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Project No. 0725.16

Mr. Gerard Sotolongo
Environmental Protection Agency
Region I, Room 2303
John F. Kennedy Federal Building
Boston, Massachusetts 02203

Subject: Preliminary Screening of Technologies/Alternatives
Fast-Track Feasibility Study
New Bedford Site

Dear Mr. Sotolongo:

Attached please find twelve (12) copies of an interim working document that provides the findings and recommendations of NUS' preliminary screening of technologies and alternatives for the remediation of hot spot areas in the upper regions of New Bedford Harbor. The copies are being provided for distribution to members of the Interagency Task Force for their review and comment. Please do not further distribute this document without notifying me since it has received only a technical review by NUS personnel, and it has not been entered into the Superfund document control system. Incidentally, Mr. Alan Briggs of NUS will be attending the Interagency Task Force meeting on February 21, in my absence.

Very truly yours,

Joseph G. Yeasted
Project Manager

JGY/dmr
Attachment

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1.0 REMEDIAL ACTION TECHNOLOGIES

1.1 Non-Removal Actions

1.1.1 Hydraulic Control

Description:

This alternative involves the construction of hydraulic structures to eliminate both Acushnet River freshwater inflows and tidal fluctuations in the hot-spot areas of the upper harbor. The objective is to minimize water contact with the contaminated sediments, and to prevent their transport to the lower harbor and bay. A pipeline or open channel structure would be devised to convey Acushnet River *flows directly from uncontaminated upstream areas* to a point below the Coggeshall Street bridge. Tidal flows would be controlled by integrated structures at the reduced openings of the Coggeshall Street or I-195 Bridge.

Technology Status:

Hydraulic control structures represent commonly used construction practices.

Conclusions:

This alternative will be retained for further consideration.

1.1.2 In-Situ Treatment

1.1.2.1 Particle Radiation

Description:

One of the major types of radiation used for the destruction of wastes is particle radiation. PCB destruction is completed in a stepwise manner using the electron beam or gamma radiation processes. Sufficient doses of gamma radiation can carbonize PCBs, leaving no trace of the orginial pollutants. Similar results are noted using electron beams produced at lower energy levels. A cost effective approach to the use of radiation technologies for sediment decontamination would be their use as an in-situ detoxification process, although there are no reported plans to develop such a process.

Technology Status:

The use of particle radiation as a PCB destruction technique for contaminated sediments is still in the early development stage.

Conclusions:

The preliminary state of the technology for radiation destruction of PCBs precludes the further evaluation of this alternative.

1.1.2.2 Biodegradation

Description:

Biological destruction of PCBs in sediments is a process which has produced only limited success during its current development. Existing biological agents (microbes, worms) are capable of using PCBs as their sole source of carbon, but only the lesser chlorinated biphenyls (1-5 chlorines) degrade readily. The highly chlorinated biphenyls (6+ chlorines) undergo negligible degradation.

Commercial PCBs are not a single compound, thus making the potential for biodegradation difficult to evaluate. There is no single microorganism that will oxidize all of the PCB Arochlors.

Technology Status:

This technology is not viable for in-place applications in an uncontrolled environment.

Conclusions:

Biodegradation has been eliminated from further consideration because of its technology status, in addition to the fact that a feasible method has not been found for the large-scale application of the biological agent.

1.1.2.3 Fixation

- **Sorbents**

Description:

Sorbents can be used for the in-place fixation of organic contaminants in sediments. Adsorbent materials, such as activated carbon, have large surface area to volume ratios that permit effective uptake of PCBs. An alternative for the stabilization of the PCBs in the New Bedford Harbor would involve the addition of activated carbon to the sediments as a slurry. Because the PCBs would have a greater affinity for the sorbent than the sediments, PCB interchange with the environment would be reduced.

Some of the problems associated with this alternative would be: some areas are more highly contaminated than others and thus some areas may not receive enough sorbent to adsorb all of the contaminants; and the material would remain on the harbor bottom, lending itself to eventual desorption.

Technology Status:

The technology associated with the application of sorbents to harbor sediments uses current engineering practices.

Conclusions:

Sorbents as an alternative will not be evaluated any further because a significant percentage of the PCBs might remain unfixed on the harbor bottom.

- **In-Situ Stabilization**

Description:

Contaminated sediments can be solidified by pumping a mixture of portland cement and proprietary reagents into the deposits. The mixture traps the sediment particles in an insoluble silicon hydroxide matrix. A vertical column of stabilized material is produced; the process is then repeated in the adjacent portions of the sediment bed.

This technique may be difficult to implement since it is difficult to assess how deep or how thoroughly the stabilizing agents penetrate the sediments. In addition, the long-term stability of the stabilized sediments has not been evaluated.

Technology Status:

Stabilization has been successfully applied to contaminated sediments and waste residues (with low organic contents), but not for areas as large as that under consideration and not in such dynamic aquatic environments. The technology has not been effective on materials with high organic contents.

Conclusions:

Due to the aforementioned implementation difficulties, this alternative has been eliminated from further evaluation.

- **Impermeable Membrane**

Description:

This alternative entails the placement of an impermeable membrane over the contaminated sediments. A disadvantage of this method is the finite life of an impermeable membrane in the environment. Also, gases formed by anaerobic biological activity could build up beneath the membrane, unless vents were incorporated into the membrane. Such venting would jeopardize the integrity of the seal.

Technology Status:

This technology has not been extensively applied to dynamic aquatic environments.

Conclusions:

For the above reasons, an impermeable membrane seal has been eliminated from further evaluation.

- **Clay Cap**

Description:

This alternative involves the construction of an impermeable clay cap on top of the contaminated estuarine sediments. In order to construct the cap by typical engineering practices, the estuary would require dewatering to expose the contaminated deposits. Extensive dewatering of the sediments might be required in order to assure subbase stability. Clay would then be placed and compacted over the entire bottom of the estuary. Very soft deposits might require stabilization in order to support the cap material and subsequent compaction equipment.

Technology Status:

Clay capping of hazardous substances is a commonly used technology in dry environments.

Conclusions:

This alternative will be retained for further evaluation.

- **Sediment Cap**

Description:

The covering of contaminated sediments with clean, fine sediments has been utilized on projects in both Japan and the United States. An extensive study on this technique was conducted on a project in the New York Bight beginning in 1980.

Results indicated that cap erosion under normal meteorologic conditions was minimal, but that major storm events could cause extensive erosion. It was also determined that the cap had positive effects on bioaccumulation rates.

Technology Status:

Sediment capping of contaminated materials is a new technology and has been implemented on only a small number of projects.

Conclusions:

This alternative shall be considered during future screening, but would likely require concomitant hydraulic control actions to prohibit storm-related erosion.

1.2 No Action

Description:

This alternative assumes that no remedial action will be taken, and PCBs and heavy metals will remain in sediments and surface waters. No immediate capital expenditures would be required under CERCLA. However, socioeconomic impacts may include:

- Loss of commercial fishing industry.
- Loss of finfish and shellfish for human consumption.
- Risk of human exposure.
- Reduced property value.
- Continued impact on harbor development projects.
- Reduced recreational value of surface waters.
- Adverse effects on public welfare.
- Increased expenditures for environmental monitoring and laboratory analyses.
- Continued transport of significant quantities of PCBs to New Bedford Harbor and Buzzards Bay.

- Continued moratorium on harbor dredging.
- Continued damages to natural resources.

Technology Status:

Not Applicable.

Conclusions:

The no action *alternative will be considered during future screening.*

1.3 PCB Removal Actions

Possible PCB removal actions for the contaminated sediments include removal of the PCBs from the harbor sediments, or removal of the contaminated sediments themselves. Assuming that the PCBs were to be removed from the sediments, the action would be followed by either PCB destruction or PCB disposal into an approved landfill. If the contaminated sediments were removed from the harbor, either excavation or dredging practices would be utilized. Predisposal actions, such as PCB destruction or extraction, could then be applied to the sediments. If no pre-disposal action is used, the contaminated sediments would be disposed directly into an approved landfill. An additional disposal option for properly decontaminated sediment is a controlled release back into the harbor.

1.3.1 Contaminated Sediment Removal

1.3.1.1 *Freezing Before Removal*

Description:

In this method, refrigeration probes are inserted into the sediments and then are cooled by a portable refrigeration unit. Porewater within the permeable soil is frozen, and the frozen sediment blocks can be removed with minimal disturbance to the remaining sediment. Each probe can freeze a zone of sediment approximately 1.5 feet in diameter.

Technology Status:

Never applied to an area as large as that under study.

Conclusions:

This procedure would not be suitable for use over a large area. Therefore, this alternative has been eliminated from further consideration.

1.3.1.2 Excavation

- **Scraper**

Description:

A scraper is both an excavating and a hauling device. As the unit is moved forward, the bottom-loading pan removes surficial soils (generally to depths of less than one foot) and collects them within the scraper body. The scraper, which can be either towed or self-propelled, can then transport the contaminated material to a transfer station or disposal site. Scrapers can excavate soil at between 30 and 100 yd^3/hr.

Relatively dry soil conditions are required for proper operation. Another disadvantage to the scraper is the possibility of uncontrolled transport of contaminated material on the scraper tires, as the unit must travel onto the contaminated area in order to remove and transport the soil.

Technology Status:

Excavation and hauling with scrapers is a widely used and well established practice.

Conclusions:

The scraper shall be removed from further consideration, since excessive dewatering, which would be required for proper operation, would be extremely difficult to achieve in an in-situ condition.

