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ASSESSMENT OF THE POTENTIAL COSTS, BENEFITS, AND OTHER IMPACTS OF CHAT USE IN TRANSPORTATION PROJECTS

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INTRODUCTION

As stipulated by Section 6006, "Use of Granular Mine Tailings," of the 2005 transportation bill (S.793), EPA is required to evaluate the costs, benefits, and economic impacts of establishing criteria for the safe and environmentally protective use of granular mine waste, known as "chat," in concrete and transportation projects. EPA is therefore proposing a rule that would establish criteria for the use of chat in various transportation and concrete applications, including those that use asphalt and are carried out using Federal funds. Established criteria under the proposed rule would affect chat from the following four Superfund sites that are located in the Tri-State mining area: (1) Tar Creek in Ottawa County, OK; (2) Cherokee County in Galena, KS, (3) Oronogo-Duenweg Mining Belt ("Jasper") in Joplin, MO, and (4) Newton County Mine Tailings, near Joplin, MO.

As part of this effort, EPA is evaluating the costs, benefits, and other impacts associated with changes in disposal and use of chat in specific transportation applications that might result from the proposed regulation.[1] Transportation applications include, for example, the use of chat as a source of aggregate for asphalt and road base. The costs, benefits, and impacts of the proposed regulation will depend largely on the extent to which additional chat use is encouraged or discouraged by a change in criteria. All costs are presented in 2006 dollars, the year in which remediation activities at the sites will likely commence.[2] The remainder of this report includes the following sections:

- Overview of key results;
- Background and purpose of analysis;
- Overview of current and previous chat use and markets;
- Baseline and alternative remediation methods;
- Compliance cost analysis;
- Economic impact analysis;
- Benefits analysis; and
- Equity considerations and other impacts.

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[1] The purpose of our analysis is solely to evaluate the costs, benefits and other impacts of chat use in transportation projects. Although the analysis considers baseline remediation disposal options for chat as a basis for the analysis, it does not recommend specific remedial options for the Tri-State sites. In addition, the analysis does not attempt to consider distributional impacts of the remediation costs (e.g., costs incurred by the government or private entities responsible for generating the mine waste).

[2] The net present value of remediation costs, as developed in this analysis, is estimated using an annual discount rate of 3 percent. Application of an alternative discount rate of 7 percent would reduce the disposal costs for each remedial option considered in our analysis. However, this would not affect our overall conclusions regarding the use of chat in transportation projects.

OVERVIEW OF KEY FINDINGS

Our analysis of the costs and benefits of chat use in transportation projects under the proposed rule suggests the following key conclusions; (1) the direct costs as a result of the rule are very small, and (2) to the extent that the rule increases the use of chat for transportation projects, remediation cost savings are possible. Our assessment is based on the following insights:

1. **A well-established market exists for chat use as an aggregate in asphalt.** The total quantity of chat at the Tri-State mining area sites is roughly 100 million tons.[3] Currently, Tri-State area chat distributors compete effectively with other aggregate suppliers within a 200 mile range. However, this 200 mile radius represents an upper bound of the current market. In at least some cases, chat haulers use the same trucks to bring back other products thereby reducing the effective per ton costs of transporting chat. Within the 200 mile "economic" radius, chat from the Tri-State sites is used in asphalt at a rate of approximately one million tons per year. Information from the existing chat markets suggests that the use of chat in asphalt is not restricted by current EPA policy. Assuming chat use in asphalt continues at the current market levels, the net present value of chat remediation costs range from $592 million to $1,631 million, depending on the Superfund remedy selected and disposal period.[4]

[3] The US EPA Office of Solid Waste (OSW) estimates that the total tonnage of chat at the four sites is approximately 100,000,000 tons. However, recent information indicates that this total quantity estimate is uncertain. The specific quantity of chat at each site has not been rigorously quantified and may overstate the total amount of chat currently present at all four sites.

[4] The range in costs reflects baseline remedial options 1 and 2, and two disposal periods - 10 years and 20 years. The remediation costs are based on the Jasper County ROD (see NewFields Feasibility Study, Japer County, Missouri, Mine and Mill Waste Operable Unit, OU-1, April 2003). Figures are inflated to 2006 dollars using the Construction Cost Index (CCI). The costs are inflated to October 2005 based on CCI value of 7563 as of October 2005 and 6695 as of January 2003. Costs were then inflated to January 2006, based on an average annual rate of inflation of 2.93 percent or monthly inflation of 0.24 percent. (See http://enr.construction.com/features/coneco/subs/recentindexes.asp.) The net present value reflects disposal costs discounted at 3 percent annually over 30 years. Although we assume major chat disposal activities are completed after 20 years, the costs include monitoring activities for an additional 10 years. Application of a 7 percent discount rate would reduce these cost estimates by an average of approximately 20 percent.

2. **The proposed rule should not result in a significant increase in incremental compliance costs to current chat users.** The primary compliance costs are related to notification of chat utilization for each project. We estimate incremental cost of compliance totals $0.05 million annually, which yields a net present value of $0.43 million over 10 years and $0.74 million over 20 years.[5]

3. **The proposed rule is unlikely to have a significant economic impact on entities, including small businesses, or result in significant benefits.** To the extent that the rule, as proposed, may encourage the increased movement of chat away from the current piles and into transportation projects, some human health and environmental risk reductions may occur. In addition, industries and governmental organizations are unlikely to experience significant economic impacts from the proposed rule. The potential economic impacts associated with the proposed rulemaking may include marginal changes in employment and cost impacts on local companies. However, we do not expect chat use (or corresponding remediation costs) to change significantly as a result of the proposed rule. Even if the proposed rulemaking did have the effect of significantly increasing chat use in highway applications and reducing the need for site remediation, any employment gains in the aggregate industry would likely be balanced by reduction in employment associated with site remedy construction.[6]

4. **Our GIS analysis suggests that it may be possible to increase the use of chat within the current economically feasible range. Such an increase has the potential to reduce Superfund remediation costs.** An estimate of demand for asphalt based on GIS analysis and road design specifications from the U.S. Department of Transportation (DOT) suggests that up to 1.9 million tons of chat per year might be used for asphalt road construction within the current 200 mile market range. Under this "expanded market" scenario, we estimate that about 19 million tons of chat could be used in asphalt over 10 years and 39 million tons over the next twenty years. The additional use of chat in transportation practices would reduce the expected present value of the cost of remediation by between $95 and $476 million (net of compliance costs) depending on the remedy selected and disposal period. Under this

[5] The net present value (NPV) estimates are based on a 3 percent annual discount rate. Assuming a 7 percent discount rate, the NPV of the incremental costs would total $0.35 million over 10 years and $0.53 million over 20 years. Dust control and leachate prevention, while considered appropriate for use with chat, are not directly required in the proposal and are not included in our cost estimates. In most cases these controls are likely to already be implemented by chat users.

[6] The entities affected by the proposed rule may include: (1) State governments (Oklahoma, Missouri, and Kansas), (2) Quapaw Tribe of Oklahoma (NAICS 81391002), and (3) approximately 50 other sand and gravel companies in the states of Oklahoma, Missouri, and Kansas (NAICS 4233202), including two major chat haulers, Bingham Sand & Gravel, Inc. ("Bingham Sand") and Oklahoma Flint Rock Products, LLP ("Flint Rock").

expanded market scenario, the total net present value of chat remediation costs would be $402 million to $1,393 million[7].

5. **There is considerable uncertainty about the likelihood of expanding use of chat in asphalt within the currently economic area.** The proposal does not specifically alter economic drivers for chat use. Moreover, current chat suppliers do not believe that demand for asphalt in general, or other uses will increase significantly as a result of EPA policy. However, this rule as proposed, will help clarify practices, and may help remove some stigma associated with chat use in transportation projects.

6. **Total remediation costs for the Tri-State sites may be reduced through selection of remedies that increase the amount of chat used for transportation.** To expand the use of chat in transportation, the government or other entities could potentially offset transport costs to allow hauling the chat beyond the current economically practical zone (e.g., 200 miles).[8] Our analysis concludes that the use of chat in asphalt could be maximized by offsetting $4.99 to $12.51 per ton of chat transport costs, depending on the remediation option selected. Assuming a current market scenario, this would divert an additional 2.9 million to 16.3 million tons of chat to use in asphalt over the next 10 to 20 years, and would result in present value cost savings of $15 million to $203 million, depending on the remedy and disposal period selected.

Exhibit 1 presents a summary of the annual net cost impacts as a result of the proposed rule for each baseline remedial option. As shown in Exhibit 1, we estimate total incremental costs resulting from the proposed rule of approximately $0.05 million per year. In addition, we present incremental impacts if the chat market was expanded, or chat transport costs were offset. Exhibit 2 presents a summary of the net present value of the proposed rule for each baseline scenario. The remediation costs are estimated using a 10-year and 20-year disposal period for chat. These are generalized assumptions used only for the calculation of a representative range in this analysis. These disposal periods do not reflect Agency policy or final decisions. The lower-end of the cost range for each scenario reflects a 20-year disposal period and the upper end reflects a 10-year disposal period. Generally, the disposal costs assuming a 10-year period are higher given the fact that less chat may be used for transport, thereby requiring higher costs for chat disposal. We describe our basis for the above conclusions below.

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[7] We do not anticipate that this rule, as proposed, will stimulate any significant increase in the use of chat over the short-term. These cost impacts are based on a 3 percent annual discount rate. The application of a 7 percent rate would reduce cost and cost savings impacts by an average of approximately 20 percent.

[8] Offsetting costs would be similar to a subsidy or compensation of chat transport costs to make it economical for use in transportation projects.

Exhibit 1

SUMMARY OF *ANNUAL* NET COST IMPACTS AND BENEFITS [1]

Cost Impact (Savings) of Proposed Rule on Chat Disposal [2]				***Sensitivity Analysis (Expanded Market)***		
Baseline Remediation Option (10 year and 20 year disposal period)	**Without Proposed Rule ($/year) (2006$ millions)**	**Additional Cost of Proposed Rule (Current Market) ($/year) (2006$ millions)**	**Total Annualized Cost with Proposed Rule ($/year) (2006$ millions)**	**Incremental Cost of Proposed Rule ($/year) (2006$ millions)**	**Total Annualized Cost with Proposed Rule ($/year) (2006$ millions)**	**Environ-mental Impact**
Baseline Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits	$ 39.79 - $ 81.09	$ 0.05	$ 39.84 - $ 81.14	($ 12.74) - ($ 11.10)	$ 27.05 - $ 69.99	Most Protective
Baseline Remediation Option 2: Chat Consolidation, In-Place Containment and Revegetation	$ 92.81 - $ 191.20	$ 0.05	$ 92.86 - $ 191.25	($ 31.99) - ($ 27.89)	$ 60.82 - $ 163.31	Protective
Baseline Remediation Option 3: No Further Action and Monitoring of Water Quality	$ 0.36 - $ 0.62	$ 0.05	$ 0.41 - $ 0.67	$ 0.05	$ 0.41 - $ 0.67	May Not be Adequately Protective
Optimization Analysis: Cost Impact (Savings) of Chat Use in Transportation and Disposal [3]						
Baseline Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits	$ 39.79 - $81.09	($ 1.92) - ($ 1.67)	$ 37.87 - $ 79.43	($ 16.58) - ($ 14.45)	$ 23.21 - $ 66.64	Most Protective
Baseline Remediation Option 2: Chat Consolidation, In-Place Containment and Revegetation	$ 92.81 - $ 191.20	($ 13.62) - ($ 11.87)	$ 79.19 - $ 179.33	($ 58.69) - ($ 51.18)	$ 34.12 - $ 140.02	Protective
Baseline Remediation Option 3: No Further Action and Monitoring of Water Quality	$ 0.36 - $ 0.62	$ 0.05	$ 0.41 - $ 0.67	$ 0.05	$ 0.41 - $ 0.67	May Not be Adequately Protective

Notes:

[1] Annualized costs based on an interest rate of 3 percent and a 10 and 20 year timeframe. The costs include remediation activities over 30 years. However, we assume major disposal activities will be completed after 10 to 20 years. After the chat is disposed, the remediation costs include minimal monitoring costs.

[2] The incremental costs include annual certification, notification, and recordkeeping costs of $50,000/yr. There are no additional requirements in this proposal associated with chat use. Considerations such as dust control and leachate prevention are already implemented by chat users during construction. Therefore, costs under the proposed rule are expected to remain minimal.

[3] Optimization analysis assumes that the government or other entity offsets transport cost to a point where the total disposal cost and transport costs are minimized. It is important to note that cost offsets are not part of the proposed rule. In addition, the 'negative' cost impact or savings of the proposed rule represents total saving to society, based on the assumptions for each analysis.

Exhibit 2

SUMMARY OF PRESENT VALUE COSTS AND BENEFITS OF CHAT USE

Baseline Remedial Option	Scenario	Quantity Used for Transport (million tons)	Quantity Disposed (million tons)	Quantity Remaining (million tons)	Total NPV Remedial Cost (2006$ millions) \1	Total NPV Incremental Cost (2006$ millions) \2	NPV Cost Impact (2006$ millions)	Environmental Impact
Impact of Proposed Rule on Chat Disposal								
Baseline Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits	Without Rule	10 - 20	59.29 - 69.29	20.71	591.91 - 691.74	-	-	Most Protective
	Current Market	10 - 20	59.29 - 69.29	20.71	591.91 - 691.74	0.43 - 0.74	0.43 - 0.74	
Baseline Remediation Option 2: Chat Consolidation, In-Place Containment and Revegetation	Without Rule	10 - 20	55.20 - 65.20	24.80	1,380.83 - 1,630.97	-	-	Protective
	Current Market	10 - 20	55.20 - 65.20	24.80	1,380.83 - 1,630.97	0.43 - 0.74	0.43 - 0.74	
Baseline Remediation Option 3: No Further Action and Monitoring of Water Quality	Without Rule	10 - 20	-	80 - 90	5.31	-	-	May Not be Adequately Protective
	Current Market	10 - 20	-	80 - 90	5.31	0.43 - 0.74	0.43 - 0.74	
Optimization Analysis: Impact of Chat Use in Transport and Disposal \3								
Baseline Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits	Current Market (Optimization)	12.86 - 25.86	53.43 - 66.36	20.71	562.64 - 677.10	0.43 - 0.74	(28.53) - (14.21)	Most Protective
	Expanded Market	19.53 - 39.06	40.24 - 59.77	20.71	401.67 - 596.62	0.43 - 0.74	(189.50) - (94.69)	
	Expanded Market (Optimization)	25.26 - 50.51	28.78 - 54.04	20.71	344.50 - 568.03	0.43 - 0.74	(246.66) - (123.28)	
Baseline Remediation Option 2: Chat Consolidation, In-Place Containment and Revegetation	Current Market (Optimization)	18.13 - 36.26	38.94 - 57.07	24.80	1,177.41 - 1,529.26	0.43 - 0.74	(202.67) - (101.28)	Protective
	Expanded Market	19.53 - 39.06	36.15 - 55.67	24.80	904.14 - 1,392.62	0.43 - 0.74	(475.95) - (237.92)	
	Expanded Market (Optimization)	35.41 - 75.20	0 - 39.79	24.80	505.31 - 1,194.00	0.43 - 0.74	(874.78) - (436.54)	
Baseline Remediation Option 3: No Further Action and Monitoring of Water Quality	Current Market (Optimization)	10 - 20.00	-	80.00 - 90.00	5.31	0.43 - 0.74	0.43 - 0.74	May Not be Adequately Protective
	Expanded Market	19.53 - 39.06	-	60.94 - 80.47	5.31	0.43 - 0.74	0.43 - 0.74	
	Expanded Market (Optimization)	19.53 - 39.06	-	60.94 - 80.47	5.31	0.43 - 0.74	0.43 - 0.74	

Exhibit 2

SUMMARY OF PRESENT VALUE COSTS AND BENEFITS OF CHAT USE

Source: See Appendix A to D for a detailed list of assumptions and sources.

Notes:

\1 The present value of costs is based on a discount rate of 3 percent for a period of 10 to 20 years. The costs include remediation activities over 30 years. However, we assume major disposal activities will be completed after 10 to 20 years depending on site specific conditions. After the chat is disposed, the remediation costs include minimal monitoring costs.

\2 The incremental costs include annual certification, notification, and recordkeeping costs of $50,000, which have a net present value of $0.43 million over 10 years or $0.74 million over 20 years, assuming a discount rate of 3 percent. There are no additional proposed requirements associated with the use of chat (e.g., dust control and leachate prevention measures). Therefore, these costs under the proposed rule are expected to remain minimal.

\3 Optimization analysis assumes that the government or other entity offsets transport cost to a point where the total disposal cost and transport costs are minimized. It is important to note that cost offsets are not part of the proposed rule.

BACKGROUND AND PURPOSE OF ANALYSIS

This analysis addresses a requirement in Section 6006 of the 2005 transportation bill (S.793). The section requires EPA to evaluate the costs, benefits, and economic impacts of developing standards for use of chat at Tar Creek in various transportation uses. The purpose of this analysis is to identify the costs and benefits specifically associated with the development of criteria for chat use in transportation.[9] Costs, benefits, and impacts depend largely on the extent to which additional chat use is encouraged or discouraged by a change in criteria.

Need for Regulation

Section 6006 of the 2005 Transportation Bill (S.793) requires that EPA develop criteria for use of chat in transportation applications, focusing on "encapsulated" uses, such as asphalt and concrete. While EPA currently has established regional policy governing these uses, the aim of the bill is for EPA to clarify this policy.[10] Ideally, clarification of criteria for use of chat in transportation projects would encourage increases in safe "beneficial reuse" applications, and would result in substantial energy savings and associated environmental benefits.[11] This regulation is promulgated under the context that expanded use of chat that is safe to human health and the environment is preferred to existing conditions.

Alternatives to Regulation

Currently, chat from the Tar Creek and other Tri-State sites is used in various transportation uses - particularly in asphalt - pursuant to guidance published by EPA's Region 6 and Region 7. In addition, under CERCLA, EPA is in the process of identifying and selecting response actions for chat at each of the Tri-State sites (see Exhibit 3).

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[9] The proposed rule also includes chat use in concrete for selected non-transportation construction applications. However, these uses are believed to be negligible to non-existent at this time and are therefore not included in this analysis.

[10] See Tar Creek Mining Waste, Fact Sheet, June 28, 2002, Ottawa County, Oklahoma.

[11] See "Increased use of recovered minerals in cement or concrete" 108th Congress Report to Senate on November 17, 2003. <http://thomas.loc.gov/cgi-bin/cpquery/T?&report=sr198&dbname=cp108&>

Exhibit 3

TRI-STATE MINING DISTRICT SUPERFUND SITES

Name	City, State	Tonnage of Chat	Surface Area of Chat (acres)
Cherokee County	Galena, KS	5,000,000 /1	4,000
Oronogo-Duenweg Mining Belt (a.k.a Jasper County)	Joplin, MO and vicinity	7,200,000 /2	2,321
Newton County Mine Tailings Site	Joplin, Granby, Racine, Seneca, Spring City, and Wentworth, MO	*Undetermined* /3	*Undetermined*
Tar Creek	Picher, Cardin, Quapaw, Commerce, and North Miami, OK	45,100,000 to 75,000,000 /4	25,600
TOTAL /6		**100,000,000 /5**	

Sources:
US EPA Office of Solid Waste (OSW).
NewFields Feasibility Study, Japer County, Missouri, Mine and Mill Waste Operable Unit, OU-1, April 2003, Table 2-2.
Tar Creek, OK, EPA ID: OKD980629844, Site Description, August 2005
Remedial Investigation and Feasibility Study Report, Cherokee County, Danes & Moore, 1993.

Notes:
/1 Based on information from Remedial Investigation and Feasibility Study Report, Cherokee County, Danes & Moore, 1993. Recent information on the current quantity of chat at the site is not available. Volume of chat presented as 4,000,000 cubic yards. A conversion factor of 0.8 cubic yards of chat per ton was used to estimate the tonnage. This figure does not include mine tailings and vegetated chat.
/2 Volume of chat presented as 5,732,190 cubic yards in ROD. As such a conversion factor of 0.8 cubic yards of chat per ton was used to estimate the tonnage of chat at Jasper County site. Note that this figure does not include mine tailings and vegetated chat.
/3 The U.S. EPA Office of Solid Waste indicates that no reliable data is currently available to estimate the quantity of chat at the Newton County site.
/4 Volume of chat at Tar Creek (36,084,607 cubic yards) based on the LIDAR survey conducted by the USGS in approximately June 2005. Tonnage of chat calculated by dividing volume by conversion factor of 0.8 cubic yards per ton of chat. However, an August 2005 Tar Creek Fact Sheet indicates there may be as much as 75 million tons of chat in-place at the Tar Creek site. The source of this 75 million ton estimate is unclear.
/5 The US EPA Office of Solid Waste (OSW) estimates that the total tonnage of chat at the four sites is approximately 100,000,000 tons. However, recent information indicates that this total quantity estimate is uncertain. The specific quantity of chat at each site has not been rigorously quantified. As a result, our total quantity estimate may overstate the total amount of chat currently present at all four sites.
/6 Figures may not sum to total due to rounding.

OVERVIEW OF CURRENT AND PREVIOUS CHAT USE AND MARKETS

Chat is comprised largely of angular chert fragments containing residual amounts of lead sulfide and zinc sulfide. Chat ranges in diameter from 15.875 mm to less than 0.075 mm. As a byproduct of mining and milling operations, chat has been exempted from regulation as a "hazardous waste" under RCRA. However, given the varying concentration of lead (a hazardous substance) present in chat, it is subject to CERCLA regulations.[12]

[12] See Summary Report of Washed and Unwashed Mine Tailings (Chat) from Two Piles at the Tar Creek Superfund Site, Ottawa County, OK, Oklahoma Department of Environmental Quality, June 2003.

Currently, chat at the Tri-State mining area sites is found in above-ground piles of varying sizes, reflecting the different types of mining operations that occurred in each of the areas. The total quantity of chat at the Tri-State mining area sites is roughly 100 million tons.[13]

In general, Tar Creek has larger and fewer chat piles than Jasper County, where piles are small and widely dispersed. The Tar Creek Superfund site covers approximately 25 square miles, while the Jasper County Superfund site covers more than 100 square miles.[14] The estimated 45 to 75 million tons of chat at Tar Creek is divided over 1,022 piles, the largest of which contains slightly more than seven million tons of chat and covers approximately 106 acres.[15] The total quantity of chat at Jasper County is approximately seven million tons. In addition, chat at Jasper County tends to be more varied in composition, with greater percentages of "overburden," which is not amenable to use in transportation construction.[16]

A small but well-established market for chat in transportation applications exists in the Tri-State region. Within the area in which chat can be economically transported approximately one million tons of chat is used each year.

Key Factors in Chat Supply and Demand

Demand for chat as aggregate in transportation uses is price sensitive; as long as "finished" chat can be provided and used at prices that are competitive with other sources of aggregate, consistent demand exists. Key cost drivers for chat include raw material costs, processing and washing, and transport.

Raw material costs for obtaining unwashed "raw" chat at the Tri-State sites are typically very low. However, before chat can be used for transportation-related uses, it must be washed or dry screened and "sized." This processing is included in the "market price" of chat which is

[13] The US EPA Office of Solid Waste (OSW) estimates that the total tonnage of chat at the four sites is approximately 100,000,000 tons. However, recent information indicates that this total quantity estimate is uncertain. The specific quantity of chat at each site has not been rigorously quantified. Thus, our total quantity estimate for all sites may be overstated.

Our assessment suggests that the key overarching conclusions of our analysis would not be affected by a reduction in the total quantity of chat at the Tri State sites. However, if the total quantity of chat at the sites is less than approximately 25 million tons, it may be more cost effective to use the chat exclusively for transportation projects at no cost, as opposed to disposal. This assumes that approximately 20 percent or 5 million tons of chat would remain on site (consistent with baseline remediation options 1 and 2) and 20 million tons would be marketable over a 20-year timeframe based on current chat demand. However, it is likely that the total quantity of chat at the Tri-state sites is greater than 25 million tons.

[14] Based on personal communication with Mark Doolan (EPA) on October 6, 2005.

[15] Volume of chat at Tar Creek (36,084,607 cubic yards) based on the LIDAR survey conducted by the USGS in approximately June 2005. Tonnage of chat calculated by dividing volume by conversion factor of 0.8 cubic yards per ton of chat. However, an August 2005 Tar Creek Fact Sheet indicates there may be as much as 75 million tons of chat in-place at the Tar Creek site. The source of this 75 million ton estimate is unclear.

