DATE, 2016

MEMORANDUM

SUBJECT: National Remedy Review Board Recommendations for the San Jacinto River Waste Pits Superfund Site

FROM: Amy R. Legare, Chair
National Remedy Review Board

TO: Carl E. Edlund, P.E.
Director, Superfund Division
U.S. Environmental Protection Agency Region 6

Purpose

The National Remedy Review Board (the Board) has completed its review of the proposed cleanup action for the San Jacinto River Waste Pits Superfund site, in Harris County, Texas. This memorandum documents the Board's advisory recommendations.

Context for Board Review

The U.S. Environmental Protection Agency (EPA) Administrator established the Board as one of the October 1995 Superfund Administrative Reforms to help control response costs and promote consistent and cost-effective remedy decisions. The Board furthers these goals by providing a cross-regional, management-level, "real time" review of high cost proposed response actions prior to their being issued for public comment. The Board reviews all proposed cleanup actions that exceed its cost-based review criteria.

The Board review is intended to help control remedy costs and to promote both consistent and cost-effective decisions. Consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), in addition to being protective, all remedies are to be cost-effective. The Board considers the nature of the site; risks posed by the site; regional, state, tribal and potentially responsible party (PRP) opinions on proposed actions; the quality and reasonableness of the cost estimates; and any other relevant factors or program guidance in making our advisory recommendations. The overall goal of the review is to ensure sound decision making consistent with current law, regulations, and guidance.

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Generally, the Board makes the advisory recommendations to the appropriate regional division director. Then, the region will include these recommendations in the administrative record for the site, typically before it issues the proposed cleanup plan for public comment. While the region is expected to give the Board's recommendations substantial weight, other important factors, such as subsequent public comment or technical analyses of response options, may influence the region's final remedy decision. The Board expects the regional division director to respond in writing to its recommendations within a reasonable period of time, noting in particular how the recommendations influenced the proposed cleanup decision, including any effect on the estimated cost of the action. Although the Board's recommendations are to be given substantial weight, the Board does not change the Agency's current delegations or alter the public's role in site decisions; the region has the final decision-making authority.

Overview of the Proposed Action

The Preferred Remedy for cleaning up the Site is Alternative 6N (Removal of Waste Materials Exceeding Cleanup Levels, Monitored Natural Recovery, and Institutional Controls) and Alternative 4S (Removal and Offsite Disposal with Institutional Controls). These alternatives will achieve protectiveness by removal of dioxin waste materials that are considered Principal Threat Waste and removal dioxin contaminated materials at concentrations greater than the Preliminary Remediation Goals, resulting in a permanent solution to address the highly toxic dioxin waste materials from the Northern and Southern impoundments. The removed material will be transported to and disposed of at an approved permitted disposal facility.

Based on the information available at this time, the Environmental Protection Agency believes that the Preferred Remedy is protective of human health and the environment, complies with applicable, relevant, and appropriate requirements, and provides the best balance of tradeoffs among the balancing criteria. It reduces risks within a reasonable time frame, provides for long-term reliability of the remedy, and minimizes reliance on institutional controls. It will achieve substantial risk reduction by removing the contaminated materials and manages the remaining risks to human health through institutional controls. The Environmental Protection Agency considered several options for contaminated materials. The Environmental Protection Agency's preferred remedy includes full removal of contaminated waste materials above cleanup levels for the following reasons:

- The material is highly toxic and may be highly mobile in a severe storm and therefore is considered a Principal Threat Waste. The Environmental Protection Agency considers material at the Site with more than 300 ng/kg dioxin to be Principal Threat Waste. This concentration was calculated by multiplying the sediment Preliminary Remediation Goal of 30 ng/kg by a factor of 10.
- The location of materials, either partially submerged within the San Jacinto River (northern impoundments) or on a small peninsula on the San Jacinto River (southern impoundment), is in a river environment that is subject to dramatic change, creating concerns about the permanence of an armored cap.
- The area has a high threat of repeated storm surges and flooding from hurricanes and tropical storms, which, if the material was left in place, could result in a release of hazardous substances.
- The history of repeated armor cap maintenance as a result of floods that are much less severe than the design 100-year flood.

For all of these factors, the Preferred Remedy provides greater permanence in comparison to other alternatives. Less costly alternatives rely on remedies that have a higher chance of failure by leaving Principal Threat Waste materials in the river, resulting in greater uncertainty as to their long-term

effectiveness. The Preferred Remedy can change in response to comment received during the public comment period or new information presented to the Environmental Protection Agency.

National Remedy Review Board Advisory Recommendations

The Board reviewed the informational package describing this proposal and discussed related issues with Region 6 staff and management by web conference on June 15, 2016. Based on this review and discussion, the Board offers the following comments:

Site Characterization

In the presentation to the Board, the Region discussed the site's human health exposure issues, the potential for upstream point and non-point source site recontamination (background), and the challenges associated with the ability to achieve protectiveness due to these uncontrolled sources. Background sampling was mentioned in the package but it lacked details. The Board recommends that decision documents include details on how the Region addressed background concentrations in a manner consistent with the guidance document, *Role of Background in the CERCLA Cleanup Program* (Office of Solid Waste and Emergency Response [OSWER] Directive No. 9285.6-07P, April 2002). The Board recommends that the Region clearly articulate non-site sources risks in the decision documents, explain how the preferred site remedy would achieve protectiveness and also explain how these risks provide a basis for action. In addition, the Region should explain how the site cleanup, with the help of institutional controls (ICs), is designed to achieve protectiveness. Furthermore, the Board believes it may be appropriate for the Region to highlight the accomplishment of mass removal of contaminants from the site, which may lead to future, long-term reduction in contaminant levels.

Region 6 Response:
Recontamination for upstream and background source is not expected at the San Jacinto site. The sediment background sampling locations are upstream of the waste pits. The maximum background sediment dioxin level is less than 7.2 ng/kg. For the river areas outside of the armor cap, the surface area–weighted average dioxin concentration in sediment located just south of the waste pits is 16.1 ng/kg, and the surface area–weighted average dioxin concentration in sediment in areas located adjacent to and upstream of the waste pits is 11.2 ng/kg. The average dioxin concentrations in sediment both upstream and downstream of the waste pits are less than the 30 ng/kg Preliminary Remediation Goal for sediment.

Region 6 Response:
The purpose of this response action is to implement a site wide strategy that addresses the contaminated material at the Site with the primary objectives of preventing human and ecological exposure to contaminants, and preventing further migration of contaminants. This response action will:

- Prevent releases of dioxins from the former waste impoundments;
- Reduce human exposure to dioxins from consumption of fish;
- Reduce human exposure to dioxins from contact with contaminated materials; and
- Reduce exposures of benthic macroinvertebrates (clams, crabs, etc.) to dioxin.

The Preferred Alternative, 6N and 4S, consisting of removal of waste materials that exceed the Preliminary Remediation Goals, Monitored Natural Recovery, and Institutional Controls, is intended to address the threats to human health and environment. The Preferred Alternative is the only one that will reliably result in no catastrophic future release of waste material upon completion of construction. The San Jacinto River has been subject to severe flooding in the past and future flooding may even be more severe. The river has also experienced significant changes over the last 50 to 60 years as a result of subsidence and flooding cutting new channels. This is expected to continue in the future.

Dioxin in the environment is very persistent, and is expected to remain toxic for hundreds of years. Therefore, any cleanup approach involving containment would have to reliably achieve containment for hundreds of years. The methods that can be used to predict the long-term performance of the river and the stability of a containment remedy have a high degree of uncertainty, as well as not being able to predict future changes in the river channels and riverbanks. The containment alternatives, while costing less, cannot be shown to reliably contain the waste material long-term. The benefit of removal of the dioxin waste material is that it will eliminate the possibility of a catastrophic release that could result in a much more severe impact to the environment.

Institutional controls

The information provided to the Board indicates that the preferred alternatives would rely on ICs (including Coast Guard notices and a state law based restrictive covenants) to help ensure protectiveness. The Board recommends that the Region explain in its decision documents how the ICs would be monitored and enforced in order to maintain their effectiveness.

Region 6 Response:
ICs will be used to notify the public and prevent disturbance at and around the remediated areas. A special sampling and analysis protocol will be required for each permittee conducting activities under the Clean Water Act Section 404 and Rivers and Harbors Action Section 10 within a defined watershed area around the remediated areas. This protocol will be monitored and enforced by a joint EPA, USACE, and TCEQ agreement and will ensure that permitted dredging activities do not impact site cleanup. Additional land deed notices will be filed in Harris County for remediated areas owned by property landowners. All sections of the decision document that specify ICs to prevent dredging or disturbance of the dredge residuals at and around the remediated areas (e.g., dredging, anchoring, construction, and excavation) will refer to a special CWA 404/RHA 10 permits process.

