chara(Total)ppm									
	PCB	<1	5.25	0.57	0.0008	0.0013	4.73	2.9	0.00068	0.0008
	Sulfides	<5000	7833	130	ND	<0.5	ND	25	290	76
	Ammonia	<200	ND	ND	ND	ND	ND	ND	ND	ND
	Asbestos fiber	<1%	ND	ND	ND	ND	ND	ND	ND	ND
3	Testing frequency and analytical requirements as per section 01415-Chemical Testing	as described	OK	OK	OK	OK	OK	OK	OK	OK
III	**Barrier Protection Layer** (cover soils and topsoil)									
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

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1	Shall consist of soil classified according to the Unified Soil Classification system as GM,SM,GC or SC		ND	ND	ND	ND	ND	ND	ND	ND
2	Meet the NYSDEC clean soil criteria	clean fill	Fail	Fail	Fail	Fail	Fail	Fail	Fail	Fail
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

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3	Particle size <3 inches where geosynthetic drainage composite is required. Where a cushion geotextile is required particle size< 1 inch measured in its greatest dimension and this soil shall be considered as select BPL	as described	0.18% over 4.75mm	Ok			Ok	Ok	Ok	ND
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

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4	Fines content shall be 20%-40% by wt defined as finer than No. 200 sieve	as described	45%	28%	ND	ND	ND	ND	15.5%	ND
5	Clay content shall be	<10% by wt	35%	13%	ND	<10%	<10%	ND	5%	ND
6	Permeability	<1 x10^{-7}	ND	ND	ND	ND	ND	ND	ND	ND
	VOCs(total)in ppm									
	Total VOCs	10	ND	ND	ND	ND	ND	ND	ND	ND
	Acetone	0.2	ND	ND	ND	ND	0.11	ND	ND	ND
	Benzene	0.06	ND	ND	ND	ND	<0.024	ND	ND	ND
	Bromodichloromethane	*	ND	ND	ND	ND	<0.024	ND	ND	ND
	Bromoform	*	ND	ND	ND	ND	<0.024	ND	ND	ND
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

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	Bromomethane	*	ND	ND	ND	ND	<0.024	ND	ND	ND
	2-Butanone	0.3	ND	ND	ND	ND	0.067	ND	ND	ND
	Carbon disulfide	2.7	ND	ND	ND	ND	<0.024	ND	ND	ND
	Carbon tetrachloride	0.6	ND	ND	ND	ND	<0.024	ND	ND	ND
	chlorobenzene	1.7	ND	ND	ND	ND	<0.024	ND	ND	ND
	Chloroethane	1.9	ND	ND	ND	ND	<0.047	ND	ND	ND
	Chloroform	0.3	ND	ND	ND	ND	<0.024	ND	ND	ND
	Chloromethane	*	ND	ND	ND	ND	<0.047	ND	ND	ND
	Cis-1,3-Dichloropropene	*	ND	ND	ND	ND	<0.024	ND	ND	ND
	Dibromochloromethane	*	ND	ND	ND	ND	<0.024	ND	ND	ND
	1,1 Dichloroethane	0.2	ND	ND	ND	ND	<0.024	ND	ND	ND
	1,2 Dichloroethane	*	ND	ND	ND	ND	<0.024	ND	ND	ND
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT
	1,1 Dichloroethene	*	ND	ND	ND	ND	<0.024	ND	ND	ND
	1,2 Dichloroethene(tot)	*	ND	ND	ND	ND	<0.024	ND	ND	ND

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	1,2-Dichloropropane	*	ND	ND	ND	ND	<0.024	ND	ND	ND
	1,3 Dichloropropene(trans)	*	ND	ND	ND	ND	<0.024	ND	ND	ND
	Ethylbenzene	5.5	ND	ND	ND	ND	0.012	ND	ND	ND
	2-Hexanone	*	ND	ND	ND	ND	0.011	ND	ND	ND
	Methylene Chloride	0.1	ND	ND	ND	ND	0.19	ND	ND	ND
	4-Methyl-2-Pentanone	1.0	ND	ND	ND	ND	0.023	ND	ND	ND
	Styrene	*	ND	ND	ND	ND	<0.024	ND	ND	ND
	Tetrachlorothene	1.4	ND	ND	ND	ND	<0.024	ND	ND	ND
	1,1,1 Trichloroethane	0.8	ND	ND	ND	ND	<0.024	ND	ND	ND
	1,1,2 Trichloroethane	*	ND	ND	ND	ND	<0.024	ND	ND	ND
	1,1,2,2,tetrachloroethane	0.6	ND	ND	ND	ND	<0.024	ND	ND	ND
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT
	Toluene	1.5	ND	ND	ND	ND	0.10	ND	ND	ND
	Tricloroethaene	*	ND	ND	ND	ND	<0.047	ND	ND	ND

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	Vinyl chloride	0.2	ND	ND	ND	ND	<0.047	ND	ND	ND
	Xylenes(Total)	1.2	ND	ND	ND	ND	0.056	ND	ND	ND
	SVOCs(Total) in ppm									
	Total SVOCs	500	ND	ND	ND	ND	ND	ND	ND	ND
	Acenaphthene	50.0	1.04	0.105	<0.0199	<0.0648	0.30	0.95	<0.0432	0.19
	Acenaphthylene	41.0	1.28	0.119	<0.011	<0.0431	0.320	1.03	<0.0271	0.011
	Anthracene	50.0	3.7	1.1	<0.0098	<0.0452	1.1	0.034	<0.0345	ND
	Benzo(a)anthracene	0.224	4.48	1.31	<0.0083	<0.0203	1.6	4.9	<0.0256	0.008
	Benzo(a)pyrene	0.061	2.12	0.886	<0.0116	<0.022	1.0	0.027	<0.039	0.007
	Benzo(b)floranthen	1.1	2.92	1.55	<0.0105	<0.0207	1.3	0.039	<0.0359	0.007
	Benzo(g,h,i)perylen	50.0	1.25	0.341	<0.0157	<0.0243	0.54	0.0171	<0.0369	0.006
	Benzo(k)flouranthene	1.1	1.11	0.528	<0.0115	<0.0208	0.76	0.0162	<0.0403	0.007
	bis(2ethylhexyl)phalate	50.0	48.6	5.88	0.0207	0.0443	27.2	80	6.243	0.322
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

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	bis(2chloroethyl)ether	0.58	<0.75	<0.136	<0.0517	<0.0833	0.93	0.6	<0.0683	0.037
	bis(2-chloroethoxy)methane	50.0	<0.63	<0.106	<0.0392	<0.0702	0.93	0.5	<0.053	0.033
	4-Bromophenylphenylether	50.0	<1.01	<0.318	<0.0341	<0.224	2	0.8	<0.15	0.05
	Butylbenzylphthalate	50.0	1.47	0.148	<0.013	0.188	0.07	0.18	<0.0275	0.015
	Carbazole	32	ND	ND	ND	ND	ND	ND	ND	ND
	Chrysene	0.4	4.56	1.886	<0.009	<0.0232	1.8	5.8	<0.0282	0.009
	4-Chloroaniline	0.220	1.0	0.121	<0.029	<0.0945	0.81	0.48	<0.0634	0.027
	4chloro3methylphenol	0.240	<0.84	<0.129	<0.045	<0.119	1.5	0.73	<0.0639	0.027
	2-cholorphenol	0.8	<0.7	<0.146	<0.0354	<0.0873	0.93	0.49	<0.0761	0.027
	4Chlorophenylphenylethe	50.0	<0.54	<0.149	<0.0262	<0.1025	0.81	0.58	<0.0861	0.022
	2Chloronaphthalene	50.0	<0.37	<0.081	<0.0175	<0.0616	1.5	0.3	<0.0429	0.017
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

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	2,4Dinitrotoulene	50.0	<1.01	<0.220	<0.0415	<0.752	1.98	0.94	<0.124	0.045
	Dibenzofuran	6.2	1.17	0.388	<0.0119	<0.0491	0.22	1.34	<0.0308	0.012
	Dibenzo(a,h)anthracene	0.014	0.4	0.189	<0.0181	<0.0281	<1.8	0.0089	<0.0267	0.007
	1,2Dichlorobenzene	50.0	<0.57	<0.058	<0.0285	<0.0751	0.86	0.46	<0.0768	0.025
	1,3 Dichlorobenzene	50.0	<0.51	<0.14	<0.0288	<0.0702	0.81	0.42	<0.0687	0.023
	3,3' Dichlorobenzidine	1.4	<0.29	<0.132	<0.0234	<0.0693	0.44	0.36	<0.077	0.025
	2,4 Dichlorophenol	0.4	<0.68	<0.162	<0.0367	<0.104	1.2	0.64	<0.0823	0.033
	4,6Dinitro2methylphenol	50.0	<1.73	<0.465	<0.0741	<0.337	2.4	1.3	<0.217	0.085
	2,4 Dimethylphenol	50.0	<0.72	<0.119	<0.0371	<0.0795	1	0.59	<0.0615	0.027
	2,4Dinitrophenol	0.200	<2.5	<0.617	<0.1262	<0.752	5.2	2.4	<0.314	0.134
	2,6 Dinitrotoluene	1.0	<1.4	<0.292	<0.0601	<0.297	3.1	1.14	<0.171	0.064
	Diethylphthalate	7.1	<0.276	<0.103	<0.0119	<0.0547	0.57	0.247	0.0334	0.012
	Dimethylphthalate	2.0	<0.31	<0.066	<0.0138	<0.0605	0.63	0.26	<0.0371	0.014
	Di-n-butylphtthalate	8.1	1.23	<0.262	0.0568	0.0258	0.55	0.72	<0.0187	0.029
	DEC Specifications**	Criteria**	Raw	Treated sediment						
			Sediment***	Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT

