Technical Assistance Services for Communities
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TASC WA No.: TASC-3- HQ-RCRA-001
Technical Directive No.: 4.0 TD #4rev – ASARCO, El Paso, TX

TECHNICAL MEMORANDUM

TO: **Texas Rio Grande Legal Aid**
RE: **Potential Mono-fill Remedy for the Former ASARCO Smelter Site in El Paso**
DATE: **October 12, 2012**

In 2012, Skeo Solutions received a work request from the U.S. Environmental Protection Agency (EPA) under the Technical Assistance Services for Communities (TASC) contract to address community concerns regarding potential remedies for the ASARCO-El Paso site. The property comprising the former ASARCO smelter is currently in an environmental custodial trust as a result of ASARCO's bankruptcy action filed in August 2005. The trustee, Project Navigator, manages the property as well as the ongoing remediation with the oversight of both the Texas Commission on Environmental Quality (TCEQ) and EPA. This memorandum provides an independent technical response to community concerns about the potential use of mono-fill instead of asphalt as a site cover. This memorandum does not necessarily reflect the policies, actions or positions of EPA.

This document includes the following sections:

- Brief Overview of Potential Use of Mono-fill as a Capping Remedy
- Summary of Community Concerns
- Assessment of Use of Mono-fill as a Capping Remedy
- Final Thoughts and Considerations[1]

I. Brief Overview of Potential Use of Mono-fill as a Capping Remedy

Conventional landfill cover systems for Resource Conservation and Recovery Act (RCRA) sites are engineered to have low permeability which encourages precipitation to run off the cap rather than percolate into the cover. These covers utilize multiple layers of soil materials, such as compacted clay, frequently in conjunction with some type of geomembrane, frequently a high-density polyethylene (HDPE) liner, to encourage precipitation to run off the cover rather than percolate into the soil (EPA OSWER 2011, p. 1).

[1] Acknowledgements: Preparation of this technical memorandum benefited by three TASC conference calls involving representatives from the site's trustee, Project Navigator, the site's remedial contractor, Malcolm Pirnie, Texas Rio Grande Legal Aid and EPA Region 6. These representatives also reviewed a draft version of this document. Project Navigator and Malcolm Pirnie also provided studies and design information for mono-fill cover systems in California and Texas.

Mono-fill cover systems are different from the low-permeability covers described in the previous paragraph. Mono-fill covers use soils that can store precipitation until it naturally evaporates (EPA OSWER 2011, p. 2). As the name mono-fill implies, this type of cover uses a single type of soil for the cover, frequently native soils from a location elsewhere on the site. The greater the cover's water storage capacity is, the lower the potential for percolation through the cover system (EPA OSWER 2011, p. 3).

According to EPA, mono-fill covers have been installed, or approved for installation, at 186 sites throughout the country since 1994 (EPA CLU-IN). Mono-fill covers have been successfully used in nine of the ten EPA regions for municipal solid waste landfills, industrial waste landfills, hazardous waste landfills and Superfund sites (EPA OSWER 2011, p. 3).

At the ASARCO site, a mono-fill cover is proposed to be used (instead of the previously approved asphalt cover) for areas of the site that will contain soils or solids contaminated from historic smelting operations but at levels that are not a concern for impact to ground water if properly managed (Category II materials) (Texas Custodial Trust 2011, p. 1-3) Category I materials, or those soils or solids that contain elevated concentrations of contaminants of concern (COCs) that have the potential to affect human health and the environment, will be consolidated on site, on top of a HDPE bottom liner with a leachate collection system, and covered with a multi-layer cover system.

A borrow source on the Trust property east of Interstate 10 has been identified as a potential source of soil for use as the mono-fill (Texas Custodial Trust 2011, p. 4-7). The soils from this area (referred to as the ASARCO-East soils) will be tested for several key parameters, including but not limited to the presence of COCs and water storage capacity, to determine their appropriateness for use as the mono-fill material.

II. Summary of Community Concerns

Texas Rio Grande Legal Aid requested assistance to address the following community concerns and questions about the potential use of mono-fill as a capping remedy.