Human Health and Ecological Risk Assessment

Based on the package and presentation, the Board notes that it found the site's risk assessment information difficult to understand. For example, cancer risks were presented as hazard quotients, and soil and sediment exposure were merged into a single hazard index. The Board recommends that the Region correct the risk calculations using the most current integrated risk information system (IRIS) information and clarify the risk information prior to its inclusion in the decision documents.

The human health risk information provided to the Board included information on exposure to subsistence fishers. However, the package also stated that detailed information regarding fishing activities and consumption patterns was absent. Therefore, the baseline risk assessment did not include a

quantitative evaluation of the subsistence fisher. The Board recommends that the Region strengthen the explanation of how it determined that there is no significant ongoing subsistence fishing at the site. In the event there is ongoing subsistence fishing, the Board notes that this information may lower the cleanup goal.

Within the ecological risk materials presented to the Board, several contaminants (including, but not limited to, lead and zinc) were concluded to pose an ecological risk. The Board recommends that the Region more fully present the risk characterization and results identified in the baseline ecological risk assessment related to these contaminants and how that risk is being addressed as part of the remedy.

Region 6 Response:
As described on page 36 and 37 of the Site Information Package, dioxins/furans were assessed using three approaches: cancer risk, non-cancer hazard, and cancer hazard. Only the cancer hazard approach deviated from traditional EPA risk assessment guidance. Similar to the non-cancer hazard assessment, this approach assumed a threshold dose, utilized a reference dose rather than a cancer slope factor, and generated hazard quotients. Although dioxin/furan risk was calculated from all three approaches, the non-cancer hazard assessment proved to be the most conservative. As such, preliminary remediation goals are based on the non-cancer hazard indices.

EPA provided an addendum to the risk assessment report in the form of a memorandum dated August 29, 2016 and titled: Human Health Risk Evaluation and Recommended Sediment Cleanup Level for Site Specific Exposure to Sediment at the San Jacinto River Superfund Site. In the memorandum EPA, Region 6 used the most current IRIS non-cancer oral reference dose in calculating hazard index and used a tier 3 toxicity value or slope factor that is used in the EPA Regional Screening Level Calculator for evaluating excess cancer risk associated with site specific exposure scenario. Although the Baseline Human Health Risk Assessment examined cancer hazards for comparative purposes, those values were less conservative than non-cancer hazards and were not used for any PRG development or remedial decisions. Language regarding cancer hazards is not included in the draft Proposed Plan.

Human Health Risk:

The human health risk assessment identified non-cancer hazards greater than one for some recreational fisher exposure scenarios (direct exposure to surface areas identified and the ingestion of catfish, clam, or crab from fishing areas identified), for some recreational visitor exposure scenarios (direct exposure to the surface area identified), and for some future construction worker exposure scenarios. The tables below provide a summary of Site related non-cancer hazard quotients above one. Hazard quotients greater than one indicate the potential that contaminants of concern (e.g. dioxin) may cause adverse health effects to those that are exposed in the manner specified in the tables. There were no cancer risks above the upper limit of the Environmental Protection Agency's target cancer risk range ($1x10^{-4}$) for all surface areas identified in the human health risk assessment except for Beach Area E, which had an excess cancer risk of 6.6×10^{-4} for a recreational fisher exposed through ingestion and dermal contact with surface waste material and sediment. The basis for action at the Site are the unacceptable hazards to the recreational fisher (Hazard Index 65), to the recreational visitor (Hazard Index 66), and to the construction worker (Hazard Index 46). The three tables below provide more information on these hazards. For the recreational fisher (Figures 13 and 14) and the recreational visitor (Figure 14), risk assessments were done for areas both north and south of I-10. For the construction worker, the risk assessment applies to the area south of I-10 (Figure 15).

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Non-Cancer Hazards for a Recreational Fisher

Chemical	Primary Target Organ	Non-Cancer Hazard Quotient			Exposure Route Total
		Incidental Ingestion of Sediment	Dermal Contact with Sediment	Consumption of Fish or Shellfish	
Scenario 1A: Direct Exposure Beach Area A; Ingestion of Catfish from Fish Collection Area 2/3					
Dioxins and dioxin-like Polychlorinated Bi-Phenyls	Reproductive/Developmental	0.0006	0.0016	**1.8**	**1.8**
Scenario 2A: Direct Exposure Beach Area B/C; Ingestion of Catfish from Fish Collection Area 2/3					
Dioxins and dioxin-like Polychlorinated Bi-Phenyls	Reproductive/Developmental	0.0081	0.0229	**1.8**	**1.8**
Scenario 3A: Direct Exposure Beach Area E; Ingestion of Catfish from Fish Collection Area 2/3					
Dioxins and dioxin-like Polychlorinated Bi-Phenyls	Reproductive/Developmental	**16**	**47**	**1.8**	**65**
Scenario 3B: Direct Exposure Beach Area E; Ingestion of Clam from Fish Collection Area 2					
Dioxins and dioxin-like Polychlorinated Bi-Phenyls	Reproductive/Developmental	**16**	**47**	0.27	**64**
Scenario 3C: Direct Exposure Beach Area E; Ingestion of Crab from Fish Collection Area 2/3					
Dioxins and dioxin-like Polychlorinated Bi-Phenyls	Reproductive/Developmental	**16**	**47**	0.008	**63**
Scenario 4A: Direct Exposure Beach Area D; Ingestion of Catfish from Fish Collection Area 1					
Dioxins and dioxin-like Polychlorinated Bi-Phenyls	Reproductive/Developmental	0.0027	0.0076	**1.8**	**1.8**
Note: Polychlorinated Biphenyls - PCBs Dioxins – see Glossary					

Non-Cancer Hazards for a Recreational Visitor

Chemical	Primary Target Organ	Non-Cancer Hazard Quotient				Total
		Incidental Ingestion of Sediment	Incidental Ingestion of Soil	Dermal Contact with Sediment	Dermal Contact with Soil	
Scenario 3: Direct Exposure Beach Area E						
Dioxin	Reproductive/ Developmental	**17**	0.03	**49**	0.0021	**66**
Note: Dioxin – 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity equivalent quotient						

Non-Cancer Hazards for a Future Construction Worker

Chemical	Primary Target Organ	Non-Cancer Hazard Quotient		Total
		Incidental Ingestion of Soil	Dermal Contact with Soil	
Scenario DS-1: Direct Exposure to Surface and Subsurface Soils				
Dioxin	Reproductive/Developmental	**9.6**	0.49	**10**
Scenario DS-2: Direct Exposure to Surface and Subsurface Soils				
Dioxin	Reproductive/Developmental	**44**	**2.2**	**46**
Scenario DS-4: Direct Exposure to Surface and Subsurface Soils				
Dioxin	Reproductive/Developmental	**32**	**1.6**	**34**
Scenario DS-5: Direct Exposure to Surface and Subsurface Soils				

Dioxin	Reproductive/Developmental	**2.2**	**0.11**	**2.3**
Note: Dioxin – 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity equivalent quotient				

Ecological Risk

Baseline risks to ecological receptors associated with the wastes in the impoundments north of I-10 are the result of exposures to dioxins localized to the immediate vicinity of the impoundments. Baseline ecological risks include reproductive risks to mollusks from dioxin, but primarily in the area that surrounds the former waste impoundments north of I-10, and low risks of reproductive effects in individual mollusks in sediments adjacent to the sand separation area, but not to populations of mollusks. Baseline risks include moderate risks to individual birds like the killdeer or spotted sandpiper whose foraging area could regularly include the shoreline adjacent to the impoundments north of I-10, but low risk to populations because of the low to moderate probability that individual exposures reach effects levels. Baseline risks include risks to individual small mammals with home ranges that include areas adjacent to the impoundments such as the marsh rice rat, but low to negligible risks to small mammal populations because of the moderate probability that exposures will reach levels associated with reproductive effects in individuals, and because small mammals reproduce rapidly. Baseline risks to benthic macroinvertebrate communities and populations of fish, birds, mammals, and reptiles resulting from the presence of metals, bis(2-ethylhexyl) phthalate, Polychlorinated Bi-Phenyls, carbazole, and phenol on the Site are negligible. Risks to fish populations from all chemicals of potential concern are negligible.