- **Front End Loader**

Description:

A front end loader is an excavating/loading device which is composed of a tractor and front-mounted bucket. Soil is collected in the bucket, and then raised for dumping into trucks or other modes of transportation. Relatively dry soil conditions are required for operation. Front end loaders have an average excavation rate of between 70 and 180 yd^3/hr.

Technology Status:

Excavation and loading with front end loaders is a widely used and well established practice.

Conclusions:

The front end loader shall be considered in future screening, although dewatering of the sediment areas will be required.

- **Backhoe**

Description:

A backhoe is an excavation device composed of a hinged arm with a bucket attached to the free end. Large backhoes are capable of excavating to maximum depths on the order of 30 feet and at rates of up to 150 yd^3/hr. This type of equipment is technically suitable for the excavation of wet materials.

Technology Status:

The backhoe has been commonly used in many applications.

Conclusions:

Backhoe excavation shall be retained for further evaluation, although dewatering of the sediment areas will be required.

- **Dragline**

Description:

A dragline can be used for the excavation of exposed sediments, and is quite suitable for the removal of wet soils. Small draglines have an average production rate of between 30 and 110 yd^3/hr; larger draglines, such as those used in strip mining operations, are capable of much higher production rates, but may not be practical to mobilize for this site.

Technology Status:

Dragline excavation is a well established and commonly used practice.

Conclusions:

The dragline shall be retained for further evaluation, although dewatering of the sediment areas will be required.

1.3.1.3 Sediment Dredging

- **Mechanical Dredges**

  - **Clamshell Dredge**

Description:

A clamshell dredge utilizes a bi-parting bucket to collect/remove subaqueous earth materials. The bucket and contents are raised and the contents dumped into barges or trucks for transportation to the location of final disposition. Conventional clamshell buckets may lose between 15 and 50 percent of the contained sediments during the raising of the bucket. Watertight clamshell buckets which reduce such losses are available. Location and depth of the bucket excavation are not easily controlled, and PCB removal efficiency can be quite varied. An advantage of clamshell dredging is that removed sediments may not require fixation or dewatering before disposal.

Technology Status:

Clamshell dredges have been in wide use for several years.

Conclusions:

This alternative was retained for further evaluation, although the potential resuspension of contaminated sediments is a significant drawback.

- **Dragline Dredge**

Description:

A dragline dredge operates by pulling a bucket through the sediment and back towards the rig. The bucket is then raised and the sediments dumped into barges or trucks. Average production rates of dragline dredges are slightly less than those of the clamshell dredges. This type of dredge requires a large amount of open space for movement during operation, and also causes considerable sediment suspension.

Technology Status:

Dragline dredging is a well-established process.

Conclusions:

Since the process could result in the suspension of highly contaminated sediments, dragline dredging has been removed from further consideration.

- **Dipper**

Description:

A dipper is composed of an articulated arm with a bucket attached to the free end. Sediments are scooped with the bucket, and then raised out of the water. Greater sediment dispersion is caused by this method than by most other mechanical dredging techniques.

Technology Status:

Information on the technology status of the dipper has not yet been received.

Conclusions:

The dipper has been removed from further consideration, since the process could result in a high degree of contaminated sediment dispersion.

- **Bucket Ladder**

Description:

A bucket ladder is basically composed of a continuous chain with attached buckets to reach into the sediments which are to be dredged. The buckets scoop sediments and carry them to the surface in a continuous motion. Dredged materials are then transferred to a conveyor or chute, which in turn transport the sediments to a barge or truck. Severe disturbance and suspension of contaminated sediments can be expected with this method.

Technology Status:

The bucket ladder is used extensively in Europe and also for commercial applications in the U. S.

Conclusions:

This method has been removed from further consideration due to the large amount of contaminated sediment that would be suspended.

- **Sauerman Dredge**

Description:

A Sauerman dredge utilizes an overhead cable, supported on one end by a tower and on the other by a deadman. A horseshoe-shaped bucket, which is used to scrape the sediments into a pile, is suspended from a pulley which runs on the cable. Since the cable is slanted downward towards the deadman, the bucket and pulley assembly can be moved across the water by gravity. After being lowered into the water, the bucket is then pulled toward the crane with a tagline, and the sediments piled for subsequent removal. This procedure severely disturbs and suspends the bottom sediments.

Technology Status:

Information on the technology status of the Sauerman dredge has not yet been received.

Conclusions:

Since the process could result in the suspension of highly contaminated sediments, the Sauerman Dredge has been removed from further consideration.

- **Terra Marine Scoop**

Description:

This system utilizes a scoop-shaped bucket to scrape sediment from the harbor bottom. A set of steel cables is connected to a truck-mounted winch on one end of the harbor; and to a deadman on the other. The cables are extended across the water body to be dredged. The bucket is pulled through the sediments, and is then dumped when it reaches the opposite bank. It is expected that the procedure would be slow, and would result in the resuspension of large amounts of fines.

Technology Status:

Information on the technology status of Terra Marine Scoop has not yet been received.

Conclusions:

This technology has been removed from futher consideration, since the process could result in a high degree of contaminated sediment dispersion.

- **Hydraulic Dredges**

  - **Hopper Dredge**

Description:

The hopper dredge is a self-contained ship that uses a suction pump to draw sediments into hopper compartments within the vessel. Sediments are collected by a suction head, and then are drawn through piping to the hoppers. When the hoppers are full, the dredge travels to a discharge location, and the sediments are pumped out of the hoppers to either a landfill/lagoon or a means of further transportation. Operation of the hopper dredge would require extensive maneuvering space. The sediment slurry would require dewatering, and the slurry water would have to be treated. Sediment suspension would be low to moderate, although some sediment dispersal control might be required.

Technology Status:

Originally used for ocean operations, the hopper dredge is now being utilized for shallow water applications as well.

Conclusions:

The hopper dredge has been retained for further evaluation.

- **Cutterhead Pipeline Suction Dredge**

Description:

Cutterhead suction dredges utilize rotating, circular cutter blades at the end of a suction pipe, which are suitable for the dredging of materials varying in size from fine silts to decomposed rock fragments. A shroud can be attached to the top of the cutterhead in order to reduce sediment dispersion. The cutterhead could be eliminated entirely, in order to reduce dispersion, but this would allow the removal of only loose, unconsolidated sediments. A disadvantage of this method is the requirement for a floating or submerged pipeline to transfer the sediments to a disposal or transportation area. These pipelines require approximately one booster pumping station for each mile of pipe, and could introduce significant costs to the process.

Technology Status:

Cutterhead suction dredges are very widely used.

Conclusions:

The cutterhead suction dredge has been retained for further evaluation.

- **Suction Dredge**

Description:

A suction dredge removes sediments hydraulically from the harbor bottom, and discharges the materials through a floating pipeline. It is similar to a cutterhead dredge except for the absence of the cutter. Water jets can be attached to the head in order to loosen dense sediments. Floating pipelines and booster pumps could become a major cost item.

Technology Status:

Suction dredges have been used for several applications, and tests are being conducted on their suitability for contaminated sediments.

Conclusions:

The suction dredge shall be retained for further consideration.

- **Clean-up Dredge**

Description:

The Clean-up dredge consists of a hydraulic suction dredge with a modified suction head. The modified head can deflect currents generated by the suction, and can collect gases released during the dredging process. Monitoring equipment is also utilized during operation.

Technology Status:

The Clean-up dredge was developed in Japan, and apparently has not been used in the U.S. No information on the technology status has not yet been received.

Conclusions:

This alternative has been eliminated from further evaluation, as there is a requirement (as mandated by the Jones Act) that all dredging equipment used in the continental United States must also be manufactured in the U. S.

- **Dustpan Dredge**

Description:

A dustpan dredge utilizes a suction head that is shaped like a dust pan; water jets are mounted on the cutting edge of the head in order to loosen stiff sediments. The dredges are suitable for removing sediments in a path up to 36 feet in width.

Technology Status:

Dustpan dredges are in regular use on the lower Mississippi River for maintenance dredging.

Conclusions:

This alternative has been retained for further evaluation.

- **Mudcat Dredge**

Description:

A Mudcat dredge utilizes a hydraulically operated boom to lower an auger-cutter assembly into the sediments. The sediments are first loosened and then delivered to a pump suction intake by the auger-cutter assembly. The slurry mixture is conveyed to a remote location, such as a settling basin, for dewatering and final disposition. Larger Mudcat dredge models are suitable for dredging at depths of up to 15 feet.

Technology Status:

Mudcat dredges are widely used, particularly for shallow water areas where maneuverability of larger equipment is restricted.

Conclusions:

The Mudcat dredge has been retained for further evaluation.

- **Pneumatic Dredges**

  - **Airlift Dredge**

Description:

The airlift dredge operates by forcing compressed air into the lower end of a vertical conveying tube. An upward movement of the water in the conveying tube results, due to the decrease in water density (within the tube). This vertical movement acts as suction on the sediments and causes the conveyance of the solids. The sediments are transported to the surface through the pipe, and then are discharged into a recovery barge. An airlift dredge is suitable for sand and gravel deposits, and for deep deposits; in practice, depths of up to 300 feet have been reached.

Technology Status:

Airlift dredges are not commonly available equipment; generally the dredge is manufactured for a specific purpose. Accordingly, experience with this dredge is expected to be somewhat limited.

Conclusions:

The airlift dredge has been retained for further evaluation.