[16] Based on personal communication with Jane Kloeckner (EPA) on September 21, 2005.

typically similar to the price of other aggregates. Once processed, chat is hauled to the final construction site. Due to lead and other contaminants in chat, construction crews monitor dust and particulate matter during construction.[17] These marginal costs are factored into the market price of chat as well. The current market price for chat and other forms of aggregate, *net of transport*, is approximately five dollars per ton.[18]

Since chat (like all aggregates) is a heavy, high volume product, the distance the chat must be hauled to the construction site largely determines the size of the market. Rail is not available for chat transport in the region, so all hauling is done by truck. The cost to transport chat is approximately $0.36 per ton per mile via truck.[19] Currently, according to Tri-State chat haulers and processors, chat is not competitive with other aggregate suppliers beyond a 200 mile haul from the Tar Creek site. Even this 200 mile radius represents an upper bound of the current market, because in at least some cases, chat haulers use the same trucks to bring back other products (e.g., sand) thereby reducing the effective per ton costs of transporting chat by 50 percent. If trucks were to return from chat deliveries empty, then the effective market could be significantly smaller in radius.

Finally, demand for chat in transportation applications is limited by various technical and performance standards implemented by State and Federal Transportation Departments. These specifications typically limit the quantity of chat (and other types of material) to a certain percentage of the total aggregate used in a highway project. For example, the most common mix design for use of chat in asphalt specifies 10 to 30 percent chat by weight of hot mix asphalt aggregate.[20]

Supply of chat is currently plentiful, but the quantity and characteristics of chat vary significantly among chat piles and sites and can affect whether a specific chat pile can be economically loaded, hauled, and processed for use. Significant fixed costs are incurred to set up equipment for loading chat from a pile. Small piles far from the washing facility are usually less attractive to chat processors than larger, closer piles. Furthermore, some piles have significant non-chat material (e.g., overburden and mine tailings) and require more processing to obtain market quality chat.[21] As a result, some potential sources of chat are not economically competitive at current costs and prices. However, sufficient "high quality" chat is available to meet current levels of demand for several decades.

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[17] These requirements are based on consent decrees between the state environmental departments and chat processors (see for example, Consent Order No. 02-352 between Oklahoma Department of Environmental Quality and Bingham Sand and Gravel Co., dated November 1, 2002).

[18] Based on personal communication with Larry Bingham (Bingham Sand & Gravel, Inc.) on September 26, 2005.

[19] This cost was provided by Mark Doolan of US EPA.

[20] Based on personal communication with Richard Adams, Manager of Oklahoma Flint Rock Products, LLP on October 5, 2005 (see Appendix D-3b).

[21] Metal concentrations also vary significantly between piles. In general, particle size and metal concentrations are directly related. As a result, criteria that specify allowable levels of metal contamination may decrease or increase the current quantity of chat available for transportation-related use.

Major Distributors of Chat

A limited number of small companies act as brokers, processors and distributors (washers and haulers) of chat in the Tri-State area. Bingham Sand & Gravel, Inc. ("Bingham Sand") and Oklahoma Flint Rock Products, LLP ("Flint Rock") are the two major chat haulers and washers near the Tar Creek Superfund site. Both companies currently have capacity to process additional volumes of chat annually.[22] Chat haulers and washers buy chat from several "chat pile" owners, each typically owning only a small total volume of chat. Sixteen of 29 chat piles remaining within the Picher Mining Field in Ottawa County are located on land controlled by the Quapaw Tribe of Oklahoma.[23] Recently, the Bureau of Indian Affairs (BIA) made efforts to further develop the chat market by offering appraisal services to Quapaw chat owners to identify high-quality chat on their land.

Chat hauling and washing operations in and around the Tar Creek Superfund site operate under consent orders with the Oklahoma Department of Environmental Quality to ensure that management and processing operations are protective of human health and the environment. In addition, EPA has issued widely distributed guidance documents for the sale and use of chat, such as the "Tar Creek Mining Waste Fact Sheet" (June 28, 2002). According to these guidance documents, use of chat in encapsulated asphalt and concrete, as well as sub-grade and base for roads, is considered acceptable.[24] In 2000, EPA (Region 7) also signed a "Covent Not to Sue" with the Missouri Highway and Transportation Commission for allowing use of 588,000 cubic yards of chat in construction of Highway 71 bypass, which sits within the Tar Creek Superfund site.[25]

Current Uses of Chat

Approximately 95 percent of processed chat is used as aggregate for asphalt in highway and road construction. Asphalt is a combination of aggregates (usually crushed stone and some sand), filler (cement, hydrated lime or stone dust) and a bituminous binder called asphalt cement (or asphalt binder).[26] Sometimes recyclable materials are used in addition to stone and sand for the aggregate (e.g., rubber from old car tires or chat). The remaining five percent of chat includes the following uses: 1) component in non-skid surfaces, 2) sand blasting material, 3) rough coating for drill rigs and gas/oil pipes, and 4) waste water sewer filter.[27]

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[22] Based on personal communication with Richard Adams, Manager of Oklahoma Flint Rock Products, LLP on October 5, 2005.

[23] Chat Sales Treatabilty Study Work Plan for the Sale of Indian-Owned Chat within the Tar Creek Superfund Site Ottawa County, Oklahoma, page 4.

[24] See Tar Creek Mining Waste, Fact Sheet, June 28, 2002, Ottawa County, Oklahoma

[25] See Information Briefing on the Use of Chat, Office of Solid Waste, U.S. EPA, August 2005.

[26] See "Asphalt Basics," www.streetprint.com.

[27] Based on personal communication between US EPA OSW and Richard Adams (Flint Rock) on September 26, 2005.

Chat use in concrete applications is currently insignificant. Although a preliminary study of chat use as aggregate for concrete was promising, research on environmental impacts of use in concrete is not conclusive.[28] In recent years (2001 through 2003) the Chanute, Kansas Ash Grove Cement facility used a limited amount of chat in the manufacture of Portland cement, but operational issues and the emergence of a less expensive substitute ended the company's use of chat.[29]

Although chat has been identified as acceptable for use as a sub-grade or base material for highways, it has not been significantly used for this purpose. One reason may be that not enough research has been conducted by engineers to develop specifications for the use of chat in these applications. Alternatively, chat may not represent the most economical source of road base material.

Market Outlook

Historical trends and information from regional chat suppliers suggest that demand for chat for transportation-related uses is unlikely to change significantly in the next few decades in the absence of the proposed rule. The viable market is well defined; transport costs make chat economically unattractive beyond the current market limits. Within the current market, rates of growth for new roads are modest (estimated at less than two percent per year) and population densities in areas surrounding the Superfund sites are not high. Chat use in other applications such as concrete does not appear to be economically attractive at this time, and the proposed rule is not likely to create economic incentives to pursue these uses.

It is possible that clarification of criteria for chat use could result in increased demand for chat in asphalt within the current market area, particularly if stigma or some other consideration is limiting current use. A geographic analysis of the area of roads in the region implies that demand for chat could increase, with an upper limit of demand that represents a potential doubling of current use. However, current chat market experts do not expect significant growth in the market and it is difficult to determine what, if any, impact the proposed rule will specifically have on demand.

BASELINE AND SCENARIO IDENTIFICATION

To evaluate the impact of the proposed rule, it is necessary to first identify a reasonable baseline from which to measure the proposed rule's costs and benefits. Because the final CERCLA remedies have not yet been selected for the Tri-State sites, we develop our analysis relative to three alternative baseline remedial options. Two of these baselines incorporate alternative Superfund remedies for the Jasper County site in Missouri; the third is a hypothetical "no action" baseline in which no remediation activities take place:

[28] Based on personal communication with Richard Adams (Flint Rock) on October 5, 2005.

[29] Mike Harrell, Ash Grove Cement Company, personal communication, October 12, 2005.

- **Baseline Remedial Option 1:** Chat Removal and Disposal in On-Site Subsidence Pits (with continuing use of chat for transportation projects while remediation continues);

- **Baseline Remedial Option 2:** Chat Consolidation, In-Place Containment and Revegetation (with continuing use of chat for transportation projects while remediation continues); and

- **Baseline Remedial Option 3:** No Further Action Except Monitoring of Water Quality (with use of chat for transportation projects).

The remedy selected for the Jasper site includes the on-site disposal remediation option (Baseline Remedial Option 1). Of the remediation alternatives evaluated for the Jasper site, this is considered the most protective of human health and the environment, while also being the most cost effective.[30] Although the 'no-action' alternative was evaluated for the site, it is not considered a viable option because it is not believed to be adequately protective of human health and the environment.

The time frame we assume for chat disposal and removal is 10 to 20 years. This range reflects uncertainty in the volume of chat at each Superfund site and required disposal period. The smaller sites will likely require a shorter clean-up period while the larger sites may require a longer clean-up period.[31] For example, at the Jasper Superfund site, disposal activities are estimated to be completed within 7 to 10 years, depending on the remedy selected.[32] However, the Tar Creek site containing the largest volume of chat, may require a longer disposal period.

To evaluate the compliance costs and benefits of chat use in transportation products under the proposed rule, we examine the use of chat based on a **current market scenario**. This scenario is based on information from chat market experts, companies using and selling chat, and EPA that suggests the regional market for chat, within 200 miles of Tar Creek, is currently saturated and demand for chat is not likely to change significantly as a result of the proposed rule.

In addition, we evaluate the impact of chat use in an **expanded market scenario.** This scenario is based on a GIS analysis that suggests that current demand for asphalt within 200 miles of the Tar Creek site might accommodate a doubling of chat use, assuming the most

[30] See Record of Decision, Oronogo-Duenweg Mining Belt Site, Jasper County Superfund Site, Jasper County, Missouri, Prepared by U.S. EPA, Region VII, September 2004, page 17.

[31] For purposes of our analysis, the costs include remediation activities over 30 years. However, we assume disposal activities will be completed after 10 to 20 years, with monitoring activities following. This remediation period is applied as a broad generalization for application across all sites analyzed in this analysis, and is not meant to reflect a final Agency determination or Agency policy.

[32] See NewFields Feasibility Study, Japer County, Missouri, Mine and Mill Waste Operable Unit, OU-1, April 2003, Alternative 3 and 4.

common mix design of 20 percent chat in asphalt aggregate.[33] However, it is important to note that this scenario does not assume that the proposed rule would necessarily double the chat market.

Both scenarios focus on the use of chat as an aggregate in asphalt and evaluate potential costs to the government and compliance costs to end users of chat. In addition, both scenarios evaluate the impact on costs of increasing the use of chat in transportation applications based on a number of sensitivity analyses. These analyses include (a) estimating the optimal tonnage of chat use in transportation that would minimize total remedial and transport costs, (b) estimating the total tonnage of chat in asphalt that would equal the baseline remedial costs, and (c) estimating the cost of using chat that was originally designated for disposal, only in transportation applications.[34] We illustrate these scenarios in Exhibit 4.

[33] The most common mix design for chat in asphalt aggregate (20 percent) is based on personal communication (October, 2005) with Richard Adams (Flint Rock Manager). It is important to note, however, that EPA is not promoting the use of this mix design.

[34] Our analysis of chat in "transport only" applications does not consider the cost of containing the chat on-site (e.g., retention basins) prior to use in transport projects. However, these costs are likely to be minimal.

Exhibit 4

SUMMARY OF CHAT COST ANALYSIS BASELINES AND SCENARIOS

		Impact of Chat Use in Transportation and Disposal (Based on Sensitivity Analyses)						
	Post-Proposal	**Current Market**			**Expanded Market**			
Baseline Remedial Option	**Current Market**	**Optimization Analysis**	**Breakeven Analysis**	**"Transportation Only" Analysis**	**Expanded Market**	**Optimization Analysis (High-End)**	**Breakeven Analysis**	**"Transport-ation Only" Analysis**
Baseline Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits	Estimates remediation costs assuming 1 million tons of chat per year used for transportation applications, within 200 mile economic radius. Assumes: Current market demand for chat within 200 mile economic does not change under proposed rule.	Estimates minimal remediation costs while maximizing use of chat in asphalt. Assumes: a) Offsets for chat hauling costs, beyond 200 mile economic radius. b) Current market demand for chat within 200 mile economic does not change under proposed rule.	Estimates maximum amount of chat for use in asphalt while keeping total remedial costs equal to baseline remedial costs. Assumes: a) Offsets for chat hauling costs, beyond 200 mile economic radius. b) Current market demand for chat within 200 mile economic does not change under proposed rule.	Estimates total cost of remediation for chat assuming all chat designated for disposal is used for asphalt. Assumes: a) Offsets for chat hauling costs, beyond 200 mile economic radius. b) Current market demand for chat within 200 mile economic does not change under proposed rule.	Estimates remediation costs, similar to current market scenario. Assumes a) 1.9 million tons of chat per year used for transportation applications, within 200 mile economic radius.	Estimates minimal remediation costs while maximizing use of chat in asphalt. Assumes a) Offsets for chat hauling costs, beyond 200 mile economic radius. b) Market demand for chat *doubles* under proposed rule.	Estimates maximum amount of chat for use in asphalt while keeping total remedial costs equal to baseline remedial costs. Assumes: a) Offsets for chat hauling costs, beyond 200 mile economic radius. b) Market demand for chat *doubles* under proposed rule.	Estimates total cost of remediation for chat assuming all chat designated for disposal is used for asphalt. Assumes: a) Offsets for chat hauling costs, beyond 200 mile economic radius. b) Market demand for chat *doubles* under proposed rule.
Baseline Remediation Option 2: Chat Consolidation, In-Place Containment and Revegetation	Same as above. Costs are evaluated in comparison to baseline remedial option 2.	Same as above. Costs are evaluated in comparison to baseline remedial option 2.						
Baseline Remediation Option 3: No Further Action and Monitoring of Water Quality \4	Same as above. Costs are evaluated in comparison to baseline remedial option 3.	Same as above. Costs are evaluated in comparison to baseline remedial option 3.						

COMPLIANCE COST ANALYSIS

The two types of costs that may be affected by the proposed rule are compliance costs to users of chat (e.g., state highway departments) associated with management of the material during construction, and potential changes in the costs to remediate the sites in the Tri-State mining area as a result of changes in the quantity of chat removed for transportation projects under the proposed rule.

This analysis focuses on the use of chat as aggregate in asphalt. Chat may be used for a variety of transportation products, including asphalt and concrete. However, 95 percent of chat is currently used in asphalt applications; other uses do not appear economically attractive at this time. The proposed rule is unlikely to encourage significant new use of chat in concrete and other transportation applications because it will not have a significant cost-reducing impact on the use of chat in concrete and road base. Currently approximately 1,000,000 tons per year of chat are used for transportation applications (primarily asphalt) from the Tri-State sites at no cost to the government.[35] Based on this estimate, approximately 10 million tons of chat may be used in transportation projects if disposal of chat at all sites is accomplished in 10 years or 20 million tons of chat over a 20-year disposal period Although the language in Section 6006 specifies an analysis of chat at the Tar Creek mining site, this cost analysis examines the potential impact of EPA criteria for chat at all four sites in the Tri-State area. These sites contain chat of different qualities and quantities. In some cases, the quality or geographical distribution of the chat affects the feasibility and cost of use in transportation. While the compressed time frame of our analysis precludes a detailed investigation of site-specific conditions for all chat, the analysis attempts to identify generally applicable cost estimates and to identify key impacts and inherent uncertainties.

Compliance Costs to Chat Users

The proposed rule is not expected to present a significant increase in compliance costs to current chat users. Although the rule does not require specific measures related to the management of the material during construction, use of chat in transportation projects is likely to include some level of construction costs, combined with administrative costs. Construction related costs may include increased dust control, subsurface drainage and leachate control (Exhibit 5). While not specifically required in the rule, these construction costs may be necessary to address liability concerns associated with the use of chat. For example, the Tar Creek Mining Waste Fact Sheet, dated June 28, 2002, noted that "even when chat is put to uses that are described as generally acceptable, care must be used to prevent a release." However, discussions with chat suppliers and state and federal agency experts suggest that in many cases these controls may already have been implemented by chat users. In addition, these costs are modest compared to transport costs ($0.36 per ton-mile) for chat and are therefore unlikely to result in significant reduction in the quantity of chat that can be economically used in asphalt.

[35] The estimated current market demand for chat within the Tri-state area (1,000,000 tons per year) is based on personal communication with Steve Hoffman of EPA's OSW and is corroborated by Larry Bingham of Bingham Sand and Gravel, Inc.

Therefore, we do not include any incremental construction costs in our analysis of the proposed rule.[36]

Exhibit 5 SUMMARY OF ESTIMATED COMPLIANCE CHAT COSTS IN TRANSPORTATION PRODUCTS UNDER PROPOSED RULE					
Chat Use	**Description**	**Cost ($/unit) (2006 $)**	**Unit**	***Average* Annual Cost**	**Sources and Assumptions**
Asphalt	Digital Dust Sampler, Monthly Rental	1,023	month	*minimal*	RS Means Remediation Costs 2001, inflated to 2005 dollars using the Construction Cost Index (approximately 3 percent per year inflation factor). *Not directly required by the rule, as proposed*
Asphalt	Geotextiles for subsurface drainage, laid in trench, ideal conditions	1.69	square yard	*minimal*	RS Means Heavy Construction Costs 2005 *Not directly required by the rule, as proposed*
Asphalt	Furnish and install drainage fabric	2.25	square yard	*minimal*	RS Means Heavy Construction Costs 2005 *Not directly required by the rule, as proposed*
Asphalt	Certification, Notification, Recordkeeping	200 - 300	project	$50,000	Assumes 5 labor hours at cost of $40 to $60 per hour (obtained from RS Means Heavy Construction Costs 2005) to complete one notification per project. Annual costs assume 200 asphalt projects per year.

As shown in Exhibit 5, under the proposed rule compliance chat costs in transportation products may also include costs associated with notification, recordkeeping, and reporting requirements. Assuming five labor hours are required to process the required paperwork and meet the reporting requirements for each project using chat and that the average regional cost of labor and benefits is $40 to $60 per hour, we estimate that these compliance costs may range from $200 to $300 per project, assuming one notification per project.[37] Supposing approximately 200 projects use chat per year, this results in an annual notification cost of between $40,000 to $60,000 - averaging $50,000 per year. As these costs are modest compared to transport costs ($0.36 per ton-mile) for chat, we do not expect the reporting requirements to result in significant reduction in the quantity of chat that can be economically used in asphalt. In addition, in many cases the companies using chat may be already tracking this information for other purposes, therefore, we expect the costs to have little, if any, impact.

We estimate that five to six federal and state agencies and two dedicated chat haulers will be directly subject to the reporting requirements under the proposed rule. However, all entities in the industry will likely have the need to review the regulation. We estimate that approximately 50 sand and gravel companies operate within Oklahoma, Kansas, and

[36] The construction costs for leachate and drainage control, if incurred, may range from $0 to $1.8 million per year, averaging $900,000 annually. The upper end of this range is estimated by multiplying the cost of drainage fabric (2.25 per square yard) by 800,000 cubic yards of chat per year. (Assumes that the chat is laid on a construction site at a depth of one yard.)

[37] Unit labor cost range reflects average rate, including overhead, for field engineer ($1,550 per week) and a project manager ($2,225 per week). We assume 40 hours per week to estimate the per hour rates of $40 to $60 per hour. (See RS Means Heavy Construction 2005).

Missouri.[38],[39] We do not believe that counties will be subject to these requirements, as most highway projects are large enough to involve both state and federal participation. To the extent that county governments become primary users of chat, without state participation, they may also need to read the regulations and file the appropriate paperwork.

TCLP or SPLP testing for any chat uses are not required by this proposal and therefore are not incorporated into our total cost estimates. However, we developed an alternative testing cost analysis in an effort to determine the potential impact such a requirement may have on this action. We found the potential cost impact of testing for non-encapsulated transportation related chat uses would be minimal. Assuming 10 non-encapsulated transport related projects per year (within the economically feasible range), the total annual testing costs may range from $5,250 to $11,250 per year, with an average of $8,250 per year. This estimate assumes testing of eight metals, with three to five tests per project.

Changes in Remediation Costs[40]

A preliminary analysis of the chat market based on consultation with regional market experts suggests that in their view the market for chat in asphalt is well established, fully supplied (saturated) and not constrained by current EPA policy.[41] As a result, these experts do not expect that demand for chat will be affected by the proposed rule and therefore, the costs of remediating the Tri-State area sites will be unaffected by the proposed rule. However, our analysis indicates that if the proposed rule alters attitudes about the acceptability of chat or influences Superfund remedy selection, some increase in the use of chat in transportation might be possible. Under these conditions, the proposed rule might:

(1) **Increase the economic distance the chat can be transported through funded offsets for hauling costs.** The current cost of hauling the chat is approximately $0.36 per ton-mile. Therefore, if the government or other entities were to provide cost offsets to extend the functional market beyond the current 200 mile 'economic radius' in which chat is currently used, it may be able to expand demand for chat use in asphalt.

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[38] Based on NAICS code 4233202, for Sand Gravel and Stone Merchant Wholesalers in Oklahoma, Kansas, and Missouri.

[39] If all these entities read the rule, we estimate an annual review cost of between $4,000 to $6,000. This assumes two labor hours are required for each entity to review the proposed rule and that the average regional fully-loaded cost of labor is $40 to $60 per hour. Unit labor cost range reflects average rate, including overhead, for field engineer ($1,550 per week) and a project manager ($2,225 per week). We assume 40 hours per week to estimate the per hour rates of $40 to $60 per hour. (See RS Means Heavy Construction 2005).

[40] All dollar values presented in this section have been adjusted to 2006 dollars.

[41] Based on discussions with Mark Doolan and Steve Hoffman of U.S. EPA on October 6 and 7, 2005, Larry Bingham (of Bingham Sand and Gravel, Inc.) on September 26, 2005, and Richard Adams (of Oklahoma Flint Rock Supply, LLP) on October 5, 2005.

- (2) **Increase chat's share of the potential "economic" market for chat in asphalt.** Using a Geographic Information System ("GIS") analysis and information from DOT, we estimate the total road area within the 200 mile economic radius, quantity of asphalt use, and rate of repavement (see Appendix C-4). The analysis indicates that as much as 1.9 million tons of chat per year might be used for asphalt road construction if all major highways and roads were repaved every 13 years using 20 percent chat - nearly twice the current demand. This contrasts with the opinion of regional experts that the current market for chat is saturated and suggests there might be additional demand within 200 miles. We therefore consider the potential expansion of the existing market as a possible (although unlikely) "high-end" scenario.

It is important to note that the 200 mile economic radius for chat is based on information from regional market experts, and represents a high-end estimate of the potential regional market.[42] This market area is determined in part on the practice by existing chat distributors of ensuring that when trucks haul chat to a construction site, at least some of these trucks return loaded with other products, thereby reducing transport costs specifically related to chat. However, this 200-mile radius may be uneconomical for "dedicated chat trucks" that would be required to return empty; consequently the actual economic radius for additional chat demand may be smaller than 200 miles. However, for the purpose of this analysis we assume that chat transport within 200 miles of the Tar Creek site is economical. In addition, the incremental cost of hauling the chat beyond a given economic radius would remain constant on a per mile basis, and the estimates in this analysis assume that the truck returns empty.

We present our analysis of chat remediation costs based on the three Superfund baseline remedies: (1) disposal of chat in on-site subsidence pits, (2) consolidation, in-place containment of chat, and revegetation, and (3) no action coupled with periodic monitoring of water quality. To assess the costs associated with the disposal and transportation uses of chat, we incorporate available information from the Superfund program, existing cost and risk studies, and industry sources. For each disposal and transportation scenario we consider several cost elements including: the cost of remediating the chat piles, chat preparation costs, and transport costs to haul the chat to construction sites.[43]

The cost estimates in this analysis for the proposed Superfund remedies, including the no-action alternative, are based on costs developed for the Oronogo-Duenweg Mining Belt Site in Jasper County, Missouri.[44] As such, each Tri-State site may have unique conditions (e.g., proximity to surface water, quality of chat, etc.) affecting its costs under each scenario. In addition, although we estimate that the tonnage of chat posing a risk to the environment would

[42] Based on discussions with Larry Bingham (of Bingham Sand and Gravel, Inc.) on September 26, 2005, and Richard Adams (of Oklahoma Flint Rock Supply, LLP) on October 5, 2005.

[43] Not all cost elements will be relevant to all scenarios.

[44] See NewFields Feasibility Study, Japer County, Missouri, Mine and Mill Waste Operable Unit, OU-1, April 2003.

be removed after 10 to 20 years under the remediation alternatives, our costs reflect the net present value of remediation activities spanning 30 years. The remediation activities after the major disposal activities are completed primarily include operating and maintenance costs (e.g., water quality monitoring) of the site.[45]

Below we present a summary of the baseline costs for remediation, which are in effect equal to the post-regulatory costs. In addition, we present cost estimates based on an optimization analysis (maximizing the use of chat in asphalt and minimizing total remediation costs), a breakeven analysis (maximizing the use of chat in asphalt assuming the total remediation costs are equal to the baseline costs), and a "transportation only" analysis (estimating the costs of chat removal using only transportation as an option).