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	Di-n-octylphthalate	50.0	REJ	<0.058	REJ	<0.0139	0.07	0.08	0.0604	0.007
	Fluoranthene	50.0	10.3	2.5	<0.0075	<0.0227	3.8	0.071	<0.0253	0.009
	Fluorene	50.0	1.4	0.337	<0.0153	<0.0651	0.9	0.0175	<0.0436	0.014
	Hexachlorobenzene	0.41	<0.78	<0.24	<0.026	<0.161	1.4	0.61	<0.113	0.041
	Hexachlorobutadien	8.2	<0.71	<0.159	<0.0365	<0.080	1.1	0.88	<0.096	0.033
	Hexachloroethane	46	<1.25	<0.192	<0.0521	<0.121	1.3	0.91	<0.0925	0.04
	Hexachlorocyclopentadiene	50.0	<0.67	<0.195	<0.0362	<0.126	1.1	1.1	<0.0935	0.033
	Indeno(1,2,3-cd)pyrene	3.2	1.075	<0.382	<0.0133	<0.0216	<1.8	0.0102	<0.0352	0.006
	Isophorone	4.4	<0.334	<0.63	<0.0191	<0.0392	0.5	0.28	<0.0319	0.017
	2Methylnaphthalene	36.4	2.3	<0.491	<0.0181	<0.0472	0.32	2.7	0.0251	0.019
	2-Methylphenol	0.100	<0.875	<0.148	<0.0233	<0.102	1.1	0.58	<0.0788	0.035
	4-Methylphenol	0.9	1.4	<0.253	<0.0447	<0.090	ND	ND	<0.0702	ND
	Naphthalene	13.0	2.73	<0.754	<0.0131	<0.0318	0.55	5.2	0.0479	0.012
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
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	Nitrobenzene	0.200	<0.57	<0.105	<0.0325	<0.0669	0.85	0.55	<0.0532	0.027
	2-Nitroaniline	0.43	<1.1	<0.190	<0.0549	<0.275	2.5	0.94	<0.114	0.042
	4Nitroaniline	50.0	<1.32	<0.303	<0.0599	<0.234	2.2	1.13	<0.176	0.063
	2-Nitrophenol	0.330	<1.05	<0.265	<0.0524	<0.155	1.8	0.94	<0.131	0.054
	4-Nitrophenol	0.100	<1.62	<0.293	<0.051	<0.222	1.9	2.25	<0.119	0.057
	3-Nitroaniline	0.500	<1.35	<0.291	<0.0635	<0.354	3.4	0.98	<0.182	0.074
	N-Nitrosodi-n-propylamine	0.091	<1.09	0.20	<0.0627	<0.113	1.25	0.8	<0.0937	0.044
	NNitrosodiphenylamine	50.0	<0.566	<0.145	<0.0228	<0.113	0.97	0.38	<0.0697	0.031
	2,2'oxybis(1-chloropropane)	50.0	<0.864	<0.119	<0.047	<0.077	0.83	0.45	<0.0566	0.03
	Pentachlorophenol	1.0	<1.038	<0.350	<0.0395	<0.328	2.2	0.92	<0.158	0.071
	Phenanthrene	50.0	6.6	2.35	<0.0099	<0.043	4.8	8.37	<0.0233	0.014
	Phenol	0.03	0.638	0.176	<0.0391	<0.070	0.57	0.44	<0.022	0.028
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						

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				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT
	Pyrene	50.0	7.1	3.6	<0.0068	<0.023	3.4	0.0489	<0.0233	0.01
	1,2,4Trichlorobenzene	50.0	<0.623	<0.209	<0.029	<0.072	0.93	0.55	<0.0725	0.028
	2,4,5Trichlorophenol	0.1	<0.798	<0.201	<0.0381	<0.196	0.93	0.833	<0.119	0.024
	2,4,6Trichlorophenol	50.0	<0.843	<0.217	<0.0395	<0.181	1.7	0.75	<0.111	0.034
	Organic Pesticides and PCBs in ppm									
	Total Pesticides	10	ND	ND	ND	ND	ND	ND	ND	ND
	Aldrin	0.041	0.075	0.0018	<0.0017	<0.0017	<0.053	0.0074	<0.0034	0.0017
	alpha-BHC	0.11	0.0145	<0.0018	<0.0017	<0.0017	<0.053	0.0074	<0.0034	0.0017
	Endine aldehyde	*	<0.0289	<0.0035	<0.0033	<0.0033	<0.110	0.015	<0.0068	0.0033
	alpha-chlordane	*	<0.0145	<0.0018	<0.0017	<0.0017	<0.053	0.0074	<0.0034	0.0017
	beta-BHC	0.2	<0.145	<0.0018	<0.0017	<0.0017	<0.053	0.0074	<0.0034	0.0017
	delta-BHC	0.3	<0.0148	<0.0018	<0.0017	<0.0017	<0.053	0.0074	<0.0034	0.0017
	4,4'-DDD	2.9	0.162	0.00918	<0.0033	<0.0033	<0.110	0.11	<0.0068	0.0033

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	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT
	4,4'DDE	2.1	0.150	0.0035	<0.0033	<0.0033	<0.110	0.086	<0.0068	0.0033
	4,4'-DDT	2.1	<0.0289	<0.0035	<0.0033	<0.0033	<0.110	0.015	<0.0068	0.0033
	Dieldrin	0.044	0.0745	0.0035	<0.0033	<0.0033	<0.110	0.018	<0.0068	0.0033
	EndosulfanI	0.9	<0.0145	<0.00177	<0.0017	<0.0017	<0.053	0.0074	<0.034	0.0033
	Endosulfan II	0.9	<0.0289	<0.00354	<0.0033	<0.0033	<0.110	0.015	<0.0068	0.0033
	Endosulfan sulfate	1.0	<0.0289	<0.0354	<0.0033	<0.0033	<0.110	0.015	<0.0068	0.0033
	Endrin	0.10	<0.0289	<0.00354	<0.0033	<0.0033	<0.110	0.015	<0.0068	0.0033
	Endrin ketone	N/A	ND	ND	<0.0017	ND	<0.011	ND	ND	ND
	gamma-BHC(Lindane)	0.06	<0.0145	<0.00177	<0.0017	<0.0017	<0.053	0.0074	<0.0034	0.0017
	gamma-chlordane	0.54	<0.0145	<0.00177	<0.0017	<0.0017	<0.053	0.0074	<0.0034	0.0017
	Heptachlor	0.10	<0.0145	<0.00177	<0.0017	<0.0017	<0.053	0.0074	<0.0034	0.0017
	Heptachlor epoxide	0.02	<0.0145	<0.00177	<0.0017	<0.0017	<0.053	0.0074	<0.0034	0.0017
	Methoxychlor	*	<0.144	<0.0177	<0.017	<0.017	<0.53	0.074	<0.034	0.017
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment						

1-Org X results(M&E,1996) 3-Product glass(Westhouse, 1996) 5-Sediment washing technology(triangle lab analysis) 7-Total organic Carbon
2-BNL analysis(FBT process) 4-Marcor 1996, 30 day cured product 6-Thermally treated DES(BNL analysis) 8-Org X process
ND-Not Determined
**- New York City Landfill Closure Specifications for fill materials
***- BNL analysis results

				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogenes[5]	IT Corp[6]	IGT
	Total PCBs	1.0	5.25	0.57	0.0008	0.0013	5.1	3.1	0.00068	0.0008
	Arochlor-1016	*	ND	ND	ND	ND	ND	ND	ND	ND
	-1221	ND	ND	ND	ND	ND	ND	ND	ND	ND
	-1232	ND	ND	ND	ND	ND	ND	ND	ND	ND
	-1242	ND	ND	ND	ND	ND	ND	ND	ND	ND
	-1248	ND	ND	ND	ND	ND	ND	ND	ND	ND
	-1254	ND	ND	ND	ND	ND	ND	ND	ND	ND
	-1260	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Toxaphene	*	<1.45	<0.177	ND	<0.166	<2.7	0.74	<0.34	0.17
	Heavy metals, Asbestos and Conventional(ppm)									
	Aluminum	5680	ND	ND	ND	ND	14,000	ND	ND	ND
	Antimony	5.1	10.29	7.69	0.8	1.35	<0.37	<0.962	5.99	1.04
	Arsenic	7.5	33.5	ND	1.9	5.18	<0.38	3.01	13.55	9.2

1-Org X results(M&E,1996) 3-Product glass(Westhouse, 1996) 5-Sediment washing technology(triangle lab analysis) 7-Total organic Carbon
2-BNL analysis(FBT process) 4-Marcor 1996, 30 day cured product 6-Thermally treated DES(BNL analysis) 8-Org X process
ND-Not Determined
**- New York City Landfill Closure Specifications for fill materials
***- BNL analysis results