Criteria for Screening of PCB Destruction Technologies

- Time required for destruction/cleanup
- Construction/operation and maintenance costs
- Land use requirements
- Legal/institutional constraints
- Public health & environmental concerns
- Design considerations and applicability
- Technology status
- Community impacts
- Time required for implementation
- % PCB destruction attainable
- Properties of contaminated sediments for handling
- Miscellaneous

- **Pneuma Dredge**

Description:

The Pneuma dredge utilizes a two-stage vacuum suction system for the removal of fine-grained sediments of near in-situ densities. However, this dredge, which was designed overseas for the purposes of toxic waste removal and lake reclamation, is not suitable for shallow deposits. Also, there is a requirement (as mandated by the Jones Act) that all dredging equipment used in the continental United States must also be manufactured in the U. S.

Technology Status:

Only three units are available in the U. S., and use of the Pneuma dredge is expected to have been minimal.

Conclusions:

This alternative has been eliminated from further consideration due to the aforementioned legal constraints.

- **Namtech Dredge**

Description:

The Namtech dredge operates on the same principle as the airlift and Pneuma dredges. Pumping at up to 40 percent solids may be possible with the unit. The dredge has been tested under EPA approval, and more information should be available in the near future.

Technology Status:

This dredge has been manufactured in the U. S., but operational data is limited.

Conclusions:

This alternative has been retained for further evaluation.

- **Oozer Dredge**

Description:

A Japanese dredging sysem has been developed that combines vacuum suction and air compression to remove sediments. The Oozer dredge is favorably viewed by the Corps of Engineers, and is considered effective in controlling turbidity. However, this system is not currently available in the United States, and the use of foreign-manufactured dredge equipment is prohibited in the U.S.

Technology Status:

All work with the Oozer dredge has taken place overseas; the technology status is presently not well documented.

Conclusions:

The Oozer Dredge has been eliminated from further consideration due to limited availability and legal constraints.

1.3.2 Pre-Disposal Actions

1.3.2.1 PCB Extraction

Description:

This process would involve the extraction of PCBs from the dredged sediments, disposing of the sediments as non-hazardous material, and sending the PCB-contaminated solvent to a *licensed hazardous waste landfill or incinerator.* Commercially available equipment could be used, although the use would be non-conventional. This process has not been demonstrated and the economics are uncertain.

Technology Status:

PCB extraction is a new application of existing technology.

Conclusions:

Since there are many uncertainties associated with the feasibility and economics of this process, it has been removed from further examination.

1.3.2.2 PCB Destruction

- **Thermal Destruction**

Destruction of contaminants in soils or sediments can be accomplished with the use of a mobile incinerator. The incinerator must meet federal requirements, which state that the incineration of contaminated materials must only be done at steady-state operating conditions, and all wastes must be analyzed before incineration to determine the PCB content and the concentrations of metals in the sediments. All EPA and Massachusetts monitoring requirements must also be met. Incineration methods considered for use for this site are: rotary kiln, Thagard HTFW, pyromagnetics, plasma arc, fluidized bed, molten salt, controlled air, and multiple hearth incineration.

- **Rotary Kiln Incinerator**

Description:

The rotary kiln is a high temperature PCB destruction technique currently available to the market. Two facilities have EPA permits (Texas and Arkansas) to operate incinerators in the 1800 - 2,200°F temperature range. In addition, a test by the EPA is underway using a mobile rotary kiln that will operate at a temperature of 2,200°F.

Technology Status:

Rotary kiln incineration is the only incineration process for contaminated sediments and soils that has been approved by EPA. Mobile or stationary units are currently available, and with little modification can be readied for sediment decontamination.

Conclusions:

Rotary kiln incinerators would be required to be used on site. Transportation of large volumes of sediments to incinerators in Texas or Arkansas would create large economic burdens. The use of this system is feasible however, and the rotary kiln incinerator will be retained for further evaluation.

- **Thagard HTFW**

Description:

Thagard Research Corporation has developed a high-temperature, fluid wall reactor (HTFW) that completely pyrolyzes PCBs, and fixes the residues into nonleachable glasses. This reactor maintains a high temperature (4,000°F) by radiant heat emanating from a gaseous fluid envelope (generally nitrogen). It operates without catalysts, and is thus unaffected by impurities in the feed (water, sulfur, metal). Laboratory tests using hexachlorobenzene (HCB) as a surrogate for PCBs showed a destruction order of 99.9999 percent upon a 0.1 second reaction time.

Technology Status:

Testing of this process is still being done at the laboratory level.

Conclusions:

The destruction of PCBs using a high-temperature, fluid wall reactor will not be evaluated any further, because of its laboratory status.

- **Pyromagnetics Incinerator**

Description:

This incinerator, developed by the Pyromagnetics Corporation, is a portable unit for the detoxification of approximately one ton per hour of total solids. The destruction process uses 5,000 pounds of molten iron at 2,600 to 2,700°F in a primary chamber, into which 200-300 pounds of sand in addition to the contaminated sediments are added (per hour). The volatiles are removed and burned in a second chamber at 4,000°F, while the nonvolatiles are slagged off with the molten sediment and sand. EPA approval has yet to be given to this process since a test with PCBs has not been completed. One problem that may be encountered is the likelihood of the byproduct being greater in volume than the contaminated feedstock.

Technology Status:

PCB destruction via the Pyromagnetics incinerator is considered a developmental process. Until tests are completed with PCBs large scale, use will not be permitted by the EPA.

Conclusions:

This process appears to be a long way from full scale production. Incineration by this method is still under development and more tests will be required before EPA approval is obtained. The use of the Pyromagnetics incinerator for sediment decontamination will therefore not be evaluated further.

- **Plasma Arc Incinerator**

Description:

The plasma arc process is a technique developed for PCB solids destruction which dechlorinates by molecular fracture. The plasma arc is produced by a low-pressure gas through which an electric current (arc) is passed. The by-products that result from passing PCBs through this arc are simple chlorine, hydrogen, and carbon atoms. This process is expected to work on contaminated sediments, and has the advantage of not requiring a solvent extraction of the solids. The development of a soil/sediment facility is still in the future, with the expectations of an energy-efficient process.

Technology Status:

Plasma arc incineration is a preliminary process, that is still in the early stages of laboratory development. This process involves the use of new technologies for which a high degree of testing will be required before operational models are produced.

Conclusions:

Because of the early stage of development and the technical status of the process, plasma arc incineration will not be evaluated further.

- Fluidized Bed Incinerator

Description:

PCB destruction is obtained with this method at a temperature of 1250°F using a chromic oxide and aluminum catalyst. Rockwell International's (the developer) fluidized bed incinerator recently underwent a successful one-gallon test burn of PCBs (at 700°F) for the EPA. Although this process has proven useful for PCB destruction, there are no reported plans to develop this system any further, or to use it in connection with contaminated sediments.

Technology Status:

Although fluidized bed incineration is a well developed technology, its application to hazardous wastes--specifically PCB Contaminated sediments--is still considered developmental.

Conclusions:

Fluidized bed technology has been a long proven process for waste incineration, although its direct application to PCBs remains uncertain. Because a PCB incineration process is not being developed at this time, this process will not be evaluated further.

- Molten Salt Incinerator

Description:

The molten salt incineration process, demonstrated by Rockwell International, destroys PCB waste by injecting a mixture of the waste and air into a sodium carbonate/molten salt mixture at 1450°F to 1800°F. By mid-1983, a portable incinerator rated at 225 pounds per hour should be available. Very good results have been achieved for PCB removal using this method, but this system has not been recommended by Rockwell for use with organic river sediments (a high ash material) due to the high flow requirements needed for transport through the sodium carbonate solution.

Technology Status:

This technology is currently being developed as a spin-off of a process development for coal gassification. Developmental efforts are not focused towards a PCB destruction application, so process development may be slow.

Conclusions:

The availability of this process does not appear probable in the near future, and the molten salt incinerator will not be evaluated further.

- Controlled Air Incinerator

Description:

The Los Alamos National Laboratory has modified a controlled-air radioactive waste incinerator to burn PCB waste. The incinerator is a conventional dual-chamber, controlled-air design with operating temperatures for PCB destruction ranging from 1,600°F (Chamber No. 1) to 2,000°F (Chamber No. 2). Attempts are currently underway to obtain a permit for a PCB test burn. However, the state of development renders this process unsuitable for near-term use on contaminated sediments.

Technology Status:

The use of a controlled air incinerator for PCB destruction is still under development, and much more testing will be required before approval is given for sediment decontamination.

Conclusions:

Because a full scale use of this process for sediment decontamination appears to be uncertain at this time, it was removed from further evaluation.

- Multiple Hearth Incinerator

Description:

Multiple hearth incinerators were originally developed for the treatment of sewage sludges, but have recently been applied to the treatment of various types of industrial wastes. Test burns have been conducted on mixtures of pesticides and PCBs with sewage sludges, and have resulted in high destruction ratios.

Technology Status:

Multiple hearth incineration technology is well developed and has been available for decades. The status of its PCB application is still considered developmental, awaiting testing results and EPA approval.

Conclusions:

Multiple hearth incineration can be used for sediment decontamination with a high degress of process control and high destruction percentages, but excessive costs can be expected. Because of high costs and its developmental status, PCB destruction by multiple hearth incineration will not be evaluated further.

- <u>Critical Point Oxidation</u>:

<u>Description:</u>

A proprietary system developed by MODAR Incorporated uses water at supercritical conditions (1300°F and 3200 psi) and oxygen to effect PCB oxidation. The process is similar to wet air oxidation, although this process takes advantage of the fact that at the supercritical operating conditions, oxygen and many organic materials are completely soluble in water, greatly facilitating the oxidation process. This process has been used to treat contaminated waste streams, and is claimed to be useful for the treatment of contaminated solids (sediments).

