Issues in Evaluating Impacts of Dredged Sediment
Confined Disposal Facilities

G. Fred Lee, PhD, MSPH, PE, BCEES, F.ASCE & Anne Jones-Lee, PhD
G. Fred Lee & Associates
El Macero, California
530 753-9630
gfredlee33@gmail.com www.gfredlee.com
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Members of the public in the immediate vicinity of a proposed dredged sediment confined disposal facility (CDF) slated for repeated dredged sediment disposal and mining, are concerned about the potential impacts of the facility. In response to their request of us, this report provides a technical assessment of potential impacts of CDFs on public health/welfare and environmental quality in the vicinity of the facility.

Summary of Findings

Overall, CDFs, like landfills, are inherently incompatible with nearby residential, and recreational, and wildlife areas. There is strong technical justification for the requirement of a substantial land buffer, of at least a half mile, between confined disposal facilities for dredged sediment and residences, recreational areas, and wildlife areas. CDFs can have significant public health/welfare and environment impacts on nearby property owners/users and wildlife through airborne emissions of odors, hazardous chemicals and dust, and discharges of hazardous chemicals to surface and groundwaters. They are known to attract rodents and other vermin, and birds that are a nuisance and public health/welfare problem for nearby residential, recreational, and wildlife areas.

The operation of a CDF for repeated use as temporary storage until sediment is mined for reuse will cause endless noise, odor, visual, and traffic problems in the vicinity and thus disturbance of use and enjoyment of residential property, and to recreational and wildlife areas.

Dredged sediment, even sandy material can be expected to emit noticeable unpleasant to noxious odors. Even if the odors were short-lived and dissipate soon after placement operations, repeated cycles of excavation and additional placement would create repeated episodes of odor emission for as long as the facility operated.

A physical barrier such as a berm is an inadequate "buffer" between a CDF and those within the sphere of influence of a CDF; only an adequate spatial/distance buffer requirement could protect the public and wildlife from adverse impact. Furthermore, not only is a high berm around the CDF not a "buffer" against adverse impact of surrounding areas, but it also creates a visual eyesore and psychological impact.

Because of the nature of dredge sediments (spoils), the unavoidable realities of the operation of a CDF, and the predictable, well-recognized, and inevitable effects of CDF operations on nearby properties, placement of CDFs near residential properties, and recreational and wildlife areas is inappropriate. Many of those impacts cannot be prevented or eliminated by conventional engineering and operation, and thus proper siting is critical. The approaches used for assessing the potential for adverse impacts to ecosystems and public health posed by dredged sediment when placed in an upland disposal area are technically flawed and unreliable for making reliable assessments of potential adverse impacts on ecosystems, groundwater resources, or public health/welfare. Furthermore, there are no regulations sufficient to counter the real "public perceptions" of harmful impacts and depressive effects on values of properties located in too close proximity to a CDF.

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Experience in Evaluating Adverse Impacts of Dredged Sediments and CDFs

General Background

Dr. G. Fred Lee (GFL) earned a Bachelors degree in Sanitary Science/Public Health from San Jose State College, San Jose, CA in 1955, a Masters of Science in Public Health degree from the University of North Carolina, Chapel Hill in 1957, and a PhD degree in Environmental Engineering with minors in aquatic chemistry and public health from Harvard University in 1960. For 30 years GFL held university graduate level environmental engineering teaching and research positions at several US universities, including the University of Wisconsin, Madison, the University of Texas at Dallas, and Colorado State University. From 1984 to 1989, he served as Distinguished Professor of Civil and Environmental Engineering at New Jersey Institute of Technology in Newark, NJ. There he also held the position of Director of the Site Assessment and Remedial Action Division of the industry/university Cooperative Center for Research in Hazardous and Toxic Substances, as well as Coordinator of the Estuarine and Marine Water Quality Management Program for the New Jersey Marine Sciences Consortium Sea Grant

Program. During his professorial career, Dr. Lee conducted over $5 million in research and published more than 500 professional papers and reports on the results of his work.

Since retiring from academia and relocating to California in 1989, Dr. Lee has been a full-time consultant to governmental agencies, industry and public groups in myriad issues of the sources, significance, fate, and control of chemical contaminants in the environment. Focusing largely on public health and environmental quality issues of solid and hazardous waste landfills, discharges to surface and groundwater, stormwater runoff, he has developed another 600 professional papers and reports covering these professional activities. Additional information on Dr. Lee's academic and professional career is available on his website at www.gfredlee.com where many of his professional papers/reports are available.