	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment				
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogene
	Barium	300	ND	ND	ND	ND	180	ND
	Beryllium	0.6	<0.56	<0.19	<0.2	<0.18	<0.23	<0.241
	Cadmium	1	37	36.25	22.5	4.4	19	0.437
	Calcium	8,631	ND	ND	ND	ND	95,000	ND
	Chromium	23.2	376	385	55	74	180	8.43
	Cobalt	30	ND	ND	ND	ND	10	ND
	Copper	30.6	1171	1180	22.6	166	540	12.1
	Cyanide	3.9	ND	ND	ND	ND	ND	ND
	Iron	13,652	ND	ND	ND	ND	23,000	ND
	Lead	112.8	617	628	0.8	93.5	300	9.69
	Magnesium	5592	ND	ND	ND	ND	12,000	ND
	Managnese	119.5	ND	ND	ND	ND	730	ND
	Mercury	0.1	1.29	3.06	<0.04	<0.07	1.5	0.103
	Nickel	13	297	289	27	50	140	7.91
	Potassium	1286.5	ND	ND	ND	ND	3,000	ND
	selenium	2	3.24	2.72	<1	<0.89	<0.14	<0.722
	DEC Specifications**	Criteria**	Raw Sediment***	Treated sediment				
				Metcalf& Eddy[1]	Biosafe[2]	Westing house[3]	Marcor[4]	Biogene
	Silver	200	18.4	ND	0.9	2.47	8.1	<0.241
	Sodium	1405.5	ND	ND	ND	ND	10,000	ND
	Thallium	20	<2.77	<1.85	<1	<0.89	<0.36	<1.2
	Vanadium	150	ND	ND	ND	ND	51	ND
	Zinc	70.8	1725	1705	<92.1	333	1,300	41.3
	Asbestos fiber content	1% by wt	ND	ND	ND	ND	ND	ND

1-Org X results(M&E,1996) 3-Product glass(Westhouse, 1996) 5-Sediment washing technology(triangle lab analysis)
2-BNL analysis(FBT process) 4-Marcor 1996, 30 day cured product 6-Thermally treated DES(BNL analysis)
ND-Not Determined
**- New York City Landfill Closure Specifications for fill materials
***- BNL analysis results

	pH	TBP	7.9	6.96	ND	7.89	ND	ND	11.65	ND
IV	**Structural Fill**									
1	maximum particle size < 3 inches	0.18%(>4.75mm)		Pass	ND	Pass	ND	Pass	Pass	ND
V	**COST(100000cy/yr)**			$64/cy[8]	ND	$64-84/ton	ND	ND	ND	ND

Moisture Content

The moisture content must be <+7% of the standard proctor optimum moisture content. The standard proctor optimum moisture content is calculated using the moisture-density - permeability relation. A graph is usually drawn relating these three parameters and used to determine the unknown parameter. The moisture content for a given compaction and the optimum permeability is the optimum moisture content and can be determined using the graph. Table 7-1 gives the moisture content for raw and treated sediments as determined. The optimum moisture content may be calculated based on the moisture-density-permeability relation.

Plasticity Index:

The plasticity index is not determined for any samples including the raw sediment. Interface Friction:

The interface friction is not determined for the raw or treated sediments.

Hazardous Nature:

None of the raw or treated sediment is classified as hazardous waste based on the concentration of contaminants or other characteristics.

Conclusion:

Elevated organic content is found in M&E sample (6% compared to 5% criterion). The organic content in the Biogenesis sample is found to be <7.3%. However, a specific concentration is not given for the Biogenesis sample. Also, the IGT sample is not analyzed for organic content.

Table 7-2

DREDGED MATERIAL AS OFFSITE BORROW MATERIALS

SPECIFICATIONS	NY City Criteria	Raw	M&E	Biosafe	Westinghouse	Marcor	Biogenesis
Organic Content[1]	5.00%	7.32%	6.00%	0.40%	0.05%	0.88%	<7.3%
Moisture Content	<7% of std proctor	67.00%	3.00%	ND	0.30%	24.50%	ND

1- Total Organic Content

ND- Not Determined

7.2 Grading Fill

Following is an analysis of the raw and treated material to be used as Grading Fill in a landfill closure. The criteria have been developed for the two Brooklyn landfills is used for comparison (Table 7-3).

Organic Content:

All raw and treated sediments have an organic content less than 15% criterion. Also both the treated and untreated sediments are non hazardous.

Waste Characteristics:

The raw and treated sediment samples pass the waste characteristics such as ignitability, Corrosivity, and reactivity. Reactivity is a concern primarily due to the presence of cyanide and sulfides.

All the TCLP characteristics for volatiles, semi-volatiles and metals analysis meet the criteria for the raw sediment. However, Biogenesis and IGT samples were not analyzed for all parameters. We can assume that the treated samples also pass those unanalyzed criteria, since the raw sediment does not contain those analytes more than the permissible concentrations. M&E, Biosafe, Westinghouse, Marcor and IT Corp samples meet the TCLP criteria for all the analysis performed for semivolatiles, metals and volatiles.

Total PCBs and sulfide exceed the criteria in raw sediment. Raw sediment has a total PCB of 5.25 ppm in comparison to the 1 ppm criterion and 7833 ppm of sulfide in comparison with 5000 ppm criterion. Marcor and Biogenesis exceed the criteria for PCBs as well. Those

sample contain total PCBs of 4.73 and 2.9 ppm, respectively. M&E, Biosafe, Westinghouse and IT Corp samples have PCBs well below the 1 ppm criteria. Biosafe, Marcor, Biogenesis and IGT samples were not analyzed for sulfides (total). Ammonia and asbestos fiber were not analyzed for raw or treated sediments.

Conclusion

IGT and Biogenesis samples have to be analyzed for all the parameters to determine whether these technologies produce sediment which can be used as grading fill. All other treatment processes except Marcor produce product meeting specifications for grading fill. Marcor has elevated level of PCB (4.73 ppm) in comparison to 1 ppm criteria. Also Westinghouse sample has to be analyzed for nitrobenzene, pentachlorophenol, pyridine, 2,4,5 trichlorophenol and 2,4,6 trichlorophenol using the TCLP method. Table 4-3 is a summary of the analysis results. The shaded boxes indicate

Table 7-3

DREDGED MATERIAL AS GRADING FILL

	NYCity Criteria	raw	M&E	Biosafe	West.House	Marcor	Biogenesis	IT Corp	IGT
Organic content	15%	7.32%	6%	0.40%	0.05%	0.88%	12.30%	3.40%	0.10%
TCLP Waste Chara in ppm									
Arsenic	5	0.1	0.1	0.1	0.1	0.23	0.4	0.1	0.1
Barium	100	0.5	0.5	0.5	0.5	0.28	0.5	0.5	0.5
Benzene	0.5	0.2	0.2	0.2	0.2	0.005	0.2	0.02	0.2
Cadmium	1	0.01	0.525	0.04	0.01	0.02	0.365	0.01	0.01
Carbob tetra chloride	0.5	0.2	0.2	0.2	0.2	0.005	0.2	0.2	0.2

ND- Not Determined

Chlordane	0.03	0.005	0.005	0.005	0.005	0.005	0.005	
Chlorobenzene	100	0.2	0.2	0.2	0.2	0.005	0.2	
Chloroform	6	0.2	0.2	0.2	0.2	0.001	0.2	
Chromium	5	0.028	0.05	0.01	0.01	0.01	0.57	
o-cresol	200	0.1	0.1	0.1	ERR	ND	0.1	
m-cresol	200	0.1	0.1	0.1	ERR	ND	0.1	
p-cresol	200	0.1	0.1	0.1	ERR	ND	0.1	
1,4 Dichlorobenzene	7.5	0.2	0.2	0.2	0.2	0.0067	0.2	
1,2Dichloroethane	0.5	0.2	0.2	0.2	0.2	0.005	0.2	
1,1 Dichloroethylen	0.7	0.2	0.2	0.2	0.2	0.005	0.2	
2,4 Dinitrotoulene	0.13	0.1	0.1	0.1	ND	0.0067	0.1	
Endrin	0.02	0.0005	0.0005	0.0005	0.0005	0.00027	0.0005	
Heptachlor	0.008	0.0005	0.0005	0.0005	0.0005	0.00013	0.0005	
Hexachlorobenzene	0.13	0.1	0.1	0.1	ERR	0.0067	0.1	
Hexchloro1,3, butadiene	0.5	0.1	0.1	0.1	ND	0.0067	0.1	
	NY City cirteria	raw	M&E	Biosafe	West.House	Marcor	Biogenesis	IT C
Hexachloroethane	3	0.1	0.1	0.1	ND	0.0067	0.1	
Lead	5	0.05	0.095	0.11	0.14	0.17	7.9	
Lindane	0.4	0.0005	0.0005	ND	0.0005	0.00013	0.0005	
Mercury	0.2	0.001	0.001	0.0005	0.001	0.006	0.001	
Methoxychlor	10	0.001	0.001	0.001	0.001	0.0013	0.001	
MEK	200	5	5	5	5	0.046	5	
Nitrobenzene	2	0.1	0.1	0.1	ND	0.0067	0.1	
Pentachlorophenol	100	0.25	0.25	0.25	ND	0.0067	0.25	
Pyridine	5	0.25	0.25	0.25	ND	0.0067	0.25	
Selenium	1	0.1	0.1	0.1	0.1	0.15	0.1	
Silver	5	0.01	0.01	0.01	0.01	0.08	0.01	
Tetrachloroethylene	0.7	0.2	0.2	0.2	0.2	0.0005	0.2	
Toxaphene	0.5	0.01	0.01	0.01	0.01	0.0067	0.01	
Trichloroethylene	0.5	0.2	0.2	0.2	0.2	0.01	0.2	
2,4,5 Trichlorophenol	400	0.1	0.1	0.1	ND	0.0067	0.1	
2,4,6 trichlorophenol	2	0.1	0.1	0.1	ND	0.0067	0.1	
2,4,5 TP	1	0.01	0.01	0.01	0.01	0.0001	0.01	
vinyl chloride	0.2	0.1	0.1	0.1	0.1	0.01	0.1	
Total PPM								
PCB	10	5.25	0.57	0.0008	0.0013	4.73	2.9	
Sulfides	5000	7833	130	ND	0.5	ND	25	

ND - Not Determined

elevated concentrations of contaminants. However, Westinghouse and IGT samples are not intended for the use of grading fill.