Baseline Remedial Option 1: Chat Removal and Disposal in On-Site Subsidence Pits

The first baseline scenario we consider allows for the disposal of chat in selected on-site subsidence pits, which provide a suitable environment for subaqueous mill waste disposal. We estimate the costs of chat remediation under this alternative is approximately $9.98 per ton, based on the costs estimated for the Jasper site.[46] This scenario assumes that, similar to the Jasper site, approximately 21 percent of the chat at each site would remain on-site and un-disposed. At Jasper, EPA found that leaving this quantity at the site does not pose a significant threat to human health or the environment. In this scenario, approximately 59 million tons of chat are estimated to be disposed over 10 to 20 years, resulting in a present value cost of between $592 million and $692 million. Generally, the disposal costs assuming a 10 year period are higher given the fact that less chat may be used for transport at no cost for disposal, thereby requiring the use of more expensive disposal options for a larger quantity of chat.

As noted previously, to expand the use of chat in transportation, the government or other entities could fund the incremental costs of hauling the chat beyond the 200 mile economic radius. We use an optimization analysis to estimate the costs that the government or other entities would likely incur to maximize the use of chat for asphalt, while minimizing the present value of the total site remediation costs. As illustrated in Exhibit 6, our analysis indicates that if the government or other entities fund an average of $4.99 per ton of chat, it could expand the

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[45] Note that the length of total remediation activities (30 years) assumed in our analysis is consistent with the Record of Decision, Oronogo-Duenweg Mining Belt Site, Jasper County Superfund Site, Jasper County, Missouri, Prepared by U.S. EPA, Region VII, September 2004.

[46] This unit disposal cost is based on the total net present value of remediation costs for the Jasper site for this alternative of approximately $50 million divided by the total tonnage of chat (not including vegetated chat and tailings) disposed or approximately 5 million tons (See Appendix B-2 for additional detail).

Also note that this unit cost estimate is consistent with the Declaration of Mark Doolan, dated August 2, 1995 for the U.S. Bankruptcy Court, Southern District of Ohio. In this declaration, Mr. Doolan estimated per acre remediation costs of $15,000 for Jasper County, chat, vegetated chat, and tailings. Multiplying this figure by the total acreage at the site (3,958 acres) and dividing by the total tonnage of chat, vegetated chat, and mine tailings (8.9 million tons), results in a per ton cost estimate of approximately $6.67 per ton in 1995 dollars (see NewFields Feasibility Study, Japer County, Missouri, Mine and Mill Waste Operable Unit, OU-1, April 2003). Adjusted for inflation using the Consumer Cost Index, this figure is approximately $9.33 in 2006 dollars.

economic market for chat by 28 miles – resulting in a potential additional demand for chat in asphalt of approximately 2.9 million tons and present value remediation costs of $677 million (assuming a 10 year disposal period). This results in a cost savings of approximately $14.6 million compared to the baseline remedy. Assuming a 20-year disposal period, we estimate 5.9 million additional tons of chat may be used for transportation projects resulting in present value remediation costs of $563 million (see Exhibit 7). This net present value cost savings of approximately $30 million compared to the first baseline Superfund remedy. Under a best-case scenario, assuming EPA's new proposed rule increases the overall demand for chat *and* there is funding for the transport of chat beyond the current 200 mile economic radius (for $4.99 per ton), we estimate present value remediation costs of $344 million assuming a 20 year disposal period (see Exhibit 7) and $568 million assuming a 10 year disposal period (see Exhibit 6).

Exhibit 6

BASELINE REMEDIAL OPTION 1: OPTIMIZATION OF CHAT COSTS AND BENEFITS
CHAT REMOVAL AND DISPOSAL IN ON-SITE SUBSIDENCE PITS
10 YEAR DISPOSAL PERIOD

Description	**Current Market Scenario *(Same as without rule)***	**Current Market Scenario (Optimization)**	***Difference***	**Expanded Chat Market Scenario (High-end)**	***Difference***
Total Chat on Site (tons)	100,000,000	100,000,000	-	100,000,000	-
Time Frame (years)	10	10	-	10	-
Total Chat Disposed (tons)	69,300,000	66,400,000	*(2,900,000)*	54,000,000	*(15,300,000)*
Total Chat used for Asphalt (tons)	10,000,000	12,900,000	*2,900,000*	25,300,000	*15,300,000*
Remaining Chat, Un-disposed (tons)	20,700,000	20,700,000	-	20,700,000	-
Environmental Impacts	**Protective**	**Protective**	***NA***	**Protective**	***NA***
Unit Disposal Cost ($ per ton)	$ 9.98	$ 9.98	-	$ 9.98	*$ -*
Unit Transportation Cost ($ per ton)	$ -	$ 4.99	*4.99*	$ 4.99	*$ 4.99*
Transport Radius (miles)	200	228	*28*	228	*28*
Present Value Costs ($2006) \1	**$ 691,700,000**	**$ 677,100,000**	*$(14,600,000)*	**$ 568,000,000**	*$ (123,700,000)*

\1 The net present value of remediation costs is estimated using a discount rate of 3 percent and timeframe of 10 years (see Appendix A-1 for additional detail).

Exhibit 7 BASELINE REMEDIAL OPTION 1: OPTIMIZATION OF CHAT COSTS AND BENEFITS CHAT REMOVAL AND DISPOSAL IN ON-SITE SUBSIDENCE PITS 20 YEAR DISPOSAL PERIOD					
Description	**Current Market Scenario *(Same as without rule)***	**Current Market Scenario (Optimization)**	***Difference***	**Expanded Chat Market Scenario (High-end)**	***Difference***
Total Chat on Site (tons)	100,000,000	100,000,000	-	100,000,000	-
Time Frame (years)	20	20	-	20	-
Total Chat Disposed (tons)	59,300,000	53,400,000	*(5,900,000)*	28,800,000	*(30,500,000)*
Total Chat used for Asphalt (tons)	20,000,000	25,900,000	*5,900,000*	50,500,000	*30,500,000*
Remaining Chat, Un-disposed (tons)	20,700,000	20,700,000	-	20,700,000	-
Environmental Impacts	**Protective**	**Protective**	***NA***	**Protective**	***NA***
Unit Disposal Cost ($ per ton)	$9.98	$9.98	-	$9.98	$ -
Unit Transportation Cost ($ per ton)	$ -	$4.99	*$4.99*	$4.99	*$4.99*
Transport Radius (miles)	200	228	*28*	228	*28*
Present Value Costs ($2006) \1	**$592,000,000**	**$562,600,000**	*$(29,300,000)*	**$344,500,000**	*$(247,400,000)*
\1 The net present value of remediation costs is estimated using a discount rate of 3 percent and timeframe of 20 years (see Appendix A-1 for additional detail).					

We also evaluated two additional scenarios as sensitivity analyses. If the government or some other entity chose to promote the maximum use of chat in transportation applications while keeping the total cost of remediation *equal* to the baseline costs, it could divert approximately 6 to 12 million additional tons of chat to transportation uses (depending on the disposal period), expanding the zone of use from 200 to 250 miles. Alternatively, if the government or another entity chose to divert all the chat initially designated for disposal to asphalt applications, it would cost between $35.62 and $65.16 per ton based on current demand, increasing the present value of remediation costs by a total of $1,520 million assuming a 20 year disposal period and $3,823 million assuming a 10 year disposal period. Assuming a transport-only expanded market scenario (see Exhibit 4), however, it would cost on average $15.32 to $36.48 per ton, increasing the present value of remediation costs by $24 million under a 20 year remediation scenario and $1,488 million under a 10 year scenario (see Appendix A-1). Note that the costs under a 10 year scenario are higher because the distance that chat must be transported for use in transportation projects over 10 years is significantly greater (405 miles assuming a 10-year period as opposed to 285 miles assuming 20-year disposal period under the expanded market scenario).

Baseline Remedial Option 2: Chat Consolidation, In-Place Containment and Revegetation

As shown in Exhibits 8 and 9, using a similar approach we evaluate costs against the second baseline alternative for a 10 year and 20 year disposal period. Under this alternative, non-recyclable chat would be consolidated, capped and revegetated in place for approximately $25.01 per ton.[47] This scenario assumes that, similar to the Jasper site, approximately 25 percent of non-hazardous chat at each of the sites would remain on-site and un-disposed (or uncapped). Under this remedy, assuming a 10 year disposal period approximately 65 million tons of chat is estimated to be disposed over 10 years, resulting in a present value cost of $1,631 million (see

[47] See Appendix B-3 for detail.

Exhibit 8). Assuming a 20 year disposal period, approximately 55 million tons of chat is estimated to be disposed resulting in a present value cost of $1,381 million (See Exhibit 9).

Given the high unit cost of this remediation option, it is more economic to use a larger percentage of chat for transportation purposes to minimize remediation costs. Our optimization analysis indicates that if there are funds for an average of $12.51 per ton of chat, it could expand the economic market for chat by 69 miles – resulting in an additional demand for chat in asphalt of approximately 8 to 16 million tons, over 10 to 20 years, with present value remediation costs of between $1,177 million and $1,529, depending on the length of the remediation period.

Exhibit 8

BASELINE REMEDIAL OPTION 2: OPTIMIZATION OF CHAT COSTS AND BENEFITS
CHAT CONSOLIDATION, IN-PLACE CONTAINMENT AND REVEGETATION
10 YEAR DISPOSAL PERIOD

Description	**Current Market Scenario *(Same as without rule)***	**Current Market Scenario (Optimization)**	***Difference***	**Expanded Chat Market Scenario (High-end)**	***Difference***
Total Chat on Site (tons)	100,000,000	100,000,000	-	100,000,000	-
Time Frame (years)	10	10	-	10	-
Total Chat Disposed (tons)	65,200,000	57,100,000	*(8,100,000)*	39,800,000	*(25,400,000)*
Total Chat used for Asphalt (tons)	10,000,000	18,100,000	*8,100,000*	35,400,000	*25,400,000*
Remaining Chat, Un-disposed (tons)	24,800,000	24,800,000	-	24,800,000	-
Environmental Impacts	**Protective**	**Protective**	***NA***	**Protective**	***NA***
Unit Disposal Cost ($ per ton)	$ 25.01	$ 25.01	-	$ 25.01	*$ -*
Unit Transport Cost ($ per ton)	$ -	$ 12.51	*12.51*	$ 12.51	$ 12.51
Transport Radius (miles)	200	269	*69*	269	*69*
Present Value Costs ($2006) \1	**$1,631,000,000**	**$1,529,300,000**	*$(101,700,000)*	**$1,194,000,000**	*$(437,000,000)*

\1 The net present value of remediation costs is estimated using a discount rate of 3 percent and a timeframe of 10 years (see Appendix A-1 for additional detail).

Exhibit 9

BASELINE REMEDIAL OPTION 2: OPTIMIZATION OF CHAT COSTS AND BENEFITS
CHAT CONSOLIDATION, IN-PLACE CONTAINMENT AND REVEGETATION
20 YEAR DISPOSAL PERIOD

Description	**Current Market Scenario *(Same as without rule)***	**Current Market Scenario (Optimization)**	***Difference***	**Expanded Chat Market Scenario (High-end)**	***Difference***
Total Chat on Site (tons)	100,000,000	100,000,000	-	100,000,000	-
Time Frame (years)	20	20	-	20	-
Total Chat Disposed (tons)	55,200,000	38,900,000	*(16,300,000)*	0	*(55,200,000)*
Total Chat used for Asphalt (tons)	20,000,000	36,300,000	*16,300,000*	75,200,000	*55,200,000*
Remaining Chat, Un-disposed (tons)	24,800,000	24,800,000	-	24,800,000	-
Environmental Impacts	**Protective**	**Protective**	***NA***	**Protective**	***NA***
Unit Disposal Cost ($ per ton)	$ 25.01	$25.01	-	$0	*($25.01)*
Unit Transport Cost ($ per ton)	$ -	$12.51	*12.51*	$13.98	$13.98
Transport Radius (miles)	200	269	*69*	278	*78*
Present Value Costs ($2006) \1	**$1,380,800,000**	**$1,177,400,000**	*$(203,400,000)*	**$505,300,000**	*$(875,500,000)*

\1 The net present value of remediation costs is estimated using a discount rate of 3 percent and a timeframe of 20 years (see Appendix A-1 for additional detail).

Assuming EPA's proposed rule nearly *doubles* the overall demand for chat *and* there is funding for the transport of chat beyond the current 200 mile economic radius (for $13.98 per ton), we estimate a total present value of remediation costs of $1,194 million assuming a 10 year disposal period (see Exhibit 8). However, assuming a 20 year disposal period, under this scenario we estimate a total present value of remediation costs of $505 million (see Exhibit 9). Under the expanded market scenario, the total cost of remediation is approximately $86.6 million less than the total cost of remediation under the first remediation alternative, assuming a twenty-year disposal period (see Exhibit 6).[48] This appears to suggest that the second remedial alternative would be more cost effective, resulting in the diversion of all the chat initially designated for disposal for asphalt use. However, this conclusion is dependent on the following assumptions:

- The second baseline remedial option is the appropriate remedy for the Tri-State sites. As noted in the Jasper ROD, dated September 2004, this remediation option was not considered as cost effective or protective of human health and the environment as the first remedial option (described above).[49]

- The proposed rule would nearly double the overall demand for chat within the 200 mile 'economic radius' and beyond this radius up to 278 miles. As noted previously, experts suggest that the demand for chat maybe saturated and thus would likely not be increased by this proposed rule.

- The cost of hauling the chat to construction sites would be offset by a subsidy of $13.98 per ton of chat.

Baseline Remedial Option 3: No Further Action and Monitoring of Water Quality

Under the no action alternative, no remedial actions are considered. Chat is not removed or disposed, but is subject to periodic surface water monitoring to asses ecological health risks. We estimate the total present value of monitoring costs under this baseline scenario of roughly $5.3 million, over 30 years. Our analysis assumes that these monitoring costs would be constant regardless of the volume of chat remaining on site. The disposal period under this baseline remedial option only affects the amount of chat remaining or not used for transportation projects after the given period (10 or 20 years). As presented in Exhibit 10 and 11, assuming a high-end scenario for chat demand after EPA's proposed rule, we estimate an additional 10 million tons of chat could be used for asphalt over 10 years and 20 million tons over 20 years. However, after 10 or 20 years, between approximately 61 to 81 million tons of chat would remain on site - resulting in an outcome that may not be protective of human health or the environment.

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[48] This estimate is calculated by subtracting the cost under the expanded market scenario for Baseline Remedial Option 2 ($505.3 million) from the cost of Baseline Remedial Option 1 under the current market ($592 million).

[49] Record of Decision, Oronogo-Duenweg Mining Belt Site, Jasper County Superfund Site, Jasper County, Missouri, Prepared by U.S. EPA, Region VII, September 2004, page 16.

Exhibit 10 BASELINE REMEDIAL OPTION 3: OPTIMIZATION OF CHAT COSTS AND BENEFITS NO FURTHER ACTION AND MONITORING OF WATER QUALITY 10 YEAR DISPOSAL PERIOD					
Description	**Current Market Scenario *(Same as without rule)***	**Current Market Scenario (Optimization)**	***Difference***	**Expanded Chat Market Scenario (High-end)**	***Difference***
Total Chat on Site (tons)	100,000,000	100,000,000	-	100,000,000	-
Time Frame (years)	10	10	-	10	-
Total Chat Disposed (tons)	-	-	-	-	-
Total Chat used for Asphalt (tons)	10,000,000	10,000,000	-	19,500,000	*9,500,000*
Remaining Chat, Un-disposed (tons)	90,000,000	90,000,000	-	80,500,000	*(9,500,000)*
Environmental Impacts	**Not Protective**	**Not Protective**	***NA***	**Not Protective**	***NA***
Unit Disposal Cost ($ per ton)		$ -	-	$ -	*$ -*
Unit Transport Cost ($ per ton)	$ -	$ -	-	$ -	*$ -*
Transport Radius (miles)	200	200	-	200	-
Present Value Costs ($2006) \1	**$ 5,300,000**	**$ 5,300,000**	*$ -*	**$ 5,300,000**	*$ -*
\1 The net present value of remediation costs is estimated using a discount rate of 3 percent and a timeframe of 10 years (see Appendix A-1 for additional detail).					

Exhibit 11 BASELINE REMEDIAL OPTION 3: OPTIMIZATION OF CHAT COSTS AND BENEFITS NO FURTHER ACTION AND MONITORING OF WATER QUALITY 20 YEAR DISPOSAL PERIOD					
Description	**Current Market Scenario *(Same as without rule)***	**Current Market Scenario (Optimization)**	***Difference***	**Expanded Chat Market Scenario (High-end)**	***Difference***
Total Chat on Site (tons)	100,000,000	100,000,000	-	100,000,000	-
Time Frame (years)	20	20	-	20	-
Total Chat Disposed (tons)	-	-	-	-	-
Total Chat used for Asphalt (tons)	20,000,000	20,000,000	-	39,100,000	*19,100,000*
Remaining Chat, Un-disposed (tons)	80,000,000	80,000,000	-	60,900,000	*(19,100,000)*
Environmental Impacts	**Not Protective**	**Not Protective**	***NA***	**Not Protective**	***NA***
Unit Disposal Cost ($ per ton)		$ -	-	$ -	*$ -*
Unit Transport Cost ($ per ton)	$ -	$ -	-	$ -	*$ -*
Transport Radius (miles)	200	200	-	200	-
Present Value Costs ($2006) \1	**$ 5,300,000**	**$ 5,300,000**	*$ -*	**$ 5,300,000**	*$ -*
\1 The net present value of remediation costs is estimated using a discount rate of 3 percent and a timeframe of 20 years (see Appendix A-1 for additional detail).					

ECONOMIC IMPACT ANALYSIS

The current market for the preparation and use of chat reflects a limited number of well-established small operations that purchase, process (e.g., wash) and distribute chat to area highway departments, primarily for use as an aggregate in asphalt. The market for chat is geographically limited because the costs of chat transport are too high beyond a certain distance to allow it to compete with other regional sources of aggregate. The current demand for chat is roughly one million tons per year, within a 200 mile radius of the Tar Creek site. Based on information from the two top distributors of chat, Bingham Sand and Flint Rock, the size of the market has been stable for several years.[50] Absent the proposed rule, the market is expected to remain fairly stable until site remediation is complete at the Tri-State sites; at this time alternative sources of aggregate will replace the current tonnage of chat.

The potential economic impacts associated with the proposed rulemaking include changes in employment and impacts on local companies resulting from changes in the use of chat. Because the impact of the proposed rulemaking on chat use over the next 20 years is unclear, it is difficult to determine whether the region or local companies will experience any significant economic impacts. Even if the proposed rulemaking did have the effect of significantly increasing chat use in highway applications and reducing the need for site remediation, it is important to note that employment gains in the aggregate industry would likely be balanced by reduction in employment associated with site remedy construction.

After 20 years, it is possible that companies that currently process and sell chat will lose competitive position to other regional aggregate suppliers, but this change is likely to happen regardless of the proposed rule.[51] On a regional level, however, aggregate demand and employment are likely to remain fairly constant regardless of the proposed rule. Any losses of employment at specific companies will likely be offset by gains at other regional aggregate operations.

BENEFITS ANALYSIS

The proposed rulemaking is designed to establish standards that would clarify and facilitate the increased safe use of chat in transportation applications. The social benefits of the proposed rule fall into two categories:

- Reduced cost associated with remediation of Tri-State mining sites; and
- Reduced human health and environmental damage in the Tri-State area related to the timely removal of chat for use in transportation.

The extent of these benefits, however, is driven by two factors: the additional quantity of chat that can expected to be used in transportation uses as a result of the proposed rule (and therefore not require remediation); and the extent to which transportation uses represent a safe alternative to remediation options under consideration by EPA.

[50] Based on personal communication with Larry Bingham (employee at Bingham Sand and Gravel Inc.) on September 26, 2005 and with Richard Adams (employee at Oklahoma Flint Rock Supply, LLP) on October 5, 2005.

[51] Even if chat processors and distributors suffer employment losses after remediation is complete, the total changes in employment are not likely to be very extensive. The two top distributors of chat, Bingham Sand and Gravel Inc. and Oklahoma Flint Rock Supply, LLP, report employing 65 and 14 workers, respectively, and depending on the other products and services offered by these companies, the number of employees affected by eliminating chat as a source of aggregate may be smaller.

Our cost analysis suggests that the current market for transportation use of chat is well-established and mature, and the proposed rulemaking may not result in a significant increase in the quantity of chat that is used in transportation applications. While an alternative analysis suggests that the market may expand, the extent to which the proposed rule would result in expansion under that scenario is highly uncertain. In all scenarios the quantity of chat demanded for use in asphalt is not sufficient to eliminate the need for site remediation.

As a result, human health and environmental benefits associated with more rapid chat removal are likely to be limited - in all scenarios, the 20-year time horizon for remediation of chat piles at the Tri-State mining area sites is likely to result in similar human health and environmental risk reductions.

Similarly, avoided disposal and remediation costs associated with chat are dependent on the expected incremental increase in chat use. The analysis of costs suggests that the government or other entities might reduce remediation expenses by pursuing transport cost offsets to encourage use of chat in transportation in lieu of other remediation approaches. The extent to which this is possible depends on both demand for chat and the feasibility of using this economic tool as a remediation approach.

The proposed rule is designed to encourage only uses of chat that would not represent increases in human health and ecological risk (e.g., as an aggregate in asphalt). A more complete discussion of potential environmental risks associated with the use of chat in transportation is available in "Report on Potential Risks Associated with the Use of Chat from the Tri-State Mining Area in Transportation Projects."[52]

EQUITY CONSIDERATIONS AND OTHER IMPACTS

As required by applicable statutes and executive orders, the following section summarizes analysis of equity considerations and other regulatory concerns associated with the proposed rulemaking for the use of chat in transportation applications. This section assesses potential impacts, with respect to the following issues:

- **Regulatory Planning and Review**: requires examination and quantification of costs and benefits of regulating with and without proposed rule;
- **Regulatory flexibility:** focuses on the potential effects of the proposed rulemaking on small entities;
- **Environmental justice:** considers potential issues for minority and low-income populations residing near chat piles;

[52] *Report on Potential Risks Associated with the Use of Chat from the Tri-State Mining Area in Transportation Projects*, February 2006.

- **Children's health protection:** examines the potential impact of the proposed rulemaking on the health of children exposed to pollutants from chat;

- **Joint impacts of other EPA policies and rules:** discusses how other regulatory efforts together with the proposed rulemaking may affect the universe of facilities affected by the criteria;

- **Unfunded mandates:** examines the implications of the proposed rulemaking with respect to unfunded mandates;

- **Tribal governments:** extends the discussion of federal unfunded mandates to include impacts on Native American tribal governments and their communities;

- **Federalism:** considers potential issues related to state sovereignty;

- **Regulatory takings:** discusses the potential for takings to occur under the proposed rulemaking;

- **Energy Impacts:** examines the impacts of the proposed rulemaking on energy use, supply, and distribution;

- **Civil Justice:** considers steps taken to minimize litigation, eliminate ambiguity, and reduce burden associated with the proposed rulemaking; and

- **Facilitation of Cooperative Conservation:** discusses implementation of the proposed rule in a manner that promotes "cooperative conservation" among the Departments of the Interior, Agriculture, Commerce, and Defense and the Environmental Protection Agency.

Regulatory Planning and Review

Under Executive Order 12866 [58 FR 51735 (October 4, 1993], the Agency, in conjunction with the Office of Management and Budget's (OMB's) Office of Information and Regulatory Affairs (OIRA), must determine whether a regulatory action is "significant" and therefore subject to OMB review and the full requirements of the Executive Order. The Order defines "significant regulatory action" as one that is likely to result in a rule that may:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

Pursuant to the terms of Executive Order 12866, it has been determined that this rule is a "significant regulatory action" because it (4) raises novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order. As such, this document was submitted to OMB for review. Changes made in response to OMB suggestions or recommendations are documented in the public record. The proposed rule is unlikely to result in any significant chat management costs or cost savings. Thus, the $100 million threshold for economic significance, as established under point number one above, is not relevant to this action. In addition, this rule is not expected to adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities. Thus, this rule is not considered to be an economically significant action

Assessment of Small Entity Impacts

The Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 requires federal agencies to consider impacts on "small entities" when developing regulations. Small entities include small businesses, small governments, and small nonprofit organizations. Under these laws, agencies must analyze regulations to determine if they will have a "significant economic impact on a substantial number" of small entities. If a regulation is found to have a significant impact on a substantial number of small entities, further analysis must be performed to determine what can be done to lessen the impact. This section summarizes whether the proposed rule establishing criteria for use of Tar Creek chat in transportation projects will adversely impact small entities.