Dr. Anne Jones-Lee earned her Bachelor of Science degree in Biology from Southern Methodist University in 1973 and her PhD degree in Environmental Science from the University of Texas Dallas in 1978. She was involved in Dr. Lee's DMRP (discussed below) study team beginning in 1975; her PhD dissertation was devoted to evaluating the release of phosphorus from dredged sediments, and she was heavily involved in developing their DMRP summary report and subsequent professional publications. For 11 years after completing her academic studies, Dr. Jones-Lee held university teaching and research positions at several US universities including NJIT, where she held the position of Associate Professor with tenure. In 1989, she relinquished her academic position and joined Dr. Lee in full-time consulting.

Dredged Sediment-Related Experience

Dr. Lee began his research into the chemistry and impacts of sediment-associated contaminants in 1961 while holding the position of Director of the Water Chemistry Program at the University of Wisconsin, Madison. By the late 1960s there was mounting concern that the US Army Corps of Engineers (Corps) practice of dredging river and harbor sediments and disposal of the dredged material open water disposal was causing water pollution; the Corps is mandated by US Congress to maintain navigable waterways to enable the transport of materials via barge/ships. Because of this concern, some environmental groups and governmental agencies advocated that the Corps should stop all open water disposal of chemically polluted dredged sediments and place all dredged sediments on land in what came to be known as "confined disposal facilities" (CDFs), which are basically open landfills. At the time there was little knowledge about adverse impacts of dredged sediments in CDFs, but it was presumed that the disposal of dredged sediment in a CDF was less environmentally damaging than the cheaper open water disposal of the sediments. The Corps staff questioned the reliability of concluding that the Corps should stop all open water dredged sediment disposal and adopt CDF disposal. This led to the Corps' obtaining a $30-million appropriation from the US Congress to support a Dredged Material Research Program (DMRP) a 5-year research program devoted to investigating and assessing the impacts of dredging and dredged sediment disposal associated with the dredging of US waterways to maintain navigation depth. In the early 1970s the Corps Waterways Experiment Station in Vicksburg, Mississippi asked Dr. Lee to initiate research on the water quality significance of chemical pollutants in dredged sediments as part of the DMRP. Dr. Lee was also appointed to the Corps' DMRP steering committee.

During his more than a decade of work with the DMRP, Dr. Lee conducted about $1-million in laboratory and field research on the water quality significance of chemical pollutants in dredged sediments associated with open water (deeper) disposal of the dredged sediments and the development of laboratory tests to predict impacts. His research specifically focused on examining the extent to which chemicals (potential pollutants) in dredged sediments would be released to the water column when disposed of or dumped in deeper waters, and thereby be a threat to aquatic life and other beneficial uses of the water. As discussed in this report however, that finding, is not applicable to the behavior of sediment-associated contaminants when placed on land. His work also focused on the development of laboratory testing approaches to reliably assess the extent to which chemicals would be expected to be released from given sediments when dredged and disposed of in open water. In cooperation with the Corps, Dr. Lee studied the release of about 30 potential pollutants in about 100 dredged sediments (including heavy metals (e.g., Cu, Zn, Hg, Pb), pesticides, PCBs, ammonia, nutrients, and oxygen-demanding substances) from about 30 locations through the US in laboratory and comprehensive field studies. His studies included measuring the aquatic life toxicity of the waters and sediments when suspended in the water column. One of the areas studied was the impact of disposal of highly polluted waterway sediments from NJ and NY channels that were dumped at the NY Bight dredged sediment disposal site. The results of these studies were published in a series of reports including the following (for some reports only limited portions are available online as noted):

Jones, R. A., and Lee, G. F., "Evaluation of the Elutriate Test as a Method of Predicting Contaminant Release during Open-Water Disposal of Dredged Sediments and Environmental Impact of Open-Water Dredged Material Disposal; Volume I: Discussion," Technical Report D-78-45, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS (1978).
http://www.gfredlee.com/Sediment/DMRP_VolumeI_Discussion.pdf