A continuous flow reactor designed for use on harbor or estuary sediments would handle an average flow of 1,000 to 5000 gallons (4-20 tons) of solution per day. Sediments would not have to be dewatered before treatment, and all reactions would be carried out in a closed system.

<u>Technology Status:</u>

This process has been demonstrated at the laboratory and pilot plant scales, and when combined with other currently available technologies it should prove to be a technically sound and cost-effective alternative.

<u>Conclusions:</u>

Critical Point Oxidation may prove to be a viable alternative to other destruction technologies and should therefore will be retained for further evaluation.

- Chemical Destruction

  - Acurex

Description:

The Acurex system is a PCB dechlorination process that uses a sodium reagent in a nitrogen atmosphere to effect decompositions. After a solvent wash of the sediments, the resultant extract is fed into the reactor, yielding NaCl and polyphenyl and solvents that can later be reused. A 250 gallon per minute portable reactor has been constructed and should be available for use with contaminated soils and sediments in the near future. Large scale use of the process should follow the approval of current testing.

Technology Status:

The Acurex process is a commercially available process that is permitted in all EPA regions.

Conclusions:

This system could prove to be a favorable alternative to incineration and should be evaluated further.

  - Hydrothermal

Description:

The principle of the hydrothermal PCB decomposition process, as developed by the Japanese at a laboratory scale, is the replacement of chlorine atoms of PCBs with hydroxyl groups in the presence of methanol and sodium hydroxide. Operating at a temperature of 570°F, and a pressure of 2,560 psi (pounds per square inch), this process is reportedly safe, simple, and rapid. The byproducts resulting from the process include sodium chloride and dechlorinated organic compounds, which are safely burned or treated in an activated sludge process.

Technology Status:

The hydrothermal destruction of PCBs is currently in the laboratory stage of development.

Conclusions:

Because the hydrothermal process is only in the laboratory stage of development, and would not be available in the forseeable future, this process was removed from further evaluation.

- *KOHPEG*

Description:

Potassium hydroxide (KOH) and polyethylene glycols (PEG) react with and destroy polychlorinated biphenyls (PCBs), producing reaction products of aryl polyglycols and biphenyls. Laboratory work indicates that PCBs contained in soils with significant organic content will be destroyed, although the process may take several months at ambient temperatures to complete. Decreased reaction time will be realized if elevated temperatures (150-250°F) are used. The process is tolerant of some water, but the use on dredged sediments will require testing to establish the limiting water content level.

Technology Status:

This technology is possibly applicable to contaminated sediments, although a final determination will not be possible until the laboratory work is completed.

Conclusions:

Although this process may prove very applicable to the detoxification of soils, the status of the process development, the problem of water content, and the high cost of the reagent eliminated this alternative from further evaluation.

- Microwave Plasma Destruction

Description:

PCBs in liquid can be destroyed rapidly and effectively by the microwave plasma process. An existing system developed by Lockheed Research Laboratory processes PCBs in liquids in a single column unit that incorporates two 2.5 killowat (kw) microwave radiation units to effect the destruction. The feed stream consists of the PCB contaminated liquid and a carrier gas (oxygen, oxygen-argon, or steam), and the wastes generated include CO_2, CO, H_2O, SO_2 and various waste-specific organochlorides.

This system is set up to handle approximately 20 pounds per hour of contaminated feed, but Lockheed has plans to develop a 100 pound per hour unit in the future. As yet, no testing has been done to determine the process applicability to contaminated sediments, although a solvent extraction of the sediments and treatment of the extract should be possible.

Technology Status:

The microwave destruction of PCBs is still in the development stage. Only laboratory scale work has been done to date.

Conclusions:

This system is not expected to be ready for use with contaminated sediments and will not be evaluated further.

- NaPEG

Description:

This process uses a molten sodium metal dispersed in a polyethylene glycol solution to achieve PCB destruction. NaPEG is similar in process and costs to the KOHPEG process. The reaction products of this process are oxygenated organics, sodium chloride, and polyglycol. The EPA is optimistic about its use in the decontamination of soils, but results from laboratory testing will not be available for some time.

Technology Status:

Testing is still being done on this process at the laboratory level.

Conclusions:

This process was removed from further consideration because of its technology status, and the expected high costs of its implementation.

- PCBX

Description:

The PCBX system is a mobile process used for the destruction of PCBs found primarily in transformer oils. This system was developed by Sun Ohio, and was the first chemical PCB treatment method approved by the EPA. The system reportedly uses sodium salts of organic compounds in an amine solution to effect PCB destruction. The use of this system for contaminated sediments necessitates a solvent extraction of the PCBs from the sediment, and its qualification as a proven method cannot be made until current testing is completed.

Technology Status:

The PCBX system is EPA permitted, but work with PCB-contaminated soils and sediments is very preliminary.

Conclusions:

This technology is EPA permitted for use on transformer oils but its status for use on sediments precludes its further evaluation.

- Goodyear Process

Description:

The Goodyear system involves a non-mobile, exothermic process using sodium naphthalide (including naphthalene, a priority pollutant) in an inert atmosphere for the destruction of PCBs in liquids (primarily oils). Operating at ambient temperatures, the system rapidly destroys PCBs, producing sodium chloride and nonhalogenated polyphenyls as by-products. Application of this process to the sediments of New Bedford Harbor would first require a solvent extraction of these sediments, with subsequent transportation of the extract to the unit for processing.

Technology Status:

This system is EPA permitted and is now standard technology for treating PCB contaminated fluids.

Conclusions:

The Goodyear process was removed from further consideration because the system is not readily available (non-mobile) and would thus incur large transportation costs. In addition, the technology is not established for soil and sediment treatment.

- **Biodegradation**

Description:

Biological destruction of PCBs in sediments is a process which has produced only limited success during its current development. Existing biological agents (microbes, worms) are capable of using PCBs as their sole source of carbon, but only the lesser chlorinated biphenyls (1-5 chlorines) degrade readily. The highly chlorinated biphenyls (6+ chlorines) undergo negligible degradation.

Commercial PCB aroclors are not a single compound, but are a mixture of PCB isomers. Large scale biodegradation of PCBs is difficult to evaluate because of the varied nature of the PCB aroclors and the uncertainties associated with the degradation of PCB isomers. No single microorganism has been found that will oxidize all of the PCB Aroclors.

Technology Status:

All work to date on the biodegradation of PCBs has been done at the Laboratory level. The large scale application of this process is unproven.

Conclusions:

Biodegradation has been elimiated from further consideration because a feasible method has not been found for the large-scale appliation of the biological agent.

- **Particle Radiation**

Description:

One of the major types of radiation used for the destruction of wastes is particle radiation. Most of the work done to date has been conducted with either electron beam or gamma radiation processes. The gamma radiation technique was shown to have little effect on PCBs, while electron beam irradiation produced very good results (96% destruction) requiring less energy. There are still questions remaining with respect to the cost effectiveness of electron beam treatment.

Technology Status:

Particle beam radiation treatment of PCBs in still a laboratory process. There are no reported plans to develop a sediment decontamination process.

Conclusions:

Sediment decontamination using particle beam radiation is still in the early stage of development, and will therefore not be retained for further evaluation.

1.3.3 Disposal Actions

1.3.3.1 Disposal Within Location of Source

Description:

If contaminated sediments are effectively cleansed of PCBs by a destruction or extraction procedure, the sediments may be disposed back into the harbor. It will be necessary to determine that the sediments satisfy any criteria (to be established) on acceptable levels of PCBs before disposal, and extensive testing of sediment properties may be required. Environmental effects of sediment redistribution and increased suspended sediment loads will be a principal issue.

Technology Status:

Not Applicable.

Conclusions:

This disposal alternative will be retained for further consideration.

1.3.3.2 Disposal Outside Location of Source

- **New Upland Landfill Site**:

Description:

This alternative includes siting, design, construction, operation, closure, and post-closure monitoring of an upland landfill facility. The containment area would be designed as a basin with an approved impermeable liner. Contaminated materials would be deposited within the basin, dewatered or stabilized as necessary, and then covered with an approved impermeable cap, in order to minimize the generation of leachate. A collection system would be installed for the monitoring, collection and possible treatment of leachate. Groundwater monitoring wells would also be installed, in order to monitor subsurface water quality. This alternative may be difficult to implement because:

- A high groundwater table is present
- Local soils are generally highly permeable.
- Complex hydrogeologic conditions exist.
- Some potential sites are located in environmentally sensitive areas.
- Long hauling distances are associated with non-urbanized areas.

Technology Status:

Landfilling is widely practiced in the management of hazardous waste sites.

Conclusions:

This alternate will be retained for further evaluation.

- Shoreline Disposal Site:

Description:

This alternative assumes that contaminated sediments will be disposed of in a waterfront location along the Acushnet Estuary or New Bedford Harbor. Bulkheads or earth embankments would be constructed to develop the containment site, and to isolate the contaminated materials from the estuary/harbor system. Potential disadvantages to this alternative include:

- Its suitability to meet federal requirements for hazardous waste disposal.
- The potential for leaching of contaminated groundwater.
- The limited design life of metal bulkheads.

Technology Status:

This technology uses available engineering features, and has been previously developed as a remedial action in similar cases (e.g., Waukegan Harbor).

Conclusions:

This alternative will be retained for further evaluation.