Chat is currently used in transportation applications as a source of aggregate for asphalt. The market for both chat and "virgin" aggregate in asphalt production is mature and dominated by small businesses.[53] Markets for aggregate are typically geographically limited by the cost of transportation. In the case of chat, the market extends in roughly a 200 mile radius from the Tar Creek site. The baseline scenarios assume that local chat distributors (e.g., Bingham Sand and Flint Rock) will continue to meet current market demand with chat until remediation at the sites in the Tri-State mining area is completed (approximately 20 years). As the remedy construction

[53] The 2002 Economic Census reports that the 2,591 establishments in the North American Industrial Classification System (NAICS) code 212321, Construction sand and gravel mining, all have fewer than 500 employees, which is the Small Business Administration size standard for that NAICS code. The two largest distributors of chat, Bingham Sand and Gravel, Inc. and Oklahoma Flint Rock Products, LLP report 65 and 14 employees, respectively (Dun & Bradstreet "Duns Market Identifiers" data received October 12, 2005).

nears completion, chat will likely be replaced by other sources of aggregate from Bingham Sand and Flint Rock, or other small businesses in the region.

In order to have a significant impact on a substantial number of small businesses, the criteria for chat use would have to cause a significant change in the quantity of chat that is used in highway applications over the next 10 to 20 years. Initial cost analysis suggests that the current market area is not likely to experience any reduction in demand for chat as a result of the proposed rule. Therefore, we conclude that the rule as proposed will not have a significant economic impact on a substantial number of small businesses.

Sixteen of 29 chat piles remaining within the Picher Mining Field in Ottawa County are located on land controlled by the Quapaw Tribe of Oklahoma. With a population smaller than 50,000 people, the Quapaw is considered a "small government jurisdiction."[54] Since demand for Quapaw chat is not likely to experience any substantial changes as a result of the proposed rule, we conclude that it will not have a significant economic impact on the Quapaw. If, however, the proposed rule increases the demand for chat on Quapaw land, potential health and ecological benefits may result from reduced lead and zinc exposure times as Quapaw chat piles are depleted at faster rates.

Note that one baseline scenario assumes that the chat piles would not be remediated within 20 years. This scenario differs from the other baseline (Superfund remediation) scenarios in that local chat producers would extend their chat production for several more decades, and other companies and sources of aggregate would not see expansion to replace chat. While this might have a long-term benefit to specific aggregate producers in the region, it does not represent an overall change in the size of the market. Note also that in this scenario any near-term local small business benefits associated with remediation activities to remove or cover the chat would be minimal.

Finally, this analysis focuses on asphalt; other potential transportation uses of chat (e.g., as aggregate in concrete) are not currently popular and initial analysis of the costs associated with introducing chat into these applications suggests that the markets would likely be very small. However, if the proposed rule does have the impact of increasing chat use for these applications, the result would be near term expansion of business for chat distributors and some reduction in demand for other sources of aggregate. This shift may have negative impacts on individual regional aggregate producers, but for two reasons it is not clear that increased chat use would have a significant impact on a substantial number of producers. First, demand for aggregate in highway projects is both project-specific and periodic, and it is unlikely that most producers of aggregate rely on steady demand from a single customer. Second, chat use in concrete or other material would be limited by design specifications, and, as a result, demand for aggregate from other sources would continue, though at a reduced level.

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[54] According to the Regulatory Flexibility Act, the term "small governmental jurisdiction" means governments of cities, counties, towns, townships, villages, school districts, or special districts, with a population of less than fifty thousand, unless an agency establishes, after opportunity for public comment, one or more definitions of such term which are appropriate to the activities of the agency and which are based on such factors as location in rural or sparsely populated areas or limited revenues due to the population of such jurisdiction, and publishes such definition(s) in the Federal Register. <http://www.sba.gov/advo/laws/regflex.html>

Environmental Justice Analysis

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (February 11, 1994), requires federal agencies to identify disproportionately large and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations.[55] Among other actions, the agencies are directed to improve research and data collection regarding health and environmental effects in minority and low-income communities.

To comply with this executive order, we provide a brief discussion of whether the proposed rule establishing criteria for the use of chat in transportation applications will have disproportionate effects on minority or low-income populations.

Chat piles in the Tri-state mining region are, in some cases, close to low-income populations. In addition, Quapaw allotted lands are located within the Picher Mining Field, where 16 of the 29 chat piles reside on Indian land**.** Existing data on the human health and ecological impacts associated with chat suggests that these populations are adversely affected by the presence of the chat piles, because the lead, cadmium and zinc can migrate through air or soil and have adverse impacts on water supplies and ecosystems. Therefore, removal of the chat for approved use in transportation applications may have a positive impact on these communities, assuming that use in transportation is as protective as Superfund remedies, and takes place in roughly the same time frame as Superfund remedies.

Children's Health Protection Analysis

Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks" (April 21, 1997), directs federal agencies and departments to evaluate the health effects of health-related or risk-related regulations on children.[56] For economically significant rules concerning an environmental health or safety risk that may disproportionately affect children, Executive Order 13045 also requires an explanation as to why the planned regulation is preferable to other potentially effective and feasible alternatives.[57] This proposed rule is not expected to have a significant economic impact; however, we briefly consider its potential effects on children's health.

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[55] As stated in Executive Order 12898, a minority is an individual who is a member of one of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.

[56] In addition, two separate directives issued by EPA, "Policy on Evaluating Health Risks to Children" (October 1995) and "National Agenda to Protect Children's Health from Environmental Threats" (October 1996), call for consideration of children's health within risk assessments and other components of regulatory analyses.

[57] As defined in Executive Order 13045, an economically significant rule is any rulemaking that has an annual effect on the economy of $100 million or more, or would adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local or tribal governments or communities.

Although the impacts of the proposed rule establishing criteria for the use of chat in transportation applications have not been evaluated quantitatively, qualitative analysis suggests that the proposed rule will not have an adverse impact on children's health assuming that use in transportation is as protective as Superfund remedies, and takes place in roughly the same time frame as Superfund remedies.

Join Impacts of Rules

The use of Tar Creek and Tri-state mining area chat in transportation applications is currently governed by EPA regional policy statements and by technical standards for road construction published by the Department of Transportation (DOT) and by various state highway departments.[58] In addition, chat production and highway application is governed by various state and federal environmental and workplace exposure laws. The proposed rule, in establishing criteria for use, may result in the use of additional protective measures for using chat, such as testing or runoff control from storage areas at the construction site, but is not likely to conflict with existing regulations. In some cases, compliance with existing regulations may ease compliance with the proposed rule, if, for example, state highway departments already require management of runoff from storage sites. Therefore, implementation of the proposed rule is not expected to jointly affect the actions of companies and entities already controlled by other regulations.

Unfunded Mandates Analysis

Signed into law on March 22, 1995, the Unfunded Mandates Reform Act (UMRA) calls on federal agencies that issue any significant regulation containing an unfunded mandate to fulfill certain requirements. These include the preparation of a statement supporting the need to issue the regulations and a description of prior consultation with representatives of affected state, local, and tribal governments. Requirements in the UMRA apply only to those federal regulations containing a significant unfunded mandate. The UMRA defines a significant unfunded mandate as a federal rule that either:

1. Results in estimated costs to state, local, and tribal governments, in aggregate, of $100 million or more in any one year; or

2. Results in estimated annual costs to the private sector of $100 million or more in any one year.

Federal rules are exempt from the UMRA requirements if:

1. The rule implements requirements specifically set forth in law; or

2. Compliance with the rule is voluntary for state and local governmental entities.

[58] For EPA regional statements, see Tar Creek Mining Waste, Fact Sheet, June 28, 2002, Ottawa County, Oklahoma.

Based on these criteria set forth by the UMRA, the proposed rule does not contain a significant unfunded mandate. As reported in the cost analysis, the criteria are not likely to result in annualized costs of $100 million or more, either for the private sector or for state and local governments. Moreover, use of chat in transportation applications remains voluntary; if additional requirements (e.g., associated with management of storage areas) increase the cost of using chat, other sources of aggregate are available.

Tribal Government Analysis

Similar in purpose to the UMRA, Executive Order 13175, "Consultation and Coordination With Indian Tribal Governments" (May 14, 1998), addresses related unfunded mandates concerns with respect to the sovereignty of tribal governments. The applicable sections of Executive Order 13175 impose requirements on federal agencies that promulgate regulations not required by statute and that significantly or uniquely affect Native American tribal governments and their communities. The requirements include description of the extent of prior consultation with affected tribal governments, a summary of the nature of their concerns, and a statement supporting the need to issue the regulation.

For many of the same reasons described in the UMRA discussion, the requirements of Executive Order 13175 do not apply to the proposed rule. As mentioned above, the use of chat is voluntary. In addition, while the Quapaw currently owns a number of chat piles, the proposed rule is not expected to significantly alter the costs associated with managing these sites. Nor is the proposed rule expected to significantly change the demand for, and income from, chat use in asphalt over the next 20 years.

Note that this analysis does not address existing funding for site remediation and the extent to which that may change.

Federalism Analysis

Executive Order 13132, entitled "Federalism" (64 FR 43255, August 10, 1999), requires EPA to develop a process to ensure "meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications." Policies that have federalism implications are defined in the Executive Order to include regulations that have "substantial direct effects on the States [in terms of compliance costs], on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government." In addition, policies have federalism implications if they preempt State law.

The proposed rule establishing criteria for the use of chat in transportation applications does not have significant federalism implications, because the proposed rule is designed to be consistent with current state highway department standards.

Regulatory Takings Analysis

Executive Order 12630, "Government Actions and Interference with Constitutionally Protected Property Rights" (March 15, 1988), directs federal agencies to consider the private property takings implications of regulations. Under the Fifth Amendment of the U.S. Constitution, the government may not take private property for public use without compensating the owner. Though the exact interpretation of this takings clause as applied to regulatory action is still subject to an ongoing debate, a framework for interpretation has been established by legal precedent through a series of prominent legal cases.[59]

Within the context of mainstream legal precedent, a regulatory taking of private property is generally deemed to result if the court determines that the government action satisfies any of the following criteria:

- Results in a physical invasion of property;
- Denies the owner all reasonable or economically viable use of property;[60]
- Interferes with reasonable investment-backed expectations for property; or
- Fails to establish a justifiable connection between the requirements imposed (e.g., permit conditions) and the underlying purposes of the regulation.

Even if a regulatory requirement meets any or all of the designated conditions for a regulatory taking, courts may still find it exempt from the takings clause if the regulatory action is meant to prevent a "nuisance" or to provide other benefits to the public. A nuisance is defined

[59] See, for instance, *Pennsylvania Coal Co. v. Mahon*, 260 U.S. 393 (1922), *Penn Central Transportation Co. v. City of New York* 438 U.S. 104 (1978), *Nollan v. California Coastal Commission* 483 U.S. 825 (1987), *Lucas v. South Carolina Coastal Council* 112 S. Ct. 2886 (1992), *Dolan v. City of Tigard* 114 S. Ct. 2309 (1994). Also see *Palazzolo v. Rhode Island* 533 U.S. 606 (2001).

[60] No universally accepted formula exists for determining at what point direct economic impacts from regulatory action constitute a taking. Rather, courts must make this determination on a case-by-case basis. In the landmark *Lucas* decision, the U.S. Supreme Court proclaimed that a 100 percent deprivation in value most often, but not always, constitutes a taking. Recent case law includes many examples in which regulations deprived owners of as much as 50 percent or more of the value associated with the economic use of property, yet the court still ruled that the regulations did not deny the owner all reasonable economic value. For instance, see *Concrete Pipe and Products v. Construction Laborers Pension Trust for Southern California*, 113 S.Ct. 2264 (1993), as cited in U.S. EPA, *Assessment of the Potential Costs, Benefits, and Other Impacts of the Hazardous Waste Combustion MACT Standards: Final Rule*, Office of Solid Waste, July 1999. The recent Supreme Court decision in *Kelo v. City of New London* (04-0108) may have significant impacts on the legal framework of takings in the United States. The nature of these potential impacts, however, is still unclear at this point; therefore, we do not consider the implications of this ruling with respect to Section 6006 of the 2005 transportation bill.

as an activity or condition that either interferes with public welfare or with the ability of another private citizen to enjoy his or her own property.[61]

Based on our review of relevant case law, the proposed rule establishing criteria for the use of chat in transportation is not likely to result in any regulatory takings. The proposed rule will not require that private property be invaded or taken for public use. The proposed rule also will not interfere with reasonable investment-backed expectations because the current market for chat is mature, and has operated under the limitations associated with the contaminants in chat and the expectation of site remediation for many years. While the remediation of Tri-State mining area sites does include management of "privately owned" chat, the proposed rule is unlikely to have a significant impact on these remediation activities.

Energy Impact Analysis

Executive Order 13211, "Actions Concerning Regulations that Affect Energy Supply, Distribution, or Use" (May 18, 2001), addresses the need for regulators to more fully consider the potential energy impacts of the proposed rule and resulting actions. Under Executive Order 13211, agencies are required to prepare a Statement of Energy Effects when a regulatory action may have significant adverse effects on energy supply, distribution, or use, including impacts on price and foreign supplies. Additionally, the requirements obligate agencies to consider reasonable alternatives to regulatory actions with adverse effects and the impacts that such alternatives might have on energy supply, distribution, or use.

The proposed rule would establish criteria for the use of chat in transportation applications. Since chat is already used in these applications in an established, geographically defined market, this proposed rule is unlikely to result in significant impacts on energy use. Limited changes in the use of energy associated with the extraction and transportation of aggregate materials (including chat) may occur if the extent of demand for chat changes, but the changes in demand from this proposed rule are expected to be small, and the impacts associated with extracting, processing, and transporting aggregate do not represent a significant use of energy.

Civil Justice Analysis

The proposed rule meets applicable standards in sections 3(a) and 3(b)(2) of Executive Order 12988, "Civil Justice Reform" (February 5, 1996), to minimize litigation, eliminate ambiguity, and reduce burden. EPA actions to meet the requirements of the Order include, but are not limited to, the following: unambiguous specification of the standards, establishment of clear compliance deadlines for regulated facilities, and a description of the effect of the standards on existing law.

[61] Numerous court decisions ranging from landmark preservation to the control of industrial pollution in residential areas have upheld regulations while at the same time acknowledging the takings claims associated with them on the basis of nuisance prevention and resource protection goals.

Facilitation of Cooperative Conservation

Executive Order 13352, "Facilitation of Cooperative Conservation" (August 26, 2004), directs the Departments of the Interior, Agriculture, Commerce, and Defense and the Environmental Protection Agency to implement laws relating to the environment and natural resources in a manner that promotes "cooperative conservation." The Order defines "cooperative conservation" as "actions that relate to use, enhancement, and enjoyment of natural resources, protection of the environment, or both, and that involve collaborative activity among Federal, State, local, and tribal governments, private for-profit and nonprofit institutions, other nongovernmental entities and individuals."

This proposed rule is designed to promote cooperation between EPA, state, and local governments by identifying clear criteria for beneficial reuse of a current disamenity in order to facilitate site remediation. In addition, this prepared rule has been displayed with input from the Department of Interior (DOI). In accordance with the Order, EPA will consider public comments on the proposed rule from State and local governments and private organizations during the development of the final standards.

APPENDIX A, B, C, & D

DESCRIPTION OF CHAT COST ANALYSIS

This appendix presents a more detailed description of the approach used to estimate the costs associated with the disposal and transportation uses of chat. To assess these costs associated with IEc incorporates available information from the Superfund program, existing cost and risk studies, and industry sources. For each disposal and transportation scenario IEc considers the following cost elements, noting that not all cost elements will be relevant to all remediation options:

- **Site preparation cost associated with chat:** specific costs associated with preparing a transportation or disposal site to be appropriate for the use of chat.

- **Transport cost associated with chat:** unit and total costs associated with moving chat to a use/disposal site, including data and assumptions about total mileage and per-mile/per-ton unit costs.

- **Chat preparation costs:** costs specific to preparing chat for use/disposal, including, for example, processing chat to assure that it is uniform size for use in asphalt preparations.

- **Implementation costs:** costs specific to the use/disposal of chat, including engineering costs associated with relevant disposal/remediation scenarios, and costs (if any) specific to the implementation of chat in transportation projects.

- **Waste treatment and disposal costs associated with chat:** costs specific to disposal of chat by-products/wastes in conjunction with transportation projects (e.g., costs to manage and dispose of dust generated if/when chat requires grinding for size).

We present our analysis of chat remediation costs based on the three Superfund baseline remedies: (1) disposal of chat in on-site subsidence pits, (2) consolidation, in-place containment of chat, and revegetation, and (3) no action coupled with periodic monitoring of water quality. The cost estimates for all three baseline remediation options, are based on costs developed for the Oronogo-Duenweg Mining Belt Site in Jasper County, Missouri.[62] As such, each site of the Tri-State sites may have unique conditions (e.g., proximity to surface water, quality of chat, etc.) affecting its costs under each scenario, which we describe in more detail below.

In addition, the remediation costs are estimated using a 10-year and 20-year clean-up period. The lower-end of the cost range for each scenario reflects a 20-year disposal period and the upper end reflects a 10-year disposal period. Generally, the disposal costs assuming a 10-year period are higher given the fact that less chat may be used for transport at no cost, thereby requiring higher costs for chat for disposal. Although we estimate that the tonnage of chat posing a risk to the environment would be removed after 10 to 20 years under the remediation alternatives, our costs reflect the net present value of remediation activities spanning 30 years.

[62] See NewFields Feasibility Study, Japer County, Missouri, Mine and Mill Waste Operable Unit, OU-1, April 2003.

The remediation activities, after disposal activities are completed, primarily include operating and maintenance costs (e.g., water quality monitoring).[63]

Below we present our approach for estimating the costs for each remediation option. In addition, we present the approach used to develop cost estimates based on an optimization analysis (maximizing the use of chat in asphalt and minimizing total remediation costs), breakeven analysis (maximizing the use of chat in asphalt assuming the total remediation costs are equal to the baseline costs), and "transportation only" analysis (estimating the costs of chat removal using only transportation as an option).

Baseline Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits

The first remediation option we consider in our analysis allows for the disposal of chat in selected on-site subsidence pits, which provide a suitable environment for subaqueous mill waste disposal. The approach involves six key steps: (1) excavation of the chat material in subsidence pits, away from floodplains and tributary channels, (2) disposal of the chat material in subsidence pits, (3) capping of the pits through the placement of a soil cover, (4) deep till of the excavated areas, (5) revegetation, and (6) drainage and erosion control. The approach also requires annual operation and maintenance controls (e.g., administering landowner agreements, monitoring caps, etc.). Based on the Jasper County cost analysis, the approach prescribes that approximately 5,002,858 tons (or 70 percent) of chat on site is disposed and 678,750 tons (or 9 percent) recycled for transportation purposes, leaving approximately 1,483,630 tons (or 21 percent) un-disposed. EPA indicated that this remaining chat did not pose any threat to human health or the environment.[64]

Based on costs estimated for the Jasper County site, we estimate that the disposal cost of chat using this approach is $9.98 per ton of chat (see Appendix B-1). This unit cost is estimated by summing the present value of costs specifically associated with chat excavation and disposal ($49,941,586) and dividing this value by the total amount of chat disposed (5,002,858 tons).[65] Costs related to remedial activities specifically associated with the Jasper County site (e.g., deep till of transition zone soils, installation of audit plugs, etc.) are not included.[66] As such, the

[63] The length of total remediation activities (30 years) assumed in our analysis is consistent with the Record of Decision, Oronogo-Duenweg Mining Belt Site, Jasper County Superfund Site, Jasper County, Missouri, Prepared by U.S. EPA, Region VII, September 2004.

[64] Based on conversation with U.S. EPA, Office of Solid Waste, on October 7, 2005.

[65] See Appendix B-2 for additional detail.

[66] Although these sites likely include mine tailings mixed with chat in some areas, we did not include costs associated with mine tailings as limited information was available regarding the total volume of mine tailings at each site to estimate disposal costs. Including the disposal cost of mine tailings would likely increase the total unit disposal cost, based on the fact that the disposal costs of mine tailing at Jasper County is slightly higher than chat disposal.

resulting unit cost estimate of $9.98 is a reasonable approximation of the unit disposal cost that would likely be incurred for the disposal of chat at other Tri-State sites.[67]

It is important to note, however, that given the varying characteristics at each site, the unit disposal cost may differ slightly. For example, the Tar Creek site contains more pits than mines for chat disposal. Although the disposal of chat in mines is slightly more expensive than pits, it is more protective. Given that the availability of mines at the Tar Creek site for disposal is uncertain, a larger percentage of chat will likely be disposed in pits. As such, disposal costs may be lower for Tar Creek than Jasper County. However, given the quantity and physical magnitude of the chat piles in Tar Creek, the site may require additional excavation and landscaping costs that may not be necessary for Jasper County.

Based on the estimated disposal cost of $9.98 per ton of chat, we estimate that the total cost of disposal for all four Tri-State sites is $591.9 million based on a 20-year disposal period and $691.7 million based on a 10-year disposal period (see Appendix B-1). This assumes that, similar to the Jasper County site, approximately 21 percent of chat at each of the other sites (including Tar Creek) would remain on-site.

<u>Baseline Remediation Option 2: Chat Consolidation, In-Place Containment, and Revegetation</u>

Under the second remediation option, non-recyclable chat would be consolidated and revegetated in place. Five key steps are necessary to complete this restoration approach, including: (1) excavation and consolidation of the chat material on-site and away from floodplains and tributary channels, (2) placement of a soil cover on the chat piles, (3) deep till of the excavated areas, (4) revegetation, and (5) drainage and erosion control of capped material. The remediation option also recognizes recycling of recyclable chat material, requiring institutional controls and chat management programs. This approach allows for approximately 38 percent of the chat at the Jasper County site to be recycled or 2,700,000 tons of chat - nearly four times the tonnage under remediation option 1. In addition, under this approach approximately 2,688,453 tons of chat (or 38 percent) would be disposed, leaving 1,776,785 tons (or approximately 25 percent) on site and un-disposed. Similar to the remedy presented in baseline remediation option 1, EPA indicated that the chat left un-disposed did not pose any significant threat to human health or the environment.[68]

Based on costs developed for the Jasper County site, we estimate that the disposal cost of chat using this approach is $25.01 per ton of chat (see Appendix B-1). This unit cost is estimated by summing the present value of costs specifically associated with chat excavation and disposal ($67,248,373) and dividing this value by the total amount of chat disposed (2,688,453 tons).[69]

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[67] Based on conversation with U.S. EPA, Office of Solid Waste, on October 6 and 7, 2005.

[68] Based on conversation with U.S. EPA, Office of Solid Waste, on October 7, 2005.

[69] See Appendix B-3 for additional detail.

As with remediation option 1, the costs related to remedial activities specifically associated with the Jasper County site were not included.[70]

Based on the estimated disposal cost of $25.01 per ton of chat, we estimate a total remediation cost of $1,381 million assuming a 20-year disposal period and $1,631 million assuming a 10-year period for all four sites. This assumes that, similar to Jasper County, approximately 25 percent of the chat at each of the remaining three sites (including Tar Creek) would remain on-site. Based on the Jasper ROD, this remedial option is considered less protective of human health and the environment.

<u>Baseline Remediation Option 3: No Further Action and Monitoring of Water Quality</u>

Under the third remediation option, no further actions are considered. Although the chat is not removed or disposed, it is subject to annual surface water monitoring to assess ecological health risks. For the Jasper County site, EPA did not believe this alternative was viable as it is not protective of ecological or human health.

For this alternative, EPA estimates costs of $27,587 per round of sampling, including labor and materials and laboratory analysis costs. EPA recommended that sampling should be done twice a year every five years, resulting in a total present value of $380,592.[71] To obtain a unit cost estimate for the scenario, we divide the total cost estimate by the tonnage of chat at the Jasper County site (or 7,165,238 tons), resulting in a unit cost estimate of approximately $0.053 per ton. The duration and frequency of sampling may vary for each Tri-State site depending on site specific conditions (e.g., proximity to surface water, population density, etc.).

Based on the estimated sampling cost of $0.053 per ton of chat, we estimate that the total cost under this option is $5,311,649 (see Appendix B-1). It is important to note that, under this remediation option, the only chat removed from the site would be the tonnage used for transportation (or other uses). For purposes of our analysis, we assume that the cost of monitoring would remain constant regardless of the volume of chat removed for transportation at the sites.