Lee, G. F., Jones, R. A., Saleh, F., Mariani, G., Homer, D., Butler, J., and Bandyopadhyay, P., "Evaluation of the Elutriate Test as a Method of Predicting Contaminant Release during Open-Water Disposal of Dredged Sediments and Environmental Impact of Open-Water Dredged Material Disposal; Volume II: Data Report Part 1" (Pages 1-611) Technical Report D-78-45, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. (1978).
http://www.gfredlee.com/Sediment/DMRP_VolumeII_Data_Report_Part1_Summary.pdf
[Data Report Summary and Table of Contents only]

Lee, G. F., Jones, R. A., Saleh, F., Mariani, G., Homer, D., Butler, J., and Bandyopadhyay, P., "Evaluation of the Elutriate Test as a Method of Predicting Contaminant Release during Open-Water Disposal of Dredged Sediments and Environmental Impact of Open-Water Dredged Material Disposal; Volume II: Data Report Part 2" (Pages 612-1186 + appendix) Technical Report D-78-45, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. (1978) [NTIS No. AD A061 710]
http://www.gfredlee.com/Sediment/DMRP_VolumeII_Data_Report_Part2.pdf

Lee, G. F., Piwoni, M., Lopez, J., Mariani, G., Richardson, J., Homer, D., and Saleh, F., "Research Study for the Development of Dredged Material Disposal Criteria," Contract Report D-75-4, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS (1975) NTIS No. AD A019 953
http://www.gfredlee.com/Sediment/DMRP_Disposal_Criteria_Summary.pdf [Abstract only]

A summary of findings of those studies is available as:

Lee, G. F. and Jones-Lee, A., "Water Quality Aspects of Dredging and Dredged Sediment Disposal," Chapter 14 IN: Handbook of Dredging Engineering, Second Edition, McGraw Hill, pp. 14.1 to 14.42 (2000). http://www.gfredlee.com/Sediment/Dredging_Water_Quality.pdf

Many other of Dr. Lee's professional papers and reports that were developed as part of his DMRP and post-DMRP studies are available on his website [www.gfedlee.com] in the Contaminated Sediments section [http://www.gfredlee.com/psedqual2.html#contaminated].

Basically the Dr. Lee's DMRP work revealed that except for ammonia, potential chemical pollutants were not released from the dredged sediments in amounts of concern when suspended in water. His work also demonstrated, based on laboratory testing and field verification, that the elutriate test developed by the Corps DMRP staff was reliable for evaluating the potential release of pollutants from dredged sediments when disposed in open water. The results of Dr. Lee's studies were adopted by the US EPA and Corps in the late 1970s as a basis for evaluating the potential for water quality problems associated with dredged sediment in open water disposal. This testing procedure is still being used today as a dredged sediment water quality evaluation methodology.

As part of their DMRP and post-DMRP studies Drs. Lee and Jones-Lee have investigated potential water quality and environmental impacts of dredged material placed in CDFs. As noted below and discussed in their DMRP reports and subsequent publications, contrary to presumptions from the late-1960s that linger in some circles to this day, disposal of polluted dredge sediment in CDFs can readily cause greater adverse impact to environmental quality than open water disposal.

Many of the public health/welfare and environmental quality concerns associated with CDFs are common to solid and hazardous waste landfills. Dr. Lee has substantial expertise and experience in the evaluation of potential and actual public health/welfare and environmental quality problems associated with proposed, new, and expanded solid and hazardous waste landfills. That work has included involvement in the development and revision of state regulations, the investigation of about 80 landfills in the US and other countries, and the publication of invited professional papers on these issues. A discussion of his experience, as well as downloadable copies of many of his professional papers and reports are available on his website, www.gfredlee.com in the Landfill Impacts section [http://www.gfredlee.com/Landfill_Impacts.html].

Review of Potential Impacts of CDFs on Nearby Properties

Public health and welfare, and environmental quality issues and problems associated with CDFs and similar sites are well described and documented in the professional literature, including our own reports and papers. This section summarizes commonly recognized issues that need to be reliably addressed in the siting, construction, and operation of CDFs to provide protection of public health and welfare and environmental quality.