- Existing Chemical Landfill

Description:

Several permitted chemical landfills are available in the U.S. for the disposal of PCB-contaminated sediments. These provide a straightforward resolution of the disposal problem, but unit disposal costs are high due to the transport distance and the current disposal fee structure. The closest PCB-permitted landfill is the CECOS facility near Buffalo, New York, and reportedly this site has a limited amount of space currently available for PCB-contaminated wastes.

Technology Status:

Chemical landfills are permitted for the disposal of PCB-contaminated wastes, but costs are high and volume limitations may be imposed.

Conclusions:

This alternative will be retained for further evaluation, particularly in regard to the disposal of highly-contaminated sediments (e.g., >500 ppm).

1.3.4 PCB Separation and Removal

1.3.4.1 Retrievable Sorbents

Description:

Sorbents can be used to collect contaminants in natural systems because the PCBs have a greater affinity for the sorbent than the sediments. The sorbents can be incorporated with magnetic particles so that the media can later by retrieved with magnetic devices. It is expected that it will be difficult to reduce the PCB concentrations below 50 ppm in very highly contaminated areas.

Technology Status:

Large-scale equipment has not yet been developed for practical application.

Conclusions:

Retrievable solvents shall be eliminated from futher consideration, since they may not be suitable for reduction of PCB concentrations to levels below 50 ppm.

1.3.4.2 Bioharvesting

Description:

This technique requires the removal of aquatic life from the harbor which have accumulated appreciable concentrations of PCBs, with subsequent disposal in an environmentally acceptable manner. An extremely large time frame would be required for this method; it has been estimated in previous studies that between 100 and 10,000 years might be required for the "clean-up" of lower levels of PCB contamination in river sediments.

Technology Status:

Very little information is presently available on the implications or the feasibility of this technology. Even if test cases were developed, the large time frame involved would prohibit a timely documentation of success necessary for futher consideration of this alternative.

Conclusions:

Bioharvesting has been eliminated from further evaluation because it is not technically feasible.

1.3.4.3 Oil-Soaked Mats

Description:

In this alternative, a medium which exhibits a great affinity for PCBs would be applied to the harbor bottom. Mats to which the medium is attached could then be retrieved to remove the contaminants from the natural system.

Technology Status:

The technology is presently in a conceptual stage.

Conclusions:

This technology has been eliminated from further evaluation due to its unproven technical feasibility.

1.3.4.4 Solvent Extraction

Description:

This process utilizes a solvent, a substance for which PCBs have great affinity. When the solvent is mixed with contaminated sediments, the PCBs exhibit a greater affinity for the solvent than the sediments. The solvent will then rise to the water surface, and can be collected and removed. Problems associated with this technique include:

- The potential for toxic residues.
- The accumulation of solvent by organic sediments.
- Turbidity associated with the mixing of the sediments.
- The potential inability of solvents to reduce levels of PCB contamination in highly contaminated sediments to acceptable levels.
- Extensive costs.

Technology Status:

The process is still in the laboratory stage.

Conclusions:

This technology has been eliminated from consideration due to technical infeasibility.

1.4 Support Actions

1.4.1 Solids Dewatering

1.4.1.1 Fixation

Description:

Waste fixation is a chemical process designed to seal wastes or contaminated soils in a hard stable mass, or to remove the free water in freshly dredged sediments. Agents such as portland cement, flyash, lime, pozzolan, sodium silicate, or organic polymers are used to bind or hydrate the free water in dredge spoils. The treated material develops properties of a concrete or loose aggregate, although many of these methods are not meant to permanently secure the waste. In addition, compatibility testing must be done for each technique to determine which would be most suited for this work. A determination would also have to be made as to the point of application of the agent, as for example in-situ treatment or treatment on the shore in preparation for sediment transportation.

Technology Status:

This method involves the use of some very common construction materials, and common mixing technologies.

Conclusions:

The fixation of sediments option was retained for further evaluation.

1.4.1.2 Mechanical/Physical Dewatering

- **Lagoon**

Description:

One of the oldest and simplest methods used for solids dewatering is the sedimentation basin or lagoon. A standard design would be to use two lagoons, alternating the use back and forth as one fills up and requires emptying. Construction would be completed above grade to prevent possible contact with the groundwater. In addition, the sides and bottom of the lagoon would have to be sealed to prevent leakage. Sediment would be retained in the lagoon while the supernatant would be decanted and treated.

Technology Status:

The construction of a dewatering lagoon uses common engineering practice and technologies.

Conclusions:

Lagoon dewatering of solids will be retained for further evaluation.

- **Portable Sediment Processing System**

Description:

A portable three-phase separation system was developed by the EPA to be used for contaminated dredge spoil dewatering. Sediment slurries are stored on shore in a pond awaiting initial sediment processing, which is the hydraulic separation of sand-size and larger particles using portable scalping-classifying tanks. Solids are then removed from the system by spiral classifiers (large-diameter sand screws) which collect, convey, and deposit the removed material in a discharge pile for storage before treatment or disposal. The supernatant leads to the secondary processing, which includes the removal of fine-grained materials. For this, a series of uni-flow filters (hanging polypropylene hoses) would be used. Separation is aided at this stage by the addition of chemical coagulants. Final separation is achieved by a tube settler working in connection with a coagulant addition to remove particles 6 microns in diameter or smaller. Return water would then be treated and returned to the harbor.

Technology Status:

The portable sediment processing system uses current engineering technologies to effect sediment dewatering.

Conclusions:

This system will be retained for further evaluation during the screening process.

- Drying Beds

Description:

Drying (gravity under drainage) bed dewatering of solids is the most widely used solids dewatering method in the United States. Low cost solids drying can be achieved in a reasonable amount of time by the use of sandbeds, requiring little operator attention and skill.

A typical unit would include at least two beds constructed with an underdrain, 8 to 18 inches of gravel or stone, and a top layer of 6 to 9 inches of sand. In addition, a major factor in the design of such a system is the local climate (the amount of precipitation, percent of sunshine, average relative humidity). Depending upon weather conditions, upwards of 45 percent solids can be achieved by this process in as little as two weeks time.

Technology Status:

This process is currently in widespread use throughout the United States.

Conclusions:

Dewatering of solids using drying beds should be effective for this application and will be retained for further evaluation.

- Dehydro Drying Beds

Description:

The sedimentation of dredge spoil solids can be accelerated by the use of dehydro drying beds. Ninety percent of the water can be removed after the addition of a flocculant to the slurry and then filtration with a permeable mat and incorporated vacuum system. To accomplish this, contaminated sediment and the associated slurry are evenly dispersed over permeable mats. and the water is drawn through the bed, aided by a vacuum. The supernatant is collected in a sump and removed or stored for eventual treatment.

Technology Status:

The dehydro drying bed method of drying dredge spoils is a relatively new concept using conventional technical practices.

Conclusions:

Dehyro drying beds will be retained for further consideration.

- **Gravity Thickener**

Description:

Gravity thickeners are similar in design to conventional circular clarifiers, except that they have a greater bottom slope and are constructed with a heavier raking and pumping mechanism. Thickener operation would also be similar to the operation of a clarifier. A sediment slurry would enter the unit at the center of the thickener and solids would settle into a sump at the bottom. Solids would then be removed for eventual treatment or disposal, and the supernatant would be removed from the overflow weir system for treatment. Prior to construction for dewatering sediments, sediment loading rates should be determined in order to optimize the size and number of units required.

Technology Status:

The technology for this dewatering technique is based on sludge thickening technology, and a scale up would present operational and mechanical complications.

Conclusions:

Because of the need to scale-up conventional equipment, considerable testing would be required, and capital and operational costs would be prohibitive. For these reasons, this technology was not retained for further evaluation.

1.4.1.3 Secondary Solids Dewatering

Description:

Secondary solids dewatering may be incorporated to improve handling characteristics and for volume and weight reduction. Methods for secondary dewatering could include:

- Vacuum Filters

  These devices utilize a rotating drum with an internal vacuum to draw the waste through the filter medium. For vacuum filters, the optimum solids content for filtration is about 8 to 10 percent; lower solids contents would probably require undesireably large filters.

- Centrifuges

  A typical centrifuge is composed of a spinning cylinder, which creates high centrifugal forces that push the solids to a screen on the perimeter of the drum. The solids are retained by the screen, while the water passes through. Operation is normally continuous.

- Filter Presses

  These units use high pressure to force water from the secondary solids. The most common type of filter press utilizes a series of rectangular plates, fitted with filter cloth. Carriage water is forced through the filter cloth and into collection channels. The plates are later be separated and the solids removed.

- Belt Filters

These devices utilize two horizontally or vertically moving belts to squeeze the water from the secondary solids. Relatively new, belt filters have been introduced in the past few years, and are projected to perform closely to vacuum filters.

- Drying Beds

Secondary solids are placed in 8 to 12 inch thick layers on the bottom of the drying beds, and allowed to air dry. The solids can then be removed and disposed of by landfill or destruction. Drying beds require large parcels of land for sizeable applications.

Technology Status:

Belt filters are a relatively new technology. The other techniques are widely used for a variety of applications.

Conclusions:

All of the secondary solids dewatering technologies will be retained for further evaluation.

1.4.2 Sediment Dispersal Control

1.4.2.1 Single Silt Curtain

Description:

Silt curtains are constructed from filter fabric, and can be used to minimize the transport of contaminated sediments. Suspended from floats, the curtain is extended around the dredge site, or at least across the downstream portion of the water body. The performance of this technique is sensitive to water surface disturbances, since water may overtop or tear the silt curtain.

Technology Status:

The technology has not been thoroughly tested in cases where performance is critical due to the highly contaminated nature of the sediments.