7.3 Barrier Protection Layer (Cover soil and Topsoil)

Raw and treated sediments may be used as Barrier Protection Layer in landfill closures. In order to determine whether these sediments are acceptable for this use, a comparison study with the NYSDEC soil clean up criteria and the specification provided for the Brooklyn landfills have been made. The result of the study is given as follows (Table 7-4).

Unified Soil Classification and clean soil criteria

Soil is classified according to the Unified Soil Classification system as GM, SM, GC or SC. Fill material used as barrier protection layer shall meet the New York State Department of Environmental Conservation (NYSDEC) criteria for clean soil. The material is considered as clean soil if the Volatile Organic Compounds (VOCs), Semi VOCs, Organic Pesticides and PCBs, Heavy Metals, Asbestos, and the pH are less than the specified criteria as listed in Table 7-1.

None of the samples, including raw sediment, except Marcor treated sample have been analyzed for the VOCs . The individual VOC concentrations in the Marcor sample are in acceptable levels to be considered as clean soil. However, two SVOCs, Benzo(a)anthracene and chrysene were found to be present in slightly higher concentrations than their clean soil criteria (1.6 and 1.8 ppm respectively vs 0.224 and 0.4 ppm criteria). Also, a number of SVOCs were not analyzed for the Marcor sample (Table 7-1). In addition, metals such as Aluminum, Cadmium, Chromium, Iron, Magnesium, Manganese, Mercury, Nickel, Potassium, Sodium and Zinc were present in higher concentrations in the Marcor sample than their corresponding clean soil criteria(Table 7-1). Almost all the samples except Biogenesis failed for clean soil chromium concentration of 23.2 ppm. In short, none of the raw or treated sediment meet the clean soil criteria.

Particle Size:

The particle size criterion is < 3 inches. The raw sediment passes this criterion. All treated samples except the IGT sample do not contain any particle greater than 3 inches. IGT sample result has not been provided in their report.

Fine Content:

The fine content, defined as finer than No.200 sieve, shall be 20-40%. Raw sediment has 47% fines in it and is unacceptable. The fine content is 28% for M&E treated sample. IT Corp sample has a fine content of 15.5% which is less than the 20-40% criterion. Biosafe, Westinghouse, Marcor, Biogenesis and IGT treated sediments were not analyzed for their fine content.

Clay Content:

The criterion is <10% by weight. The M&E treated sample has a higher clay content of 13% in comparison with the 10% criterion. Westinghouse, Marcor, IT Corp all have less than 10% clay content which is ideal to use as a barrier protection layer. Biosafe, Biogenesis and IGT samples were not analyzed for the clay content.

Permeability:

The permeability is not analyzed for any of the raw or treated sediment samples to determine whether it is less the 1×10^{-7} centimeters/second.

VOCs:

As per Table 7-1, contaminants with an '*' do not have individual limits in the NYSDEC TAGM-4046. The total VOCs in the sediment should not be higher than 10 ppm. The raw sediment is not analyzed for VOCs. So also all treated sediment except Marcor. The Marcor treated sediment, however, meets the VOC criteria to be used as a barrier protection layer.

SVOCs:

The total SVOCs criterion is 500 ppm. The total SVOCs were not determined for the raw sediment as well as for any treated sediment. Out of all parameters to be analyzed, several individual SVOCs were found to be present in high concentrations in the raw sediment(Table 7-1). Marcor, Biogenesis and IGT samples were not analyzed for most of the SVOCs. Based on the analysis, M&E treated sample failed for a few parameters such as Benzo(a)pyrene, Benzo flouranthene, chrysene, 2,4 dinitrophenol etc(Table 7-1). Biosafe sample was within the limit for all parameters except dibenzo(a,h) anthracene with a concentration of 0.0181 slightly over the criteria of 0.014. Westinghouse sample had 3 slight exceedences. Marcor sample was not analyzed for most parameters. However, there are a few parameters which exceed the criteria such as Benzo(a)anthracene, benzo(b)floranthene, chrysene and dibenzo(a,h) anthracene. Biogenesis treated sample was not analyzed for most SVOCs. All analyzed parameters were within the limit. There are 4 parameters present in excess of their corresponding criteria in the IT Corp sample. IGT was not analyzed for any one parameters of SVOCs. Overall the raw sediment has high concentrations of certain SVOCs, while the treated sediments only have a few insignificant SVOCs present.

Table 7-4

DREDGED MATERIAL AS BARRIER PROTECTION LAYER

	NYSclean up objective[1]	NYCity criteria[2]	Raw	M&E	Biosafe	WestHouse	Marcor	Biogenesis	IT Corp	IGT
SVOCS[1](TOTAL PPM)										
Total SVOCS	500	500	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	50	50	1.04	0.105	0.02	0.065	0.3	0.95	0.043	0.0195
Acenaphthylene	41	41	1.28	0.12	0.011	0.043	0.32	1.03	0.027	0.011
Benzo(a)anthracene	0.224	0.224	4.48	1.31	0.0083	0.0203	1.6	4.97	0.025	0.008
Benzo(a)pyrene	0.061	0.061	2.12	0.886	0.0116	0.022	1	0.027	0.039	0.007
Benzo(b)Floranthene	1.1	1.1	2.92	1.55	0.011	0.021	1.3	0.039	0.04	0.007
Benzo(g,h,i)perylene	50	50	1.25	0.341	0.016	0.0243	0.41	1.15	0.037	0.006
Benzo(k)flouranthene	1.1	1.1	1.11	0.528	0.012	0.0208	0.76	0.016	0.0403	0.007
bis(2ethylhexyl)phthalate	50	50	48.6	5.88	0.021	0.044	27.2	80	6.2	0.322

ND- Not Determined SVOC- Semivolatile Organic Compound

bis(2chloroethyl)ether	0.58	0.58	0.75	0.136	0.052	0.0833	0.93	0.6	0.0683	0.0375
bis(2chloroethoxy)methane	50	50	0.63	0.106	0.039	0.07	0.93	0.49	0.05	0.033
4-Bromophenylphenylether	50	50	1	0.32	0.034	0.224	2	0.79	0.15	0.049
Butylbenzylphthalate	50	50	1.47	0.148	0.013	0.188	0.07	0.18	0.0275	0.0155
Carbazole	32	32	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	0.4	0.4	4.56	1.89	0.009	0.0232	1.8	5.8	0.028	0.009
4 Chloroaniline	0.22	0.22	1	0.121	0.029	0.095	0.81	0.48	0.0634	0.027
4 Chloro3 methylphenol	0.24	0.24	0.84	0.13	0.045	0.12	1.5	0.73	0.064	0.027
2 Chlorophenol	0.8	0.8	0.7	0.146	0.0354	0.0873	0.93	0.49	0.076	0.027
4chlorophenylphenylether	50	50	0.54	0.15	0.026	0.103	0.81	0.58	0.086	0.022
	NYSclean up objective	NYCity criteria	raw	M&E	Biosafe	WestHouse	Marcor	Biogenesis	IT Corp	IGT
2 Chloronaphthalene	50	50	0.37	0.08	0.017	0.062	1.5	0.3	0.0429	0.017
2,4dinitrotouluene	50	50	1	0.22	0.4	0.75	1.98	0.94	0.12	0.045
Dibenzofuran	6.2	6.2	1.17	0.388	0.012	0.049	0.22	1.34	0.031	0.012
Dibenzo(a,h)anthracene	0.014	0.014	0.4	0.19	0.018	0.028	1.8	0.09	0.0267	0.007
1,2 Dichlorobenzene	50	50	0.57	0.058	0.0285	0.075	0.86	0.46	0.0768	0.025
1,3 Dichlorobenzene	50	50	0.51	0.14	0.029	0.07	0.81	0.42	0.0687	0.023
1,4 dichlorobenzene	50	50	0.52	0.566	0.0274	0.0679	0.776	0.38	0.07	0.024
3,3'dichlorobenzidine	1.4	1.4	0.29	0.132	0.0234	0.069	0.44	0.36	0.077	0.025
2,4 Dichlorophenol	0.4	0.4	0.68	0.162	0.0367	0.104	1.2	0.64	0.0823	0.033
4,6dinitro2methylphenol	50	50	1.73	0.465	0.074	0.337	2.4	1.3	0.217	0.085
2,4dimethylphenol	50	50	0.72	0.12	0.037	0.079	1	0.59	0.0615	0.027
2,4dinitrophenol	0.2	0.2	2.5	0.617	0.126	0.75	5.1	2.44	0.314	0.134
2,6Dinitrotouluene	1	1	1.4	0.29	0.06	0.297	3.1	1.14	0.17	0.064
diethylphthalate	7.1	7.1	0.276	0.103	0.012	0.0547	0.57	0.247	0.0334	0.012