<u>GIS Analysis: Road Surface Area and Asphalt Pavement Volumes</u>

To estimate the total length of roads within various distances from Bingham Sand & Gravel's Treece, KS washing facility, we use the 2005 version of ESRI's StreetMap USA dataset. The dataset identifies streets in the United States. We created buffers of varying distances from

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[70] Although these sites likely include mine tailings mixed with chat in some areas, we did not include costs associated with mine tailings as limited information was available regarding the total volume of mine tailings at each site to estimate disposal costs. Including the disposal cost of mine tailings would likely increase the total unit disposal cost, based on the fact that the disposal costs of mine tailing at Jasper County is slightly higher than chat disposal.

[71] See Appendix B-4 for additional detail.

Bingham Sand and Gravel and used the buffers to select, by location, subsets of streets within a specified radius. Streetmap USA categorizes roads by class route. Class routes 0 (major highway), 1 (major highway connector), 2 (highway), and 3 (major road) were included in the GIS analysis. All other class routes are not included for calculation of road lengths. Detailed steps are as follows:

- Using the default address locator in StreetMap USA, we geo-code Bingham Sand & Gravel's street address (40 SW Grove Rd., Treece, KS 66778) to a point with latitude and longitude values.

- With the point representing Bingham Sand & Gravel's street address, we create buffers of 200, 222, 250, 300, and 400 mile radii.

- Using the "select by location" function, we select subsets of streets intersecting a certain buffer. This selection procedure is repeated once for each buffer (i.e., total of five times for five buffers). Each selection is exported as a new layer. Records not classified with class route values of 0, 1, 2, or 3 are eliminated from the subset.

- To calculate the length of roads, we use the XTools "calculate length" tool. Output is projected in USA Contiguous Albers Equal Area.

- To obtain road lengths by class route, we dissolve features by class route and sum resulting lengths.

Once street lengths were obtained from the GIS analysis, we estimate road surface areas and asphalt pavement volumes based on several assumptions concerning lane widths, number of lanes by road category, pavement depths, and hot mix asphalt designs.[72] As presented in Appendix D-3a, we assume that major highways are 68 feet wide, major highway connectors are 68 feet wide, highways are 56 feet wide, and major roads are 44 feet wide. Asphalt pavement depths (necessary for estimating asphalt pavement volumes) for all road categories are based on 3 inches. As presented in Appendix D-3b, we also assume that the most common hot asphalt mix design specifies 20 percent , by weight, of chat in hot asphalt mix.[73] This figure is necessary for estimating the amount of chat necessary to make a certain unit of asphalt pavement.

We use outputs (i.e., road surface areas and asphalt pavement volumes within certain radii from Treece, KS) from the GIS analysis to estimate chat quantities corresponding to different unit transportation costs, under both current and expanded chat market scenarios.

[72] All assumptions based on discussions with John D'Angelo on October 12, 2005.

[73] Based on personal communication with Richard Adams (Oklahoma Flint Rock LLC manager) on October 5, 2005.

Regulatory Scenario: Current Market Scenario

This scenario is based on information from chat market experts, companies using and selling chat, and EPA that suggests the regional market for chat is currently saturated and demand for chat is not likely to change significantly as a result of the proposed rule. The scenario evaluates the impact on costs of increasing the use of chat in transportation applications based on a number of sensitivity analyses.

Using GIS, we approximate the surface area of roads associated with current chat market demand in the absence of price changes. We only examine roads that are likely to be funded by Federal money and that are located within the spatial extent of the current market, as defined by a 200 mile radius from Tar Creek (Treece, KS). The surface area of relevant roads within the spatial extent of the current market is approximately 284 square miles (see Appendix D-1). This represents the area of roadway that supports the current demand of chat from the Tri-State sites of one million tons per year. Currently, it costs approximately $0.36 per ton per mile (for a round-trip haul) to transport the chat to the construction site.[74]

Sensitivity Analysis: Expanded Chat Market Scenario

This scenario is based on a GIS analysis that suggests that current demand for asphalt within 200 miles of the Tar Creek site might accommodate a doubling of chat use.

Using GIS, we approximate the asphalt pavement quantity on roads likely to be federally funded and located within several different radius distances from the Tar Creek site. Using the asphalt pavement quantity outputs from the GIS analysis, we approximate an upper-end potential demand for chat in asphalt under an expanded market scenario, assuming that all asphalt roads are paved using chat as aggregate. Since the amount of chat necessary to construct a fixed unit of asphalt depends on the hot mix asphalt design specifications, we examine four different hot mix asphalt designs, ranging from 20 to 80 percent chat composition (see Appendix D-3b). Based on the most common mix design, we estimate the potential yearly demand for chat, assuming a 13 year re-pavement life is approximately 1.9 million tons per year (see Appendix D-2).

[74] Transportation cost ($0.36 per ton-mile) provided by U.S. EPA, Office of Solid Waste, on October 7, 2005. Price based on round-trip hauling in Kansas and Oklahoma.

Appendix A-1.a.

SUMMARY OF EPA COSTS AND BENEFITS OF CHAT USE AT ALL TRI-STATE SUPERFUND SITES - 20 YEAR DISPOSAL PERIOD

Option	Analysis	Quantity of chat (tons) \1	Unit disposal cost ($/ton chat) \2	Time frame (years) \3	Quantity disposed per year (tons/year) \4	Total quantity disposed (tons) \5	Average unit transportation cost ($/ton) \6	Quantity used for transportation per year (tons/year) \6	Total quantity used for transportation (tons) \6	Total tons managed (tons) \7	Tons remaining (tons) \8	Total cost ($) \9	Difference from baseline cost ($)	Environmental impact
Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits	Current Market Scenario	100,000,000	$ 9.98	20	2,964,702.84	59,294,056.90	$ -	1,000,000	20,000,000.00	79,294,057	20,705,943	$ 591,909,566	$ -	Most Protective
	Current Market Scenario (Optimization)	100,000,000	$ 9.98	20	2,671,462.30	53,429,246.10	$ 4.99	1,293,241	25,864,810.80	79,294,057	20,705,943	$ 562,636,501	$ (29,273,065)	Most Protective
	Current Market Scenario (Breakeven)	100,000,000	$ 9.98	20	2,405,061.53	48,101,230.51	$ 9.98	1,559,641	31,192,826.38	79,294,057	20,705,943	$ 591,909,566	$ -	Most Protective
	Current Market Scenario (Transport Only)	100,000,000	$ 9.98	20	-	-	$ 35.62	3,964,703	79,294,056.90	79,294,057	20,705,943	$ 2,112,193,814	$ 1,520,284,248	Most Protective
	Expanded Chat Market Scenario	100,000,000	$ 9.98	20	2,011,845.03	40,236,900.69	$ -	1,952,858	39,057,156.21	79,294,057	20,705,943	$ 401,669,369	$ (190,240,197)	Most Protective
	Expanded Chat Market Scenario (Optimization)	100,000,000	$ 9.98	20	1,439,187.96	28,783,759.12	$ 4.99	2,525,515	50,510,298	79,294,057	20,705,943	$ 344,503,235	$ (247,406,332)	Most Protective
	Expanded Chat Market Scenario (Breakeven)	100,000,000	$ 9.98	20	783,964.37	15,679,287.48	$ 9.98	3,180,738	63,614,769	79,294,057	20,705,943	$ 401,669,369	$ (190,240,197)	Most Protective
	Expanded Chat Market Scenario (Transport Only)	100,000,000	$ 9.98	20	-	-	$ 15.32	3,964,703	79,294,057	79,294,057	20,705,943	$ 616,281,537	$ 24,371,970	Most Protective

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Appendix A-1.a.

SUMMARY OF EPA COSTS AND BENEFITS OF CHAT USE AT ALL TRI-STATE SUPERFUND SITES - 20 YEAR DISPOSAL PERIOD

Option	Analysis	Quantity of chat (tons) \1	Unit disposal cost ($/ton chat) \2	Time frame (years) \3	Quantity disposed per year (tons/year) \4	Total quantity disposed (tons) \5	Average unit transportation cost ($/ton) \6	Quantity used for transportation per year (tons/year) \6	Total quantity used for transportation (tons) \6	Total tons managed (tons) \7	Tons remaining (tons) \8	Total cost ($) \9	Difference from baseline cost ($)	Environmental impact
	Current Market Scenario	100,000,000	$ 25.014	20	2,760,135.31	55,202,706	$ -	1,000,000	20,000,000	75,202,706	24,797,294	$ 1,380,828,629	$ -	Less Protective
	Current Market Scenario (Optimization)	100,000,000	$ 25.014	20	1,946,913.04	38,938,261	$ 12.51	1,813,222	36,264,445	75,202,706	24,797,294	$ 1,177,410,957	$ (203,417,671)	Less Protective
	Current Market Scenario (Breakeven)	100,000,000	$ 25.014	20	886,396.74	17,727,935	$ 25.01	2,873,739	57,474,771	75,202,706	24,797,294	$ 1,380,828,629	$ -	Less Protective
Remediation Option 2: Chat Consolidation, In-Place Containment and Revegetation	Current Market Scenario (Transport Only)	100,000,000	$ 25.014	20	-	-	$ 33.76	3,760,135	75,202,706	75,202,706	24,797,294	$ 1,863,479,358	$ 482,650,729	Less Protective
	Expanded Chat Market Scenario	100,000,000	$ 25.014	20	1,807,277.50	36,145,549.91	$ -	1,952,858	39,057,156.21	75,202,706	24,797,294	$ 904,137,018	$ (476,691,610)	Less Protective
	Expanded Chat Market Scenario (Optimization)	100,000,000	$ 25.014	20	219,170.03	4,383,400.69	$ 12.51	3,540,965	70,819,305	75,202,706	24,797,294	$ 506,891,231	$ (873,937,398)	Less Protective
	Expanded Chat Market Scenario (Transport Only)	100,000,000	$ 25.014	20	-	-	$ 13.98	3,760,135	75,202,706	75,202,706	24,797,294	$ 505,309,407	$ (875,519,222)	Less Protective
	Current Market Scenario	100,000,000	$ -	20	-	-	$ -	1,000,000	20,000,000.00	20,000,000	80,000,000	$ 5,311,649		Not Protective
Remdiation Option 3: No Further Action and Monitoring of Water Quality	Current Market Scenario (Optimization)	100,000,000	$ -	20	-	-	$ -	1,000,000	20,000,000.00	20,000,000	80,000,000	$ 5,311,649		Not Protective
	Expanded Chat Market Scenario (High-End Scenario)	100,000,000	$ -	20	-	-	$ -	1,952,858	39,057,156.21	39,057,156	60,942,844	$ 5,311,649		Not Protective

Sources and Notes:

\1 US EPA Office of Solid Waste indicated that the total tonnage of chat at the four sites is approximately 100,000,000 tons. In addition, US EPA Office of Solid Waste stated that the volume of chat at Cherokee and Newton is approximately equal. The total volume of chat at the Jasper site is 5,732,190 cubic yards, based on the September 2004 ROD. As such, a conversion factor of 0.8 cubic yards of chat per ton was used to estimate the tonnage of chat at the Jasper County site.

\2 Unit Costs are based on Record of Decision, Oronogo-Duenweg Mining Belt Site, Jasper County Superfund Site, Jasper County, Missouri, Prepared by U.S. EPA, Region VII, September 2004. See Appendices B-2 (unit costs related to remediation option 1), B-3 (unit costs related to remediation option 2), and B-4 (unit costs related to remediation option 3).

\3 Based on the period estimated to dispose and recycle chat at the Tar Creek site using a baseline Superfund remediation option. Estimate of the Tar Creek remediation period (20 years) is based on discussions with Mark Doolan and US EPA Office of Solid Waste on October 6 and 7, 2005.
\4 Quanity disposed per year estimated by dividing the total quantity disposed (tons) by the time frame (years).

Appendix A-1.a.

SUMMARY OF EPA COSTS AND BENEFITS OF CHAT USE AT ALL TRI-STATE SUPERFUND SITES - 20 YEAR DISPOSAL PERIOD

Option	Analysis	Quantity of chat (tons) \1	Unit disposal cost ($/ton chat) \2	Time frame (years) \3	Quantity disposed per year (tons/year) \4	Total quantity disposed (tons) \5	Average unit transportation cost ($/ton) \6	Quantity used for transportation per year (tons/year) \6	Total quantity used for transportation (tons) \6	Total tons managed (tons) \7	Tons remaining (tons) \8	Total cost ($) \9	Difference from baseline cost ($)	Environmental impact

\5 Total quantity of chat diposed is based on the total tons managed minus the amount used for transportation. This estimate is derived for each remedial option, based on the Jasper Site ROD (see Appendix B-1 for additional detail).

\6 Assume that cost of transport to EPA is $0 per ton within the 200 mile current economic market for chat use in tranportation products. The unit cost of tranport and quanity tranported is based on the following analyses: (1) optimization analysis (maximizing the use of chat in asphalt and minimizing total remediation costs), (2) a breakeven analysis (maximizing the use of chat in asphalt assuming the total remediation costs are equal to the baseline costs), and (3) a "transport only" analysis (estimating the costs of chat removal using only transportation as an option). (See Appendix C for additional detail).

\7 Total tons of chat managed is based on the percentage of chat managed for the Jasper site ROD (see Appendix B-1 for additional detail.).

\8 The total chat remaining is equal to the total volume of chat on site (one million tons) minus the total chat managed.

\10 The total net present value of costs is estimated by summing the disposal cost and tranportation cost. The disposal cost is estimated by multiplying the unit disposal cost by the quantity disposed for each remediation option. We assume the tranportation cost is equal to the unit transportation cost multiplied by the difference between the additional chat hauled beyond the 200 mile economic radius and the chat used within the 200 mile radius (or 20 million tons based on current demand and 39 million tons based on expanded demand).

Appendix A-1.b

SUMMARY OF EPA COSTS AND BENEFITS OF CHAT USE AT ALL TRI-STATE SUPERFUND SITES - 10-YEAR DISPOSAL PERIOD

Option	Analysis	Quantity of chat (tons) \1	Unit disposal cost ($/ton chat) \2	Time frame (years) \3	Quantity disposed per year (tons/year) \4	Total quantity disposed (tons) \5	Average unit transportation cost ($/ton) \6	Quantity used for transportation per year (tons/year) \6	Total quantity used for transportation (tons) \6	Total tons managed (tons) \7	Tons remaining (tons) \8	Total cost ($) \9	Difference from baseline cost ($)	Environmental impact
Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits	Current Market Scenario	100,000,000	$ 9.98	10	6,929,405.69	69,294,056.90	$ -	1,000,000	10,000,000.00	79,294,057	20,705,943	$ 691,735,687	$ -	Most Protective
	Current Market Scenario (Optimization)	100,000,000	$ 9.98	10	6,636,165.15	66,361,651.50	$ 4.99	1,293,241	12,932,405.40	79,294,057	20,705,943	$ 677,099,154	$ (14,636,533)	Most Protective
	Current Market Scenario (Breakeven)	100,000,000	$ 9.98	10	6,369,764.37	63,697,643.70	$ 9.98	1,559,641	15,596,413.19	79,294,057	20,705,943	$ 691,735,687	$ -	Most Protective
	Current Market Scenario (Transport Only)	100,000,000	$ 9.98	10	-	-	$ 65.16	7,929,406	79,294,056.90	79,294,057	20,705,943	$ 4,515,078,696	$ 3,823,343,009	Most Protective
	Expanded Chat Market Scenario	100,000,000	$ 9.98	10	5,976,547.88	59,765,478.79	$ -	1,952,858	19,528,578.10	79,294,057	20,705,943	$ 596,615,588	$ (95,120,099)	Most Protective
	Expanded Chat Market Scenario (Optimization)	100,000,000	$ 9.98	10	5,403,890.80	54,038,908.01	$ 4.99	2,525,515	25,255,149	79,294,057	20,705,943	$ 568,032,521	$ (123,703,166)	Most Protective
	Expanded Chat Market Scenario (Breakeven)	100,000,000	$ 9.98	10	4,748,667.22	47,486,672.19	$ 9.98	3,180,738	31,807,385	79,294,057	20,705,943	$ 596,615,588	$ (95,120,099)	Most Protective
	Expanded Chat Market Scenario (Transport Only)	100,000,000	$ 9.98	10	-	-	$ 36.48	7,929,406	79,294,057	79,294,057	20,705,943	$ 2,180,145,486	$ 1,488,409,799	Most Protective

Appendix A-1.b

SUMMARY OF EPA COSTS AND BENEFITS OF CHAT USE AT ALL TRI-STATE SUPERFUND SITES - 10-YEAR DISPOSAL PERIOD

Option	Analysis	Quantity of chat (tons) \1	Unit disposal cost ($/ton chat) \2	Time frame (years) \3	Quantity disposed per year (tons/year) \4	Total quantity disposed (tons) \5	Average unit transportation cost ($/ton) \6	Quantity used for transportation per year (tons/year) \6	Total quantity used for transportation (tons) \6	Total tons managed (tons) \7	Tons remaining (tons) \8	Total cost ($) \9	Difference from baseline cost ($)	Environmental impact
Remediation Option 2: Chat Consolidation, In-Place Containment and Revegetation	Current Market Scenario	100,000,000	$ 25.014	10	6,520,270.61	65,202,706	$ -	1,000,000	10,000,000	75,202,706	24,797,294	$ 1,630,966,480	$ -	Less Protective
	Current Market Scenario (Optimization)	100,000,000	$ 25.014	10	5,707,048.34	57,070,483	$ 12.51	1,813,222	18,132,223	75,202,706	24,797,294	$ 1,529,257,644	$ (101,708,836)	Less Protective
	Current Market Scenario (Breakeven)	100,000,000	$ 25.014	10	4,646,532.04	46,465,320	$ 25.01	2,873,739	28,737,386	75,202,706	24,797,294	$ 1,630,966,480	$ -	Less Protective
	Current Market Scenario (Transport Only)	100,000,000	$ 25.014	10	-	-	$ 62.52	7,520,271	75,202,706	75,202,706	24,797,294	$ 4,076,713,524	$ 2,445,747,044	Less Protective
	Expanded Chat Market Scenario	100,000,000	$ 25.014	10	5,567,412.80	55,674,128.02	$ -	1,952,858	19,528,578.10	75,202,706	24,797,294	$ 1,392,620,675	$ (238,345,805)	Less Protective
	Expanded Chat Market Scenario (Optimization)	100,000,000	$ 25.014	10	3,979,305.34	39,793,053.40	$ 12.51	3,540,965	35,409,653	75,202,706	24,797,294	$ 1,193,997,781	$ (436,968,699)	Less Protective
	Expanded Chat Market Scenario (Transport Only)	100,000,000	$ 25.014	10	-	-	$ 34.59	7,520,271	75,202,706	75,202,706	24,797,294	$ 1,925,808,372	$ 294,841,893	Less Protective
Remdiation Option 3: No Further Action and Monitoring of Water Quality	Current Market Scenario	100,000,000	$ -	10	-	-	$ -	1,000,000	10,000,000.00	10,000,000	90,000,000	$ 5,311,649		Not Protective
	Current Market Scenario (Optimization)	100,000,000	$ -	10	-	-	$ -	1,000,000	10,000,000.00	10,000,000	90,000,000	$ 5,311,649		Not Protective
	Expanded Chat Market Scenario (High-End Scenario)	100,000,000	$ -	10	-	-	$ -	1,952,858	19,528,578.10	19,528,578	80,471,422	$ 5,311,649		Not Protective

Sources and Notes:

\1 US EPA Office of Solid Waste indicated that the total tonnage of chat at the four sites is approximately 100,000,000 tons. In addition, US EPA Office of Solid Waste stated that the volume of chat at Cherokee and Newton is approximately equal. The total volume of chat at the Jasper site is 5,732,190 cubic yards, based on the September 2004 ROD. As such, a conversion factor of 0.8 cubic yards of chat per ton was used to estimate the tonnage of chat at the Jasper County site.

\2 Unit Costs are based on Record of Decision, Oronogo-Duenweg Mining Belt Site, Jasper County Superfund Site, Jasper County, Missouri, Prepared by U.S. EPA, Region VII, September 2004. See Appendices B-2 (unit costs related to remediation option 1), B-3 (unit costs related to remediation option 2), and B-4 (unit costs related to remediation option 3).

\3 Based on the period estimated to dispose and recycle chat at the Tar Creek site using a baseline Superfund remediation option. Estimate of the Tar Creek remediation period (20 years) is based on discussions with Mark Doolan and US EPA Office of Solid Waste on October 6 and 7, 2005.
\4 Quanity disposed per year estimated by dividing the total quantity disposed (tons) by the time frame (years).

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Appendix A-1.b

SUMMARY OF EPA COSTS AND BENEFITS OF CHAT USE AT ALL TRI-STATE SUPERFUND SITES - 10-YEAR DISPOSAL PERIOD

Option	Analysis	Quantity of chat (tons) \1	Unit disposal cost ($/ton chat) \2	Time frame (years) \3	Quantity disposed per year (tons/year) \4	Total quantity disposed (tons) \5	Average unit transportation cost ($/ton) \6	Quantity used for transportation per year (tons/year) \6	Total quantity used for transportation (tons) \6	Total tons managed (tons) \7	Tons remaining (tons) \8	Total cost ($) \9	Difference from baseline cost ($)	Environmental impact

\5 Total quantity of chat diposed is based on the total tons managed minus the amount used for transportation. This estimate is derived for each remedial option, based on the Jasper Site ROD (see Appendix B-1 for additional detail).

\6 Assume that cost of transport to EPA is $0 per ton within the 200 mile current economic market for chat use in tranportation products. The unit cost of tranport and quanity tranported is based on the following analyses: (1) optimization analysis (maximizing the use of chat in asphalt and minimizing total remediation costs), (2) a breakeven analysis (maximizing the use of chat in asphalt assuming the total remediation costs are equal to the baseline costs), and (3) a "transport only" analysis (estimating the costs of chat removal using only transportation as an option). (See Appendix C for additional detail).

\7 Total tons of chat managed is based on the percentage of chat managed for the Jasper site ROD (see Appendix B-1 for additional detail.).

\8 The total chat remaining is equal to the total volume of chat on site (one million tons) minus the total chat managed.

\10 The total net present value of costs is estimated by summing the disposal cost and tranportation cost. The disposal cost is estimated by multiplying the unit disposal cost by the quantity disposed for each remediation option. We assume the tranportation cost is equal to the unit transportation cost multiplied by the difference between the additional chat hauled beyond the 200 mile economic radius and the chat used within the 200 mile radius (or 20 million tons based on current demand and 39 million tons based on expanded demand).

Appendix B-1.a

SUMMARY OF EPA COSTS OF DISPOSAL AND CHAT USE AT TRI-STATE SUPERFUND SITES - 20 YEAR DISPOSAL PERIOD

Baseline Option	Description	Tri-State site	Quantity of chat (tons) \1	Unit disposal cost ($/ton chat) \2	Time frame (years) \3	Quantity disposed per year (tons/year) \4	Total quantity disposed (tons) \5	Quantity used for transportation per year (tons/year) \6	Total quantity used for transportation (tons) \7	Total tons managed (tons) \8	Tons remaining (tons) \9	Total cost ($) \10
1	Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits	ALL SITES	100,000,000	$ 9.98	20	2,964,703	59,294,057	1,000,000	20,000,000	79,294,057	20,705,943	$ 591,909,511
		Jasper Site	7,165,238	$ 9.98	7	714,694	5,002,858	96,964	678,750	5,681,608	1,483,631	$ 49,941,586
		All other sites	92,834,762	$ 9.98	20	2,714,560	54,291,194	966,063	19,321,250	73,612,444	19,222,318	$ 541,967,926
2	Remediation Option 2: Chat Consolidation, In-Place Containment and Revegetation	ALL SITES	100,000,000	$ 25.01	20	2,760,135	55,202,701	1,000,000	20,000,000	75,202,701	24,797,299	$ 1,380,828,497
		Jasper Site	7,165,238	$ 25.01	10	268,845.25	2,688,453	270,000	2,700,000	5,388,453	1,776,786	$ 67,248,373
		All other sites	92,834,762	$ 25.01	20	2,625,712	52,514,248	865,000	17,300,000	69,814,248	23,020,514	$ 1,313,580,124
3	Remdiation Option 3: No Further Action and Monitoring of Water Quality	ALL SITES	100,000,000	$ 0.053	20	0	0	1,000,000	20,000,000	20,000,000	80,000,000	$ 5,311,649
		Jasper Site	7,165,238	$ 0.053	20	0	0	71,652	1,433,047.60	1,433,048	5,732,190	$ 380,592
		All other sites	92,834,762	$ 0.053	20	0	0	928,348	18,566,952.40	18,566,952	74,267,810	$ 4,931,057

008309

Appendix B-1.a

SUMMARY OF EPA COSTS OF DISPOSAL AND CHAT USE AT TRI-STATE SUPERFUND SITES - 20 YEAR DISPOSAL PERIOD

Baseline Option	Description	Tri-State site	Quantity of chat (tons) \1	Unit disposal cost ($/ton chat) \2	Time frame (years) \3	Quantity disposed per year (tons/year) \4	Total quantity disposed (tons) \5	Quantity used for transportation per year (tons/year) \6	Total quantity used for transportation (tons) \7	Total tons managed (tons) \8	Tons remaining (tons) \9	Total cost ($) \10

Sources and Notes:

\1 US EPA Office of Solid Waste indicated that the total tonnage of chat at the four sites is approximately 100,000,000 tons. In addition, US EPA Office of Solid Waste stated that the volume of chat at Cherokee and Newton is approximately equal. The total volume of chat at the Jasper site is 5,732,190 cubic yards, based on the September 2004 ROD. As such, a conversion factor of 0.8 cubic yards of chat per ton was used to estimate the tonnage of chat at the Jasper County site.