There are negligible risks to populations of wading birds represented by the great blue heron, and to populations of diving birds like the neotropic cormorant. There are negligible risks to populations of terrestrial mammals such as the raccoon. There are low to negligible risks to individual terrestrial insectivorous birds like the killdeer from exposure to zinc, and negligible risks to populations of such birds. Although the upper bound of estimated daily intakes of zinc by individual killdeer is about equal to conservative effects thresholds, the exposure estimate is influenced by the use of generic models to estimate zinc concentrations in the foods of the killdeer, and this model likely overestimates ingested tissue concentrations, resulting in overestimates of exposure and risk. The highest exposures of killdeer to zinc occur outside of the northern impoundment perimeter, and background exposures less than 30 percent were lower than on the Site. In addition, the low probability of individual exposures exceeding effects levels indicates low risk to populations. There are also low to negligible risks to individual terrestrial insect eating birds from exposure to dioxins. The ecological risk assessments identified risk to ecological receptors as summarized in the tables below.

Ecological Risks

Receptor of Concern	Feeding Guild	Contaminant of Concern	Baseline Risk Identified
Benthic Macroinvertebrates			
Mollusks	Filter feeders	2,3,7,8-TCDD	Reproductive risks to mollusks (primarily in the area which surrounds the waste impoundments)
Individual mollusks	Filter feeders	2,3,7,8-TCDD	Low risks of reproductive effects (sediments adjacent to the sand separation area)
Birds			
Spotted sandpiper	Invertivore (probing)	Dioxin	Low risk to populations
Killdeer	Invertivore (terrestrial)	Dioxin	Low risk to populations
Mammals			
Marsh rice rat	Omnivore	Dioxin	Low to negligible risk to populations

Note:
2,3,7,8-TCDD – 2,3,7,8-tetrachlorodibenzo-p-dioxin Dioxin – toxicity equivalent quotient for 2,3,7,8-tetrachlorodibenzo-p-dioxin calculated using toxicity equivalent factors for mammals

Region 6 Response:
The Texas Department of State and Health Services (DSHS) provided the following information by email on 24 June 2016. The information will be added to the decision document, to strengthen the explanation of how it was determined there was no significant subsistence fishing at the site.

"The USEPA suggests that, along with ethnic characteristics and cultural practices of an area's population, the poverty rate could contribute to any determination of the rate of subsistence fishing in an area. The USEPA and the DSHS find it is important to consider subsistence fishing to occur at any water body because subsistence fishers (as well as recreational anglers and certain tribal and ethnic groups) usually consume more locally caught fish than the general population. These groups sometimes harvest fish or shellfish from the same water body over many years to supplement caloric and protein intake. People, who routinely eat fish from chemically contaminated water bodies or those who eat large quantities of fish from the same waters, could increase their risk of adverse health effects. The USEPA suggests that states assume that at least 10% of licensed fishers in any area are subsistence fishers. Subsistence fishing, while not explicitly documented by the DSHS, likely occurs in Texas. The DSHS assumes the rate of subsistence fishing to be similar to that estimated by the USEPA.

In the DSHS Public Health Assessment that was released in October 2012, one of the exposure scenarios was that of a subsistence fishermen. This was incorporated to account for the potential exposure pathway to children and adults that may be subsistence fishermen and consume fish caught from areas surrounding the SJRWP. The scenario used was:

Adults who fish 260 days/year for 30 years and children of subsistence fishers who are exposed from age 3 – 50 (47 years).

Through DSHS outreach activities, ***most of the people interviewed along the San Jacinto River, Houston Ship Channel, and Upper Galveston Bay have told DSHS that they are fishing and/or crabbing for recreational purposes****; however, some people do admit to consuming fish and/or crabs from these areas. One could assume that a small percentage of people found fishing in these areas could potentially be subsistence fishers but don't admit it."*

Given the general lack of predictability of subsistence behaviors based on demographic characteristics, and the very low likelihood that long-term subsistence fishing is occurring within USEPA's Preliminary Site Perimeter (TDSHS 2012), the subsistence fisher, as evaluated in this BHHRA, is hypothetical and unlikely to have been present or to be present in the future in the area under study.

Region 6 Response:
The ecological risk in question refers to potential risks found for the killdeer in the Southern Impoundment. Region 6 acknowledges that this table is misleading. Accounting for risks associated with background and the fact that this is an industrial site with very poor habitat quality, risk from these metals in soil are considered acceptable to killdeer populations.

Principal Threat Waste

The site informational package provided to the Board identified principal threat waste (PTW) in the northern waste pits sediment and southern impoundment soils. However, the Region did not clearly explain its approach for identifying PTW and pursuing treatment "to the maximum extent practicable." The Board notes that *A Guide to Principal Threat and Low Level Threat Wastes* (OSWER Directive No. 9380.3-06FS, November 1991) provides guidance on identifying PTW, as well as on CERCLA's statutory preference for, and the NCP's expectation of PTW treatment. The Board recommends that the Region fully explain in its decision documents how this site's PTW approach is consistent with CERCLA and the NCP, including:

- CERCLA § 121(b)(l) (preference for treatment "to the maximum extent practicable"),
- CERCLA § 121(d)(l) (requirements regarding selection of remedies that ensure protectiveness of human health and the environment and achieve [or where appropriate, waive] applicable or relevant and appropriate requirements [ARARs]);
- 40 CFR § 300.430(a)(l)(iii)(A) (expectation that "treatment [be used] to address the principal threats posed by a site, wherever practicable")
- 40 CFR § 300.430(f)(l)(ii)(E) (preference for treatment "to the maximum extent practicable," while protecting human health and the environment, attaining ARARs identified in the ROD, and providing "the best balance of trade-offs" among the NCP's five balancing criteria).

Region 6 Response:
The dioxin waste material in the northern and southern impoundments is highly toxic and may be highly mobile in a severe storm and therefore is considered a Principal Threat Waste. The Environmental Protection Agency considers material at the Site with more than 300 ng/kg dioxin to be Principal Threat Waste. This concentration was calculated by multiplying the sediment Preliminary Remediation Goal of 30 ng/kg by a factor of 10. A factor of 10 was used based on EPA's 1991 Office of Emergency and Remedial Response fact sheet on principal threat waste. The fact sheet points out that "…where toxicity and mobility of source material combine to pose a potential risk of 10^{-3} or greater, generally treatment alternatives should be evaluated." A risk of 10^{-3} is an order of magnitude or a factor of 10 above the upper end of the generally accepted excess cancer risk range of 10^{-4} to 10^{-6}. Therefore multiplying the PRG by a factor of 10 is generally accepted as a threshold for principal threat waste. Toxicity Equivalents, or TEQs, are used to report the toxicity-weighted mass of mixtures of dioxins and furans. Elevated concentrations of $TEQ_{DF,M}$ have been detected at the Site as high as 43,000 ng/kg in the waste material at the northern impoundment and as high as 50,000 ng/kg in the southern impoundment. Dioxin and furans are highly toxic and persistent in nature (will not breakdown for hundreds of years). With the regular occurrence of severe storms and flooding in the area, there is uncertainty that the waste material can be reliably contained over the long term and therefore should be considered highly mobile. Treatability studies would be conducted during the remedial design to determine the appropriate type and amount of amendments, including stabilization amendments that would be required. Solidification was successfully performed during the Time Critical Removal Action (TCRA) on a portion of the Western Cell materials.

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Remedial Action Objectives

In the Region's package, the remedial action objectives (RAOs) do not appear to match the risk assessment results. The Board recommends that the Region clarify in the decision documents the RAOs for both direct contact risk, as well as those addressing risk from fish or shellfish consumption. The Region should refer to *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (OSWER Directive No. 9355.3-01, October 1988) and *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (OSWER Directive No. 9200.1-23P, July 1999) when drafting RAOs. The Board also recommends that the decision documents clarify that this action will be addressing only part of a larger watershed problem and that, therefore, when he RAOs are achieved, the fish advisories may not be lifted.

Region 6 Response:
At this time, an overall watershed plan to address fish consumption, PCBs, and dioxin does not exist for the Houston Ship Channel/Galveston Bay watershed. The EPA and TCEQ are looking for sources of dioxins and PCBs in the Houston Ship Channel as part of the Total Maximum Daily Load program. In addition, a fish consumption advisory exists for the San Jacinto River in which the site is located. This advisory (TX DSHS ADV-55) identifies that: For all species of fish and blue crabs, adults should limit consumption to no more than one, 8-ounce meal per month and women of childbearing age and children under 12 should not consume any fish or blue crabs from this area.

