Confined Aquatic Disposal of Dredged Material at Bremerton Naval Complex
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This presentation describes sediment remediation at the Bremerton Naval Complex (BNC) in Bremerton, Washington. Descriptions are given for state-of-the-art features including environmental clamshell buckets, dGPS guidance systems, precise dump barge positioning, extensive water quality monitoring, and removal of compressed gas cylinders with 72-inch diameter underwater magnet. Contaminated sediment was placed into a confined aquatic disposal pit (Pit CAD) 620 feet by 600 feet by 36 feet below the mudline. Project is permitted under a Corps of Engineers permit with a Biological Opinion from NMFS for protection of threatened Puget Sound Chinook salmon, and a Record of Decision for CERCLA remediation. The work was done with equipment that evolved from traditional clamshell dredging and bottom-dump barge placement. This results in cost-effective remediation for large volumes of non-hazardous sediment. The cost for dredging and disposal of 390,000 cy in the Pit CAD and 310,000 cy in open water is about 13 million U.S. dollars. Part 1 describes the remediation work performed from June 2000 through March 2001 with the planned final capping scheduled for 2001. Part 2 discuss how the successes of this project can be used to design future confined disposal facilities for contaminated sediment remediation.

PART I BNC PROJECT.
The BNC project is a combination of two separate projects: navigational dredging and CERCLA remediation. The navigational dredging included deepening turning basins and widening at Piers B, D, and 3. CERCLA remediation included (1) dredging contaminated sediment along Piers 4, 5, 6, 7, 9; Moorings A, F, and G; (2) shoreline stabilization at Site 1, and (3) capping west of Mooring G. The navigation project is permitted under a Corps of Engineers permit with a Biological Opinion from NMFS for protection of threatened Puget Sound Chinook salmon. The CERCLA Record of Decision (ROD) required that sediment above the remedial action level be dredged and placed into a submarine confined aquatic disposal facility (CAD). NMFS was also consulted for ESA compliance of CERCLA remediation work.

The CERCLA remedial action level is (a) PCBs greater than 12 mg/Kg organic carbon (OC) normalized or (b) PCBs greater than 6 mg/Kg OC and mercury greater than 3 mg/Kg. The organic carbon normalized concentration (C_n) is calculated from the dry weight concentrations (C_d)as: C_d (mg/Kg) = C_c (mg/Kg OC) times organic carbon fraction. For example, in sediment with a PCB OC normalized concentration of 12 mg/Kg OC and an organic carbon fraction of 0.03, the total dry weight concentration would be 0.36 mg/Kg.

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310,000 cy in open water is about 13 million dollars. The CAD was constructed on submerged Navy property by dredging out suitable sediment. About 380,000 cy was dredged to form the CAD between June 16 and August 12, 2000. Approximately 60,000 cy was used for habitat restoration, 35,000 cy stockpiled underwater for use as final cover over the Pit CAD, and the balance was taken off-site. The Pit CAD was dredged 36 feet below the existing mudline elevation of –30 feet MLLW, with side slopes of 3 horizontal to 1 vertical for stability. The CAD is about 620 x 600 feet at the existing mudline surface.

Dredging CERCLA sediment was done from August 30, 2000 through February 9, 2001 and 223,689 cy were placed into the Pit CAD. Dredging unsuitable MCON was done from October 4, 2000 through February 14, 2001 and 171,434 cy was placed into the Pit CAD. Dredging suitable MCON was primarily done from December 4, 2000 to February 29, 2001 and about 313,000 cy was taken to the open water disposal site.

The majority of the dredging was done with two environmental buckets. The 24 cy environmental bucket weighs 21,000 pounds empty and dredges an area of 18 feet by 20 feet. The 27 cy bucket weighs 36,800 pounds empty and dredges an area of 10.4 feet by 25 feet. The primary dredge platform was a barge-mounted 165 ton crane. The barge was 150 feet by 70 feet and has a displacement of 6 feet. Environmental buckets work well in soft fine-grained sediment and fine to medium sand, but can be damaged by debris, gravel, or cobbles. The specifications allowed the use of conventional buckets when these types of material were encountered.

The location of the bucket was determined with two dGPS guidance systems and a gyroscopic compass. One antenna was mounted on the tip of the boom, directly above the line holding the bucket. Prior to dredging, the coordinates of each dredge unit and design elevations were entered into the guidance software. The on-board engineer and dredge operator both had computer monitors that gave real-time displays of the dredge unit and location of the bucket. This system gives accurate horizontal positioning. Throughout the duration of the project, the dredging subcontractor consistently dredged right along the limits of each unit.