Under the auspices of the International Navigation Association, EnviCom Working Group 05, a group of 20 engineers and scientists from Europe, Canada and the USA developed a comprehensive review of issues and environmental guidelines for disposal of contaminated dredged sediment:

PIANC, AIPCN, "Environmental Guidelines for Aquatic, Nearshore and Upland Confined Disposal Facilities for Contaminated Dredged Material," International Navigation Association EnviCom Working Group 5, PIANC, Brussels, Belgium (2002) (http://www.pianc.org/edits/articleshop.php?id=4000051)

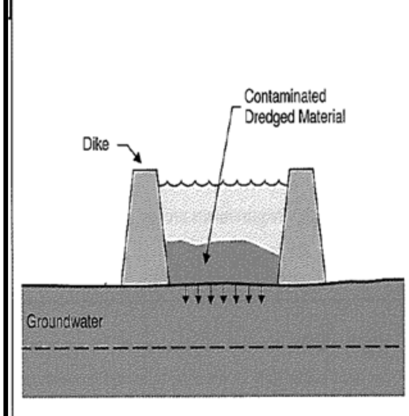
That report contains a fairly comprehensive summary of aspects of CDFs that pose concerns for the protection of public health/welfare and environmental quality, as well as the findings from case studies around the world; it is cited and quoted in this report as PIANC/AIPCN (2002). Quotations are noted by italics.

Nature of Dredged Sediment and CDFs

Dredging of waterways to maintain navigation depth is essential to commerce and a responsibility of the Corps of Engineers. However, dredged materials (also called dredge spoils), even some from seemingly "clean" waterways, frequently contain a variety of heavy metals and organic chemicals (e.g., pesticides, PCBs, oxygen-demanding substances) that can be a threat to human health/welfare, wildlife, and water quality. Open water disposal is typically the least expensive alternative for disposal of dredged sediments; those sediments that are judged to be too contaminated to permit their disposal in open water must be disposed of by alternate means, including in an upland CDF.

PIANC/AIPCN (2002) provided a schematic drawing of a CDF shown below; clearly such a facility is inappropriate near residences.

Figure 1-1



Potential Impacts on Public Health/Welfare
and Environmental Quality

CDFs can have significant impacts on public health and welfare of those in their spheres of influence and on environmental quality, impacts that cannot be prevented or eliminated by conventional engineering and management practices and must be addressed through proper siting. Many of these impacts are well described in the professional literature. A brief summary of some of this information as well as our experience is presented in this section.

The PIANC/AIPCN (2002) report summarized these effects as follows:

> *"The potential environmental impacts of CDFs include physical impacts to the surrounding environment; releases of contaminants through various pathways, including effluent during filling, surface runoff through precipitation, leachate to groundwater, volatilization to the air, and uptake by plants and animals; and other potential impacts such as noise levels, visual considerations, and traffic."*
>
> *"Plant roots from large vegetation may penetrate caps of uncontaminated material allowing oxygen to penetrate further down in the disposal site. Animals such as rats and mice may excavate tunnels in the CDF or destroy the drainage system."*

Groundwater Flow

The effects of CDFs on groundwater hydrology and quality depend on the characteristics of the soil/substrate, the depth to groundwater, the character of the dredged sediment, and the design of the CDF. As discussed by PIANC/AIPCN (2002), upland CDFs place extra weight on the underlying soil/substrate layers, which will weaken the foundation of the CDF, may lead to formation of marshy or swampy conditions around the CDF, and may change the groundwater flow pattern in the area.

Surface and Groundwater Quality

Lee and Jones-Lee (2000) discussed how disposal in CDFs affect the nature and availability of dredged sediment-associated contaminants to adversely affect public health/welfare and surface and groundwater quality:

> *"While it has been commonly assumed that confined disposal of dredged sediments, which involves placing them on land or behind dikes to form an island in water, is less environmentally damaging, these assumptions are not necessarily correct. In fact, it is now beginning to be more widely recognized that at some locations upland disposal of contaminated dredged sediments has a greater potential for adverse environmental impact than openwater disposal of dredged sediments. As generally practiced today, "confined" disposal does not truly confine deposited sediment, but rather provides a settling area where the larger, more dense particles are removed and the water associated with the hydraulic dredging operation is allowed to enter the watercourse. With few exceptions, confined disposal operations have overflows to the nearby watercourse where any constituents released from the sediments during the dredging operation, as well as those constituents associated with the fine materials that are not removed in the disposal area, enter the water. Since it is the fine materials that often have the greatest affinity for constituents, if the constituents are or become available from the fines, then more ecological/water quality damage could result from so-called confined disposal than with open-water disposal, because the area where the confined disposal overflow occurs, i.e., nearshore, is generally the most ecologically sensitive area of the waterbody.*
>
> *"Studies conducted at the US CE Waterways Experiment Station (Palermo, 1986) have shown that the sediments in a confined disposal area, which when wet retain the constituents*