ND- Not Determined SVOC- Semivolatile Organic Compound

dimethylphthalate	2	2	0.31	0.066	0.0138	0.061	0.63	0.26	0.037	0.014
Di-n-butylphthalate	8.1	8.1	1.23	0.262	0.0568	0.0258	0.55	0.72	0.0187	0.029
Di-n-octylphthalate	50	50	REJ	0.058	REJ	0.0138	0.07	0.08	0.0604	0.007
Flouranthene	50	50	10.3	2.5	0.0075	0.0227	3.8	0.071	0.0253	0.009
Fluorene	50	50	1.4	0.337	0.0153	0.0651	0.9	1.8	0.0436	0.014
Hexachlorobenzene	0.41	0.41	0.78	0.24	0.026	0.161	1.4	0.612	0.113	0.041
Hexachlorobutadiene	8.2	8.2	0.71	0.16	0.0365	0.08	1.1	0.88	0.096	0.033
Hexachloroethane	46	46	1.25	0.192	0.0521	0.12	1.3	0.91	0.093	0.04
Hexachlorcyclopentdiene	50	50	0.67	0.195	0.0362	0.126	1.1	1.1	0.0935	0.033
Indeno(1,2,3-cd)pyrene	3.2	3.2	1.075	0.382	0.0133	0.0216	0.72	1.3	0.035	0.006
Isophorone	4.4	4.4	0.334	0.63	0.019	0.039	0.5	0.28	0.032	0.017
	NYSclean up objective	NYCity criteria	raw	M&E	Biosafe	WestHouse	Marcor	Biogenesis	IT Corp	IGT
2-methylnaphthalene	36.4	36.4	2.3	0.49	0.018	0.047	0.53	2.7	0.025	0.019
2-methylphenol	0.1	0.1	0.875	0.148	0.0233	0.102	1.1	0.58	0.079	0.035
Naphthalene	13	13	2.73	0.754	0.0131	0.0318	0.55	5.2	0.048	0.012
Nitrobenzene	0.2	0.2	0.57	0.105	0.0325	0.067	0.85	0.55	0.0532	0.027
2-Nitroaniline	0.43	0.43	1.1	0.19	0.0549	0.275	2.5	0.94	0.114	0.042
4 Nitroaniline	50	50	1.32	0.303	0.06	0.234	2.2	1.13	0.176	0.063
2-Nitrophenol	0.33	0.33	1.05	0.265	0.0524	0.155	1.8	0.94	0.131	0.054
4-Nitrophenol	0.1	0.1	1.62	0.293	0.051	0.222	1.9	2.25	0.12	0.057
3 Nitroaniline	0.5	0.5	1.35	0.29	0.0635	0.354	3.4	0.98	0.182	0.074
N-Nitrosodi-n-propylamine	0.091	0.091	1.09	0.2	0.0627	0.113	1.25	0.8	0.0937	0.044
N-nitrosodiphenylamine	50	50	0.566	0.145	0.023	0.113	0.97	0.38	0.07	0.031
2-2'oxybis(1-chloropropane	50	50	0.864	0.12	0.047	0.077	0.83	0.45	0.0566	0.03
Pentachlorophenol	1	1	1.038	0.35	0.04	0.33	2.2	0.92	0.16	0.071

ND- Not Determined SVOC- Semivolatile Organic Compound

Phenathrene	50	50	6.6	2.35	0.01	0.04	4.8	8.37	0.023	0.014
Phenol	0.03	0.03	0.64	0.18	0.04	0.07	0.57	0.44	0.022	0.028
Pyrene	50	50	7.1	3.6	0.007	0.023	3.4	0.048	0.0233	0.01
1,2,4 trichlorobenzene	50	50	0.623	0.21	0.03	0.072	0.93	0.55	0.073	0.028
2,4,5 Trichlorophenol	0.1	0.1	0.8	0.2	0.038	0.2	0.93	0.833	0.119	0.024
2,4,6 Trichlorophenol	50	50	0.84	0.22	0.039	0.18	1.7	0.75	0.111	0.034
Total Pesticides and PCBs(ppm)										
Aldrin	0.041	0.041	0.075	0.0018	0.0017	0.0017	0.028	0.0074	0.0034	0.0017
Alpha-BHC	0.11	0.11	0.0145	0.0018	0.0017	0.0017	0.028	0.0074	0.0034	0.0017
Endine aldehyde			0.0289	0.0035	0.0033	0.0033	0.055	0.015	0.0068	0.0033
alpha-chlordane			0.0145	0.0018	0.0017	0.0017	0.042	0.0074	0.0034	0.0017
	NYSclean up objective	NYCity criteria	raw	M&E	Biosafe	WestHouse	Marcor	Biogenesis	IT Corp	IGT
beta-BHC	0.2	0.2	0.145	0.0018	0.0017	0.0017	0.028	0.0074	0.0034	0.0017
delta-BHC	0.3	0.3	0.015	0.0018	0.0017	0.0017	0.028	0.0074	0.0034	0.0017
4-4'DDD	2.9	2.9	0.162	0.0092	0.0033	0.0033	0.58	0.11	0.0068	0.0033
4-4''DDE	2.1	2.1	0.15	0.0035	0.0033	0.0033	0.26	0.086	0.0068	0.0033
4-4'DDT	2.1	2.1	0.029	0.0035	0.0033	0.0033	0.096	0.015	0.0068	0.0033
Dieldrin	0.044	0.044	0.0745	0.0035	0.0033	0.0033	0.055	0.018	0.0068	0.0033
Endosulfan 1	0.9	0.9	0.0145	0.0018	0.0017	0.0017	0.028	0.0074	0.034	0.0017
EndosulfanII	0.9	0.9	0.03	0.0035	0.0033	0.0033	0.055	0.015	0.0068	0.0033
Endosulfan Sulfate	1	1	0.029	0.0354	0.0033	0.0033	0.055	0.015	0.0068	0.0033
Endrin	0.1	0.1	0.0289	0.00354	0.0033	0.0033	0.055	0.015	0.0068	0.0033
Endrin Ketone	NA	NA	ND	ND	0.0017	ND	0.011	ND	ND	ND
gamma-BHC(lindane)	0.06	0.06	0.0145	0.0018	0.0017	0.0017	0.028	0.0074	0.0034	0.0017
gamma-chlordane	0.54	0.54	0.0145	0.0018	0.0017	0.0017	0.027	0.0074	0.0034	0.0017

ND- Not Determined SVOC- Semivolatile Organic Compound

Heptachlor	0.1	0.1	0.0145	0.0018	0.0017	0.0017	0.028	0.
Heptachlor epoxide	0.02	0.02	0.0145	0.0018	0.0017	0.0017	0.028	0.
Methoxychlor	NA	NA	0.144	0.018	0.017	0.017	0.27	0
Toxaphen	NA	NA	1.45	0.18	ND	0.17	2.7	
Heavy Metals(ppm)								
aluminum		5680	ND	ND	ND	ND	14000	ND
antimony		5.1	10.3	7.7	0.8	1.35	3.2	
Arsenic	7.5	7.5	33.5	ND	1.9	5.18	18	
Barium	300	300	ND	ND	ND	ND	ND	ND
Beryllium	0.16	0.6	0.56	0.19	0.2	0.18	0.18	0
Cadmium	1	1	37	36.25	22.5	4.4	10	0
Calcium		8631	ND	ND	ND	ND	95000	ND
	NYSclean up objective	NYCity criteria	raw	M&E	Biosafe	WestHouse	Marcor	Biogenesis
Chromium	50	23.2	376	385	55	74	180	
Cobalt	30	30	ND	ND	ND	ND	10	ND
Copper	25	30.6	1171	1180	22.6	166	540	
cyanide		3.9	ND	ND	ND	ND	ND	ND
Iron	2000	13652	ND	ND	ND	ND	23000	ND
Lead		112.8	617	628	0.8	93.5	300	
Magnesium		5592	ND	ND	ND	ND	12000	ND
Manganese		119.5	ND	ND	ND	ND	730	ND
Mercury	0.1	0.1	1.29	3.06	0.04	0.07	1.5	0
Nickel	13	13	297	289	27	50	140	
Potassium		1286.5	ND	ND	ND	ND	3000	ND
selenium	2	2	3.24	2.72	1	0.89	0.14	0
Silver		200	18.4	ND	0.9	2.47	7.1	
sodium		1405.5	ND	ND	ND	ND	10000	ND
Thallium		20	2.77	1.85	1	0.89	0.36	
Vanadium	150	150	ND	ND	ND	ND	51	ND
Zinc	20	70.8	1725	1705	92.1	333	1300	
Total PCBs	1	1	5.25	0.57	0.0008	0.0013	5.1	

1-TAGM 4046 (Division of Environmental Remediation, 1994

2-Appendix a

Organic Pesticides:

Organic pesticides were analyzed for raw sediment as well as for most of the treated sediments. Aldrin, Deildrin, Endrin are found in high concentration in raw sediment (0.075, 0.0745 and 0.0289 in comparison with 0.041,0.044 and 0.1 ppm respectively). Endrin is found in a slightly higher concentration of 0.11 ppm in Marcor sample in comparison with 0.1 ppm criterion. All other treated samples have organic pesticides within the limit. Biogenesis and IGT samples were not analyzed for any of the organic pesticides.