- Is the mono-fill equivalent to asphalt in terms of protectiveness?
- Do any entities (engineering or other professional organization or governmental entity) have standards for an acceptable mono-fill as a cover for hazardous waste?
- What kind of protections must be in place to ensure its integrity?
- What kind of substances can be safely included in the mono-fill to ensure that it is protective?
- What will be the subsurface impacts of the use of mono-fill consisting of ASARCO-East soils and ASARCO slag?
- Can developers effectively build upon or cut into the mono-fill without compromising the mono-fill's integrity?
- What are examples of other sites where mono-fill was similarly used and have these been successful/protective?

- Has mono-fill been used sufficiently far in the past for its success to have been evaluated? If so, what are the results?

The assessment section below addresses these community concerns.

III. Assessment of Use of Mono-fill as a Capping Remedy

Is the mono-fill equivalent to asphalt in terms of protectiveness?

Research has documented that mono-fills can equal the performance of composite covers in locations with environmental conditions similar to those found in the El Paso area and can outperform conventional compacted clay covers in certain settings (Albright et al. 2004, pp. 25-26). The initial performance of compacted clay is good, but deteriorates over time as the clay layer dries out and begins forming cracks and fissures. Similarly, asphalt covers also become susceptible to cracking and deterioration because of exposure to the sun and its ultraviolet (UV) radiation (Levitt et al. 2005, p. 789). As such, asphalt barriers will require maintenance and repair over the life of the cover. The thickness of the asphalt cover approved for use at the former ASARCO site is approximately 7.5-inches. According to the Texas Department of Transportation's laboratory in El Paso, the expected life for a 2-inch asphalt pavement layer in the El Paso area is normally about seven years (data on a 7.5-inch cover was not available). While this expected life will be affected by the amount of traffic the asphalt is subject to, the detrimental effects of UV radiation on asphalt are extensive and can be the determining factor in the flexibility of the asphalt before cracks begin to form. This will mean that an asphalt cover will require subsequent maintenance and repair and/or eventual replacement due to cracks and fissures in the cover.

There is data that indicates that under certain circumstances an asphalt cover can be less protective than a mono-fill cover. Levitt et al. (2005, p. 789) measured the water balance to a maximum depth of 65 feet under an asphalt cover and under the mono-fill cover that replaced it. They found that during the 37 years with the asphalt cover in place, water accumulated deep in the soil profile and a perched water table developed under the asphalt cover. The asphalt cover was then replaced with a mono-fill cover having only six inches of topsoil over crushed and compacted volcanic ash (tuff) varying in thickness from zero to 6-½ feet. In the first four years following the change to the mono-fill cover, the soil below the cover dried significantly (Levitt et al. 2005, p. 794; Hauser 2009, Summary).

Detailed, site-specific design procedures are very important for successful performance of mono-fill covers (Albright et al. 2004, p. 2). Albright et al. demonstrated that a mono-fill designed based on site-specific weather conditions and soil-specific hydraulic properties can be as effective as a multi-component layered cover system.

Additional benefits of a mono-fill cover include, but are not limited to, more readily available construction materials, ease of construction, increased long-term cover integrity and stability (ITRC 2003, p. 1), and lower maintenance cost.

Do any entities (engineering or other professional organization or governmental entity) have standards for an acceptable mono-fill as a cover for hazardous waste?

The Interstate Technology and Regulatory Council Alternative Landfill Technologies Team published "Technical and Regulatory Guidance for Design, Installation, and Monitoring of Alternative Final Landfill Covers" in December 2003 (ITRC 2003). This document focuses on decisions related to design, evaluation, construction and post-closure care associated with mono-fill covers.

In addition to this guidance, site-specific design papers include published papers on the investigation and design for a mono-fill cover at the Operating Industries, Inc., Landfill Superfund site in southern California (Zornberg et al. 2003). This publication can be used as a guide for how to conduct an evaluation to determine how percolation responds to design parameters such as rooting depth, cover thickness and saturated hydraulic conductivity. Proper evaluation of these parameters will facilitate selection of the proper design parameters to be used in the final cover. The analyses also provide insight into the effect of irrigation, increased natural precipitation and initial moisture content of the cover soils. In this study, it was demonstrated that the moisture retention properties of the final cover were not significantly affected by the initial density and moisture content of the compacted soils (Zornberg et al. 2003, p. 437).

What kind of protections must be in place to ensure its integrity?