\2 Unit Costs are based on Record of Decision, Oronogo-Duenweg Mining Belt Site, Jasper County Superfund Site, Jasper County, Missouri, Prepared by U.S. EPA, Region VII, September 2004. See Appendices B-2 (unit costs related to remediation option 1), B-3 (unit costs related to remediation option 2), and B-4 (unit costs related to remediation option 3).

\3 Based on the period estimated to dispose and recycle chat at the Tar Creek site using a baseline Superfund remediation option. Estimate of the Tar Creek remediation period (20 years) is based on discussions with Mark Doolan and US EPA Office of Solid Waste on October 6 and 7, 2005.

\4 Quanity disposed per year estimated by dividing the total quantity disposed (tons) by the time frame (years).

\5 Total quantity of chat diposed for Jasper County site based on ROD cost estimates for each remediation options (See Appendice B-2, B-3, and B-4). The quantity disposed for the remaining sites is based on subtracting the chat remaining on-site (based on a percentage of chat remaining at the Jasper site) and the total chat used for transport (as provided by US EPA Office of Solid Waste). For example, for the first remediation option, the ROD estimates approximately 21 percent of chat would remain on site (or 20,705,943 tons). Therefore, we subtract this volume from the total quantity of chat at the sites (100,000,000 tons) and subtract the total quantity used for transport (20 million tons) to arrive at a total quantity disposed of 59,294,057 tons.

\6 Annual quantity used for transportation based on a conversation with US EPA Office of Solid Waste on October 7, 2005. US EPA Office of Solid Waset indicated that a total of 1 million tons of chat per year are used from all Tri-State sites.

\7 Total quanity of chat used for tranportation based on multiplying the chat used annually for transport by the time frame. We note that the total chat used for tranport for Jasper county is based on the ROD, dated September 2004 for remediation alternative 1 and 2. However, the quanity disposed for the no-action alternative is based on information provided by US EPA Office of Solid Waste (see Exhibit 3).

\8 Total tons of chat managed is equal to the total chat disposed plus the total chat used for transport.

\9 The total chat remaining is equal to the total volume of chat on site (one million tons) minus the total chat managed.

\10 The total net present value of costs is estimated by multiplying the unit disposal cost by the quantity disposed for each remediation option.

Appendix B-1.b

SUMMARY OF EPA COSTS OF DISPOSAL AND CHAT USE AT TRI-STATE SUPERFUND SITES - 10-YEAR DISPOSAL PERIOD

Baseline Option	Description	Tri-State site	Quantity of chat (tons) \1	Unit disposal cost ($/ton chat) \2	Time frame (years) \3	Quantity disposed per year (tons/year) \4	Total quantity disposed (tons) \5	Quantity used for transportation per year (tons/year) \6	Total quantity used for transportation (tons) \7	Total tons managed (tons) \8	Tons remaining (tons) \9	Total cost ($) \10
1	Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits	ALL SITES	100,000,000	$ 9.98	10	6,929,406	69,294,057	1,000,000	10,000,000	79,294,057	20,705,943	$ 691,735,632
		Jasper Site	7,165,238	$ 9.98	7	714,694	5,002,858	96,964	678,750	5,681,608	1,483,631	$ 49,941,586
		All other sites	92,834,762	$ 9.98	10	6,429,119	64,291,194	932,125	9,321,250	73,612,444	19,222,318	$ 641,794,046
2	Remediation Option 2: Chat Consolidation, In-Place Containment and Revegetation	ALL SITES	100,000,000	$ 25.01	10	6,520,270	65,202,701	1,000,000	10,000,000	75,202,701	24,797,299	$ 1,630,966,348
		Jasper Site	7,165,238	$ 25.01	7	384,064.64	2,688,453	385,714	2,700,000	5,388,453	1,776,786	$ 67,248,373
		All other sites	92,834,762	$ 25.01	10	6,251,425	62,514,248	730,000	7,300,000	69,814,248	23,020,514	$ 1,563,717,975
3	Remdiation Option 3: No Further Action and Monitoring of Water Quality	ALL SITES	100,000,000	$ 0.053	10	0	0	1,000,000	10,000,000	10,000,000	90,000,000	$ 5,311,649
		Jasper Site	7,165,238	$ 0.053	7	0	0	71,652	501,567	501,567	6,663,671	$ 380,592
		All other sites	92,834,762	$ 0.053	10	0	0	949,843	9,498,433.34	9,498,433	83,336,329	$ 4,931,057

Appendix B-1.b

SUMMARY OF EPA COSTS OF DISPOSAL AND CHAT USE AT TRI-STATE SUPERFUND SITES - 10-YEAR DISPOSAL PERIOD

Baseline Option	Description	Tri-State site	Quantity of chat (tons) \1	Unit disposal cost ($/ton chat) \2	Time frame (years) \3	Quantity disposed per year (tons/year) \4	Total quantity disposed (tons) \5	Quantity used for transportation per year (tons/year) \6	Total quantity used for transportation (tons) \7	Total tons managed (tons) \8	Tons remaining (tons) \9	Total cost ($) \10

Sources and Notes:

\1 US EPA Office of Solid Waste indicated that the total tonnage of chat at the four sites is approximately 100,000,000 tons. In addition, US EPA Office of Solid Waste stated that the volume of chat at Cherokee and Newton is approximately equal. The total volume of chat at the Jasper site is 5,732,190 cubic yards, based on the September 2004 ROD. As such, a conversion factor of 0.8 cubic yards of chat per ton was used to estimate the tonnage of chat at the Jasper County site.

\2 Unit Costs are based on Record of Decision, Oronogo-Duenweg Mining Belt Site, Jasper County Superfund Site, Jasper County, Missouri, Prepared by U.S. EPA, Region VII, September 2004. See Appendices B-2 (unit costs related to remediation option 1), B-3 (unit costs related to remediation option 2), and B-4 (unit costs related to remediation option 3).

\3 Based on the period estimated to dispose and recycle chat at the Tar Creek site using a baseline Superfund remediation option. Estimate of the Tar Creek remediation period (20 years) is based on discussions with Mark Doolan and US EPA Office of Solid Waste on October 6 and 7, 2005.

\4 Quanity disposed per year estimated by dividing the total quantity disposed (tons) by the time frame (years).

\5 Total quantity of chat diposed for Jasper County site based on ROD cost estimates for each remediation options (See Appendice B-2, B-3, and B-4). The quantity disposed for the remaining sites is based on subtracting the chat remaining on-site (based on a percentage of chat remaining at the Jasper site) and the total chat used for transport (as provided by US EPA Office of Solid Waste). For example, for the first remediation option, the ROD estimates approximately 21 percent of chat would remain on site (or 20,705,943 tons). Therefore, we subtract this volume from the total quantity of chat at the sites (100,000,000 tons) and subtract the total quantity used for transport (20 million tons) to arrive at a total quantity disposed of 59,294,057 tons.

\6 Annual quantity used for transportation based on a conversation with US EPA Office of Solid Waste on October 7, 2005. US EPA Office of Solid Waset indicated that a total of 1 million tons of chat per year are used from all Tri-State sites.

\7 Total quanity of chat used for tranportation based on multiplying the chat used annually for transport by the time frame. We note that the total chat used for tranport for Jasper county is based on the ROD, dated September 2004 for remediation alternative 1 and 2. However, the quanity disposed for the no-action alternative is based on information provided by US EPA Office of Solid Waste (see Exhibit 3).

\8 Total tons of chat managed is equal to the total chat disposed plus the total chat used for transport.

\9 The total chat remaining is equal to the total volume of chat on site (one million tons) minus the total chat managed.

\10 The total net present value of costs is estimated by multiplying the unit disposal cost by the quantity disposed for each remediation option.

Exhibit B-2

Remediation Option 1: Unit Cost Estimates for Chat Removal and Disposal in On-Site Subsidence Pits (Alternative 4 of Jasper County ROD, dated September 2004)

Item No.	Item Description	Estimated Quantity	Units	Unit Price	Total Est. Cost	Comments and Assumptions
1.	**Excavate and Dispose of In/Near Stream Chat and Chat Sediment Sources in On-Site Subsidence Pits**					
	a. Excavate and load chat	2150761	cu.yds.	$3.50	$7,527,664	Actual cost from 2002 Cherokee County remedial action.
	b. Transport and dump chat in subsidence pits	2150761	cu.yds.	$0.45	$967,842	Assumes a 2 mile roundtrip haul.
	c. Excavate and haul cover soils	107448	cu.yds.	$8.80	$945,542	Assume 18 inches of borrow soil hauled 10 miles roundtrip
	d. Place and lightly compact cover soils	107448	cu.yds.	$1.82	$195,555	
	e. Furnish and install GCL liner material	214896	sq.yds.	$5.40	$1,160,438	Assume Bentomat or equivalent material
	f. Furnish and install drainage fabric	214896	sq.yds.	$2.25	$483,516	
	g. Revegetate geo-composite cover system	44.4	acres	$1,285.00	$57,102	Assume hydroseeding with mulch
	h. Install drainage and erosion controls	4929	lin.ft.	$7.60	$37,458	Assume staked hay bales not replaced after reveg.
	i. Deep till excavated area	863.8	acres	$720.00	$621,936	
	j. Add organic matter to excavated areas	43190	tons	$30.00	$1,295,700	Assume 50 tons composted organic matter per acre, spread and tilled
	k. Revegetate excavated area	863.8	acres	$1,285.00	$1,109,983	Assume hydroseeding with mulch
	Subtotal Chat Disposal	**$14,402,737**				
2.	**Excavate and Dispose of In/Near Stream Tailings and Tailings Sediment Sources in On-Site Subsidence Pits**					
	a. Excavate and load tailings	324315	cu.yds.	$3.90		Actual 2003 cost from Waco demonstration, assumes short haul with scrapers.
	b. Transport and dump tailings in subsidence pits	324315	cu.yds.	$0.45		Assumes a 2 mile roundtrip haul.
	c. Excavate and haul cover soils	16214	cu.yds.	$8.80		Assume 18 inches of borrow soil hauled 5 miles roundtrip
	d. Place and lightly compact cover soils	16214	cu.yds.	$1.82		
	e. Furnish and install GCL liner material	32428	sq.yds.	$5.40		Assume Bentomat or equivalent material
	f. Furnish and install drainage fabric	32428	sq.yds.	$2.25		
	g. Revegetate geo-composite cover system	6.7	acres	$1,285.00		Assume hydroseeding with mulch
	h. Install drainage and erosion controls	1915	lin.ft.	$7.60		Assume staked hay bales not replaced after reveg.
	i. Deep till excavated area	263.8	acres	$720.00		
	j. Add organic matter to excavated areas	13190	tons	$30.00		Assume 50 tons composted organic matter per acre, spread and tilled
	k. Revegetate excavated area	263.8	acres	$1,285.00		Assume hydroseeding with mulch
	Subtotal In/Near Stream Tailings Consolidation	**$0**				
3.	**Excavate and Dispose Upland Chat in On-Site Subsidence Pits**					
	a. Excavate and load chat	1626229	cu.yds.	$3.50	$5,691,802	Actual cost from 2002 Cherokee County remedial action.
	b. Transport and dump chat in subsidence pits	1626229	cu.yds.	$0.45	$731,803	Assumes a 2 mile roundtrip haul.
	c. Excavate and haul cover soils	81311	cu.yds.	$8.80	$715,541	Assume 18 inches of borrow soil hauled 5 miles roundtrip
	d. Place and lightly compact cover soils	81311	cu.yds.	$1.82	$147,987	
	e. Furnish and install GCL liner material	162623	sq.yds.	$5.40	$878,164	Assume Bentomat or equivalent material
	f. Furnish and install drainage fabric	162623	sq.yds.	$2.25	$365,902	
	g. Revegetate geo-composite cover system	33.6	acres	$1,285.00	$43,176	Assume hydroseeding with mulch
	h. Install drainage and erosion controls	4288	lin.ft.	$7.60	$32,585	Assume staked hay bales not replaced after reveg.
	i. Deep till excavated area	1180	acres	$720.00	$849,600	
	j. Add organic matter to excavated areas	59000	tons	$30.00	$1,770,000	Assume 50 tons composted organic matter per acre, spread and tilled
	k. Revegetate excavated area	1180	acres	$1,285.00	$1,516,300	Assume hydroseeding with mulch
	Subtotal Upland Chat	**$12,742,858**				
4.	**Excavate In/Near-Stream Veg'd Chat and Veg'd Chat Sed. Sources and Dispose of in On-Site Subsidence Pits**					
	a. Clear and grub veg'd chat areas	258.1	acres	$2,000.00	$516,200	Actual cost from 2002 Cherokee County remedial action.
	b. Excavate and load chat	225296	cu.yds.	$3.50	$788,536	Actual cost from 2002 Cherokee County remedial action.
	c. Transport and dump chat in subsidence pits	225296	cu.yds.	$0.45	$101,383	Assumes a 2 mile roundtrip haul.

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Exhibit B-2

Remediation Option 1: Unit Cost Estimates for Chat Removal and Disposal in On-Site Subsidence Pits (Alternative 4 of Jasper County ROD, dated September 2004)

Item No.	Item Description	Estimated Quantity	Units	Unit Price	Total Est. Cost	Comments and Assumptions
	d. Excavate and haul cover soils	11265	cu.yds.	$8.80	$99,130	Assume 18 inches of borrow soil hauled 5 miles roundtrip
	e. Place and lightly compact cover soils	11265	cu.yds.	$1.82	$20,502	
	f. Furnish and install GCL liner material	22530	sq.yds.	$5.40	$121,660	Assume Bentomat or equivalent material
	g. Furnish and install drainage fabric	22530	sq.yds.	$2.25	$50,692	
	h. Revegetate geo-composite cover system	4.7	acres	$1,285.00	$5,982	Assume hydroseeding with mulch
	i. Install drainage and erosion controls	1604	lin.ft.	$7.60	$12,187	Assume staked hay bales not replaced after reveg.
	j. Deep till excavated area	258.1	acres	$720.00	$185,832	
	k. Add organic matter to excavated areas	12905	tons	$30.00	$387,150	Assume 50 tons composted organic matter per acre, spread and tilled
	l. Revegetate excavated area	258.1	acres	$1,285.00	$331,659	Assume hydroseeding with mulch
	Subtotal In/Near Veg'd Chat, etc.	**$2,620,912**				
5.	**Excavate and Dispose of Acidic Overburden in the Wild Goose Pit**					
	a. Excavate and load overburden	335700	cu.yds.	$3.90		Actual 2003 cost from Waco demonstration, assumes short haul with scrapers.
	b. Transport and dump overburden in subsidence pits	335700	cu.yds.	$0.45		Assumes a 2 mile roundtrip haul.
	c. Deep till excavated area	39	acres	$720.00		
	d. Add organic matter to excavated areas	1950	tons	$30.00		Assume 50 tons composted organic matter per acre, spread and tilled
	e. Revegetate excavated area	39	acres	$1,285.00		Assume hydroseeding with mulch
	f. Excavate and place soils for berm around pit	4500	cu.yds.	$6.24		Assume an earthen berm 4 ft. high (1.2 cy/lin.ft)
	g. Construct lined diversion channel	3750	lin.ft.	$3.03		Assume 60 mil HDPE liner under soil cover
	h. Construct open limestone drain	750	sq.yds.	$65.00		Limestone cobbles placed in natural drainage channel
	Subtotal Acidic Overburden	**$0**				
6.	**Deep Till Upland Veg'd Chat, Add Biosolids and Revegetate**					
	a. Deep till upland veg'd chat	617.7	acres	$1,720.00		Includes some clearing and grubbing.
	b. Add biosolids to upland veg'd chat	30885	dry tons	$30.00		Assume 50 dry tons biosolids per acre
	c. Add lime to upland veg'd chat	6177	tons	$12.75		Assume 10 tons of lime per acre
	d. Revegetate tilled upland veg'd chat	617.7	acres	$1,285.00		Assume hydroseeding with mulch
	Subtotal Upland Veg'd Chat	**$0**				
7.	**Excavate Transition Zone Soils Exceeding Risk-Based Criteria and Use for Cover Soil**					
	a. Excavate and load T-zone soils	217800	cu.yds.	$0.00		Costs included in No. 1, 2, and 3 above.
	b. Transport and place T-zone soils on covers	217800	cu.yds.	$0.00		Costs included in No. 1, 2, and 3 above.
	c. Deep till excavated area	135	acres	$720.00		
	d. Add organic matter to excavated areas	6750	tons	$30.00		Assume 50 tons composted organic matter per acre, spread and tilled
	e. Revegetate excavated area	135	acres	$1,285.00		Assume hydroseeding with mulch
	Subtotal In/Near Stream T-Zone Soils	**$0**				
8.	**Deep Till Remaining T-Zone Soils Exceeding Risk Based Criteria, Add Biosolids and Revegetate**					
	a. Deep till T-zone soils	1073	acres	$1,220.00		Includes light clearing and grubbing.
	b. Add biosolids to T-zone soils	53650	dry tons	$30.00		Assume 50 dry tons biosolids per acre
	c. Add lime to T-zone soils	10730	tons	$12.75		Assume 10 tons of lime per acre
	d. Revegetate tilled T-zone soils	1073	acres	$1,285.00		Assume hydroseeding with mulch
	Subtotal Upland T-Zone Soils	**$0**				
9.	**Excavated Bed and Bank Sediments and Dispose of in Subsidence Pits**					
	a. Excavate sediments	8900	cu.yds.	$3.90		Actual 2003 cost from Waco demonstration, assumes short haul with scrapers.

Exhibit B-2

Remediation Option 1: Unit Cost Estimates for Chat Removal and Disposal in On-Site Subsidence Pits (Alternative 4 of Jasper County ROD, dated September 2004)

Item No.	Item Description	Estimated Quantity	Units	Unit Price	Total Est. Cost	Comments and Assumptions
	b. Transport and place sediments in waste cells	8900	cu.yds.	$0.45		Assumes a 2 mile roundtrip haul.
	c. Restore excavated areas	20459	lin.ft.	$10.00		Best guess
	Subtotal Sediments	**$0**				
10.	**Implement Drainage and Erosion Controls**					Total approximate length = 74,000 lin.ft.
	a. Install riprap revetment - ungrouted	16444	sq.yds.	$65.00	$1,068,889	Assume 10 percent of total length
	b. Install berms	54815	cu.yds.	$6.20	$339,852	Assume 20 percent of total length
	c. Regrade excavated areas	164444	sq.yds.	$1.85	$304,222	Assume total area fine graded, small irregular areas.
	d. Install geotextile erosion control material	41111	sq.yds.	$1.21	$49,744	Assume 25 percent of total
	e. Revegetate excavated areas	34.0	acres	$1,285.00	$43,659	Assume hydroseeding with mulch
	Subtotal Drainage and Erosion Controls	**$1,806,367**				
11.	**Install Adit Plugs and Drainage Ditches**					
	a. Install adit plugs	100	each	$10,000.00		Best guess
	b. Install upgradient diversion ditches	50000	lin.ft.	$13.25		Best guess
	c. Head walls, berms, riprap, etc.	1	lump sum	$500,000.00		Best guess
	Subtotal Adit Plug and Diversion Ditches	**$0**				
12.	**Institutional Controls**					
	a. Implement institutional controls	1	lump sum	$250,000.00	$250,000	Best guess
	Subtotal Institutional Controls	**$250,000**				
						2003 dollars **2006 dollars**
13.	**Indirect Capital Costs**				***Total Direct Costs:***	***$31,822,874*** **$ 36,205,352**
	a. Negotiate landowner agreements	1	lump sum	$315,729	$315,729	Assume 1% of total direct capital cost
	b. Remedial design	1	lump sum	$1,578,644	$1,578,644	Assume 5% of total direct capital cost
	c. Construction oversight and management	1	lump sum	$2,210,101	$2,210,101	Assume 7% of total direct capital cost
	d. Contingencies	1	lump sum	$6,314,575	$6,314,575	Assume 20% of total direct capital cost
		2003 dollars	**2006 dollars**			
	Subtotal Indirect Costs	**$10,419,048**	**$ 11,853,905**			
					2003 dollars	**2006 dollars**
	Total Alternative 4 Capital Costs				**$42,241,922**	**$ 48,059,256**
14.	**Annual Operation and Maintenance Costs**					
	a. Administer landowner agreements	1	lump sum	$20,000.00	$20,000	Assume 1/4 FTE plus expenses, for first 5 years only
	b. Administer institutional controls	1	lump sum	$5,000.00	$5,000	Assume 1/8 FTE in the Jasper County clerk's office plus expenses.
	c. Monitoring and maintenance of repository caps	90	acres	$250.00	$22,500	
		2003 dollars	**2006 dollars**			
	Subtotal Annual O&M Costs - Alternative 4	**$47,500**	**$ 54,041**			
	Annual Inflation Factor	2.9%	Based on CCI Index			
	Interest rate	3.0%				

15.	**Present Worth Cost Analysis**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2035**	**2036**
	Direct Capital Costs		$6,209,218	$6,389,285	$6,574,574	$6,765,237	$6,961,429	$7,163,310			
	Indirect Capital Costs	$1,975,651	$2,032,945	$2,091,900	$2,152,565	$2,214,990	$2,279,224				
	Operation and Maintenance Costs		$55,609	$57,221	$58,881	$60,588	$62,345	$64,153	$66,014	$123,815	$127,406

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Exhibit B-2

Remediation Option 1: Unit Cost Estimates for Chat Removal and Disposal in On-Site Subsidence Pits (Alternative 4 of Jasper County ROD, dated September 2004)

Item No.	Item Description	Estimated Quantity	Units	Unit Price	Total Est. Cost	Comments and Assumptions					
	Water Quality Monitoring Plan Implementation	$55,173		$58,420		$61,857		$65,497			
	Total Capital and O&M Costs	$2,030,824	$8,297,771	$8,596,826	$8,786,020	$9,102,672	$9,302,999	$7,292,961	$66,014	$123,815	$127,406
	Net Present Value of Alternative 4	$2,030,824	$8,056,088	$8,103,333	$8,040,453	$8,087,606	$8,024,848	$6,107,740	$53,675	$52,540	$52,489
		0	1	2	3	4	5	6	7	29	30

	2006 dollars	per cy	per ton
Total Net Present Value of Alternative 4	**$49,941,586**	$ 12.48	$ 9.98

Quantity of ChatDisposed/Recycled	cubic yards	tons	Percent
Total Chat:	5,732,190	7,165,238	100%
Disposed:	4,002,286	5,002,858	70%
Recycled:	543,000	678,750	9%
Remaining	1,186,904	1,483,630	21%

Sources and Notes:

\1 Biosolids costs assume cake with 20% solids at $6.00 per wet ton delivered and applied.
Total transportation and application costs per dry ton are $30.00.
Source: Brown *et al.* 2001, and Ed Malters, City of Springfield, Mo.

\2 Lime costs assume agricultural lime at $5.75 per ton plus $7.00 transportation and spreading.
Source: Brown *et al*. 2001.

\3 A total of 66,725 dry tons of biosolids are applied under this alternative. This represents
9.1 years of total daily production of Springfield, Mo., at the current rate of 20 dry tons per day.

\4 Geo-composite cover systems consist of 18 inches of soil, a GCL, and drainage layer placed over the wastes and revegetated.
Approximately 217,800 cubic yards of cover soils are needed to implement Alternative 4. This volume of soil
can be obtained from transition zone soils. Capped areas cover approximately 89.4 acres.

\5 Assumes approximately 25 percent of upland chat (543,000 cubic yards) is removed by recycling.

\6 The present worth analysis assumes 30 years of O&M at a discount rate of 3 percent.
Remedial actions are assumed to be completed between years 2 to 7. Indirect costs are incurred over the first 6 years of remediation.
The first 5 years of O&M costs reflect administration of landowner agreements, but are reduced and distributed evenly over last 25 years of the present worth period.

\7 Figures inflated to 2006 dollars using the Construction Cost Index (CCI). The costs are inflated to October 2005 based on CCI value of 7563 as of October 2005 and 6695 as of January 2003. Costs were then inflacted to January 2006, based on an average annual rate of inflation of 2.93 percent or monthly inflation of 0.24 percent. See http://enr.construction.com/features/coneco/ subs/recentindexes.asp.