As the study for an overall watershed plan is ongoing by the TMDL program, the following are proposed RAOs to address the site specific direct contact risks from dioxin and furans:

RAO 1: Prevent releases of dioxins and furans from the former waste impoundments to sediments and surface water of the San Jacinto River.

RAO 2: Reduce human exposure to dioxins and furans from consumption of fish by remediating sediments affected by paper mill wastes to appropriate cleanup levels.

RAO 3: Reduce human exposure to dioxins and furans from direct contact with paper mill waste, soil, and sediment by remediating affected media to appropriate cleanup levels.

RAO 4: Reduce exposures of benthic invertebrates, birds, and mammals to paper mill waste-derived dioxins and furans by remediating affected media to appropriate cleanup levels.

The RAOs developed consider the current and reasonably anticipated future land use including the use for industrial applications and by recreational fishers. While the Baseline Human Health Risk Assessment (BHHRA) considered subsistence fisher populations, none have been identified at the site and therefore this receptor is not considered to be consistent with the current or future land use. Reducing exposure of human and ecological receptors of concern to dioxins and furans will mitigate site baseline risks identified in the BHHRA and Baseline Ecological Risk Assessment.

The following Preliminary Remediation Goals provide numerical criteria that will be used to measure the progress in meeting the Remedial Action Objectives. The preliminary remediation goals are acceptable exposure levels (i.e., contaminant concentration levels) that are protective of human health and the environment, and are developed considering applicable, relevant, and appropriate requirements, as specified in the National Contingency Plan. Site risk-based preliminary remediation goals are presented below:

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Sampling figures are all for sediments.

- Dioxin in sediment – 30 ng/kg (recreational fisher). This level is also protective for ecological risk.
- Dioxin in paper mill waste material in the waste pits – 200 ng/kg (recreational visitor).
- Dioxin in paper mill waste material and soil in the Southern Impoundment – 240 ng/kg (Southern Impoundment construction worker).
- Texas Surface Water Quality Standard for Dioxins/Furans – 7.97 x 10^{-8} µg/L (as TCDD equivalents). [30 Texas Administrative Code §307.6(d)(a)(A) and (B) and §307.10]. This standard was updated by the Texas Commission on Environmental Quality in 2014 and approved by the Environmental Protection Agency to base the dioxin standard on water column criteria. The standard was calculated based on an oral cancer slope factor of 156,000 found in in the Environmental Protection Agency 2002 National Recommended Water Quality Criteria Matrix.

The sediment Preliminary Remediation Goal of 30 ng/kg was developed for the Site based on protecting human health of the most vulnerable potentially exposed group or individual of the community. In this case a recreational child fisher was assumed to get exposed to contaminated sediment through incidental ingestion, dermal contact, and from the ingestion of fish/shellfish. The 30 ng/kg is associated with a non-cancer Hazard Index of one with the understanding that by being protective at a Hazard Index of one will also be protective for cancer effects near the middle (2.1 x 10^{-5}) of the Environmental Protection Agency's generally acceptable cancer risk range.

Remedy Effectiveness

In the package provided by Region 6, the preferred alternative mentions stabilizing sediment and potentially treating soil prior to transporting it for disposal. The Board recommends that the decision documents clearly explain how the preferred alternative will achieve the CERCLA/NCP preference for treatment "to the maximum extent practicable." The Board further recommends that the Region consider a full range of alternatives (including varying degrees of *in-situ* treatment) since there are no currently identified alternatives other than partial removal and total removal. The Region should refer to 40 CFR 300.430(e)(3)(i).

The Region acknowledged in its presentation that groundwater quality samples collected from within the waste material exceeded maximum contaminant levels (MCLs) for some contaminants of concern (COCs). However, such samples collected beneath the waste material did not exceed MCLs. The Board recommends that, during the development of decision documents, the Region include plans for monitoring groundwater quality (including all COCs) in areas bounding waste materials (laterally and vertically) to ensure groundwater contamination does not become a concern, adjacent to the site, during remedial activities. The Board also recommends that the Region include plans for evaluating, in their groundwater quality monitoring plan, both dissolved phase COC concentrations and concentrations that may result from facilitated transport. If COCs are found to exceed MCLs in an area bounding the waste material, the Region will need to address groundwater contamination concerns as part of this remedial action or in a different OU.

The Board acknowledges the U. S. Army Corps of Engineers' work to construct a cap to withstand future hurricanes and 500-year floods. However, the preferred remedy presented to the Board is removal and off-site disposal of all contaminated waste and soils/sediments above the risk-based level

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determined to be protective for direct exposure (Alternative 6N). This alternative has the express advantage of being more effective in the long-term in face of uncertainties associated with anticipated extreme future storm events and is also expected to be garner greater community acceptance. However, the Region identified the capping alternative (3N), as being easier to implement, more protective in the short term, and an order of magnitude less expensive than the removal alternative. The Board recommends that the Region further consider the consequences of future extreme storm events and flooding, as well as the viability of maintaining cap integrity over the long term. The Board further recommends that the Region explain in site decision documents the rationale for the risk management decision considering factors, such as river conditions (stability, depositional, erosional), protectiveness, and long-term effectiveness and permanence.

Information presented to the Board indicated that part of the preferred remedy would involve off-site disposal, but the information did not provide any details about what kind of facility would receive the waste (e.g., Resource Conservation and Recovery Act subtitle C) to ensure that the transfer of the dioxin contamination to another location would lead to long-term protectiveness of human health and the environment (i.e., that dioxin contamination would be reliably contained). The Board recommends that the Region explain in its decision documents how its approach to off-site disposal would ensure protectiveness with regard to disposal.

Region 6 Response:
For remedial alternatives that require removal and offsite disposal of contaminated material (Alternatives 5N, 5aN, 6N, and 4S), excavated material would be dewatered and treated as required for transportation and disposal to eliminate free liquid prior to transporting it for disposal.

In developing the range of remedial alternatives for the Site, EPA considered more alternatives than partial removal and total removal.

The potentially responsible parties' (PRPs') consultant submitted a report entitled "Remedial Alternatives Memorandum - San Jacinto River Waste Pits Superfund Site" (RAM) in December 2012. The RAM identified and described General Response Actions (GRAs), remedial and disposal technologies, and process options for the Site. The screening of alternatives was based on three evaluation criteria: 1) implementability, 2) effectiveness, and 3) cost. Results from the screening process determined the technologies that were further evaluated in the Feasibility Study. The following table identifies the GRAs, technologies and process options evaluated for the Site and the determination for further evaluating the technology in the FS.

General Response Actions, Technology Types, and Process Options Potentially Appropriate for the San Jacinto River Waste Pits

GRA	Technology Type	Process Option		Screening Decision
		Sediment	Soil	
Institutional Controls	Administrative and Legal Controls	Waterway Use Restrictions and Maintenance Agreements	Access and Property Use Restrictions	Retained
		Access and Property Use Restrictions	Informational Devices (e.g., signage)	Retained

		Informational Devices (e.g., signage and fish consumption advisories)		Retained
Natural Recovery	Monitored Natural Recovery	Sedimentation	Not Applicable	Retained
		Placement of Thin Lay of Clean Cover		Retained
In situ Containment	Cap	Conventional Cap		Retained
		Low-Permeability Cap		Retained
In situ Treatment	Physical – Immobilization	Adsorptive Amendments	Adsorptive Amendments	Retained
		Solidification/Stabilization	Solidification/Stabilization	Retained
Removal	Dry Excavation	Excavator	Excavator	Retained
	Dredging	Mechanical Dredging		Retained
		Hydraulic Dredging		Retained
Ex situ Treatment	Thermal	Incineration	Incineration	Retained
		In Pile Thermal Desorption	In Pile Thermal Desorption	Not Retained
	Chemical	Solvated Electron Technology	Solvated Electron Technology	Not Retained
		Base-Catalyzed Decomposition	Base-Catalyzed Decomposition	Not Retained
Disposal/Reuse	Aquatic Disposal	Confined Aquatic Disposal (CAD)	Not Applicable	Retained
		Nearshore Confined Disposal Facility		Retained
		Open-Water Disposal		Not Retained
	Off-Site Upland Disposal	Confined Disposal Facility / Landfill	Landfill	Retained
		Beneficial Use	Beneficial use	Not Retained

The following table summarizes the remedial alternatives evaluated in the Feasibility Study and carried forward in the Proposed Plan of Action for the Site.

