CERTUS CHEMICAL SPILL
NATURAL RESOURCE DAMAGE ASSESSMENT

INITIAL
RESTORATION AND COMPENSATION
DETERMINATION PLAN

Prepared by:
U.S. Fish and Wildlife Service
Region 5
Virginia Field Office
Gloucester, Virginia

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"Our mission is working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people."

slow the rate of natural recovery. Also, the Mill Pond at Cedar Bluff acts as a migration barrier to mussels and host fish. Reduced upstream migration of fish and motile stages of mussels can also slow natural recovery. The wastewater treatment plant at Raven (approximately 7.7 miles downstream from where the spill occurred) uses chlorine in its secondary treatment and therefore may act as a chemical barrier to mussel migration from downstream reaches. Natural environmental perturbations such as floods and droughts will also slow natural recovery rates. In essence, the spill area was a mussel refuge in which conditions were favorable for the establishment of a diverse assemblage which was established over an unknown, but conceivably long period of time.

5.3 Alternative 2: Propagation of Federally Endangered Mussel Species

This alternative proposes to restore the federally listed mussel species within the spill zone of the upper Clinch River. The process for propagating listed and non-listed mussels has been developed and refined over the past two decades and is currently at a state where most mussel species can be propagated (O'Beirn *et al.* 1998, Henley *et al.* 2001). The process involves collecting gravid females from the wild, artificially infecting host fish with mussel larvae in the laboratory, and then collecting and holding transformed juvenile mussels. Mussels and host fish are held in the laboratory in recirculating systems for the majority of this process. Juvenile mussels are held in captivity as long as possible to improve the survival rate of the released cohort.

The environmental consequences of propagating freshwater mussels in order to restore populations are decidedly positive. Mussel propagation activities provide several benefits in addition to reestablishing extirpated populations. Propagation and release of mussels help to: 1) increase the re-colonization rates of species into suitable habitat, 2) increase the likelihood of recruitment into currently occupied habitat, 3) increase the chance of species' continued existence in currently occupied river reaches, and 4) stabilize declining populations of non-listed species which in turn may preclude the need for certain Federal listing actions.

Some uncertainty exists in the propagation of rare mussel species. The availability of gravid females may vary year to year. Rare species can be difficult to locate in general. For some species there is only a short window of a few weeks when they become gravid. The search for and availability of gravid females can be further confounded by droughts and floods. Additionally, the relative success rate of mussel releases has not been rigorously assessed. However, propagation is currently being conducted by several agencies/researchers around the country and is generally accepted as a viable solution for species restoration. A wealth of knowledge exists on the life history attributes of the mussel species that inhabit the Clinch River. Source populations and gravidity windows are also known for many species. Furthermore, a diverse community of biologists from university, state, federal, and non-governmental

organizations are working together to conserve this important natural resource and are available to assist in a variety of ways.

Mussel restoration projects must be monitored during and beyond the propagation phase to document that the mussels reach sexual maturation and to document recruitment–an important indicator of a successful restoration. Monitoring is also needed to ensure that augmented individuals within a population reach ages similar to those lost during the spill. Mortality, recovery, and fitness indicators (growth and fecundity) may also be monitored for each species. Predator control at augmentation sites will also be a necessary restoration component.

Results of the aging study indicate that the weighted average maximum age of the three endangered species injured by the spill is 19 years. The FWS has added 4 years (20%) to this number to account for variables that could inhibit workers' ability to propagate a sufficient number of mussels in a given year. These variables include drought, flood, an inability to find gravid females, and possible loss of cultured organisms (fish and/or mussels) that could be caused by a variety of factors. Therefore, 23 years is considered to be a reasonable estimate of the number of years that propagation must be accomplished in order to return the endangered mussel populations to baseline conditions.

5.4 Alternative 3: Propagation of the Entire Mussel Assemblage within the Spill Zone

This alternative takes into consideration the interdependence that exists between all the mussel species that were killed by the spill and recognizes them as a single mussel assemblage. Several thousand individuals of at least 13 species of non-listed mussels (including one federal candidate species) were also killed as a result of the August 1998 release. Since both the listed and non-listed species of mussels form an important segment of the ecosystem, this alternative proposes to restore both the listed and non-listed mussel species within the spill zone of the upper Clinch River. Monitoring and predator control efforts will also be required under this alternative.

It is important to replace the extirpated mussel assemblage with one consisting of similar species, size classes, age classes, and genetic make-up because this unique assemblage provides services that cannot be provided by a less diverse assemblage. Older and large mussels produce more offspring and do so over a long period of time. The reproductive output of this segment of the mussel assemblage will have a profound influence on the stability and rate of growth of the mussel community as a whole over time. It is generally accepted that communities that are diverse in terms of interspecific and intraspecific genetic make-up (i.e. genetic variance within and among species) are better buffered against environmental instability thus increasing the probability of the survival of the community (Tillman and Downing 1994, Tillman *et al.* 1996). Mussels also improve the water quality of a stream through their filter feeding activity. Again, it is important to have large mussels within the assemblage as their filtering and water-clarifying