such as heavy metals, upon drying tend to release these heavy metals. This appears to be related to the oxidation of the amorphous sulfides present in the sediments which are keeping the heavy metals in particulate form and the development of acidic conditions. It may also be related to the aging of the ferric hydroxide precipitate (hydrous oxides). While freshly precipitated ferric hydroxide has a substantial binding power for constituents, aged precipitates, especially those that dry out, lose some of this binding power. It is, therefore, not surprising to find that heavy metals associated with dredged sediments, when placed in a confined disposal area that is allowed to dry out, will show appreciable release of heavy metals to the overflow waters the next time that dredged sediments are introduced into the area. This situation can also occur with atmospheric precipitation drainage and runoff from these areas. It is important that those who advocate upland disposal of contaminated dredged sediments conduct a proper, critical review of the adverse impacts of the constituents associated with the sediments which leave the confined disposal area during overflow during dredging operations or via drainage from the disposal site. pH changes from neutral to acidic probably have the most profound effect on metals release."

PIANC/AIPCN (2002) also discussed these phenomena. It described that the release of contaminants from the deposited sediment is influenced by the pH of the materials, which in turn is affected by the redox conditions in the material and changes in redox conditions. Organic material in the sediment, including aquatic organisms removed with the sediment during dredging, is subject to bacterial decomposition, which consumes oxygen. As the oxygen becomes exhausted, anaerobic metabolism can proceed with sulfate reduction as the source of energy; this process will increase the pH. Under anoxic conditions, metals exist in reduced, insoluble forms. When and as the deposited materials become oxidized, the decreased pH leads to greater solubility and volatility of contaminants. That report also recognized this problem when it concluded that one of the disadvantages of CDFs is:

"De-watering of the CDM will result in oxic conditions, increasing the possibility of the mobilization of heavy metals to the surface and ground waters."

and

"Isolation measures may be needed to reduce advective transport of contaminant during the life time of the CDF."

A CDF may release sediment-associated contaminants directly to surface water and/or groundwater by dewatering or runoff discharges, and also by seepage and migration of leachate through dikes or confining structures and the bottom of the CDF. Dewatering liquid from the deposited dredged material contains leachable contaminants from the dredged material and if inadequately captured and treated, poses a threat to surface and groundwater quality as it is released from the CDF. After dewatering, leachate will continue to be formed with the introduction of precipitation and runoff water onto the CDF, as well as with the entrance of groundwater up into the CDF. As this water mixes with the deposited material it will leach components from the dredged material.

The migration of dissolved chemical substances to groundwater depends on the mobility of the contaminants as well as the nature of the substratum beneath the CDF. Once polluted with dredged sediment-associated contaminants such as heavy metals and pesticides, otherwise potable groundwater can be rendered unsuitable for domestic and certain other purposes.

The seepage of leachate from a CDF through a berm or other confinement to the surface can pose a public health risk for those who come in contact with it, as well as a risk to wildlife. Berm failure with release of sediments and pollutants to nearby property can cause physical, human health/welfare, and wildlife health impacts.

Entrance of water into a CDF, and exit of untreated leachate from the CDF via groundwater, seepage, and surface runoff needs to be prevented to prevent the pollution of groundwater and area surface water. Measures to reduce the inflow of groundwater and the escape of liquid from the CDF to groundwater typically involve measures such as placement of berms and liners beneath and around the CDF. As discussed by Lee and Jones-Lee (2015) even well-designed liners used in waste management facilities today are subject to construction and installation deficiencies, interactions with certain waste components, and deterioration that prevent them from being reliable long-term barriers to leachate migration from lined waste facilities.

Ecology

CDFs can adversely impact nearby public recreation areas due to potential chemical contamination as discussed above, as well as odors, noise, and heavy traffic. They also attract rodents, other vermin, and birds that may be expected to outcompete or otherwise not be compatible with existing sensitive wildlife.