Area North of I-10	
Alternative	**Description of Alternative**
Alternative 1N – Armored Cap and Ongoing OMM (No Further Action)	Armored Cap would remain in place, together with fencing, warning signs and access restrictions established as part of the TCRA, and would be subject to ongoing operation, maintenance and monitoring (OMM).
Alternative 2N – Armored Cap, ICs, Ground Water Monitoring, and Monitored Natural Recovery (MNR),	Includes the actions described under Alternative 1N, ICs in the form of deed restrictions and notices, and periodic monitoring to assess the effectiveness of sediment natural recovery processes and confirm no long-term impacts to ground water.

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Alternative 3N – Permanent Cap, ICs, Ground Water Monitoring, and MNR	Includes the actions described under Alternative 2N plus additional enhancements to the Armored Cap, many of which have already been implemented during the work performed in January 2014, consistent with the USACE recommendations
Alternative 4N – Partial Solidification/Stabilization, Permanent Cap, ICs, Ground Water Monitoring, and MNR	Includes the actions described under Alternative 3N; however about 25 percent of the Armored Cap (2.6 acres above the water surface and 1.0 acre in submerged areas) would be removed and about 52,000 cubic yards (cy) of materials beneath the cap with $TEQ_{DF,M}$ that exceeds a concentration set by USEPA of 13,000 ng/kg, would undergo solidification and stabilization (S/S). After the S/S is completed, the Permanent Cap would be constructed.
Alternative 5N – Partial Removal, Permanent Cap, ICs, Ground Water Monitoring, and MNR	The Armored Cap would be partially removed and the same 52,000 cy of material that would undergo S/S under Alternative 4N would instead be excavated for off-site disposal. After the removal was completed, the Permanent Cap would be constructed and the same ICs and MNR that are part of Alternatives 2N to 4N would be implemented, including monitoring to confirm no long-term impacts to ground water.
Alternative 5aN - Partial Removal of Materials Exceeding the PRG, Permanent Cap, ICs, Ground Water Monitoring, and MNR	All material beneath the Armored Cap in any location where the water depth is 10-feet or less and which has a of $TEQ_{DF,M}$ 200 nanograms per kilogram (ng/kg) or greater – about 137,600 cy – would be excavated for off-site disposal. To implement this alternative, about 11.3 acres (72 percent) of the Armored Cap would be removed to allow for this material to be dredged. After excavation of the material, the remaining areas of the Armored Cap would be enhanced to create a Permanent Cap, and the same ICs and MNR that are part of the preceding alternatives would be implemented, including monitoring to confirm no long-term impacts to ground water.
Alternative 6N – Full Removal of Materials Exceeding the PRG, ICs and MNR	All material above the PRG 200 ng/kg beneath the Armored Cap and at depth in an area to the west would be removed. This would involve removal of the existing Armored Cap in its entirety and the removal of 200,100 cy of material. The dredged area would then be covered with a layer of clean fill

Area South of I-10	
Alternative	**Description of Alternative**
Alternative 1S – No Action	
Alternative 2S – Institutional Controls and ground water monitoring	Includes the actions described under Alternative 1N, ICs in the form of deed restrictions and notices, and periodic monitoring to confirm no long-term impacts to ground water.
Alternative 3S – Enhanced Institutional Controls	This remedial alternative would incorporate the ICs and ground water monitoring identified in Alternative 1S and add physical features to enhance the effectiveness of the ICs. The physical features would include bollards to define the areal extent of the remedial action areas at the surface and a marker layer that would alert workers digging in the area that deeper soil may be impacted
Alternative 4S – Removal and Off-site Disposal	This remedial alternative involves excavation and replacement of soil in the areas exceeding the cleanup levels. Soil would be removed within these areas to a depth of 10 feet below grade. Excavated soil would be further dewatered and potentially treated to eliminate free liquids as necessary prior to transporting it for disposal. Excavated soil would be disposed of at an existing permitted landfill, the excavation would be backfilled with imported clean soil, and vegetation would be re-established.

Region 6 Response:
Ground water sampling was conducted at three locations within the perimeter of the northern waste pits from each of two ground water bearing units below the waste pits. These ground water units contained brackish to saline ground water. Samples from five of the six wells did not detect any dioxins. The sixth well screened in the uppermost ground water bearing unit below the waste pits did detect dioxin/furan at a concentration (2.64 pg/L) that is much lower than the maximum contaminant level of 30 pg/L for a drinking water zone. Harris County also sampled a total of 101 private water wells near the Site located to the east of the San Jacinto River. The analysis results did not find any exceedances of dioxin drinking water standards. Ground water sampling was conducted at two locations outside of the southern impoundment; one was below the impoundment and the other was located downgradient to the west of the impoundment. The water in this area is brackish. Neither of these samples detected any dioxin or furan. Water samples collected from within the southern impoundment contained dioxin up to a maximum of 60.2 pg/L. The Board's recommendation to monitor ground water, and take appropriate action as necessary, during the remedial action will be included in the decision document to confirm that there would be no long-term future unacceptable impacts to ground water.

Region 6 Response:
Corps of Engineers Report. The United States Army Corps of Engineers 2016 report was prepared for EPA in order to evaluate and supplement Feasibility Study work performed by the Potentially Responsible Parties. Alternative 6N* from the Corps report is the same as EPA's 6N used in this Proposed Plan. An EPA analysis of the United States Army Corps of Engineers 2016 report can be found in the Feasibility Study. The United States Army Corps of Engineers report's evaluation of containment is contingent on the continued integrity of the armored cap and is limited by uncertainties in modeling. For example, the report provided the following information that is relevant to consideration of the temporary armored cap and long-term permanence.

According to the report, the most severe event simulated was the hypothetical synoptic occurrence of Hurricane Ike and the October 1994 flood, with a peak discharge of approximately 115,000 cubic feet per second occurring at the time of the peak storm surge height at the Site. The results during the peak of the storm surge showed that the sections using Armor A (3-inches diameter) were completely eroded, while the sections using Armor D (10-inches diameter) were eroded more than 12 inches in about 33 percent of those sections. The sections using Armor B and C (6-inches diameter) incurred a net erosion of more than 9 inches in about 75 percent of those areas. Overall about 80% of the cap experienced significant erosion with scour reaching approximately 2.4-feet through the cap and into the waste material. The scenario defined above may cause significant erosion of the paper mill waste. The releases from catastrophic events can potentially be addressed by additional cap improvements, including upgrading the blended filter in the Northwestern Area to control sediment migration into the cap, upgrading the armor stone size to a diameter of 15 inches and adding 2 feet of additional armor stone over the existing cap across the waste pits to minimize the potential for disturbance during very severe hydrologic and hydrodynamic events. However, the uncertainty inherent in any quantitative analysis technique used to estimate the long-term (500 years or more) reliability of the cap is very high.

The Corps report did not consider changing river conditions. New channels eroding during flooding as well as changes in channel cross section due to bank erosion, shoreline breaches, etc. during a high flow

event caused by a major flood or hurricane is beyond the ability of existing sediment transport models to simulate. In addition, the report's evaluation of excavation and removal often focuses on risks which will be reduced and/or eliminated through use of best management practices.

There appears to be no documented cases of any armored cap or armored confined disposal facility breaches. However, there have been many occurrences of breaches and slope failures of armored dikes, jetties, and breakwaters, with some of those structures confining dredged material.

Region 6 Response:
Excavated waste material would be dewatered (decanted) and stabilized by addition of Portland cement or other additive at the offloading location, as necessary, to eliminate free liquids for transportation and disposal. Treatability studies would be conducted during the remedial design to determine the best combination of reagents to use to treat the dioxin waste materials to meet the NCP's preference for treatment and approved permitted facility disposal requirements.

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Applicable or Relevant and Appropriate Requirements

The information provided to the Board included descriptions of various ARARs. The Board recommends that the decision documents include an explanation as to why the Region considers the Safe Drinking Water Act an ARAR. Further, to be consistent with the NCP final preamble (55 Fed. Reg. at p. 8746, March 8, 1990) and *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final* (OSWER Directive No. 9355.3-01, October 1988), the Board recommends that the ARARs discussion include more specific references to the potential particular provisions in federal and state ARARs. In addition, the Board recommends that the site decision documents provide an explanation as to how the Region performed its Clean Water Act section 404(b) analysis (e.g., how cleanup may affect aquatic habitat, including any potential need to perform environmental mitigation as well as compliance with substantive provisions associated with CERCLA section 121(e)(1)'s permit exemption).