A challenge for the ASARCO site will be to implement effective and enforceable institutional controls on subsequent property owners to ensure the integrity of the mono-fill cover. Fortunately, an array of tools is available to ensure that adequate long-term protection of human health and the environment survives any property transfer. Multiple controls may prove particularly useful.

One important institutional control would be an informational notice in the deed so that future owners will be aware of the residual contamination left in place at the ASARCO site. In addition, this notice should include a listing of any use restrictions imposed on the ASARCO property. At the Tex Tin Superfund site, which also has a mono-fill in place for a portion of the site, a deed record on the property provides notice of the locations of contaminants at the site and limits land use at the former operational units to industrial purposes (EPA Region 6 2010, p. 49).

While deed notices are frequently used to inform future owners about the residual contamination and any use restrictions imposed on the facility, it should be noted that deed notices, like most informational devices, have no legal force to limit or control land use or activities. They serve a pure notice function and should not be relied upon as the sole institutional control at a site (EPA Region 5 2000, p. 14).

Restrictions on the use of land and water, zoning restrictions, ordinances, building permits or other permit requirements can also be useful in controlling potential exposure to affected materials at the ASARCO site (EPA Region 5 2000, p. 14).

Proprietary controls, including easements and covenants, create legal instruments placed in the chain of title for the property for the purpose of monitoring the site, limiting use or imposing restrictions on land and/or water. Examples of these types of control are easements to provide access rights to inspect and monitor the site and restrictive covenants limiting the type of development allowed. These types of controls can be made to "run with the land," which means they are binding on subsequent purchasers of the property (successors in title) and transferable, which may make them more reliable in the long-term than other types of institutional controls (EPA Region 5 2000, p. 15). The Tex Tin Superfund site has restrictive environmental covenants recorded in the deed records that specifically list the areas where contaminants remain in place or were disposed of at the site and restrict certain activities (such as excavation) that may impact the integrity of the caps over the disposal areas (EPA Region 6 2010, p. 49).

Institutional controls placed on the Operating Industries, Inc., Landfill Superfund site, where a mono-fill is used as a cover for a portion of the site, include the following (EPA Region 9 2010, p. 4-5):

- Standard operating procedures for controlling any type of work operations and/or maintenance that might compromise the mono-fill integrity and therefore present an exposure risk.
- Access and restrictive easements that ensure access for remedial purposes and restrict future uses of the property.
- Zoning control, ordinances and permitting process, including inter-agency meetings to review enforcement of the governmental controls.

In order to ensure the integrity of the mono-fill cover, institutional controls for the ASARCO property should consider a combination of the above. A deed notice which includes delineation of the materials left in place, the extent of the RCRA covers for Category I materials, the extent of mono-fill covers, and a summary of the known COCs for the materials present at the site would be appropriate for the site.

Land restrictions should be imposed using zoning, local ordinances and/or building permit requirements for subsequent development at the site that are compatible with the design and installation of the mono-fill cover.[2] These restrictions should probably limit subsequent development to commercial/industrial use only and prohibit residential or related uses (e.g., schools, daycares, churches, etc.). In addition, these restrictions should include specifications on subsequent building and/or pavement structures so that they will not adversely affect the soil's water storage capacity. If impervious covers, such as buildings, concrete pads and/or asphalt roads, are added to the site, adequate runoff controls should be required so as to prevent erosion of the mono-fill cover. Erosion, including channeling of runoff and/or the development of depressions in the cover that would permit the pooling of rainwater, may increase the likelihood of infiltration through the mono-fill. Similarly, if the impervious covers are not properly tied into the mono-fill cover, a preferential pathway for the infiltration of rainwater may be inadvertently provided. Therefore, restrictions on how building foundations, concrete pathways or sidewalks

[2] The ASARCO-El Paso site is within the El Paso city limits. As such, the city will issue all building permits for the site.

and/or asphalt roads are constructed must be included as an institutional control in order to ensure the integrity of the mono-fill cover.

Finally, there may be a limit to how much impervious cover can be added to the mono-fill cover before any runoff must be channeled off the mono-fill, via drainage pipes and/or utility corridors, to prevent the accumulated runoff from exceeding the evaporation rate of the mono-fill that is left exposed. In other words, it may be possible to divert some runoff (from impervious covers) to the mono-fill that remains exposed to the environment. However, if the amount of impervious cover exceeds a threshold, then the amount of water diverted to the remaining exposed mono-fill cover will exceed the capacity of the mono-fill to capture that water for eventual evaporation. This would result in infiltration of the water through the mono-fill. What that threshold value is will depend on the capacity of the soils to capture moisture and the evaporation rate from the soils, which will be evaluated as part of the engineering evaluation. There should be an institutional control regarding the amount (percentage) of impervious cover allowed at the site before supplemental storm water conveyances are required to divert precipitation to areas beyond the extent of the mono-fill.