As discussed by PIANC/AIPCN (2002),

> *"Removal of existing habit by burial beneath the deposited sediment is the most likely direct effect of a new CDF."*
>
> *"Indirect ecological effects are those generated by release or removal of chemical (toxic) compounds from the deposited sediment and from permanent changes in hydraulic and morphologic dynamics of the system."*
>
> *"The release of chemical substances that might be absorbed in the food chain is the most severe ecological effect of a CDF. The compounds, e.g., heavy metals, are often not degradable in nature or are very slow to degrade and the concentration tends to increase with the level in the food chain. A well planned, built, and maintained CDF should minimize or even totally prevent this effect and that is the whole idea of investing in a CDF."*
>
> *"Disturbance in form of traffic and noise may also have an impact on the local wildlife, but the newly created sheltered land with no access to the public, including hunters, will often function as a wildlife refuge attracting birds and other larger animals. However, this may be a problem if the animals prey on contaminated organisms with in the CDF."*

Air Quality

As discussed by PIANC/AIPCN (2002),

> *"Two main factors affecting the air quality in and around a CDF should be addressed. Oxidation of organic-rich anoxic sediment will unavoidably lead to the formation of sulphur, but under normal circumstance only the smell will affect the surroundings.*
>
> *"Volatilization of contaminants may present a hazard if free air exchange over the CDF is limited, e.g., by buildings. It is known that high levels of such contaminants as mercury can be found in the air in buildings placed on old disposal sites for mercury-contaminated*

sediment. Organic contaminants may generate toxic gases during bacteriological degradation. The concentration of such gases will not reach a critical level unless the air exchange over the CDF is limited.

"Dust formation may occur when dredged material dries out and this may also become a potential pathway for the spread of contaminants."

Airborne releases from a CDF can be expected to contain not only noxious odors from decaying organic matter and sulfur, but also hazardous volatile chemicals and chemicals such as silica that can be included in airborne dust from a CDF. It has been well established that noxious odors can, themselves, be a threat to public health, whether or not the odor is caused by chemicals that themselves cause direct harm. Airborne emissions are not controllable other than by dilution in air downwind of the CDF. These chemicals will be a threat to nearby residents who are within the sphere of influence of the CDF.

Noise Levels

As discussed by PIANC/AIPCN (2002),

"During the construction of a CDF noise levels reach the same level as that on a normal construction site. During filling, noise may be generated by earthmoving equipment."

Pumps that may be employed in the dewatering of the deposited dredged sediment would also be expected to cause nuisance noise in the residential neighborhood. While the PIANC/AIPCN report suggested that noise may not be a problem outside the CDF, it did not consider a continually or routinely intermittently operating facility at which material is repeatedly dumped and mined, or one that was sited in a residential neighborhood. Noise from a CDF may also be expected disturb wildlife and those using nearby recreational areas.

Visual Considerations

The discussion of visual impacts of CDFs by PIANC/AIPCN (2002) did not consider a situation in which a CDF is constructed in close proximity to residential areas or other areas frequented by people. However, that report did recognized the adverse aesthetic impacts of CDFs on those nearby when it stated one of the disadvantages of CDFs to be:

"Dikes may be large and the public may raise objections based on aesthetics."

It also noted, and described as an "advantage" of CDFs:

These facilities are *"Highly visible, therefore its presence will be apparent to the local community in the long term and unintentional disturbance is unlikely."*

This is clearly not an advantage to those living near such a facility.

Use of a physical barrier such as a high berm as a substitute for adequate land buffer in populated areas would be a visual blight for the residents and a constant reminder that it serves as the restraining feature to protect the residents and nearby habitat and recreational areas from seepage and odor emanations, and harm from the sediments behind it. There are also visual and aesthetic problems associated with the birds, rodents, and other vermin that would frequent the CDF.

Traffic

As discussed by PIANC/AIPCN (2002)

"Most CDFs are constructed to receive tens of thousands of cubic meters during their lifetime, which makes intensive truck traffic necessary if the only mean of access is by road. Dredged material is not easily transported by truck owing to the significant amount of water in the material. If the material is not dewatered to some degree before transport, spillage is more likely to occur and pore water will be squeezed out of the material during the transport.

"If the filling of a CDF is based fully or partly on land transport, the road and railroad net must be sufficient to cope with the increased load."

For situations in which a CDF would be used as temporary storage of dredged sediment prior to reuse, the problems of increased truck traffic in the area would be expected to occur as the dredged sediment was being removed. Since that CDF is planned to be in continuous use and reuse, truck traffic and attendant noise, disturbance, road wear and mud/dirt littering, dust emissions, etc., would continue for as long as the facility was in operation.

Property Value

Landfills of various types are known to be adverse to nearby property values; Lee and Jones-Lee (2015) discussed this issue as quoted below.