Likewise, a dGPS and gyroscopic compass system was used on the tugs to guide location of the disposal barges. The subcontractor consistently released sediment in the correct locations. For contaminated sediment placed into the Pit CAD, the target areas where initially 100 by 100 feet. The dump locations were so accurate that progress surveys showed four distinct mounds in the center of the four dump areas. Toward the end of the project, dump coordinates were adjusted to give more even distribution of material.

Sinclair Inlet is used for fishing and recreation, so protection of water quality during the project was important. Extensive water quality monitoring was required by the EPA Water Quality Certification for the CERCLA action. During the project, real-time measurements were made for turbidity and dissolved oxygen and hundreds of water samples were analyzed for PCBs, metals, and total suspended solids. Monitoring started when dredging the Pit CAD, which was done with the same environmental bucket and same restrictions of barge overflow as used for contaminated dredging. PCBs and mercury were the contaminants of concern in the sediment. The water quality modeling indicated that copper may also be a potential concern. During the

entire project, no water sample contained chemicals above water quality criteria at the point of compliance PCBs were generally below the detection limit of 0.08 ug/L .

The criteria for turbidity was less than 5 NTU above background. The point of compliance was initially 300 feet from the dredge or disposal barge. Turbidity was measured at three depths: 3 feet below the surface, 3 feet above the bottom and mid-depth. During the summer months, background turbidity was less than 5 NTU. During dredging, the turbidity was usually less than 5 NTU above background near-surface and mid-depth, but was typically 10 to 25 NTU above background near the bottom. During the first week of dredging, the dredger was directed to slow the rate of raising and lowering the bucket and not to dig with the bucket (which caused sediment to be forced out of the top water drains as the bucket is raised). These measures helped, but it still was not possible to meet the 5 NTU criteria near the bottom. The Navy worked with the federal and state agencies to resolve these issues. Since chemical concentrations were low, the agency representatives researched potential impacts of turbidity and suspended solids and revised the point of compliance.

The ROD requires that a minimum of two feet of sediment be removed where surface concentrations were above the remedial action levels. However, the actual depth of sediment removed averaged 3.8 to 4.1 feet. The goal of the ROD was to reduce average concentrations to reduce long-term risk; therefore post-dredging sampling and chemical analyses were not required. However, it was essential to confirm that the minimum depth was removed. Dredging buckets leave a flat, horizontal cut. Unlike upland work, it is not feasible to dredge on smooth slopes. The specified tolerance for dredging was +0.0 feet from the design elevation to -1.0 foot below design elevation. This tolerance was not met using the 24 cy or 27 cy buckets. Although tide elevation is measured by electronic tide gauge and shown on the computer monitor, the computer guidance system does not control depth of the bucket. Depth was controlled manually by the crane operator using measured markings on the cables. The actual depth dredged was typically 1 to 3 feet below the design elevation.

After the project was started, the Navy confirmed that divers had found high-pressure compressed gas cylinders in several areas. Gas cylinders present a serious safety hazard if they were to rupture. They could release toxic or flammable gas or could become projectiles as gas escaped. Potential cylinders on the surface were located with a side-scan sonar and underwater metal detector. In areas of metallic debris, a 72-inch diameter, 230 volt DC underwater magnet was used to remove cylinders (and ferric metal debris) prior to dredging. The magnet weighs about 8,000 pounds and can lift 4,000 pounds. A total of 36 cylinders were removed.

PART 2 FUTURE CONFINED AQUATIC DISPOSAL APPLICATIONS

Is containment of contaminated sediment in confined aquatic disposal facilities a viable disposal option for the future? ABSOLUTELY YES, in the right conditions. For the BNC Pit CAD, the cover was designed in accordance with *Guidance for Subaqueous Dredged Material Capping*, Technical Report DOER-1, U.S. Army Corps of Engineers, Washington, D.C., 1998. The Corps criteria for capping site stability and effective chemical isolation apply to confined aquatic disposal facilities. The site must be geologically stable. Current and potential future owners must implement effective institutional controls. Water quality during dredging and placement must be protected. Stakeholders must understand and accept the fact that some small quantity of

sediment becomes suspended in the water during dredging and placement. For the Bremerton Naval Complex, confinement in a submerged CAD is effective in providing reliable long-term protection for a large volume of sediment with relatively low levels of PCBs and mercury.