Exhibit B-3

Remediation Option 2: Unit Cost Estimates for Chat Consolidation, In-Place Containment, and Revegetation (Alternative 3 of Jasper County ROD, dated September 2004)

Item No.	Item Description	Estimated Quantity	Units	Unit Price	Total Est. Cost	Comments and Assumptions
1.	**Consolidate In- and Near-Stream Chat**					
	a. Excavate and load chat	410320	cu.yds.	$3.50	$1,436,120	Actual cost from 2002 Cherokee County remedial action.
	b. Transport and stockpile chat	410320	cu.yds.	$0.45	$184,644	Assumes a 2 mile roundtrip haul.
	c. Install drainage and erosion controls	3730	lin.ft.	$7.60	$28,350	Assume staked hay bales not replaced after reveg.
	d. Deep till excavated area	205.1	acres	$720.00	$147,672	
	e. Add organic matter to excavated areas	10255	tons	$30.00	$307,650	Assume 50 tons composted organic matter per acre, spread and tilled
	f. Revegetate excavated area	205.1	acres	$1,285.00	$263,554	Assume hydroseeding with mulch
	Subtotal In/Near Stream Chat Consolidation	**$2,367,989**				
2.	**Consolidate In-and Near Stream Tailings and Cap with Simple Soil Covers**					
	a. Excavate tailings	59544	cu.yds.	$3.90		Actual 2003 cost from Waco demonstration, assumes short haul with scrapers.
	b. Transport and place tailings in waste cells	59544	cu.yds.	$0.45		Assumes a 2 mile roundtrip haul.
	c. Excavate and haul cover soils	22506	cu.yds.	$8.80		Assume 18 inches of borrow soil hauled 10 miles roundtrip
	d. Place cover soils	22506	cu.yds.	$1.82		Includes light compaction
	e. Revegetate cover soils	9.3	acres	$1,285.00		Assume hydroseeding with mulch
	f. Install drainage and erosion controls	2256	lin.ft.	$7.60		Assume staked hay bales not replaced after reveg.
	g. Deep till excavated tailings areas	42.3	acres	$720.00		
	h. Add organic matter to excavated areas	2115	tons	$30.00		Assume 50 tons composted organic matter per acre, spread and tilled
	i. Revegetate excavated area	42.3	acres	$1,285.00		Assume hydroseeding with mulch
	Subtotal In/Near Stream Tailings Consolidation	**$0**				
3.	**Leave Upland Chat In Place Temporarily, Then Cap Chat Remaining After Year 10**					Assumes half of all chat areas are remediated through recycling.
	a. Install drainage and erosion controls	25419	lin.ft.	$7.60	$193,187	Assume staked hay bales replaced every 5 years through year 10.
	b. Excavate and haul cover soils	1429010	cu.yds.	$8.80	$12,575,288	Assume 18 inches of borrow soil hauled 10 miles roundtrip
	c. Place cover soils	1429010	cu.yds.	$1.82	$2,600,798	Includes light compaction
	d. Revegetate cover soils	590.5	acres	$1,285.00	$758,793	Assume hydroseeding with mulch
	Subtotal Upland Chat	**$16,128,065**				
4.	**Leave Upland Tailings In Place and Cap with Simple Soil Covers**					
	a. Regrade and recontour tailings	174873	cu.yds.	$1.35		Assume no change in surface area
	b. Excavate and haul cover soils	381150	cu.yds.	$8.80		Assume 18 inches of borrow soil hauled 10 miles roundtrip
	c. Place cover soils	381150	cu.yds.	$1.82		Includes light compaction
	d. Revegetate cover soils	157.5	acres	$1,285.00		Assume hydroseeding with mulch
	e. Install drainage and erosion controls	10477	lin.ft.	$7.60		Assume staked hay bales not replaced after reveg.
	Subtotal Upland Tailings	**$0**				
5.	**Cap Acidic Overburden with Soil Cover and Revegetate**					
	a. Clear and grub overburden deposits	39	acres	$2,000.00		Actual cost from 2002 Cherokee County remedial action.
	b. Regrade and recontour overburden	125840	cu.yds.	$1.35		Assume no change in surface area
	c. Add lime to overburden	3120	tons	$12.75		Assume 80 tons of lime per acre
	d. Excavate and haul cover soils	94380	cu.yds.	$8.80		Assume 18 inches of borrow soil hauled 10 miles roundtrip
	e. Place cover soils	94380	cu.yds.	$1.82		Includes light compaction
	f. Revegetate overburden	39.0	acres	$1,285.00		Assume hydroseeding with mulch
	g. Excavate and place soils for berm around pit	4500	cu.yds.	$6.24		Assume an earthen berm 4 ft. high (1.2 cy/lin.ft)
	h. Construct lined diversion channel	3750	lin.ft.	$3.03		Assume 60 mil HDPE liner under soil cover
	i. Construct open limestone drain	750	sq. yds.	$65.00		Limestone cobbles placed in natural drainage channel

Exhibit B-3

Remediation Option 2: Unit Cost Estimates for Chat Consolidation, In-Place Containment, and Revegetation (Alternative 3 of Jasper County ROD, dated September 2004)

Item No.	Item Description	Estimated Quantity	Units	Unit Price	Total Est. Cost	Comments and Assumptions
	Subtotal Acidic Overburden	**$0**				
6.	**Regrade In/Near-Stream Veg'd Chat and Veg'd Chat Sediment Sources and Cap In Place**					
	a. Clear and grub veg'd chat areas	258.1	acres	$2,000.00	$516,200	Actual cost from 2002 Cherokee County remedial action.
	b. Regrade vegetated chat piles	1249204	sq.yds.	$0.35	$437,221	
	c. Excavate and haul cover soils	624602	cu.yds.	$8.80	$5,496,498	Assume 18 inches of borrow soil hauled 10 miles roundtrip
	d. Place cover soils	624602	cu.yds.	$1.82	$1,136,776	Includes light compaction
	e. Revegetate cover soils	258.1	acres	$1,285.00	$331,659	Assume hydroseeding with mulch
	f. Install drainage and erosion controls	13412	lin.ft.	$7.60	$101,932	Assume staked hay bales not replaced after reveg.
	Subtotal In/Near Veg'd Chat, etc.	**$8,020,285**				
7.	**Deep Till Upland Veg'd Chat, Add Biosolids and Revegetate**					
	a. Deep till upland veg'd chat	617.7	acres	$1,720.00	$1,062,444	Includes some clearing and grubbing.
	b. Add biosolids to upland veg'd chat	30885	dry tons	$30.00	$926,550	Assume 50 dry tons biosolids per acre
	c. Add lime to upland veg'd chat	6177	tons	$12.75	$78,757	Assume 10 tons of lime per acre
	d. Revegetate tilled upland veg'd chat	617.7	acres	$1,285.00	$793,745	Assume hydroseeding with mulch
	Subtotal T-Zone Soils	**$2,861,495**				
8.	**Deep Till Transition Zone Soils Exceeding Risk-Based, Add Biosolids and Revegetate**					
	a. Deep till T-zone soils	1209	acres	$1,220.00		Includes light clearing and grubbing.
	b. Add biosolids to T-zone soils	60450	dry tons	$30.00		Assume 50 dry tons biosolids per acre
	c. Add lime to T-zone soils	12090	tons	$12.75		Assume 10 tons of lime per acre
	d. Revegetate tilled T-zone soils	1209	acres	$1,285.00		Assume hydroseeding with mulch
	Subtotal T-Zone Soils	**$0**				
9.	**Consolidate Chat Sediment Sources**					Assumed to be consolidated in existing upland chat areas.
	a. Excavate chat	1740442	cu.yds.	$3.50	$6,091,547	Actual cost from 2002 Cherokee County remedial action.
	b. Transport and stockpile chat	1740442	cu.yds.	$0.45	$783,199	Assumes a 2 mile roundtrip haul.
	c. Install drainage and erosion controls	7683	lin.ft.	$7.60	$58,388	Assume staked hay bales not replaced after reveg.
	d. Deep till excavated area	654.8	acres	$720.00	$471,456	
	e. Add organic matter to excavated areas	32740	tons	$30.00	$982,200	Assume 50 tons composted organic matter per acre, spread and tilled
	f. Revegetate excavated area	654.8	acres	$1,285.00	$841,418	Assume hydroseeding with mulch
	Subtotal Chat Sediment Sources	**$9,228,207**				
10.	**Consolidate Tailings Sediment Sources and Cap with Simple Soil Covers**					
	a. Excavate tailings	89898	cu.yds.	$3.90		Actual 2003 cost from Waco demonstration, assumes short haul with scrapers.
	b. Transport and place tailings in waste cells	89898	cu.yds.	$0.45		Assumes a 2 mile roundtrip haul.
	c. Excavate and haul cover soils	33880	cu.yds.	$8.80		Assume 18 inches of borrow soil hauled 10 miles roundtrip
	d. Place cover soils	33880	cu.yds.	$1.82		Includes light compaction
	e. Revegetate cover soils	13.9	acres	$1,285.00		Assume hydroseeding with mulch
	f. Install drainage and erosion controls	2768	lin.ft.	$7.60		Assume staked hay bales not replaced after reveg.
	g. Deep till excavated areas	64.1	acres	$720.00		
	h. Add organic matter to excavated areas	3205	tons	$30.00		Assume 50 tons composted organic matter per acre, spread and tilled
	i. Revegetate excavated area	64.1	acres	$1,285.00		Assume hydroseeding with mulch
	Subtotal Tailings Sed. Sources Consolidation	**$0**				

Exhibit B-3

Remediation Option 2: Unit Cost Estimates for Chat Consolidation, In-Place Containment, and Revegetation (Alternative 3 of Jasper County ROD, dated September 2004)

Item No.	Item Description	Estimated Quantity	Units	Unit Price	Total Est. Cost	Comments and Assumptions
11.	**Excavated Bed and Bank Sediments and Cap with Simple Soil Covers**					
	a. Excavate sediments	8900	cu.yds.	$3.90	$34,710	Actual 2003 cost from Waco demonstration, assumes short haul with scrapers.
	b. Transport and place sediments in waste cells	8900	cu.yds.	$0.45	$4,005	Assumes a 2 mile roundtrip haul.
	c. Excavate and haul cover soils	3388	cu.yds.	$8.80	$29,814	Assume 18 inches of borrow soil hauled 10 miles roundtrip
	d. Place cover soils	3388	cu.yds.	$1.82	$6,166	Includes light compaction
	e. Revegetate cover soils	1.4	acres	$1,285.00	$1,799	Assume hydroseeding with mulch
	f. Install drainage and erosion controls	875	lin.ft.	$7.60	$6,651	Assume staked hay bales not replaced after reveg.
	g. Restore excavated areas	20459	lin.ft.	$10.00	$204,590	Best guess
	Subtotal Sediments	**$287,736**				
12.	**Implement Drainage and Erosion Controls**					Total approximate length = 74,000 lin.ft.
	a. Install riprap revetment - ungrouted	16444	sq.yds.	$65.00	$1,068,889	Assume 10 percent of total length
	b. Install berms	54815	cu.yds.	$6.20	$339,852	Assume 20 percent of total length
	c. Regrade excavated areas	164444	sq.yds.	$1.85	$304,222	Assume total area fine graded, small irregular areas.
	d. Install geotextile erosion control material	41111	sq.yds.	$1.21	$49,744	Assume 25 percent of total
	e. Revegetate excavated areas	34.0	acres	$1,285.00	$43,659	Assume hydroseeding with mulch
	Subtotal Drainage and Erosion Controls	**$1,806,367**				
13.	**Install Adit Plugs and Drainage Ditches**					
	a. Install adit plugs	100	each	$10,000.00		Best guess
	b. Install upgradient diversion ditches	50000	lin.ft.	$13.25		Best guess
	c. Head walls, berms, riprap, etc.	1	lump sum	$500,000.00		Best guess
	Subtotal Adit Plug and Diversion Ditches	**$0**				
14.	**Institutional Controls and Chat Management Programs**					
	a. Implement institutional controls	1	lump sum	$250,000.00	$250,000	Best guess
	b. Implement chat recycling management program	1	lump sum	$250,000.00	$250,000	Best guess
	c. Perform post-recycling remediaton of chat piles	724	acres	$3,785.00	$2,739,583	Assumes deep till, add biosolids, and revegetate.
	Subtotal Institutional Controls and Chat Management	**$3,239,583**				
						2003 dollars **2006 dollars**
15.	**Indirect Capital Costs**				***Total Direct Costs:***	***$43,939,729*** **$ 49,990,876**
	a. Negotiate landowner agreements	1	lump sum	$407,001	$407,001	Assume 1% of total direct capital cost
	b. Remedial design	1	lump sum	$2,035,007	$2,035,007	Assume 5% of total direct capital cost
	c. Construction oversight and management	1	lump sum	$2,849,010	$2,849,010	Assume 7% of total direct capital cost
	d. Contingencies	1	lump sum	$8,140,029	$8,140,029	Assume 20% of total direct capital cost
		2003 dollars	**2006 dollars**			
	Subtotal Indirect Costs	**$13,431,048**	**$ 15,280,701**			
					2003 dollars	**2006 dollars**
	Total Alternative 3 Capital Costs				**$57,370,777**	**$ 65,271,577**
16.	**Annual Operation and Maintenance Costs**					
	a. Administer landowner agreements	1	lump sum	$20,000.00	$20,000	Assume 1/4 FTE plus expenses
	b. Administer institutional controls	1	lump sum	$5,000.00	$5,000	Assume 1/8 FTE in the Jasper County clerk's office plus expenses.
	c. Administer chat management program	1	lump sum	$20,000.00	$20,000	Assume 1/4 FTE plus expenses
	d. Replacement of drainage and erosion controls	1	lump sum	$ 38,637.00	$38,637	Assume replacement of staked hay bales at 5 year intervals through year 10 only.
		2003 dollars	**2006 dollars**		**2003 dollars**	**2006 dollars**

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Exhibit B-3

Remediation Option 2: Unit Cost Estimates for Chat Consolidation, In-Place Containment, and Revegetation (Alternative 3 of Jasper County ROD, dated September 2004)

Item No.	Item Description	Estimated Quantity	Units	Unit Price	Total Est. Cost	Comments and Assumptions
	Subtotal Annual O&M Costs - Alternative 3	**$83,637**	**$ 95,155**		$45,000	**$ 51,197**

Annual Inflation Factor	2.9%	Based on CCI Index
Interest rate	3.0%	

17.	Present Worth Cost Analysis	2006	2007	2008	2009	2010	2011	2012	2013	2035	2036
	Direct Capital Costs		$7,201,686	$7,410,534	$7,625,440	$7,846,578	$8,074,128	$3,560,691	$3,663,951		
	Indirect Capital Costs	$526,921	$542,201	$557,925	$574,105	$590,754	$607,886	$625,515	$643,655		
	Operation and Maintenance Costs			$100,754	$103,676	$106,683	$109,776	$112,960	$116,236	$117,298	$120,700
	Water Quality Monitoring Plan Implementation	$55,173		$58,420		$61,857		$65,497			$130,074
	Total Capital and O&M Costs	$582,094	$7,743,887	$8,127,634	$8,303,221	$8,605,872	$8,791,791	$4,364,662	$4,423,841	$117,298	$250,774
	Net Present Value of Alternative 3	$582,094	$7,518,337	$7,661,074	$7,598,623	$7,646,206	$7,583,876	$3,655,336	$3,596,988	$49,775	$103,316
		0	1	2	3	4	5	6	7	29	30

	2006 dollars	per cy	per ton
Total Net Present Value of Alternative 3	**$67,248,373**	$ 31.27	$ 25.01

Quantity of ChatDisposed/Recycled	cubic yards	tons	Percent
Total Chat:	5,732,190	7,165,238	100%
Disposed:	2,150,762	2,688,453	38%
Recycled:	2,160,000	2,700,000	38%
Remaining	1,421,428	1,776,785	25%

Sources and Notes:

\1 Biosolids costs assume cake with 20% solids at $6.00 per wet ton delivered and applied.
Total transportation and application costs per dry ton are $30.00.
Source: Brown *et al.* 2001, and Ed Malters, City of Springfield, Mo.

\2 Lime costs assume agricultural lime at $5.75 per ton plus $7.00 transportation and spreading.
Source: Brown *et al.* 2001.

\3 A total of 91,335 dry tons of biosolids are applied under this alternative. This represents 12.5 years of total daily production of Springfield, Mo., at the current rate of 20 dry tons per day.

\4 Simple soil covers consist of 18 inches of borrow soil placed directly on the wastes and revegetated.
Approximately 2,588,916 cubic yards of cover soils are needed to implement Alternative 3.
Capped waste cover approximately 1,713 acres.

\5 Alternative 3 assumes approximately half of all chat (2.16 million cubic yards) is removed by recycling.

\6 The present worth analysis assumes 30 years of O&M at a discount rate of 3 percent. Direct capital costs are spread evenly throughout the first 5 years then reduced over the next 7 years to reflect the time required to cap remediated waste piles. Indirect costs are spread out over the first 9 years of remediation.
The first 10 years of O&M costs reflect replacement of drainage and erosion controls but are reduced and distributed evenly over last 20 years of the present worth period.

\7 Figures inflated to 2006 dollars using the Construction Cost Index (CCI). The costs are inflated to October 2005 based on CCI value of 7563 as of October 2005 and 6695 as of January 2003. Costs were then inflacted to January 2006, based on an average annual rate of inflation of 2.93 percent or monthly inflation of 0.24 percent. See http://enr.construction.com/features/coneco/ subs/recentindexes.asp.

Exhibit B-4

Remediation Option 3: Unit Cost Estimates for No Further Action and Monitoring of Water Quality (Alternative 1 of Jasper County ROD, dated September 2004)

Item No.	Item Description	Estimated Quantity	Units	Unit Price	Total Est. Cost	Comments and Assumptions
1.	**Annual Operation and Maintenance Costs**					
	a. Annual cost of surface water monitoring	1	lump sum	$9,700.00	$9,700	Assumes implementation of water quality monitoring plan described in FS text.
	Subtotal Annual O&M Costs	**$9,700**				

Annual Inflation Factor	2.9%	Based on CCI Index
Interest rate	3.0%	

2.	**Present Worth Cost Analysis**	**Year**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2035**	**2036**
	Direct Capital Costs			$0	$0	$0	$0	$0	$0	$0	$0	$0
	Indirect Capital Costs			$0	$0	$0	$0	$0	$0	$0	$0	$0
	Operation and Maintenance Costs			$56,774	$0	$0	$0	$63,651	$0	$0	$0	$130,074
	Total Capital and O&M Costs			$56,774	$0	$0	$0	$63,651	$0	$0	$0	$130,074
	Net Present Value of Alternative 1			$55,120	$0	$0	$0	$54,906	$0	$0	$0	$53,589
			0	1	2	3	4	5	6	7	29	30

	2006 dollars		per cy		per ton			cy	tons
Total Net Present Value of Alternative 1	**$380,592**	$	0.066	$	0.053	total chat:		5,732,190	7,165,238

Sources and Notes:

\1 None of the costs of implementing institutional controls prescribed under OU-2, OU-3, or OU-4 are included in the annual O&M costs for Alternative 1.

\2 Annual O&M includes costs of implementing the water quality monitoring plan, including high- and low-flow monitoring once for baseline and once every 5 years thereafter.

\3 The present worth analysis assumes 30 years of O&M at a discount rate of 3 percent. O&M costs are assumed to be incurred at 5-year intervals for surface water monitoring.

\4 Figures inflated to 2006 dollars using the Construction Cost Index (CCI). The costs are inflated to October 2005 based on CCI value of 7563 as of October 2005 and 6695 as of January 2003. Costs were then inflacted to

Item No.	Item Description	Estimated Quantity	Units	Unit Price	Total Est. Cost	Comments and Assumptions
1.	**Labor and Materials for Conducting One Round of Water Quality Sampling**					Assumes a third-party contractor conducts all monitoring activities
a.	Project management and supervision	25	hrs.	$85	$2,125	Assumes a senior level project manager position
b.	Field technician - field measurements and sampling	112	hrs.	$65	$7,280	Assumes field technician level position
c.	Office technician - data validation and reporting	60	hrs.	$65	$3,900	Assumes field technician level position
d.	Vehicles and equipment rental	1	week	$650	$650	Recent similar quotes
e.	Per diem	14	L.S.	$75	$1,050	Assumes 2 personnel for 8 days in the field
f.	Travel to and from site	2	L.S.	$350	$700	Recent similar quotes
g.	Miscellaneous supplies and contingencies	1	L.S.	$1,570.50	$1,571	Assumes 10% of subtotal
	Subtotal Labor and Materials	**$17,276**				
2.	**Laboratory Analysis**					Analytical costs from Evergreen Labs, 2002, Denver, Colorado.
a.	Dissolved metals	82	Analyses	$24	$1,968	Three metals X 26 locations X 1.05 for QA/QC = 82, Includes sample prep.
b.	TSS	28	Analyses	$20	$560	26 locations X 1.05 for QA/QC = 28
c.	Hardness	28	Analyses	$48	$1,344	26 locations X 1.05 for QA/QC = 28

Exhibit B-4

Remediation Option 3: Unit Cost Estimates for No Further Action and Monitoring of Water Quality (Alternative 1 of Jasper County ROD, dated September 2004)

Item No.	Item Description	Estimated Quantity	Units	Unit Price	Total Est. Cost	Comments and Assumptions
d.	Alkalinity	28	Analyses	$20	$560	26 locations X 1.05 for QA/QC = 28
e.	Acidity	28	Analyses	$20	$560	26 locations X 1.05 for QA/QC = 28
f.	Sulfate	28	Analyses	$20	$560	26 locations X 1.05 for QA/QC = 28
g.	Phosphates	28	Analyses	$20	$560	26 locations X 1.05 for QA/QC = 28
h.	Nitrates/nitrites	28	Analyses	$20	$560	26 locations X 1.05 for QA/QC = 28
j.	Shipping and miscellaneous	1	LS	$300	$300	Recent similar projects
	Total Laboratory Analysis	**$6,972**				
					2003 dollars	**2006 dollars**
	Total for Each Round of Sampling, Analysis, and Reporting				**$24,248**	**$ 27,587**

Appendix C-1a:

Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits
Breakeven Cost Analysis - Current Market Scenario - 20 YEAR DISPOSAL PERIOD

Option	Current quantity of chat at all sites (tons) \1	Maximum unit transportation cost ($/ton mile)	Average unit transportation cost ($/ton mile) \2	Additional mileage (miles) \3	Radius from Bingham Sand & Gravel (miles)	Total road surface area - GIS snalysis (sq mi) \4	Chat quantity used for transportation per year (tons/year)	Time frame (years)	Total chat used for transportation (tons)	Total transportation cost to EPA ($)	Total chat not used for transport (tons)	Total chat left on-site (tons) \5	Disposal cost ($/ton)	Total disposal cost ($)	Total cost to EPA ($) \6
1	100,000,000	$ -	$ -	0	200	284	1,000,000	20	20,000,000	-	80,000,000	20,705,943	$ 9.98	$ 591,909,566	$ 591,909,566
2	100,000,000	$ 1.00	$ 0.50	3	203	291	1,024,480	20	20,489,602	244,801	79,510,398	20,705,943	$ 9.98	$ 587,022,055	$ 587,266,856
3	100,000,000	$ 5.00	$ 2.50	14	214	324	1,140,284	20	22,805,680	7,014,199	77,194,320	20,705,943	$ 9.98	$ 563,901,554	$ 570,915,753
4	100,000,000	$ 7.00	$ 3.50	19	219	341	1,200,520	20	24,010,393	14,036,377	75,989,607	20,705,943	$ 9.98	$ 551,875,365	$ 565,911,742
5	100,000,000	$ 9.98	$ 4.99	28	228	367	1,293,241	20	25,864,811	29,273,065	74,135,189	20,705,943	$ 9.98	$ 533,363,435	$ 562,636,501
6	100,000,000	$ 19.97	$ 9.98	50	250	443	1,559,641	20	31,192,826	111,733,643	68,807,174	20,705,943	$ 9.98	$ 480,175,923	$ 591,909,566
7	100,000,000	$ 71.24	$ 35.62	198	398	1,126	3,964,703	20	79,294,057	2,112,193,814	20,705,943	20,705,943	$ 9.98	$ -	$ 2,112,193,814

Sources and Notes:

\1 US EPA Office of Solid Waste indicated that the total tonnage of chat at the four sites is approximately 100,000,000 tons

\2 In option 7, to estimate the unit transportation cost necessary to carry the chat far enough to cover 1,126 square miles of road (the surface area of road necessary to fuel sufficient demand, assuming a constant ratio of surface area to chat quantity used for transportation, to consume all 100 million tons of chat within 20 years, we: 1) plotted total radius from Bingham Sand & Gravel against total surface area of roads, based on GIS analysis, 2) calculated a best-fit trendline, and 3) extrapolated. See Appendix B-3 for details.