"Hirshfeld et al. (1992), of Duke University, in a paper, 'Assessing the True Cost of Landfills,' have summarized the potential impacts of landfills that should be addressed as part of landfill development. They point out that the environmental and social costs of landfills are usually ignored, which in turn inhibits the development of other waste management options, such as waste reduction, recycling and resource recovery. They divide the impacts of landfills into "physical" impacts and "social" impacts. The physical impacts are related to ground and surface water pollution by leachate migration, atmospheric releases of landfill gas, and fires. Landfill gas is known to cause explosions resulting in loss of life and property, and damage to vegetation. Hirshfeld et al. also point out that the non-methane organic compounds in landfill gas contain toxic chemicals that are a threat to cause cancer. Further, other components in landfill gas, such as hydrogen sulfide and organosulfur compounds can cause unpleasant odors associated with landfills."

Hirschfeld et al. found that property values within about one mile of a municipal landfill experienced decreased property value.

Summary of Key Impacts

CDFs can have significant public health and environment impacts on nearby property users/owners through

- Releases of odors, hazardous chemicals in airborne and water discharges to surface and ground waters, including silica/silicosis
- Rodents, birds-gulls
- Adverse impacts on nearby public recreation areas
- Adverse impacts on nearby wetlands and wildlife habitat
- Berm failure with release of sediments and pollutants to nearby property can cause physical, human health/welfare, and wildlife health impacts
- Incompatible with residential, recreation, wildlife land use
- Disturbance of use and enjoyment of private property by industrial activity in nearby residential and public recreation area
    - Noise

- Odor
- Traffic
- Decreased property values owing to these issues, including decreased aesthetic value of area near CDF and adversely impacted visual quality of the area

These impacts can readily lead to justifiable NIMBY (not in my backyard) for those who own/use properties in the sphere of influence of a CDF that is sited without adequate buffer land between the CDF dike and adjacent property lines.

All of these potential impacts should be evaluated in the permitting of a new CDF and reuse of a formally used inactive CDF.

Unreliable Evaluation of Dredged Sediment Chemical Composition
Regulatory agencies and the US Army Corps of Engineers attempt to use the bulk chemical composition based on the total concentration of selected common contaminants to estimate the potential release from the sediments placed in a CDF. We have had more than five decades of experience in evaluating the factors that control the releases of chemical that can be adverse to public health and wildlife in CDF releases. It is clear that because of the nature of dredge spoils, the unavoidable realities of the operation of a CDF, and the predictable, well-recognized, and inevitable effects of CDF operations on nearby properties, placement of CDFs near residential properties, and recreational and wildlife areas is inappropriate.

Use of a physical barrier such as a dike, as a “buffer” between a CDF and those within the sphere of influence of a CDF is inadequate to protect the health and welfare of those near the CDF; only spatial/distance buffer requirements, such as a minimum 2000-ft separation would protect public health/welfare and environmental quality. Furthermore, not only is a high berm around the CDF not a “buffer” against adverse impact of surrounding areas, but it also creates a visual eyesore and psychological impact.

An issue of concern to those who reside near high CDF berms/levees is berm failure with release of sediments and pollutants on nearby property cause physical and human and wildlife health impacts.

CDFs located in residential and important wildlife habitat areas represent incompatible land use by being adverse to other desirable uses of nearby areas. CDFs during periods of filling and removal of the deposited sediments for beneficial uses represent disturbance by industrial activity in nearby residential and public recreation area through noise and truck and other traffic.

US Army Corps of Engineers Guidance for CDFs
The US Army Corps of Engineers (COE) has developed several documents devoted to general aspects of dredging and dredged sediment management, including in CDF. The US COE (2003) manual focused on common contaminant releases from a CDF and their impacts on public health, water quality, ecosystems and related issues. It did not, however, include information on the numerous significant adverse impacts of CDFs the property owners/users. It stated,

> *“This manual, the Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities - Testing Manual, commonly referred to*

as the Upland Testing Manual or UTM, is a resource document providing technical guidance for evaluation of potential contaminant migration pathways from confined disposal facilities (CDFs)."

"1.2 Purpose and Scope
The purpose of the UTM is to provide technical guidance for evaluation, where appropriate, of potential contaminant migration pathways for proposed disposal of dredged material in CDFs. Procedures in the UTM will:
1. Determine potential contaminant releases and contaminant-related environmental effects from CDFs.
2. Determine whether pathway-specific contaminant controls or management actions are necessary for the proposed CDF to avoid unacceptable adverse effects outside the site."