Total PCBs:

The criterion for total PCBs is 1 ppm. The total PCBs in the raw sediment is found to be 5.25 ppm. Marcor and Biogenesis samples have 4.73 and 2.9 ppm total PCBs respectively. M&E, Biosafe, Westinghouse and IT Corp samples have PCBs below the 1 ppm criterion. IGT sample was not analyzed for total PCBs.

Heavy Metals:

Heavy metals are found in significant concentrations in raw sediment. IGT sample was not analyzed for any heavy metals. All other treated sediments show some significant concentrations of heavy metals in their samples. Marcor treated sample was analyzed for almost all the metals. Table 7-1 shows that there are certain metals present in high concentrations in the treated sediment. Except for Biogenesis sample, all other samples failed for cadmium, chromium, nickel and zinc concentration (1, 23.2,13 and 70.8 ppm criteria respectively). Biogenesis sample, although passes for all the metal concentration, fail for its content of total PCBs (2.9 ppm vs 1 ppm criterion). Also, Biogenesis sample was not analyzed for most of the VOCs, SVOCs, and Organic pesticides. From the analysis results it is apparent that none of the treatment method except Biogenesis treatment are effective to meet the criteria for heavy metals.

Raw sediment has 7833 ppm sulfides which exceeds the 5000 ppm criterion. M&E, Westinghouse and IT Corp all have total sulfides well below the 5000 ppm criteria. Biosafe,

Marcor, Biogenesis and IGT samples were not analyzed for sulfides. A criterion for pH has not been established for soil to be used as barrier protection layer. M & E, Westinghouse and IT Corp samples have pH of 6.96, 7.89 and 11.65 respectively. Biosafe, Marcor, Biogenesis and IGT samples were not analyzed for their pHs.

Conclusion:

A summary of findings for the usage of raw and treated sediments as barrier protection layer is given in Table 9-1. As the table indicates, none of the raw and treated sediment meet all the criteria to use the sediment as barrier protection layer in landfill closures. All samples failed the clean soil criteria. Soil has to meet specified criteria for VOCs, SVOCs, Organic Pesticides and PCBs, and Heavy Metals to be considered as clean soil. All sediments (raw and treated) contain particle size less than 3 inches. Biosafe, Westinghouse, Marcor , Biogenesis and IGT samples were not analyzed for the fine content. M& E sample has a 28% fine content which is acceptable. Westinghouse, Marcor and IT Corp samples pass the clay content criteria and Biosafe, Biogenesis and IGT samples were not analyzed for the same. Permeability is not determined for any of the samples. Except the Marcor sample, none of the samples were analyzed for the VOCs. Marcor sample passes the VOCs criteria. Marcor, Biogenesis and IGT samples were not analyzed for SVOCs. However, none of the other samples pass the SVOC criteria. Elevated SVOCs were found in M&E, Biosafe, Westinghouse and IT Corp samples. Except the Biogenesis sample all other samples failed for metals criteria including the raw sediment.

Chapter 8

MANAGEMENT OF DREDGED MATERIAL IN NEW YORK AND IN NEW JERSEY

8.1 Management of Dredged Material in New Jersey

The New Jersey Department of Environmental Protection (NJDEP) is responsible for the evaluation and permitting of all dredging-related activities that occur in the waters of the State of New Jersey (NJDEP, 1997). As part of that review the NJDEP evaluates the proposed dredged material management option. Existing management options include in- water disposal, upland containment/disposal, and/or various potential uses of the dredged material. Disposal of dredged material in ocean waters is regulated by the U.S Army Corps of Engineers and the U.S EPA pursuant to the Marine protection, Research, and Sanctuaries Act (MPRSA). Also the management of dredged material from out-of-state waters pursuant to the permits issued for the New Jersey facility which will handle the dredged material. These permits identify the dredged material suitable for management at the facility (locations of origin, sediment quality, characteristics, quantities etc.). Any dredged material originating in out-of-state waters would have to meet the requirements specified in the permits for the New Jersey management facility. The sediments to be dredged must comply with all of the sampling and testing requirements and protocols applicable to projects in New Jersey waters. Likewise the material from out-of-state waters proposed to be used in New Jersey would have to meet the same regulatory, sampling, and testing requirements as that of the dredged material from New Jersey waters. Given these requirements, any out-of-state applicant proposing to dispose/manage or use dredged material in New Jersey must contact the Land Use Regulation program to discuss the project prior to the submittal of permit applications.

NJDEP does not consider the dredged material as “solid waste” and therefore should not be regulated under the New Jersey Solid Waste Management Act (NJSWMA). This will continue to be regulated under the provisions of the New Jersey Water Pollution Control Act,

Waterfront Development Law, and other relevant statutory and regulatory authorities. Since the NJDEP will not regulate dredged material as a solid waste pursuant to the Solid Waste Management Act, it will not regulate dredged material processing or staging/transfer facilities as it would analogous solid waste facilities. These facilities will most likely require a Waterfront Development permit and an Acceptable Use Determination (AUD). Depending on the type of dredged material management activities undertaken at the facility , additional permits-such as NJPDES- discharge to Surface Water and /or Ground Water, Air Quality--may be required.

8.2 Management of Dredged Material in New York

Unlike New Jersey, New York considers the dredged material as a "solid waste" when it is destined for disposal. New York accepts out-of-state dredged material for treatment/disposal as long as it meets the NYSDEC requirements. As discussed in Chapter 6, the NYSDEC is currently using the Interim Guidance for the management of dredged material which classified the dredged material in to three different classes based on their content. Class A and B material contain less contamination and therefore can be used for beneficial uses or for certain unrestricted uses. Class C material is considered as contaminated sediment and may be used only for restricted use and disposal.

8.2.1 Transportation and transfer

Thus far the dredged material excavated from the NY/NJ harbor indicates that the material is non hazardous. The transportation of non hazardous dredged material are exempt from the requirements of Part 364, the Waste Transporter Permit. Further, rail, water and air carriers are exempt from the requirements of Part 364. Therefore, there are no transportation permit requirements for nonhazardous dredged material. Typically, a point of usage is attached to all BUDs. Therefore, the transportation of BUD materials may require a Part 364 transportation permit until that material is dropped off at its point of usage, then material becomes deregulated.

When dredged material is being moved to an upland environment for treatment or disposal, there may be a need for materials to be transferred from one mode of transport to another. In these cases, dredged material may be moved, for instance, from barges to storage areas or into rail intermodel containers or rail cars or trucks for further transport. The transfer

activity may be regulated depending upon whether or not the facility was considered a transfer station and subject to the solid waste permitting requirements contained in Part 360. If the dredged material is transferred from vehicle to vehicle to consolidate loads for shipment to an authorized treatment or disposal facility, it may not be considered a transfer station. The material must be in leakproof, closed containers during the transfer from vehicle to vehicle, including barge to truck or train. Although not considered a transfer station requiring a part 360 solid waste permit, the facility must still comply with the following:

- the contents remain in their closed containers during transfer;
- storage remains incidental to transport;
- containers are acceptable to the Department and maintained in a safe, nuisance-free(e.g., dust, odors, etc.) manner; and
- the transfer location is under the ownership or control of the transporter.

One other means of allowing the activity to operate without a Part 360 solid waste permit would be to obtain a variance from the provisions of Part 360.

8.2.2 Disposal of dredged material

Dredged materials destined to be disposed of or discarded are considered as a solid waste, and the applicable provisions of Part 360 will need to be complied with respect to upland management of such dredged materials. Nonhazardous denatured dredged materials may be disposed of in landfills subject to the requirements of Subpart 360-2; a landfill authorized to operate pursuant to Subpart 360-2; or any landfill in New York that was under construction or operating on or after December 31, 1998, which is authorized to operate even if the landfill does not satisfy all of the requirements of Subpart 360-2, provided the landfill has adequate leachate management and surface water runoff control, as determined by the Department. Landfills are prohibited from accepting “bulk liquids” per the provisions of subdivision 360-2.17(k). Thus, the disposal of fluidized dredged materials is prohibited in existing landfills. With respect to disposal of dredged materials in existing solid waste landfills, it is recommended that dredged materials to be denatured to 20 percent solids with no free liquid being evident in the denatured sludge. “ No free liquids” can be defined through the application of the paint filter liquids test (Method 9095) as

specified in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA Publication SW-846.