Region 6 Response:
Based on concerns from the local community, groundwater monitoring is proposed for remedial alternatives where waste is left in place. Under the preferred alternative (Alternative 6N), groundwater monitoring would not take place since all of the contaminated material is removed from the Site.

To project and compare the long-term effects of the existing capping alternative (3N) versus the full removal alternative (6N), Army Research and Development Center (ERDC) modeled the contaminant flux and release into the overlying water over hundreds of years. As shown in Table 16-9 from the ERDC report, the total contaminant releases are low for all scenarios compared with the unremediated area.

Table 16-9. Total Contaminant Release over 500-yr Simulation Period

Scenario	Total Release over 500 years (mg)
Surrounding Conditions	28,900
Eastern Cell 3N - 5N Footprint	2.18
Eastern Cell 3N - 5aN Increment	8.11
Eastern Cell 3N - 6N Increment	0.0
NW Area 3N - 5N Footprint	0.0
NW Area 3N - 5aN Increment	2.54E-04
NW Area 3N - 6N Increment	2.54E-04
6N Dump Placement - 5N Footprint	10,200
6N Dump Placement - 5aN Increment	7,160
6N Dump Placement - 6N Increment	2,960
6N Rain Placement - 5N Footprint	4.06
6N Rain Placement - 5aN Increment	2.84
6N Rain Placement - 6N Increment	1.17
6N Best Practice Placement - 5N Footprint	1.22E-15
6N Best Practice Placement - 5aN Increment	8.49E-16
6N Best Practice Placement - 6N Increment	3.51E-16

Even though the potential total contaminant release is low compared to the surrounding conditions, surface water monitoring will be conducted. The reasons for conducting surface water monitoring is to confirm the assumption that potential releases from the Site are low when compared to the surrounding conditions. Furthermore, surface water monitoring is necessary to evaluate whether potential releases from the Site exceed the Texas Surface Water Quality Standard for dioxins/furans (TCDD Equivalents).

The FS did not provide a detailed CWA 404(b) analysis. The area within the Preliminary Site Perimeter includes wetlands in the area north of I-10, and a plan will need to be established that addresses the requirements (to the extent practicable) of Section 404 and 404(b)(1).

Implementation of Alternative 3N would involve the placement of fill material (the additional armor rock) into the San Jacinto River to create the Permanent Cap. The placement of fill would trigger compliance with CWA Section 404(b)(1). The removal and replacement of cap material under Alternative 4N would trigger compliance with CWA Section 404(b)(1). The removal of the Armored Cap and placement of rock for Permanent Cap construction under Alternative 5N would trigger compliance with CWA Section 404(b)(1). If Alternative 5aN is identified as the preferred alternative, additional evaluations would need to be conducted to determine the potential habitat impacts related to impacts of dredging and placement of clean residual layer management materials to document compliance with CWA Section 404(b)(1). If Alternative 6N is identified as the preferred alternative, additional evaluations would need to be conducted to determine the potential habitat impacts related to impacts of dredging and placement of clean residual layer management materials to document compliance with CWA Section 404(b)(1).

The PRPs previously prepared a report on potentially jurisdictional waters of the U.S. (including wetlands) as part of the TCRA implementation in compliance with the 1987 USACE Wetlands Delineation Manual and Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plan Region. A supplemental draft 404(b)(1) report may need to be prepared for consideration by EPA depending on the nature of the selected remedy.

Specific BMPs anticipated to be included in construction actions, if necessary to minimize the impacts of discharges of fill into the water, include:

- The use of a silt curtains and debris booms around in-water work areas.
- The use of upland erosion controls such as plastic covering of stockpiles.
- The use of silt fencing around upland areas.
- Construction of a stable upland haul route capable of handling construction traffic without creating ruts that would develop into a source of turbid water.
- Monitoring and maintenance during construction to ensure these BMPs are functioning as designed.

Alternative remedy

During the Board's review, the Region indicated that the dredging depth would be determined by the cleanup level, as opposed to a specific depth. The Board recommends that, if the preferred alternative does not result achieve the RAOs after dredging, the Region should consider employing an engineered cap to assure protectiveness.

Region 6 Response:
All the alternative that do not include full removal of the dioxin waste materials include an armor cap. For the full removal alternative in the Northwest area, the residual concentrations of contaminants following excavation and removal will be covered by at least two layers of clean fill to limit intermixing of residual material with the clean fill, and armored.

Cost

As discussed during the review, the Board recommends that the Region's alternative cost estimates be more detailed. Specifically, the Board recommends that the Region: (1) break out the volumes of sediment to be dewatered and solidified, as well as stabilized; (2) evaluate any off-site disposal cost savings to be gained by increasing truck size; (3) include cost estimates for the treatability studies associated with the excavated sediments' solidification or stabilization, (4) include costs associated with best management practices; and (5) assure the cost table accurately reflects the costs of monitoring versus those of monitored natural recovery (MNR).

Region 6 Response:
The detailed cost estimates included in the Feasibility Study, and included as an appendix to the Site Information Package presented to the Board, break out sediment volumes, Best Management Practices, monitoring, and Monitored Natural Recovery. The decision document will include the information as requested. However, in response to part 2, the truck size will be determined during the Remedial Design or Remedial Action and will take into consideration road weight restrictions, maneuverability at the site, and other relevant issues. Feasibility Study cost estimates per EPA guidance are expected to provide an accuracy of plus 50 percent to minus 30 percent. The total present worth costs for all the alternatives were calculated using a 30 year timeframe and a 7% discount rate. Adjustment to the truck size costs is anticipated to be within the expected acceptable cost range. Similarly, while the cost estimates do not specifically identify a line item for treatability study costs, these studies will be conducted as needed. The costs of treatability studies for MNR are minimal in comparison to other components of the alternatives and therefore expected to be within EPA's acceptable cost estimate range.

Monitored Natural Recovery

In the package presented to the Board, monitored natural recovery (MNR) is being considered to address contamination in the aquatic environment north of Interstate-10. However, the package did not include an evaluation of MNR's efficacy relative to reaching the relevant RAOs. Given the effects of storms on sediments, it is unclear whether MNR (e.g., by facilitating a covering of cleaner sediments) can be relied upon as a remedial component. The Board recommends that the Region include in the decision documents information on where MNR may be used and an evaluation as to how aquatic conditions (deposition, erosion) in those areas will affect the remedy's protectiveness and future permanence.

Region 6 Response:
A Chemical Fate and Transport Modeling Study was conducted during the RI/FS to simulate physical and chemical processes governing chemical fate and transport of dioxins and furans at the Site. The fate and transport modeling was based on three linked models that simulate hydrodynamics, sediment transport and chemical fate and transport. The sediment transport portion of the model was used to simulate the erosion, deposition and transport of sediment in the San Jacinto River. Simulations were conducted to provide estimates of rates of natural recovery (i.e., reductions in surface sediment dioxin and furan concentrations over time) in various portions of the Model Study Area in the absence of any remedial action beyond the current Armored Cap.

In response to EPA's request for additional hydrodynamic and sediment transport model sensitivity analyses in its conditional approval letter for the draft final Chemical Fate and Transport Modeling Study report, a series of simulations was conducted to evaluate: 1) sediment deposition and erosion

during high-flow events; and 2) the sensitivity of model predictions to water surface elevation (WSE) at the downstream boundary.

The calibrated hydrodynamic and sediment transport models prepared by the PRPs were used to simulate sediment transport processes in the San Jacinto River during high-flow events. A range of high-flow conditions, from 2- to 100-year events, were investigated. The effects of varying the following model inputs were evaluated: 1) erosion rate parameters; 2) incoming sediment load at the Lake Houston Dam, and 3) effective bed roughness.

Spatial distributions of predicted net sedimentation rates (NSRs) for the long-term simulation period for pre- (i.e., the sediment transport model calibration) and post-TCRA conditions as shown on Figures 3-4 and 3-5 (Appendix A of the FS), respectively are shown below.