Conclusions:

Single silt curtains were previously ruled out in similar applications due to perceived inadequate containment of contaminated sediments, and will be similarly ruled out in this study.

1.4.2.2 Double Silt Curtain

Description:

A double silt curtain utilizes the same basic concept as the single silt curtain, except that two curtains are used in parallel with a buffer zone in between. Turbidity in the buffer zone can be further reduced by application of a cationic polymer.

Technology Status:

The technology has not been thoroughly tested in similar applications, but has proven reliable in other uses.

Conclusions:

The double silt curtain shall be retained for further evaluation.

1.4.2.3 Sheet Piling

Description:

Sheet piling, driven into the harbor sediments, can be used to limit the dispersal of *contaminated sediments during dredging. An enclosure constructed of interlocking* sheet piles would substantially reduce the movement of contaminated water and suspended sediment to the outside of the piling. Generally, the water level within the enclosure is maintained at a lower level than the surrounding water. Pumping and treatment of contaminated water would then be required.

Technology Status:

The use of sheet piling in cofferdam construction is a common technology.

Conclusions:

Sheet piling shall be retained for further evaluation.

1.4.3 Surface Water Control

1.4.3.1 Sheet Piling

Description:

Sheet piling can also be used in conjunction with a dewatering process to control surface water flows, and to expose contaminated sediments for subsequent removal or containment. Since the sheet piles are not watertight, water pumping and treatment would be required constantly during the excavation/construction process.

Technology Status:

Surface water control through use of sheet piling is a well established method.

Conclusions:

Sheet piling for use in surface water control shall be retained for further evaluation.

1.4.3.2 Bypass Pipeline

Description:

A gravity pipeline could be utilized to transport the Acushnet River outflow from the northernmost end of the estuary to a point below the Route 195 bridge. This pipeline would accommodate the dewatering of the upper estuary for sediment removal or containment purposes. However, it would still be necessary to handle the local surface water runoff and groundwater which flow directly into the upper estuary.

Technology Status:

Gravity pipelines are used in standard practice.

Conclusions:

This alternative shall be considered during future screening.

1.4.3.3 Bypass Channel

Description:

A bypass channel would be constructed to carry the Acushnet River flows across the upper estuary to the Coggeshall Road bridge. The channel could be constructed from sheet piling, earth berms, or as a structurally supported adueduct. Construction of the channel would permit dewatering, treatment, or dredging of the upper estuary, independent of tidal effects and without disturbance/contamination of river flows.

Technology Status:

Channel construction is a straightforward and commonly used practice.

Conclusions:

This technology shall be retained for further evaluation.

1.4.4 Water Treatment

1.4.4.1 Carbon Adsorption

Description:

Carbon adsorption has been the most widely used process for the removal of PCBs from industrial wastewater. It has proven to be particularly successful in the removal of soluble PCB fractions to below detectable limits in the process effluent. Carbon particles have an extensive surface area that is particularly suitable for the collection of soluble substances. One obstacle to the use of carbon adsorption is that the surface of the carbon is also susceptible to clogging and blinding by suspended solids. Accordingly, a prerequisite to carbon treatment would be influent sedimentation and filtration.

Technology Status:

Carbon adsorption of PCBs is a proven technology.

Conclusions:

Carbon adsorption has been shown to be useful for PCB removal and will be retained for further evaluation.

1.4.4.2 Coagulation/Sedimentation/Filtration

Description:

Coagulation, sedimentation, and filtration have been commonly utilized to collect and remove normally non-settleable particles from contaminated water. Initially, a coagulant is introduced and mixed with the water. Physical and chemical transformations result in the formation of floc. The water is then flocculated (gently agitated) to expedite the growth of floc particles. During sedimentation, the flow-velocity is reduced to allow settleable floc particles to be removed from suspension. Finally, filtration is used to remove all remaining solids that were not settleable during the sedimentation phase.

Technology Status:

These processes are commonly used in wastewater treatment.

Conclusions:

This alternative shall be retained for further evaluation.

1.4.4.3 Klensorb and Activated Carbon

Description:

Klensorb (trademark) is similar to activated carbon and finds its best application when used in combination with carbon. Because Klensorb is not adversely affected by blinding of the absorbent particles, as is carbon, the life of a tandem treatment system can be much greater than a granular activated carbon (GAC) treatment system alone. (PCBs are oily and can be particularly troublesome to blinding of the carbon surface). Some testing has been done with this system, and it has proven to be very effective in the removal of PCBs in water.

Technology Status:

The technology for the use of Klensorb in combination with GAC is presently commercially available.

Conclusions:

This system was retained for further evaluation during the screening process.

1.4.4.4 UV/Ozonolysis

Description:

PCB destruction in wastewater can be achieved with very good results when the water is treated by the use of ultraviolet (UV) light and ozone. This method is suited to treatment of large quantities of waste, although some stringent process conditions must be met. The effectiveness of UV irradiation decreases rapidly with increasing depth, so only a thin film of the process stream can be treated at one time, creating the need for a large surface area. In addition, ozone will decompose at high temperatures so excess heat must continuously be removed from the system.

One problem to be overcome is that ozone is a non-selective oxidant, and it is not known if undesirable end products would develop. Treatability studies would have to be performed on the harbor sediments to determine if further treatment would be required.

Technology Status:

The technique of using ultraviolet light and ozone to destroy PCBs in wastewater is currently in the pilot plant stage of development.

Conclusions:

Since this technology is still in the pilot plant stage of development, and is not available for large-scale use at this time, the system will not be further evaluated.

1.4.4.5 Catalytic Reduction

Description:

Catalytic reduction of PCBs results in the reduction of the chlorine groups on PCBs, leaving a hydrocarbon skeleton that would be susceptible to further biochemical (or other) oxidation. There are no data on the actual performance of the process, which uses a copper-iron catalyst to effect PCB reduction.

Technology Status:

The reduction of PCBs using a copper-iron catalyst is in the conceptual stage of development.

Conclusions:

This treatment technology will not be further evaluated because the technological status is too preliminary.

1.4.4.6 Wet-Air Oxidation

Description:

Wet-air oxidation involves an aqueous phase rapid oxidation of dissolved or suspended organic substances (PCBs) at elevated temperatures and pressures. An almost complete destruction of PCBs can be achieved by a system using a co-catalyst at moderate temperatures (530°F). One method uses a bromide and nitrate anion catalyst in an acidic aqueous solution to accomplish a PCB destruction in excess of 99 percent. The primary advantage of this system is that no dewatering is necessary. This process is also energy efficient due to the fact that the process is exothermic and steam can be obtained from the unit and reused in the process.

Technology Status:

Wet-air oxidation treatment relies on technologies that were orginially developed in the 1950s, and has been successfully applied to PCB-contaminated wastewaters.

Conclusions:

Although the technology is available to achieve the treatment objectives, there are no commercial systems available for PCB destruction, and there are no plans for their development. This technology was removed from further consideration since it is presently not available, and has high costs associated with the development and testing of a commercial unit.

1.4.4.7 High-Efficiency Boilers

Description:

Wastewater containing up to 500 ppm of PCBs can be decontaminated using high-efficiency boilers. A typical system would inject PCB-contaminated water along *with a fuel source into a boiler-tube lined incinerator, where destruction occurs at* approximately 200°F. Much of the heat generated during the process can be recovered as steam generated in the boiler tubes. This steam can then be reused in the process or for power generation.

The high-efficiency boiler destruction of PCBs in water is a very efficient process, whereby PCB contaminant levels can be reduced to almost non-detectable limits.

Technology Status:

The technological basis for this process is acceptable, but the process has not been widely used in industry because of high initial capital costs.

Conclusions:

Because of the high development and implementation costs that would be associated with the construction of a high efficiency commercial boiler, this process will not be evaluated further.

1.4.4.8 Chlorinolysis

Description:

Chlorinolysis would involve the conversion of PCBs to carbon tetrachloride by the addition of chlorine under high pressure and temperature conditions. This process is not reaction-specific, so undesirable by-products may result. This process has not been tested for its applicability to PCB-contaminated water.

Technology Status:

Although this process has been proven to be successful in converting many chlorinated hydrocarbons, no work has been done with PCBs.

Conclusions:

Chlorinolysis will not be retained for futher evaluation because its applicability to PCB-contaminated wastes is unknown.

1.4.4.9 Goodyear Process

Description:

The Goodyear system involves a non-mobile, exothermic process using sodium naphthalide in an inert atmosphere for the destruction of PCBs in liquids. The reagent rapidly destroys PCBs at ambient temperatures, producing sodium chloride and nonhalogenated polyphenyls as by-products. Treatment volumes could be reduced by using a solvent extraction of the liquids. The Goodyear process includes the use of a priority pollutant (naphthalene).

Technology Status:

This method is EPA-permitted and uses available technology.

Conclusions:

Since this system is non-mobile (no mobile unit has been developed), a further evaluation of this technology has been declined due to logistical problems.

1.4.4.10 PCBX

Description:

The PCBX system is a mobile process used for the destruction of PCBs found primarily in transformer oils. This system reportedly uses sodium salts of organic compounds in an amine solution to effect PCB destruction. Water treatment may be enhanced by solvent extraction, although this may not be a cost-effective solution.

Technology Status:

This process is EPA-permitted, and uses available technology for treatment of PCBs.

Conclusions:

Although this process has been proven useful for treating PCBs in oil, no recommendations have been made as to its use on PCBs in aqueous streams, thus eliminating this technology from futher evaluation.