capacity is concomitantly greater than that of juvenile mussels. Mussel assemblages serve to stabilize river and stream bottoms and add to the general biotic integrity and diversity of the river system. The habitat heterogeneity is thus enhanced by a mussel assemblage of diverse age and size class make-up. The relic shells of the entire mussel assemblage provide important substrate and refugia for mussel host fish eggs and also provide habitat for insect larvae that comprise mussel host fish prey base. By restoring the entire assemblage, non-listed mussels will serve to reduce predation on the endangered mussels. The replaced mussel assemblage will again provide vital aquatic ecosystem functions such as nutrient cycling, the conversion of food resources into forms readily assimilated by other organisms, and long-term storage and release of important elements such as calcium, phosphorous, and nitrogen (Nedeau *et al.* 2000).

5.5 Alternative 4: Propagation of Entire Mussel Assemblage Within the Spill Zone and Off-Site Area(s)

This alternative includes the mussel propagation goals of Alternative 3 and additionally provides for the release of propagated species into predetermined areas outside of the spill zone within the Clinch River watershed. This alternative provides an additional tool for use in ensuring that propagated mussels are replaced into the broader watershed in areas where these species already occur. Increasing the number and location of augmentation areas beyond the footprint of the spill will enable restoration biologists to reduce the risk of losing propagated mussels to potential natural and human perturbations. Pressures on freshwater mussels are varied and diverse. Mussels are generally susceptible to water quality degradation, droughts, flooding events, spill events, agricultural and urban runoff, and natural predation. Alternative 4 provides a hedging strategy that does not put all of the propagated mussels in one "basket." Three other mussel augmentation sites on the Clinch River have been identified in a planning document of the VDGIF (Woodfin 2000).

The trade-off that must be considered under this alternative is that gains in terms of safety/protection by spreading out propagated mussels comes at the price of possibly increasing the time it would likely take for the extirpated mussel cohort to return to its pre-spill size and age structure and to provide baseline ecological services.

5.6 Alternative 5: Combination of Mussel Propagation, Mussel Translocation, Habitat Protection, and Community Outreach

This alternative seeks to combine certain habitat protection and community outreach goals with some of the mussel propagation goals of Alternative 3. Translocation of some non-listed mussel species is considered here as an option to facilitate mussel assemblage restoration.

5.6.1 Mussel Translocation Component

Adults of several species of non-listed mussels may be opportunistically translocated from other areas within the Clinch River to the spill area to facilitate restoration of the mussel assemblage. Mussel translocation by itself is not considered to be a viable option for mussel restoration as it does not produce a net gain in mussels in the river. However, translocation of some non-listed mussel species could potentially enhance the rate at which mussel restoration takes place by setting up conditions that are supportive of a stable mussel assemblage (see Section 4.4). Several issues must be considered in a restoration plan before any mussel translocation could take place. Surveys would be required to identify appropriate source populations. These surveys must include baseline information such as size/age structure and sex ratios to assess possible impacts of removing adult mussels (Pinder 2002). Some work may be required to address concerns about the genetic relatedness, or lack thereof, of certain source populations and mussel populations within the Upper Clinch watershed. The VDGIF has indicated they will require that mussels removed from one part of the river to restore another must be "back-propagated" so that no net loss of mussels occurs. Mussel translocation projects have met with mixed success (Sheehan *et al.* 1989, Cope and Waller 1995), therefore, a translocation plan would have to be developed that includes protocols for yearly monitoring to detect potential problems and provide assurance that those issues would be rectified. It is likely that several years of translocation efforts would be necessary for each species that meets predetermined criteria for translocation.

5.6.2 Habitat Protection/Restoration Component

The selection of any form of habitat protection and/or agriculture/forest best management practice (BMP) implementation as a viable alternative must be based upon the supposition that mussel restoration is occurring, at some level, within the spill zone on the Clinch River. Implementation of non-point runoff control BMPs within the Clinch River watershed can include specific activities such as erecting livestock exclusion fencing, installing alternative watering sources, planting stream-side buffer vegetation, stabilizing eroding stream banks, and sedimentation control structures.

The spill-impacted area of the Clinch River lies within Tazewell County, Virginia and is encompassed by two separate Hydrologic Units (HU); P02 (Upper Clinch River) and HU P03 (Clinch River/Indian Creek), which are 37,914 and 41,531 square acres in area respectively (Virginia Hydrologic Unit Atlas, 1995[y]). Habitat protection activities selected under this

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[y] The Virginia Hydrologic Unit Atlas is a collection of maps which depict the hydrologic unit system of Virginia. The maps, like the atlas itself, are an end-product of the effort by the USDA National Resources Conservation Service (NRCS) and the Commonwealth of Virginia to develop a detailed hydrologic and resource inventory. The Atlas was last revised in November, 1995. Further information can be obtained by contacting the USDA, NRCS office at 1606 Santa Rosa Road, Suite 209, Richmond, VA 23229-5014 or (804) 287-1691.

alternative would likely take place within one or both of these HUs.

Figure 5.1 Clinch River Hydrologic Units Affected by the Chemical Spill