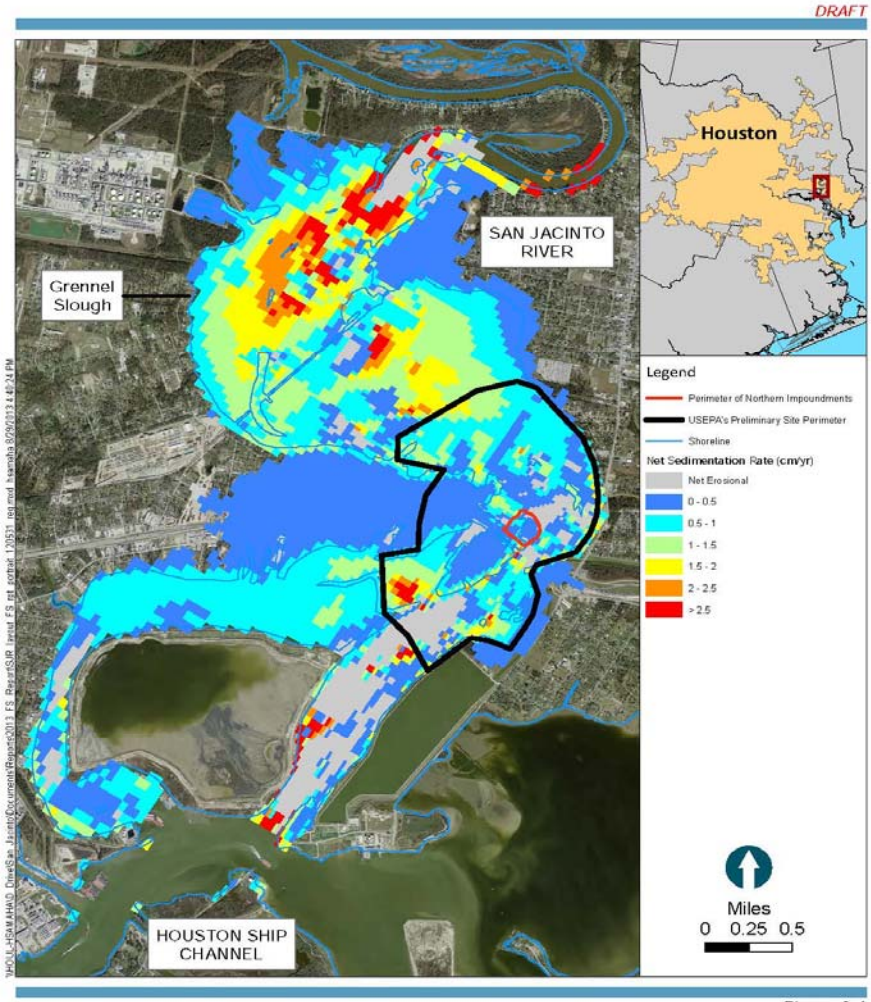

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Figure 3-4
Spatial Distribution of Predicted Net Sedimentation Rate for 21-Year Period: Pre-TCRA Base Case Simulation
Feasibility Study
San Jacinto River Waste Pits Superfund Site

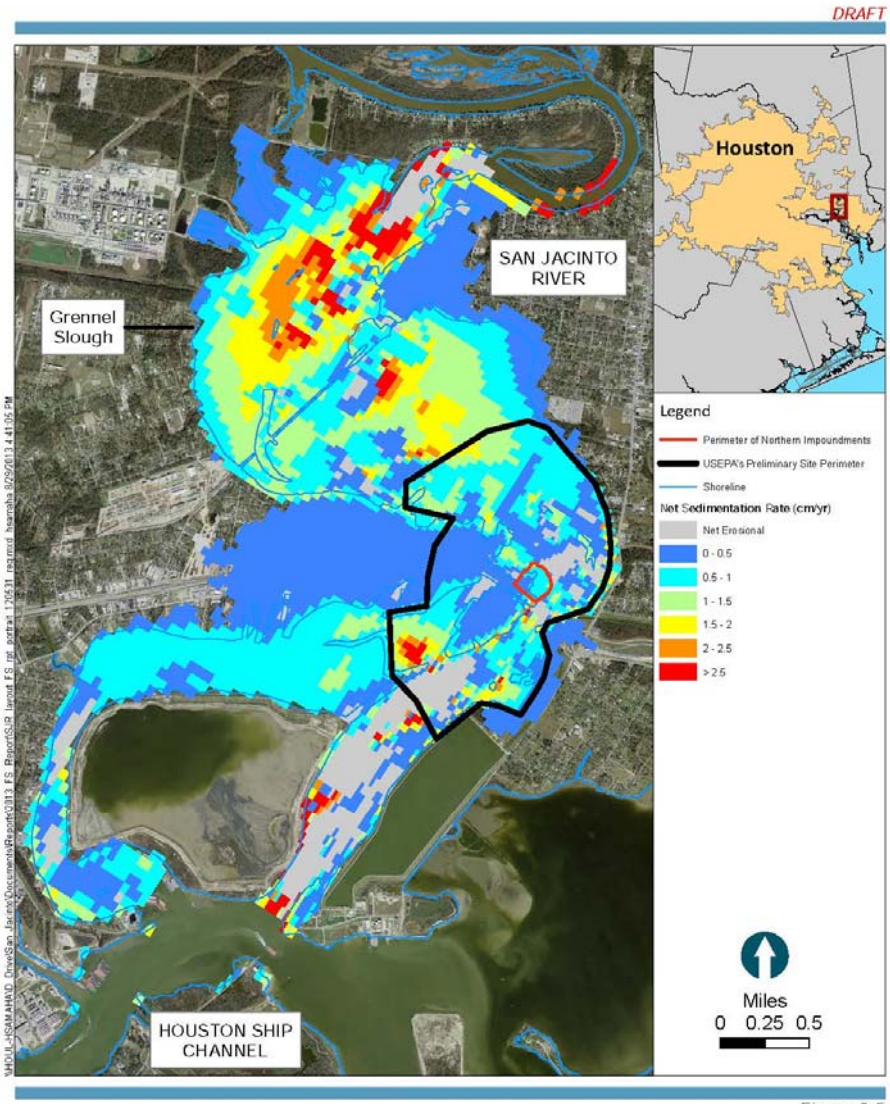

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Figure 3-5
Spatial Distribution of Predicted Net Sedimentation Rate for 21-Year Period: Post-TCRA Base Case Simulation
Feasibility Study
San Jacinto River Waste Pits Superfund Site

Model-predicted future rates of natural recovery in surface sediments, including the range of model uncertainty, were evaluated at various spatial scales over the Model Study Area. Figure 3-18 from Appendix A of the Feasibility Study shown below presents a time series of model-predicted surface (0- to 6-inch) sediment TCDD concentrations averaged over the Preliminary Site Perimeter. The figure shows a base case predicted decrease in TCDD concentration of approximately 75 percent over the Future Projection Period (decreasing from an initial TCDD concentration of approximately 8 nanograms per kilogram [ng/kg] to 2 ng/kg by Year 21). To quantify the rate of decline, an exponential decay curve was fit through the model results, and the rate of decline was calculated (see example for the base case simulation shown as a dotted line on Figure 3-18); the model-predicted decline of TCDD in surface sediment concentrations within the Preliminary Site Perimeter corresponds to a half-life of 11 years.