Under paragraph 360-1.15(b)(10) the Department has determined that certain materials are no longer considered to be solid waste when beneficially used in landfill applications. Dredged materials used in landfills pursuant to the equivalent design provision specified in subdivision 360-2.13(w) are therefore not considered to be disposed of in this application.

Existing landfills are vast consumers of natural soils used for daily cover material. The State's solid waste regulations were revised/enhanced in 1993 to allow, pursuant to Department approval, the use of wastes that can meet the performance criteria for daily cover material. The performance criteria for daily cover material are specified in the provisions of subdivision 360-2.17(c) as cited below:

"360-2.17(c) Daily Cover. A minimum of six inches of compacted cover materials must be applied on all exposed surfaces of solid waste at the close of each operating day to control vectors, fires, odors, blowing litter and scavenging. The department may approve the use of alternative daily cover materials of an alternative thickness, upon a demonstration that the alternative daily cover material will adequately control vectors, fires, odors, blowing litter and scavenging without presenting a threat to human health and the environment. Such demonstrations are not subject to variance procedures of this Part."

Depending on the mechanical characteristics of a dredged material, it may be possible to consider it for use as an "alternative grade building material" associated with closing landfills that need added fill material to attain the closure designs. Under the equivalent design provisions of subdivision 360-2.13(w), the applicant may propose an equivalent design of individual components of a landfill's liner and final cover systems through the submission of an application substantiating the alternative component's ability to perform in the same manner. If it can be demonstrated that the dredged material can be substituted for fill material (i.e.,below the barrier layer of the final cover), such determination will be made under the provisions of 360-1.15(b)(10).

The minimum liner requirements for an upland dredged disposal facility will be a double lined disposal facility that will be designed to allow for the disposal of fluidized dredged materials

realizing that sometimes it may not be practical to dewater the dredged materials if the disposal facility is located such that the fluidized dredged material could be accepted for disposal. Monofills used solely for disposing dredged material must have a double liner system. More specifically, the monofill double liner system should consist of a 24-inch thick combined soil drainage/filter/protective layer placed as the upper surface of the dredged material liner system; a geosynthetic drainage system; an upper geomembrane liner; a second geosynthetic drainage system; and a lower composite liner. Odor and air emission controls should be in compliance with the provisions of 360-2.17(x) which states:

"360-2.17(x) Air criteria. Owners or operators of all solid waste landfills must ensure that air emissions from the landfill will not violate any applicable requirements developed pursuant to section 111 of the clean air Act..."

At a minimum real time air monitoring would be required at these facilities to evaluate the need for added air emission control. Such monitoring would include sampling for releases of volatile organic compounds and other air pollutants based upon characterization of the dredged material.

The Department may issue Research, Development and Demonstration (RD&D) permits pursuant to subdivision 360-1.13(a). The purpose is to provide an avenue for the Department to consider innovative proposals from applicants and gather data and information with respect to the environmental effects of proposals that do not necessarily fit into regulatory category of Part 360 and in cases where scientific community does not have complete information on the potential environmental effects. Thus, RD&D permit program provides a means for the Department to consider innovations in solid waste management technology and reuse/reduction of solid wastes.

There is no legal restriction for accepting any solid waste from other states other than specified in the accepting facility's Permit or other equivalent authorization. Thus New York may receive dredged material from New Jersey for treatment, disposal and/or reuse. The management facility has to comply with all applicable regulations of NYSDEC. Some of the applicable regulations are described above. The NYSDEC is in the process of drafting a policy *"NYSDEC dredged material assessment and management guidance"* which addresses this

issue as well as other issues such as the classification of dredged material.

Chapter 9

CONCLUSION AND RECOMMENDATION

9.1 Conclusion

The preceding chapters discussed various options of managing navigational dredged material from the NY/NJ harbor. The raw sediment from the harbor contains elevated amount of contaminants in order to consider for ocean disposal or for certain beneficial uses, such as grading fill, barrier protection layer in landfill closure etc. However, once the sediment is treated, the contaminant concentration can be reduced to acceptable levels for beneficial uses.

According to NYSDEC, the dredged material is a solid waste when it is destined for upland disposal. As such, the disposal of dredged material in New York State is regulated under Part 360 regulation. Also if the dredged material is to be managed for other purposes such as beneficial uses, Part 360 regulations for beneficial use determinations are applicable as described in chapter 3.

As part of the Beneficial Use Determinations, we evaluated the options of beneficial uses for the raw and treated sediments. As described in Chapter 7, usage of raw dredged material as grading fill or barrier protection layer during landfill closure is restricted due to high levels of contamination. Treated sediments from Metcalf & Eddy, Biosafe, and IT Corp produce sediments which meet the specification for grading fill. However, treated sediments from Marcor and Biogenesis samples have elevated levels of PCBs (4.73 and 2.9 ppm respectively) in comparison to the 1 ppm criterion. Westinghouse and IGT samples, although produces materials which meet the criteria for grading fill, are not intended for the use of landfill cover material.

Raw sediment contains elevated amounts of contaminants and may be considered for beneficial uses only on a case by case basis. Part 360-1.15 is the governing regulations for the purposes of beneficial uses. As described in section 4.2, there are some predetermined BUDs for the treated dredged material(only if they meet at least class B criteria) such as aggregate substitute in concrete, for road base, structural fill in building foundations and construction backfill,

alternative grading material, barrier protection layer and alternative daily cover at an approved landfill etc. All other uses should be reviewed and approved by the NYSDEC according to Part 360-1.15.

The dredged material may be used to manufacture asphalt which meet the specification criteria provided in the *NYSDOT Standard Specifications construction and Materials*. An air permit may be required for the emissions from the asphalt manufacturing process as per USEPA's 40 CFR Part 60.90. Emissions from the asphalt plant may not contain particulate matter in excess of 90 mg/dscm (0.04gr/dscf). Also, the emissions should not exhibit an opacity of 20% or greater. In addition emissions of VOCs and other hazardous air pollutants may be regulated as well. Also depending on the BUD determination, a solid waste management unit/transfer station permit may be required form the Division of Solid Waste. A Beneficial Use Determination may be made on this by submitting an application to the New York State Department of Environmental Conservation (NYSDEC), Beneficial Use Determination Section of the Solid Waste Division (*Appendix C*).

Institute of Gas Technology evaluated the sediment for producing pozzolan by melting, to partially replace Portland cement for construction purpose. A number of formulations were designed and melted. In one formulation 80% of the sediment and 20% of other additives were required to generate a pozzolan of adequate reactivity. It also produced cement with compressive strengths comparable to that of ASTM C 595 specifications. With 40% Portland cement replaced with pozzolan in the blended cement, it generated 3 and 7 day compressive strengths comparable to those identified for general purpose concrete, and exceeded the levels required for moderate early strength concrete.

As discussed in chapter 5, NYSDEC is using the Interim guidance as the guidance for regulating the management of dredged material. None of the raw or treated sediment meets the Class A criteria, which is the most stringent standard. Other than a few excursions, some treated samples could meet the Class B criteria. However, most raw and treated samples

come under the Class C criteria. Again metals are the significant contributor for the contamination. Thus, in order to dispose of the raw sediment in a landfill, it has to be authorized to operate pursuant to Part 360-2 or a monofill used solely for the purpose of disposing of navigational dredged material with double liner system . Except the Biogenesis treated sediment, all other treated sediment failed for Class C category. Biogenesis treated sample meets the Class B category, because it has high PCBs (2.9 ppm), mercury (0.103), beryllium (0.241ppm) and silver (1.2 ppm). All other treated sediments except Biogenesis product fall in to Class C criteria with at least one elevated contaminant concentration. Thus, these materials may be disposed of in a landfill authorized to operate pursuant to 360-2. However, regardless of the their class, the treated sediment can be considered for an appropriate beneficial use as described in Chapter 4.

If the sediment to be used for unrestricted use, the NYSDEC applies a Technical and Administrative Guidance Memorandum (TAGM 4046). Chapter 6 explains the use of the TAGM and compares the analyzed parameters with the cleanup objective. VOCs were not analyzed for most of the parameters thus making it difficult to compare with the TAGM numbers. However, generally, VOCs, SVOCs, Herbicides and Pesticides were removed significantly using all of the treatment samples analyzed. Removal of the heavy metals is the major concern for all technologies except Biogenesis.

In order to use the sediment as barrier protection layer, the sediment has to meet the NYSDEC clean soil criteria as discussed in Chapter 7. The closure specification is based on the New York City landfill closure criteria developed for the Pennsylvania Ave and Fountain Avenue landfills located in Brooklyn (*Appendix A*). This can be achieved only if the soil meets the specified criteria for VOCs, SVOCs, Organic pesticides and PCBs, and heavy metals. A summary table (Table 9-1) shown below explains the analysis results to use the dredged material as barrier protection layer in a landfill closure and it shows that none of the raw or

treated sediment meets the specified criteria. Although the removal of VOCs, SVOCs , Pesticides and Herbicides are significant for almost all treatment technologies, heavy metals are relatively hard to remove to acceptable levels. Biogenesis is probably the only one treatment technology which was able to meet most of the criteria for barrier protection layer.