Criteria for Screening of Dredging Equipment:

- Equipment availability
- Draft requirements
- Mobilization/demobilization problems
- Workable dredging depths
- Additional equipment required
- System reliability
- Site-specific applicability
- Dredging rates
- Dredging effectiveness
- Dredge spoil density
- Interference with harbor traffic
- Degree of sediment resuspension
- Legal/institutional constraints
- Technical feasibility
- Transportation requirements for spoils
- Handling of aquatic vegetation
- Equipment/operation costs
- Miscellaneous

Criteria for Screening of Fixation (Capping) Technologies:

- Construction/operation and maintenance costs
- Time required for implementation
- Design life
- Construction problems
- Effects on aquatic environment
- Technical feasibility
- Risk/effect of design failure
- Risk/effect of maintenance failure
- Legal/institutional constraints
- Maintenance requirements
- Interference with harbor traffic
- Miscellaneous

Criteria for Screening of Excavation Equipment:

- Operation costs
- Excavation rates
- Time required for mobilization/demobilization
- Terrain requirements for maneuverability
- Properties of contaminated sediments for handling
- Additional equipment required
- Miscellaneous

Criteria for Screening of Disposal Alternatives:

- Dredge spoil transport distance
- Construction/operation and maintenance costs
- Legal/institutional constraints
- Implementation time
- Public acceptability
- Properties of contaminated sediments
- Degree of sediment contamination
- Potential for PCB exposure to public during operations
- Potential for land use after action
- Type of dredge spoil transport
- Risk/effect of design failure
- Risk/effect of maintenance failure
- Maintenance requirements
- Miscellaneous

Criteria for Screening of Solids Dewatering Technologies

- Process drying rates
- Design considerations and applicability
- Construction/operation and maintenance costs
- Land use requirements
- Legal/institutional constraints
- Public health and environmental concerns
- Community impacts
- Potential for land use after action
- Time required for implementation
- Resultant % solids
- Sediment handling requirements
- Miscellaneous

Criteria for Screening of Sediment Dispersal Control Technologies:

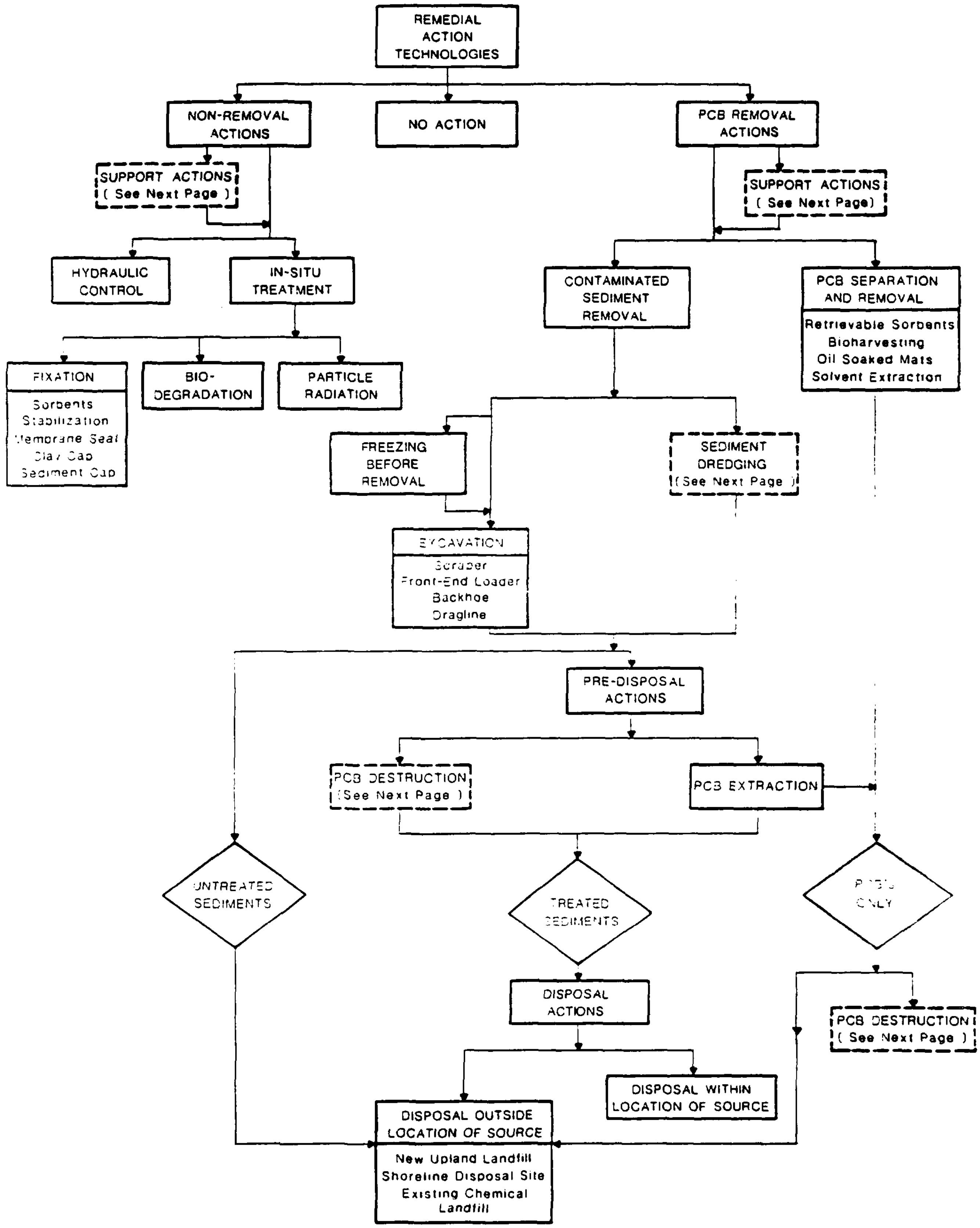
- Construction/operation and maintenance costs
- Time required for implementation
- Durability
- Sediment control efficiency
- Availability of material
- Maintenance requirements
- Miscellaneous

Criteria for Screening of Surface Water Control Technologies:

- Construction/operation and maintenance cost
- Time required for implementation
- Design life
- Construction problems
- Technical feasibility
- Legal/institutional constraints
- Potential for contamination of surface waters
- Handling of high flow conditions
- Maintenance requirements
- Interference with harbor traffic
- Miscellaneous

Criteria for Screening of Water Treatment Technologies

- Construction operation and maintenance costs
- Design considerations and applicability
- Treatment capacities/rates
- Public health & environmental concerns
- Legal/institutional constraints
- Time required for implementation
- Degree of cleanup achievable
- Technology status
- Miscellaneous



TECHNOLOGIES/ALTERNATIVES IDENTIFIED FOR PRELIMINARY SCREENING PROCESS
NEW BEDFORD HARBOR FEASIBILITY STUDY
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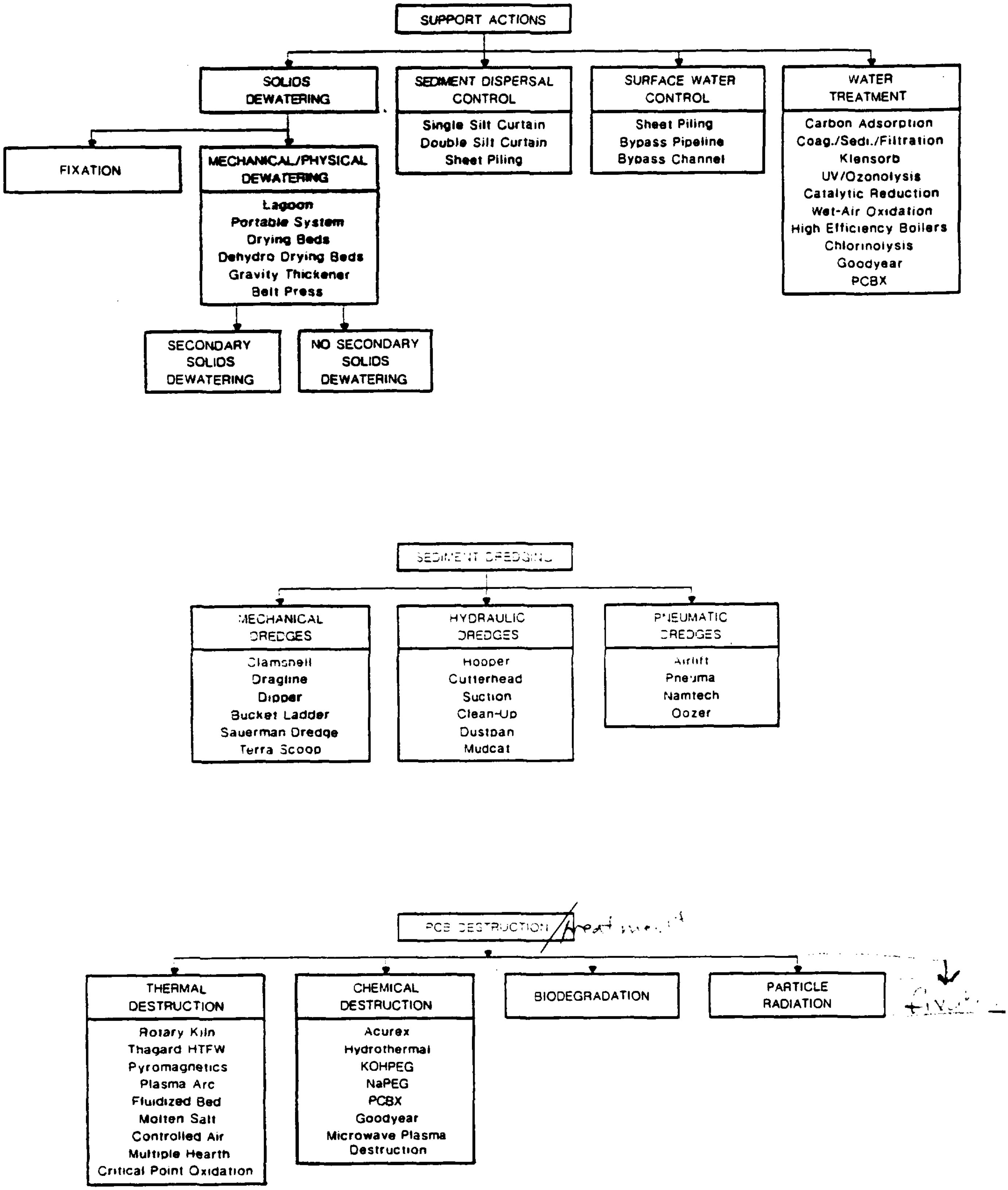