What kind of substances can be safely included in the mono-fill to ensure that it is protective?

Materials that will be used in the mono-fill should be sampled and analyzed for COCs to ensure that only materials meeting commercial/industrial standards are used. In addition, materials used in the mono-fill should only include soils and/or slags whose properties will optimize soil water storage (ITRC 2003, p. 30). Cover materials must provide the capacity to trap and store the water, while evaporation from atmospheric conditions will provide the mechanisms to remove the water from the soil. Mono-fills control the precipitation falling on the surface by providing adequate water storage capacity in the soil to contain the infiltrating precipitation and reduce or eliminate the movement of water through the waste. Available soil water-storage capacity is controlled by soil properties and should be optimized by selecting beneficial soil properties during the design and specification development process.

The soil must have desirable water-retention characteristics. A number of additional soil properties are of interest to design and construction engineers, such as compaction characteristics, Atterberg limits, clay content by mineralogy, and grain size. These properties can be used to delineate acceptable borrow sources, evaluate the potential for shrink/swell problems, and assist in construction quality assurance (ITRC 2003, p. 31).

Nearby or on-site source material can be used for the mono-fill as long as they have adequate water storage capacity characteristics.

What will be the subsurface impacts of the use of mono-fill consisting of ASARCO-East soils and ASARCO slag?

As discussed above, mono-fills have been demonstrated to be effective in preventing infiltration of precipitation through the profile of the mono-fill (Albright and Benson 2005, p. 3-31). Even though a mono-fill cover system allows, by design, shallow infiltration of precipitation, the water storage capacity of the mono-fill material limits the depth of this infiltration before the moisture is naturally evaporated.[3] This will mean that even if some heavy metals (such as arsenic) are leached from mono-fill materials, the affected leachate will not penetrate to a depth that will affect ground or surface water at the site before it evaporates. The greater the storage capacity, the lower the potential for percolation through the cover system (EPA OSWER 2011, p. 3). This means that any affected leachate that may be generated from precipitation will be limited to the upper portion of the mono-fill profile and will not penetrate to the ground water.

Can developers effectively build upon or cut into the mono-fill without compromising the mono-fill's integrity?

TASC expects that appropriate institutional controls would allow developers to build upon the mono-fill cover without compromising its integrity. As discussed previously, in order to ensure the integrity of the mono-fill cover, institutional controls will include restrictions on how subsequent building and/or pavement structures are installed so that they do not create preferential pathways for the infiltration of precipitation. This may include a limit regarding how much (percentage) impervious cover will be allowed at the site before supplemental storm water conveyances are required to divert runoff to areas beyond the extent of the mono-fill to prevent erosion of the mono-fill cover. Finally, restrictions or design standards for underground utilities, water and wastewater, must be developed given their potential to add water through leakage to the subsurface below the effective zone of the mono-fill cover. This is being evaluated and will be specified for the site based on the results of the engineering evaluation.

The Waste Disposal Inc. Superfund site in Santa Fe Springs, California, is one location which demonstrates that land development is possible at a site where a mono-fill cover is in use. This 38-acre site is currently zoned as industrial, with approximately 35 small businesses operating at the site, many of them on top of the mono-fill. Businesses include auto shops, industrial gas distribution, machine shops, fabricators and various manufacturing operations (EPA Region 9 2009, p. 1).

What are examples of other sites where mono-fill was similarly used and have these been successful/protective?

According to EPA, mono-fill covers have been installed, or approved for installation, at 186 sites throughout country since 1994 (EPA CLU-IN). Mono-fill covers have been successfully used in nine of the ten EPA regions for municipal solid waste landfills, industrial waste landfills, hazardous waste landfills and Superfund sites (EPA OSWER 2011, p. 3). Of the 13 sites

[3] The Trust does not plan to rely on vegetation as part of the mono-fill cover.

included in EPA's Alternative Cover Assessment Program (ACAP), which evaluated mono-fill covers versus composite covers with a geomembrane and compacted clay covers, 11 sites have subsequently applied, or have been approved, to install a mono-fill cover system (Albright and Benson 2005, p. 3-36). An additional 15 sites that were not included in the ACAP study have obtained regulatory approval for their mono-fill covers based on the ACAP data and designs.