Table 9-2 gives a summary of the findings based on the studies. It shows the Metcalf & Eddy, Biosafe and IT Corp materials can be used in grading fill for a landfill closure. Raw and Marcor sediments can not be used as grading fill. Westinghouse and IGT samples were not intended for the use of grading fill. Whereas none of the sediment can be used as barrier protection layer based on the results, further modification to processes are necessary to produce materials meeting the barrier protection layer criteria. Also except for IGT sample, all other samples including the raw sediment failed to satisfy TAGM 4046 soil clean up criteria. IGT sample was not fully analyzed for its TAGM 4046 contaminant list. Also all samples are only meeting the high contamination class of Class C and Category 3 criteria based on the Interim Guidance (Division of Water, 1994). Hence, the material can be placed only on a restricted landfill for disposal.

Table 9-1

Summary of Results to use Dredged Material as Barrier Protection Layer

Criteria	Raw Sediment	M & E	Biosafe	Westing-house	Marcor	Biogenesis	IT Corp	IGT
Particle Size	Pass	Pass	Pass	Pass	Pass	Pass	Pass	ND
Fine Content	Fail	Pass	ND	ND	ND	ND	Fail	ND
Clay Content	Fail	Fail	ND	Pass	Pass	ND	Pass	ND
Permeability	ND	ND	ND	ND	ND	ND	ND	ND
VOCs	ND	ND	ND	ND	Pass	ND	ND	ND
SVOCs	Fail	Fail	Fail	Fail	ND	ND	Fail	ND
Organic Pesticides	Fail	Pass	Pass	Pass	Pass	ND	Pass	ND
Total PCBs	Fail	Pass	Pass	Pass	Fail	Fail	Pass	ND
Heavy Metals	Fail	Fail	Fail	Fail	Fail	Pass	Fail	ND
Asbestos Fiber	ND	ND	ND	ND	ND	ND	ND	ND

ND- Not Determined

Table 9-2

Summary of Findings for the use of Dredged Material

Description	Raw	M&E	Biosafe	West-house	Marcor	Biogenesis	ITCorp	IGT
Grading fill	No	Yes	Yes	ND	No	ND	Yes	ND
BPL	No	No	No	No	No	No	No	ND
TAGM4046	No	No	No	No	No	No	No	ND
Int.Guid-Class	C	C	C	C	C	C	C	ND
Int.Guid-Category	3	3	3	3	3	3	3	ND

BPL- Barrier Protection Layer

NYSDEC Soil Clean Up criteria, TAGM 4046

Int. Guid-Class- NYSDEC, Interim Guidance for Freshwater Navigational Dredging

Int. Guid-Category- NYSDEC, Interim Guidance for Freshwater Navigational dredging, On-land disposal

Yes- Meet the requirements

No-Does not meet the requirements ND- Not Determined

Thus far the dredged material excavated from the NY/NJ harbor indicates that the material is non hazardous. The transportation of non hazardous dredged material are exempt from the requirements of Part 364, the Waste Transporter Permit. Further, rail, water and air carriers are exempt from the requirements of Part 364. Therefore, there are no transportation permit requirements for nonhazardous dredged material. Typically, a point of usage is attached to

all BUDs. Therefore, the transportation of BUD materials may require a Part 364 transportation permit until that material is dropped off at its point of usage, then material becomes deregulated.

When dredged material is being moved to an upland environment for treatment or disposal, there may be a need for materials to be transferred from one mode of transport to another. In these cases, dredged material may be moved, for instance, from barges to storage areas or into rail intermodel containers or rail cars or trucks for further transport. The transfer activity may be regulated depending upon whether or not the facility was considered a transfer station and subject to the solid waste permitting requirements contained in Part 360. If the dredged material is transferred from vehicle to vehicle to consolidate loads for shipment to an authorized treatment or disposal facility, it may not be considered a transfer station. The material must be in leakproof, closed containers during the transfer from vehicle to vehicle, including barge to truck or train. Although not considered a transfer station requiring a part 360 solid waste permit, the facility must still comply with the following:

- the contents remain in their closed containers during transfer;
- storage remains incidental to transport;
- containers are acceptable to the Department and maintained in a safe, nuisance-free(e.g., dust, odors, etc.) manner; and
- the transfer location is under the ownership or control of the transporter.

One other means of allowing the activity to operate without a Part 360 solid waste permit would be to obtain a variance from the provisions of Part 360.

Depending on the mechanical characteristics of a dredged material, it may be possible to consider it for use as an “alternative grade building material” associated with closing landfills that need added fill material to attain the closure designs. Under the equivalent design provisions of subdivision 360-2.13(w), the applicant may propose an equivalent design of individual components of a landfill’s liner and final cover systems through the submission of an application substantiating the alternative component’s ability to perform in the same manner. If it can be demonstrated that the dredged material can be substituted for fill material (i.e.,below the barrier layer of the final

cover), such determination will be made under the provisions of 360-1.15(b)(10).

According to the NYSDEC regulations there are no restrictions to transport and manage New Jersey's dredged material in New York State. The transportation and the management has to meet the New York State's applicable regulations for the activities.

9.2 Recommendation

The navigational dredged material from the NY/NJ harbor contain several contaminants at different levels depending on the dredging location of the materials. However, it is confirmed that the dredged material contains elevated concentrations of VOCs, SVOCs, PCBs, Pesticides , Herbicides and Metals and is to be managed properly. The treatment processes analyzed in earlier chapters disclosed certain treatment technologies are superior than others and evidently none of the treatment technologies produces "absolute" clean sediment that can be used for unrestricted use.

The treatment technologies generally used the following three methods:

- Chemical fixation, extraction or washing (Marcor, Metcalf &eddy, and Biogenesis)
- Thermal desorption (IT Corp)
- High temperature destruction (Biosafe, Westinghouse and IGT)

Most treatment technologies were somewhat successful in removing VOCs, SVOCs, Pesticides and Herbicides from the dredged material but generally failed to remove metals and PCBs . Table 9-1 shows a summary of different treatment technologies and their overall results in removing the primary contaminants.

Out of the seven treatment methods evaluated based on their bench scale studies, biogenesis produces the cleanest sediments of all. Even this treatment cannot be considered as perfect since it failed to remove PCBs to an acceptable level for unrestricted use. If they can modify the technology to improve the removal efficiency of PCBs, it will be one of the better available treatment technology evaluated so far for this purpose.

High temperature processes are generally efficient in removing VOCs, SVOCs, Pesticides and Herbicides. Westinghouse and Institute of Glass Technology use methods to lock or encapsulate metals so that it will not be an environmental problem for the product or for further use of the material.

Since neither high temperature destruction or a chemical fixation or chemical extraction serve the purpose in reducing the contaminant concentration, a combination of these processes may produce the intended result. Each should be analyzed individually to identify the problem in order to modify and to improve the removal efficiency. It appears that all treatment technologies produce products that can be considered for beneficial uses. The proposed beneficial use should be evaluated individually to determine whether the intended use could be met.

Most technologies do not address the issue of waste management. Almost all the processes, in addition to producing a product , generate wastes in various forms. Air emissions, waste water discharges, hazardous wastes, and solid wastes are various forms of wastes generated from these processes. The management of these wastes have to be addressed.

The NYSDEC does not have clear regulations for the management of dredged material. In 1996 the NYSDEC proposed a new set of regulations Part 360-18 and could not be finalized due to lack of scientific evidence to support some of the concentration levels proposed for "clean" standard. Now, the NYSDEC is in the process of developing new guidelines called "*NYSDEC dredged material assessment and management Guidance"*. This is in the draft form now and will be available for public review in the near future. Once finalized, this guidance will be used for regulating the management of dredged material in New York State.

Since the NY/NJ harbor dredging will be generating millions of tons of dredged material each year, specific regulations for the management of dredged material are desirable. These

regulations should address a variety of issues related to dredging and disposal of the dredged material. It should address from the initial step of dredging to the final step of disposal/reuse of the dredged material. The dredging may generate oversize material from the harbor waters; including scrap metal, drift wood, electric poles, automobile parts, animal parts, to mention a few. The sediment may have higher concentrations of volatile organic compounds and storage of the material immediately after dredging may pose hazardous environment to everyone on the dredging barge. A hazardous risk category should be assigned and proper safety measures should be taken based on the health risk assessment of the dredged sediment. Transporting the dredged material from one point to another should also be addressed in the regulations so that proper precaution may be taken during transfer.

Proper permit should be required by the regulations for transportation and storage of the dredged material prior to treatment. This storage shall not pose a threat to human health and environment to any extent. Proper run-on, run-off controls should be provided for the storage of dredged material. Odor control, dust control, vector control and other nuisance factors should be considered and should be addressed in the regulations. The air quality surrounding the storage pile shall be monitored and should be within the human health thresholds set by the Department of Health standards.

Even though beneficial use determinations are made on a case by case basis, all predetermined BUD should have the criteria listed so that new applicants will be able to determine their product's eligibility for a beneficial use. Applicability on other permits and regulations such as Air, water etc., should be explained in the dredged material regulations.

If a facility is proposing to utilize an innovative and experimental solid waste management technology or process, including a beneficial use demonstration project, they would have to obtain a research, development and demonstration permit from the NYSDEC, Division of Solid Waste. If a BUD is approved on a case-by-case basis, a determination will

be also made at which stage of the operation the dredged material ceases to be a solid waste and depending on this determination a solid waste management facility permit may be required if the facility is managing solid waste at the facility.

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