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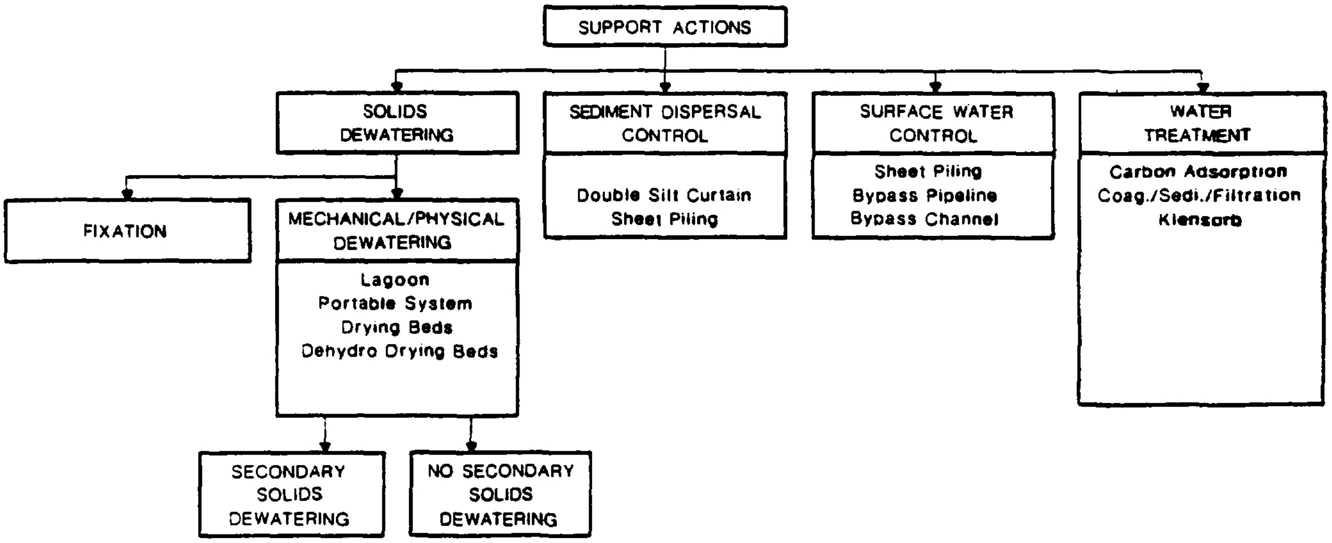

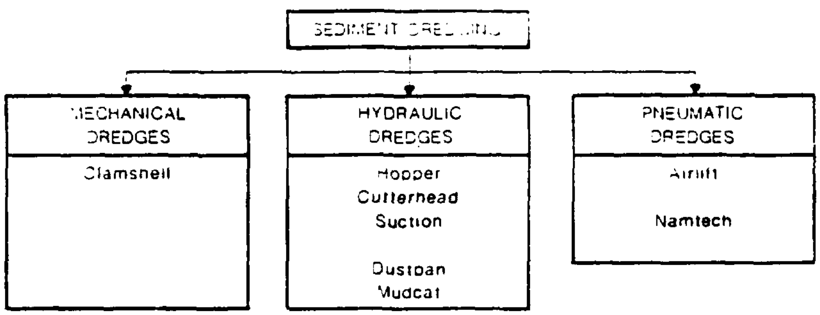

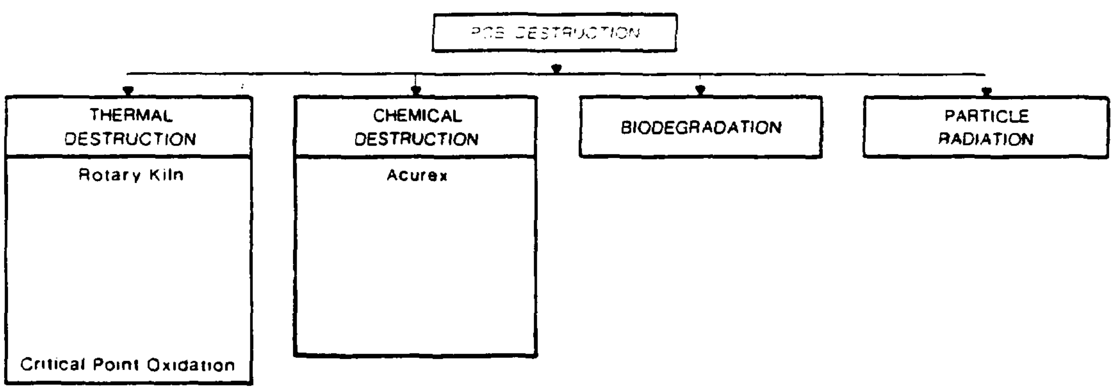

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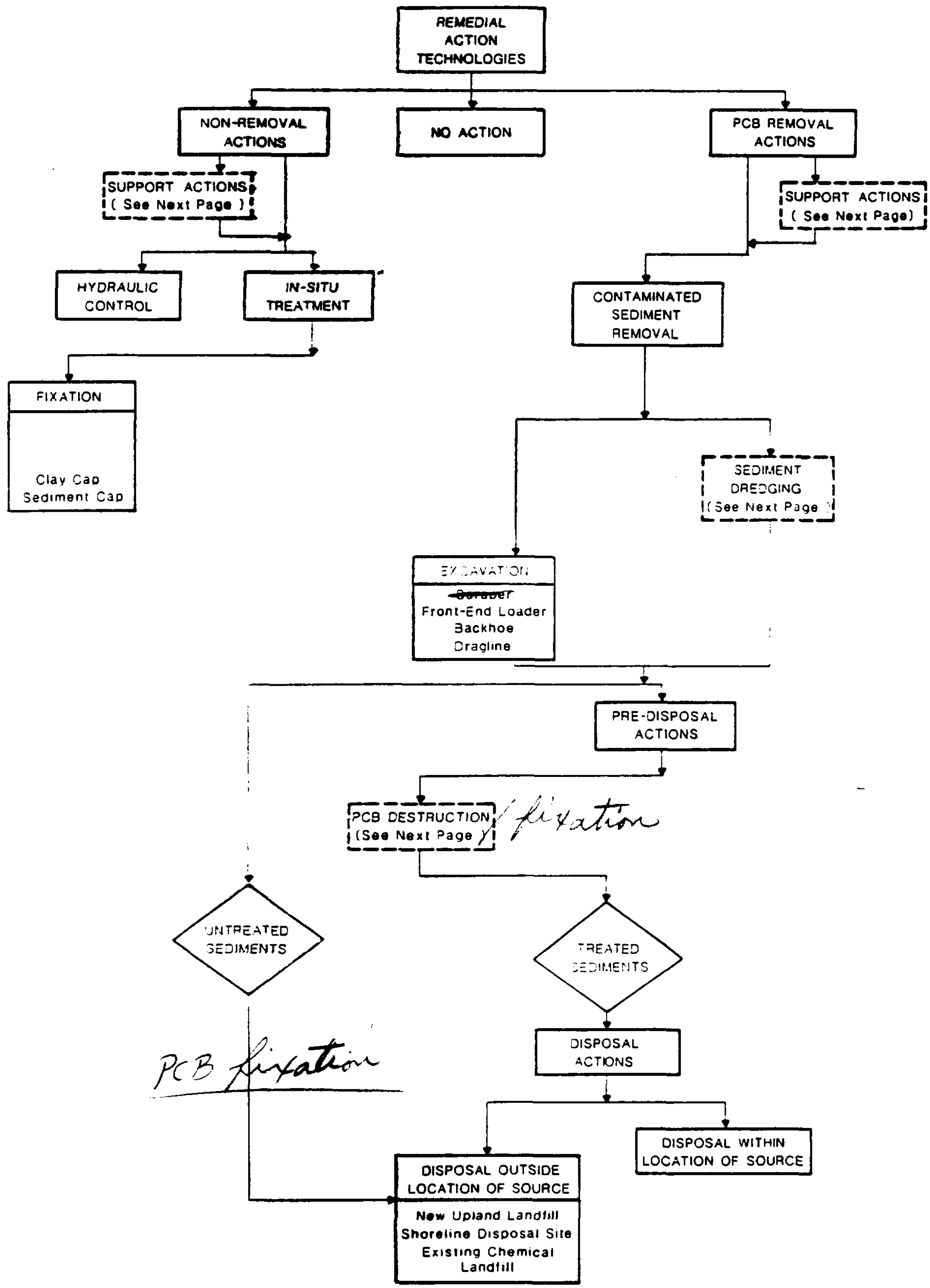

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