Specific examples of success include the Operating Industries, Inc., Landfill Superfund site in Monterey Park, California (EPA CLU-IN), the Nevada Test Site landfill in Nye County, Nevada (EPA CLU-IN) and the Coyote Canyon Landfill in Newport Beach, California (EPA CLU-IN). At each of these sites, detailed performance data has demonstrated that the mono-fill cover has successfully prevented the infiltration of precipitation into the covered waste materials and is protective of the environment. At the Coyote Canyon Landfill site, performance data has indicated that bottom-up wetting was occurring, indicating that the cover material was actually pulling moisture out of the waste material below the mono-fill cover (EPA CLU-IN). This indicates that for this location, not only did the mono-fill reduce the likelihood of percolation through the cover, but it actually removed moisture from the waste material below the cover, thereby preventing this moisture within the waste material from migrating into the underlying ground water.

Has mono-fill been used sufficiently far in the past for its success to have been evaluated? If so, what are the results?

Mono-fill covers have been in use since the mid-1990s, although performance data is not readily available for all installations. Two mono-fill covers installed in 1994, one at the Nevada Test Site (Nevada) and one at the Coyote Canyon Landfill (California) (EPA OSWER 2011) do have performance data available from EPA (EPA CLU-IN). At the Nevada site, which averages approximately 7 inches of annual precipitation, soil moisture measured with a lysimeter indicated that infiltrating precipitation is generally removed from the soil profile by evaporation. Data at the California site indicated bottom-up wetting was occurring, indicating that the cover material was actually pulling moisture out of the waste material below the cover (EPA CLU-IN). Both of these locations are in areas with annual average precipitation similar to that found in the El Paso area, which is approximately 8 to 10 inches per year. As part of the O&M plan, any significant erosion that could affect the performance of the mono-fill cap, including erosion caused by significant rain events, would be repaired as necessary (Texas Custodial Trust 2011, p. 2-3 and NOWData).[4]

In 2003, a mono-fill cover was installed at the Johnson County Landfill in Kansas (EPA CLU-IN). Performance data from 2003 to 2005 showed that this mono-fill was not as successful as the Nevada and California sites discussed above. At this location, the infiltration rate measured by lysimeters exceeded the design rates (EPA CLU-IN). However, the average annual rainfall for this location is 38 inches (four times that of the El Paso area) and there were several high precipitation events (at least one 25-year storm), as well as an extraordinary snowfall event. In addition, there appeared to be problems with the lysimeter installation. More recent data for this site was not readily available.

[4] The Trust has stated that local rain event information will be used to design the mono-fill cap.

IV. Final Thoughts and Considerations

- There has been extensive, documented research into the effectiveness of mono-fill covers at waste disposal sites (EPA OSWER 2011, EPA CLU-IN, Albright and Benson 2005, ITRC 2003).
- Mono-fill covers are most effective in arid and semi-arid environments with low annual rainfall (EPA OSWER 2011).
- The soil moisture capacity of the cover material is critical to the success of the mono-fill.
- Mono-fill covers, in the appropriate situations, have been shown to be more effective than impermeable covers (Albright and Benson 2005, Ward and Gee 1997, Levitt et al. 2005).
- A mono-fill cover will be less susceptible to UV degradation than an asphalt cover (Ward and Gee 1997).
- Even with the installation of a mono-fill cover, appropriate and effective institutional controls limiting the type of subsequent land development will be required (EPA Region 5 2000 and EPA Region 9 2010).
- The institutional controls will require specifications for the proper construction of buildings, walkways, roads, utility corridors and other impervious cover during subsequent land development (EPA Region 5 2000).[5]
- Subsequent land development compliant with the institutional controls chosen for the site should not adversely affect the performance of the mono-fill cover (EPA Region 5 2000).
- Guidance is available for the design, installation and monitoring of a mono-fill cover (ITRC 2003).

[5] The Trust has stated that procedures for the monitoring and enforcement of institutional controls will be included as part of the mono-fill remedy.

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