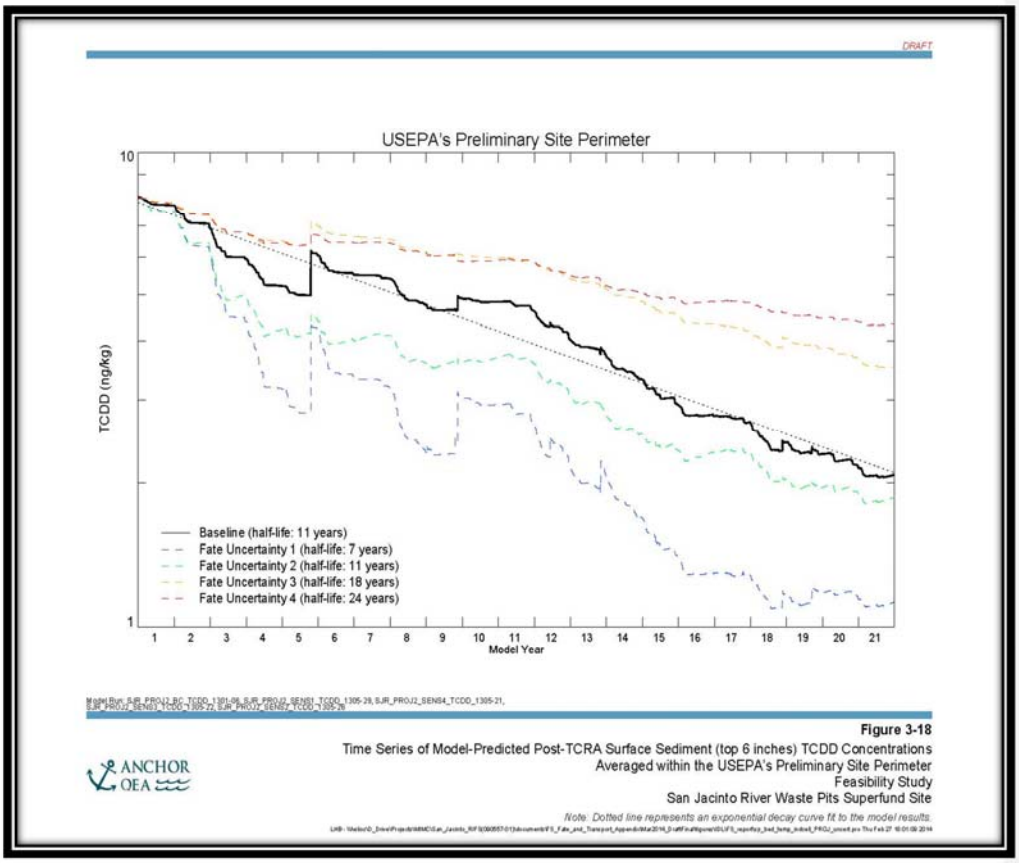

Figure 3-18
Time Series of Model-Predicted Post-TCRA Surface Sediment (top 6 inches) TCDD Concentrations
Averaged within the USEPA's Preliminary Site Perimeter
Feasibility Study
San Jacinto River Waste Pits Superfund Site

For the uncertainty simulations, the predicted decline ranged from more than 85 percent (Fate Uncertainty 1) to 40 percent (Fate Uncertainty 4), corresponding to half-lives that vary by about a factor of 2 from the base case, ranging from 7 years to 24 years. The faster rates of natural recovery predicted for the Fate Uncertainty 1 simulation are a result of a combination of increased sedimentation rates and decreased mixing within the bed for this simulation. Conversely, the slower rates of recovery predicted for the Fate Uncertainty 4 simulation are a result of lower sedimentation and increased mixing within the bed.

As discussed above, ERDC provided technical support to the EPA. One of the tasks ERDC undertook was an evaluation of the rate of natural attenuation in sediment concentrations/residuals and the uncertainty regarding the rate of natural attenuation.

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Based on the modeling performed by ERDC, the estimated range of net sedimentation rates (NSR) at the site is 1.3 cm/year ± 0.8 cm/yr. This NSR is the average value over the entire cap, and it is important to keep in mind that the NSR was calculated by averaging the instances of both erosion and deposition in each grid cell over the simulated time period. The latter included long periods of fair (i.e., normal) weather, as well as high energy events including storms and floods. The positive value, i.e., 1.3 cm/year, indicates that there was, averaged over the cap, more deposition than erosion, albeit a small net site-averaged quantity per year. Nevertheless, even this relatively low average NSR on the cap is predicted to maintain the cap's effectiveness, and will contribute to the rate of natural attenuation in the contaminated sediment concentrations found from the 500-year simulations performed. The uncertainty in the long-term NSR of ± 0.8 cm/year is based on the sensitivity analysis, and is in the same range as that given by the PRPs.

Policy and Guidance

The Board notes that the site requires additional considerations during remedy design because of its location within a floodplain area and hurricane inundation zone. The Board recommends that the Region consider any existing Agency guidelines related to Executive Order 13653, *Preparing the United States for the Impacts of Climate Change*, and Executive Order 13690, *Establishing a Federal Flood Risk Management Standard and Process*, when developing the remedial design or preparing site decision documents. The Board notes that the Region took the site's proximity to the San Jacinto River into consideration when selecting its preferred remedy. The Board recommends that the Region go further and include a climate change vulnerability evaluation in the site's administrative record. This evaluation may encompass a climate-change exposure assessment to evaluate a wide range of climate change scenarios, including, but not limited to, major flood and storm events and how such events might impact the remedial alternatives.

The package provided to the Board included an assessment of the nature and extent of sediments contamination, and the remedy under consideration addresses sediments. The Board recommends that the Region follow the Tier 1 protocol under EPA's sediments guidance, *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites* (OSWER Directive No. 9285.6-08, February 2002), prior to remedy selection. Further, the Board recommends that the Region's decision documents address how its approach is consistent with this 2002 guidance and other relevant sediments guidance (e.g., 2005 Contaminated Sediments guidance).

EPA Region 6 Response:

ERDC provided technical support to EPA. The goal of ERDC's work was to prepare an independent assessment of the Potentially Responsible Parties' (PRP) remedial alternative designs for the San Jacinto River Waste Pits Superfund Site. The report prepared by ERDC presented the results from tasks that were identified by EPA for the ERDC to perform. The following discussion summarizes tasks conducted by ERDC that address this NRRB comment.

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ERDC performed an assessment of the San Jacinto River (SJR) flow/hydraulic conditions and river bed scour in and around the Site for severe storms, hurricanes, storm surge, etc., using surface water hydrology model(s) appropriate for the Site. The assessment included an evaluation of potential river bed scour/erosion in light of the historical scour reports for the Banana Bend area and for the SJR south of the I-10 Bridge.

The simulation showed that the current cap is expected to be generally resistant to erosion except for very extreme hydrologic events, which could erode a sizable portion of the cap and more than 1.5 feet of underlying sediment. The most severe event simulated was the hypothetical synoptic occurrence of Hurricane Ike and the October 1994 flood, with a peak discharge of approximately 390,000 cubic feet per second occurring at the time of the peak storm surge height at the Site. Approximately 80 percent (12.5 acres) of the 15.7 acre TCRA cap incurred severe erosion during the simulated extreme storm. Issues related to cap permanence can be addressed by additional cap modifications, including upgrading the blended filter in the Northwestern Area to control sediment migration into the cap, upgrading the armor stone size in vulnerable areas by doubling its size to prevent movement during very severe hydrologic and hydrodynamic events, thickening of the armor cap from a minimum of 12 inches to at least 24 to 30 inches across the site to minimize the potential for disturbance by anthropogenic activities or gas entrapment in submerged areas where a geotextile filter was used , and installing pilings to protect the cap from barge strikes. The armored cap is predicted to have long-term reliability from scour related processes except under very severe hydrologic and hydrodynamic events. The ERDC assessment recognized that the uncertainty associated with estimates of the effects of some of the potential cap failure mechanisms, e.g., propwash, stream instability, is very high.

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The ERDC also evaluated floodplain management and impacts of remedy construction on flood control, water flow issues and obstructions in navigable waters. The evaluation concluded that the construction of any of the proposed Alternatives is not expected to cause any flooding in the vicinity of the Site, and therefore should not require the implementation of any flood control measures during the construction of any of the Alternatives under consideration for the Site.

If a storm (e.g., tropical storm or high flows under flood conditions) occurred during the actual removal/dredging operation, the likelihood of extremely significant releases of contaminated sediment occurring is very high. A silt curtain would not be able to withstand the forces of high flow or waves and therefore the bottom shear stresses would not be controlled. The only BMPs that would be capable of preventing most of the contaminated sediment releases would be a substantial containment structures to isolate the removal operations, residuals and exposed sediment. The containment structures could consist of berms and sheet pile walls or caissons to an elevation of about +9 NAVD88.

EPA may perform the removals in small sections at a time such that the armor stone and geotextile within the small section would be removed, and then the sediment removed and a thin layer of sacrificial

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fill placed before advancing to the next section and repeating the process. Under these removal operations, EPA may limit or restrict removal activities to a period when there is a lower probability of tropical storms and flooding conditions. Decisions on these activities will be made during the remedial design or remedial action.

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Conclusion

We commend the Region's collaborative efforts in working with the Board and stakeholder groups at this site. We request that a draft response to these recommendations be included with the draft proposed plan when it is forwarded to the Office of Superfund Remediation and Technology Innovation's Site Assessment and Remedy Decisions (SARD) branch for review. The SARD branch will work with both your staff and the Board to resolve any remaining issues prior to your release of the record of decision. This memo will be posted to the Board's website (https://www.epa.gov/superfund/national-remedy-review-board-nrrb) within 30 calendar days of my signature. Once your response is final and made part of the site's administrative record your response will also be posted on the Board's website.

Thank you for your support and the support of your managers and staff in preparing for this review. Please call me at (703) 347-0124 should you have any questions.

cc: J. Woolford (OSRTI)
D. Stalcup (OSRTI)
C. Mackey (OSRE)
C. Bertrand (FFRRO)
D. Ammon (OSRTI)
J. Hovis (OSRTI)
NRRB members