"1.3 CDF Contaminant Pathways
Contaminant migration pathways (hereinafter referred to as pathways) are routes by which contaminants or constituents of concern (COCs) associated with dredged material may move from the dredged material within the site into the environment outside the site.

The possible pathways from an upland CDF are illustrated in Figure 1-2.
These pathways are:
1. Effluent discharges to surface water during filling operations and subsequent settling and dewatering.
2. Precipitation surface runoff.
3. Leachate into groundwater.
4. Volatilization to the atmosphere.
5. Direct uptake by plants and animals living on the dredged material and subsequent cycling through food webs. For evaluation in the UTM, the direct uptake pathway is subdivided into animal bioaccumulation and plant bioaccumulation."

"Effects on surface water quality, groundwater quality, air quality, plants, and animals depend on the characteristics of the dredged material, management, and operation of the site during and after filling, and the proximity of the CDF to potential receptors of the contaminants."

Its review of the potential impacts of CDFs on nearby properties stated that at this time there are no restrictions of siting of CDF considering impacts of CDFs on public health and the environment.

US Army Corps of Engineers Environmental Laboratory staff report (Schroeder et al., 2000) describes testing and analysis of dredged material for evaluating the material for suitability of disposal in an upland CDF. This report could serve as guide that should be used for evaluating the potential impact of contaminant release that is disposed in a CDF. One of the chemical characterization of a sediment is the toxicity characteristics leaching procedure (TCLP). The authors propose that this procedure can be used to predict whether the contaminants on dredged sediments when deposited in a CDF will release the contaminant in water discharges from the CDF and thereby adversely impact receiving the CDF discharges. As discussed in the our

DMRP report referenced above extensive testing of the leaching of contaminants associated with dredged sediments from waterway sediments from many areas of the US the TCLP is not a reliable approach for evaluating the release of a pollutants from dredged sediments. This issue is discussed in

> Lee, G.F. and Jones, R.A., "Application of Site-Specific Hazard Assessment Testing to Solid Wastes," IN: Hazardous Solid Waste Testing, ASTM STP 760, American Society for Testing and Materials, pp. 331-344 (1981).
> http://www.gfredlee.com/HazChemSites/Haz_Assess_Solid_Wst.pdf

The TCLP test was developed by the US EPA somewhat arbitrarily divide the solid waste stream into those wastes that can be placed in a municipal solid waste landfill or must be deposited in a hazardous waste landfill. The conditions of the TCLP are inappropriate for evaluating the potential for a chemical that is a potential pollutant to be leased in a particular situation at sufficient concentrations to be adverse to water quality. Another problem that is frequently encountered is that those conducting leaching tests fail to use sufficiently sensitive analytical testing procedure to determine whether the so-called non-detect analytical result is below the concentrations that can be adverse to water quality. An example of this issues frequently occurs with evaluating the potential for PCBs in a sediment or waste are released at sufficient concentration to bioaccumulate in aquatic life to excessive to impair the use of fish as a food.

> Lee, G.F., and Jones-Lee, A., "TCLP Not Reliable for Evaluation of Potential Public Health and Environmental Hazards of PCBs or Other Chemicals in Wastes: Unreliability of Cement-Based Solidification/Stabilization of Wastes," Report of G. Fred Lee & Associates, El Macero, CA, September (2009).
> http://www.gfredlee.com/Landfills/TCLP_Solidification.pdf

Overall it is not possible to reliably estimate whether chemicals in dredged sediments will be pollutants and impair the water quality, violate water quality criteria/standards in the receiving waters through the use of the TCLP.

Recommendations

Overall recommendation for siting, operation, closure, utilization, and maintenance of CDFs to minimize impacts:

- Provide adequate setback/buffer between the CDF dike and nearby residential recreational, and wildlife areas
    - A minimum of a half-mile is reasonable to provide dilution of releases on nearby property; greater distance may be appropriate given site-specific considerations
    - Setback/buffer must be sufficient to prevent adverse impacts to use and enjoyment of properties and public health/welfare at the CDF property line
    - Allow no trespass of odors, nuisance, pollutants off CDF property
- Permitting a new CDF or the reuse of a previously used CDF should include proper, disinterested evaluation of the suitability of the proposed facility to accept and manage dredged sediment without significant adverse impact to public health, environmental quality, or the interests and welfare of the public within the sphere of influence of the CDF, and should be conducted with full public review.

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