\3 Additional mileage is estimated by dividing the maximun tranport cost by the unit hauling cost of chat ($0.36/ ton mile). This cost was provided by Mark Doolan of US EPA.

\4 For option one, total road surface area is based on GIS analysis outputs. For options 2 to 6, total road surface area based on assumption of the following relationship: total surface area = 0.0068*(radius from Bingham)^2.0075. The equation was derived from trendline imposed on five data points from the GIS analysis. Radii were set to a constant to calculate total road surface area. For example, in option five, the radius from Bingham is set to 228 miles, based on $9.98 unit transportation cost. $9.98 is the unit cost of disposal for remediation option 1. See Appendix C-2 for details on the equation and Appendix A-1 for details on remediation option 1. For option seven, total road surface area based on assumption of a constant ratio between total road surface area and chat quantity used for transportation per year (i.e., 284 mi^2 to 1 million tons per year). Quantity used for transportation per year is set, in option five, to 3,964,703 tons per year, the rate of chat consumption necessary to consume all below action threshold chat on all four Superfund sites, assuming no Superfund remediation disposal. See Appendix C-3 for details on current demand.

\5 We assume 20 percent (based on personal communication with Mark Doolan (EPA) in October, 2005) of total chat falls below the action threshold for Superfund remediation and can be left on-site as is.

\6 Total costs to EPA include (a) disposal costs associated with remediating chat (above the action threshold) that remains after 20 years, assuming realization of all potential demand within the relevant mileage away from Bingham and (b) transportation costs associated with transporting chat beyond the 200 mile radius away from Bingham. In addition, we assume any road growth experienced by both current and potential demand will be equivalent and likely considerably lower than two percent per year, as discussed with John D'Angelo (USDOT) in October, 2005.

Appendix C-1.b:

Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits
Breakeven Cost Analysis - Current Market Scenario - 10-YEAR DISPOSAL PERIOD

Option	Current quantity of chat at all sites (tons) \1	Maximum unit transportation cost ($/ton mile)	Average unit transportation cost ($/ton mile) \2	Additional mileage (miles) \3	Radius from Bingham Sand & Gravel (miles)	Total road surface area - GIS snalysis (sq mi) \4	Chat quantity used for transportation per year (tons/year)	Time frame (years)	Total chat used for transportation (tons)	Total transportation off-set cost ($)	Total chat not used for transport (tons)	Total chat left on-site (tons) \5	Disposal cost ($/ton)	Total disposal cost ($)	Total cost to EPA ($) \6
1	100,000,000	$ -	$ -	0	200	284	1,000,000	10	10,000,000	-	90,000,000	20,705,943	$ 9.98	$ 691,735,687	$ 691,735,687
2	100,000,000	$ 1.00	$ 0.50	3	203	291	1,024,480	10	10,244,801	122,401	89,755,199	20,705,943	$ 9.98	$ 689,291,931	$ 689,414,332
3	100,000,000	$ 5.00	$ 2.50	14	214	324	1,140,284	10	11,402,840	3,507,100	88,597,160	20,705,943	$ 9.98	$ 677,731,681	$ 681,238,780
4	100,000,000	$ 7.00	$ 3.50	19	219	341	1,200,520	10	12,005,197	7,018,188	87,994,803	20,705,943	$ 9.98	$ 671,718,586	$ 678,736,774
5	100,000,000	$ 9.98	$ 4.99	28	228	367	1,293,241	10	12,932,405	14,636,533	87,067,595	20,705,943	$ 9.98	$ 662,462,621	$ 677,099,154
6	100,000,000	$ 19.97	$ 9.98	50	250	443	1,559,641	10	15,596,413	55,866,822	84,403,587	20,705,943	$ 9.98	$ 635,868,865	$ 691,735,687
7	100,000,000	$ 130.32	$ 65.16	362	562	2,252	7,929,406	10	79,294,057	4,515,078,696	20,705,943	20,705,943	$ 9.98	$ -	$ 4,515,078,696

Sources and Notes:

\1 US EPA Office of Solid Waste indicated that the total tonnage of chat at the four sites is approximately 100,000,000 tons

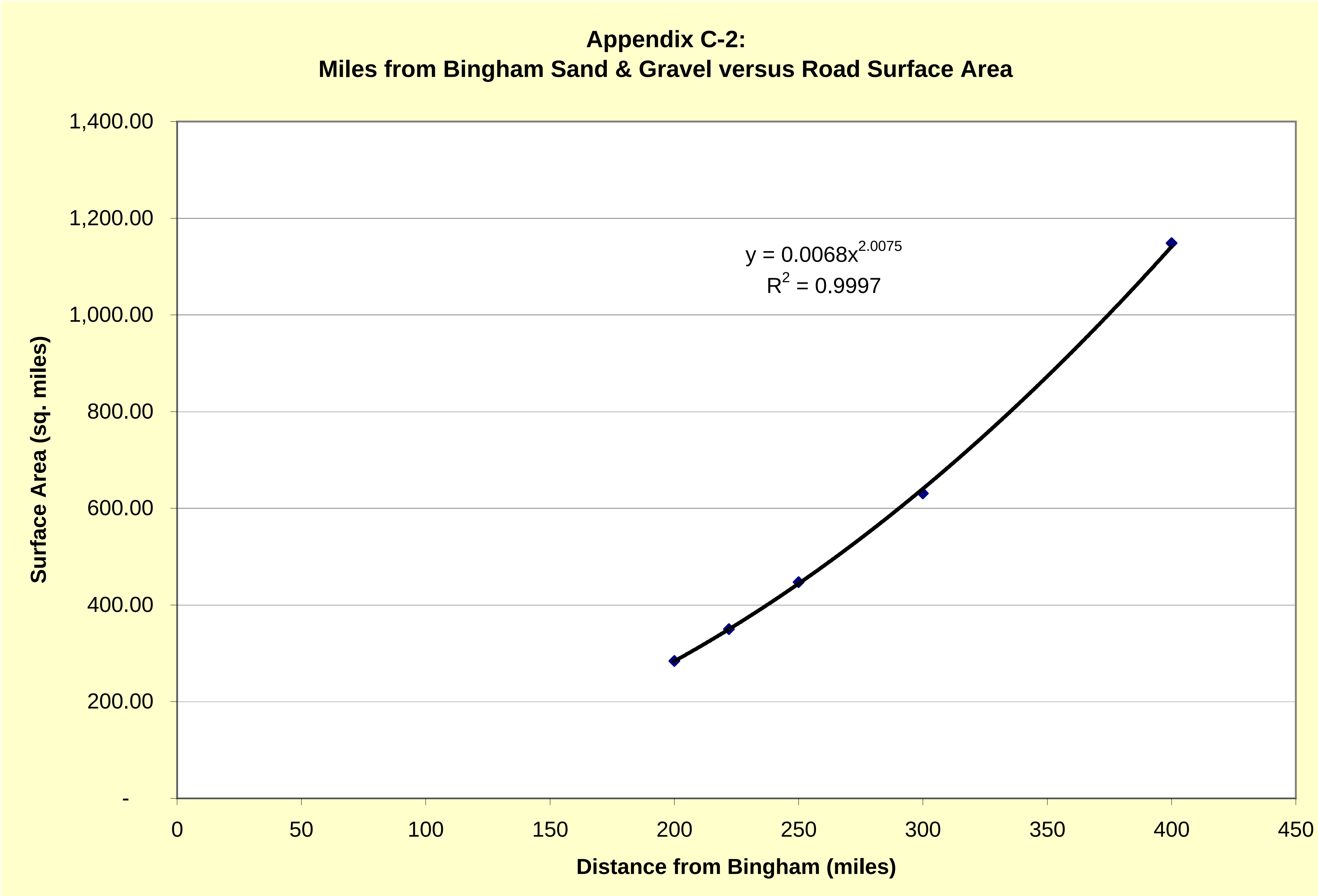
\2 In option 7, to estimate the unit transportation cost necessary to carry the chat far enough to cover 1,126 square miles of road (the surface area of road necessary to fuel sufficient demand, assuming a constant ratio of surface area to chat quantity used for transportation, to consume all 100 million tons of chat within 20 years, we: 1) plotted total radius from Bingham Sand & Gravel against total surface area of roads, based on GIS analysis, 2) calculated a best-fit trendline, and 3) extrapolated. See Appendix B-3 for details.

\3 Additional mileage is estimated by dividing the maximun tranport cost by the unit hauling cost of chat ($0.36/ ton mile). This cost was provided by Mark Doolan of US EPA.

\4 For option one, total road surface area is based on GIS analysis outputs. For options 2 to 6, total road surface area based on assumption of the following relationship: total surface area = 0.0068*(radius from Bingham)^2.0075. The equation was derived from trendline imposed on five data points from the GIS analysis. Radii were set to a constant to calculate total road surface area. For example, in option five, the radius from Bingham is set to 228 miles, based on $9.98 unit transportation cost. $9.98 is the unit cost of disposal for remediation option 1. See Appendix C-2 for details on the equation and Appendix A-1 for details on remediation option 1. For option seven, total road surface area based on assumption of a constant ratio between total road surface area and chat quantity used for transportation per year (i.e., 284 mi^2 to 1 million tons per year). Quantity used for transportation per year is set, in option five, to 3,964,703 tons per year, the rate of chat consumption necessary to consume all below action threshold chat on all four Superfund sites, assuming no Superfund remediation disposal. See Appendix C-3 for details on current demand.

\5 We assume 20 percent (based on personal communication with Mark Doolan (EPA) in October, 2005) of total chat falls below the action threshold for Superfund remediation and can be left on-site as is.

\6 Total costs to EPA include (a) disposal costs associated with remediating chat (above the action threshold) that remains after 20 years, assuming realization of all potential demand within the relevant mileage away from Bingham and (b) transportation costs associated with transporting chat beyond the 200 mile radius away from Bingham. In addition, we assume any road growth experienced by both current and potential demand will be equivalent and likely considerably lower than two percent per year, as discussed with John D'Angelo (USDOT) in October, 2005.



Appendix C-2:
Miles from Bingham Sand & Gravel versus Road Surface Area
y = 0.0068x^2.0075
R^2 = 0.9997
Surface Area (sq. miles)
1,400.00
1,200.00
1,000.00
800.00
600.00
400.00
200.00
-
0
50
100
150
200
250
300
350
400
450
Distance from Bingham (miles)

008325

Appendix C-3.a:

Remediation Option 2: Chat Consolidation, In-Place Containment, and Revegetation
Breakeven Cost Analysis - Current Market Scenario - 20 YEAR DISPOSAL PERIOD

Option	Current quantity of chat at all sites (tons) \1	Maximum unit transport-ation cost ($/ton mile)	Average unit transport-ation cost ($/ton mile)	Add-itional mileage (miles) \2	Radius from Bingham Sand & Gravel (miles) \3	Total road surface area - GIS analysis (sq mi) \4	Chat quantity used for transportation per year (tons/year)	Time frame (years)	Total chat used for transport-ation (tons)	Total Transport-ation Cost to EPA ($)	Total chat not used for transport (tons)	Total chat left on-site (tons) \5	Disposal cost ($/ton)	Total disposal cost ($)	Total cost to EPA ($) \6
1	100,000,000	$ -	$ -	0	200	284	1,000,000	20	20,000,000	-	80,000,000	24,797,294	$ 25.01	$ 1,380,828,629	$ 1,380,828,629
2	100,000,000	$ 10.00	$ 5.00	28	228	367	1,293,791	20	25,875,825	29,379,123	74,124,175	24,797,294	$ 25.01	$ 1,233,852,014	$ 1,263,231,137
3	100,000,000	$ 20.00	$ 10.00	56	256	463	1,629,998	20	32,599,951	125,999,515	67,400,049	24,797,294	$ 25.01	$ 1,065,656,150	$ 1,191,655,665
4	100,000,000	$ 25.01	$ 12.51	69	269	515	1,813,222	20	36,264,445	203,417,671	63,735,555	24,797,294	$ 25.01	$ 973,993,286	$ 1,177,410,957
5	100,000,000	$ 50.03	$ 25.01	139	339	816	2,873,739	20	57,474,771	937,385,879	42,525,229	24,797,294	$ 25.01	$ 443,442,749	$ 1,380,828,629
6	100,000,000	$ 67.51	$ 33.76	187.54	388	1,068	3,760,135	20	75,202,706	1,863,479,358	24,797,294	24,797,294	$ 25.01	$ -	$ 1,863,479,358

<u>Sources and Notes:</u>

\1 US EPA Office of Solid Waste indicated that the total tonnage of chat at the four sites is approximately 100,000,000 tons

\2 Additional mileage is estimated by dividing the maximun tranport cost by the unit hauling cost of chat ($0.36/ ton mile). This cost was provided by Mark Doolan of US EPA.

\3 In option six, to estimate the unit transportation cost necessary to carry the chat far enough to cover 1,068 square miles of road (the surface area of road necessary to fuel sufficient demand, assuming a constant ratio of surface area to chat quantity used for transportation, to consume all 100 million tons of chat within 20 years), we: 1) plotted total radius from Bingham Sand & Gravel against total surface area of roads, based on GIS analysis, 2) calculated a best-fit trendline, and 3) extrapolated. See Appendix C-2 for details.

\4 For option one, total road surface area is based on a GIS analysis output. For options two through five, total road surface area is based on an assumption of the following relationship: total surface area = 0.0068*(radius from Bingham)^2.0075. The equation was derived from trendline imposed on five data points from the GIS analysis. R^2 value was 0.9997. Radius from Bingham is set to a constant value. For example, in option five, the radius from Bingham is set to 339 miles, based on the $25.01 unit transportation cost. $25.01 is the unit cost of disposal for remediation option 2. See Appendix B-3 for details on the equation and Appendix A-1 for details on remediation option 2. For option six, the total road surface area is based on an assumption of a constant ratio between total road surface area and chat quantity used for transportation per year (i.e., 284 mi^2 to 1 million tons per year). Quantity used for transportation per year is set, in option six, to 3,760,135 tons per year, the rate of chat consumption necessary to consume all below action threshold chat on all Tri-State sites, assuming no disposal.

\5 We assume 20 percent (based on personal communication with Mark Doolan (EPA) in October, 2005) of total chat falls below the action threshold for Superfund remediation and can be left on-site as is.

\6 Total costs to EPA include (a) disposal costs associated with remediating chat (above the action threshold) that remains after 20 years, assuming realization of all potential demand within the relevant mileage away from Bingham and (b) transportation costs associated with transporting chat beyond the 200 mile radius away from Bingham. In addition, we assume any road growth experienced by both current and potential demand will be equivalent and likely considerably lower than two percent per year, as discussed with John D'Angelo (USDOT) in October, 2005.

Appendix C-3.b:

Remediation Option 2: Chat Consolidation, In-Place Containment, and Revegetation
Breakeven Cost Analysis - Current Market Scenario - 10-YEAR DISPOSAL PERIOD

Option	Current quantity of chat at all sites (tons) \1	Maximum unit transport-ation cost ($/ton mile)	Average unit transport-ation cost ($/ton mile)	Add-itional mileage (miles) \2	Radius from Bingham Sand & Gravel (miles) \3	Total road surface area - GIS analysis (sq mi) \4	Chat quantity used for transportation per year (tons/year)	Time frame (years)	Total chat used for transport-ation (tons)	Total transportation off-set cost ($)	Total chat not used for transport (tons)	Total chat left on-site (tons) \5	Disposal cost ($/ton)	Total disposal cost ($)	Total cost to EPA ($) \6
1	100,000,000	$ -	$ -	0	200	284	1,000,000	10	10,000,000	$ -	90,000,000	24,797,294	$ 25.01	$ 1,630,966,480	$ 1,630,966,480
2	100,000,000	$ 10.00	$ 5.00	28	228	367	1,293,791	10	12,937,912	$ 14,689,562	87,062,088	24,797,294	$ 25.01	$ 1,557,478,172	$ 1,572,167,734
3	100,000,000	$ 20.00	$ 10.00	56	256	463	1,629,998	10	16,299,976	$ 62,999,757	83,700,024	24,797,294	$ 25.01	$ 1,473,380,240	$ 1,536,379,998
4	100,000,000	$ 25.01	$ 12.51	69	269	515	1,813,222	10	18,132,223	$ 101,708,836	81,867,777	24,797,294	$ 25.01	$ 1,427,548,809	$ 1,529,257,644
5	100,000,000	$ 50.03	$ 25.01	139	339	816	2,873,739	10	28,737,386	$ 468,692,940	71,262,614	24,797,294	$ 25.01	$ 1,162,273,540	$ 1,630,966,480
6	100,000,000	$ 125.05	$ 62.52	347.35	547	2,136	7,520,271	10	75,202,706	$ 4,076,713,524	24,797,294	24,797,294	$ 25.01	$ -	$ 4,076,713,524

Sources and Notes:

\1 US EPA Office of Solid Waste indicated that the total tonnage of chat at the four sites is approximately 100,000,000 tons

\2 Additional mileage is estimated by dividing the maximun tranport cost by the unit hauling cost of chat ($0.36/ ton mile). This cost was provided by Mark Doolan of US EPA.

\3 In option six, to estimate the unit transportation cost necessary to carry the chat far enough to cover 1,068 square miles of road (the surface area of road necessary to fuel sufficient demand, assuming a constant ratio of surface area to chat quantity used for transportation, to consume all 100 million tons of chat within 20 years), we: 1) plotted total radius from Bingham Sand & Gravel against total surface area of roads, based on GIS analysis, 2) calculated a best-fit trendline, and 3) extrapolated. See Appendix C-2 for details.

\4 For option one, total road surface area is based on a GIS analysis output. For options two through five, total road surface area is based on an assumption of the following relationship: total surface area = 0.0068*(radius from Bingham)^2.0075. The equation was derived from trendline imposed on five data points from the GIS analysis. R^2 value was 0.9997. Radius from Bingham is set to a constant value. For example, in option five, the radius from Bingham is set to 339 miles, based on the $25.01 unit transportation cost. $25.01 is the unit cost of disposal for remediation option 2. See Appendix B-3 for details on the equation and Appendix A-1 for details on remediation option 2. For option six, the total road surface area is based on an assumption of a constant ratio between total road surface area and chat quantity used for transportation per year (i.e., 284 mi^2 to 1 million tons per year). Quantity used for transportation per year is set, in option six, to 3,760,135 tons per year, the rate of chat consumption necessary to consume all below action threshold chat on all Tri-State sites, assuming no disposal.

\5 We assume 20 percent (based on personal communication with Mark Doolan (EPA) in October, 2005) of total chat falls below the action threshold for Superfund remediation and can be left on-site as is.

\6 Total costs to EPA include (a) disposal costs associated with remediating chat (above the action threshold) that remains after 20 years, assuming realization of all potential demand within the relevant mileage away from Bingham and (b) transportation costs associated with transporting chat beyond the 200 mile radius away from Bingham. In addition, we assume any road growth experienced by both current and potential demand will be equivalent and likely considerably lower than two percent per year, as discussed with John D'Angelo (USDOT) in October, 2005.

Appendix C-4.a:

Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits
Breakeven Cost Analysis - Expanded Chat Market Scenario - 20 YEAR DISPOSAL PERIOD

Option	Current tonnage on all Superfund sites (tons) \1	Maximum unit transportation cost ($/ton mile)	Average unit transportation cost ($/ton mile)	Additional mileage (miles) \2	Radius from Bingham Sand & Gravel (miles) \2	Total asphalt pavement on roads, based on GIS analysis (sq mi) \3	Potential chat demand (tons/year)	Time frame (years)	Total chat used for asphalt (tons) \4	Total transportation cost to EPA ($)	Total chat not used for transport (tons)	Total chat left on-site (tons) \5	Chat disposed by Superfund remediation (tons)	Disposal cost ($/ton) \6	Disposal cost ($)	Total cost to EPA ($) \7
1	100,000,000	$ -	$ -	0	200	284	1,952,858	20	39,057,156	-	60,942,844	20,705,943	40,236,901	$ 9.98	$ 401,669,369	$ 401,669,369
2	100,000,000	$ 2.00	$ 1.00	6	206	299	2,056,062	20	41,121,239	2,064,083	58,878,761	20,705,943	38,172,818	$ 9.98	$ 381,064,433	$ 383,128,515
3	100,000,000	$ 4.00	$ 2.00	11	211	315	2,169,136	20	43,382,722	8,651,132	56,617,278	20,705,943	35,911,335	$ 9.98	$ 358,488,922	$ 367,140,054
2	100,000,000	$ 4.50	$ 2.25	13	213	320	2,197,879	20	43,957,587	11,025,969	56,042,413	20,705,943	35,336,470	$ 9.98	$ 352,750,270	$ 363,776,239
2	100,000,000	$ 4.75	$ 2.38	13	213	322	2,212,322	20	44,246,444	12,324,558	55,753,556	20,705,943	35,047,613	$ 9.98	$ 349,866,726	$ 362,191,284
4	100,000,000	$ 8.00	$ 4.00	22	222	350	2,404,400	20	48,087,994	36,123,352	51,912,006	20,705,943	31,206,063	$ 9.98	$ 311,518,018	$ 347,641,369
5	100,000,000	$ 9.98	$ 4.99	28	228	367	2,525,515	20	50,510,298	57,166,134	49,489,702	20,705,943	28,783,759	$ 9.98	$ 287,337,100	$ 344,503,235
6	100,000,000	$ 19.97	$ 9.98	55	255	463	3,180,738	20	63,614,769	245,149,125	36,385,231	20,705,943	15,679,287	$ 9.98	$ 156,520,244	$ 401,669,369
7	100,000,000	$ 30.63	$ 15.32	85	285	577	3,964,703	20	79,294,057	616,281,537	20,705,943	20,705,943	-	$ 9.98	$ (0)	$ 616,281,537

Sources and Notes:

\1 US EPA Office of Solid Waste indicated that the total tonnage of chat at the four sites is approximately 100,000,000 tons

\2 Additional mileage is estimated by dividing the maximun tranport cost by the unit hauling cost of chat ($0.36/ ton mile). This cost was provided by Mark Doolan of US EPA.
Option seven's additional and total mileage were based on the following equation: total mileage (set at 226 miles) is equal to 0.0068*(total asphalt pavement^2.0075). This equation was derived from a trendline imposed on 5 data points from the GIS analysis. The R^2 value is 0.9997. See Appendix C-2.
\3 Total asphalt pavement on roads for option 1 is a direct output from the GIS analysis. For options two through six, total asphalt pavement was calculated based on the following equation: total mileage (set at 226 miles) is equal to 0.0068*(total asphalt pavement^2.0075). This equation was derived f trendline imposed on 5 data points from the GIS analysis. The R^2 value is 0.9997. See Appendix C-2 for details. For option seven, total asphalt pavement was calculated based on the following equation: chat demand under expanded market scenario= 6875.8(total asphalt pavement) - 3E-09. This equatio was derived from a trendline imposed on 5 data points from the GIS analysis.The R^2 value is 1. See Appendix C-5.
\4 We assume that any road growth experienced by both current and potential demand will be equivalent and likely considerably lower than two percent per year, as discussed with John D'Angelo (USDOT) in October, 2005.
\5 We assume 21 percent based on Jasper County ROD (See Appendix B-2).
\6 Unit disposal costs based on remediation option 1. See Appendix B-1.
\7 Total costs to EPA include (a) disposal costs associated with remediating chat (above the action threshold) that remains after 20 years, assuming realization of all potential demand within the relevant mileage away from Bingham and (b) transportation costs associated with transporting chat beyond th mile radius away from Bingham.

Appendix C-4.b:

Remediation Option 1: Chat Removal and Disposal in On-Site Subsidence Pits
Breakeven Cost Analysis - Expanded Chat Market Scenario - 10-YEAR REMEDIATION PERIOD

Option	Current tonnage on all Superfund sites (tons) \1	Maximum unit transportation cost ($/ton mile)	Average unit transportation cost ($/ton mile)	Additional mileage (miles) \2	Radius from Bingham Sand & Gravel (miles) \2	Total asphalt pavement on roads, based on GIS analysis (sq mi) \3	Potential chat demand (tons/year)	Time frame (years)	Total chat used for asphalt (tons) \4	Total transportation off-set cost ($)	Total chat not used for transport (tons)	Total chat left on-site (tons) \5	Chat disposed by Superfund remediation (tons)	Disposal cost ($/ton) \6	Disposal cost ($)	Total cost to EPA ($) \7
1	100,000,000	$ -	$ -	0	200	284	1,952,858	10	19,528,578	$ -	80,471,422	20,705,943	59,765,479	$ 9.98	$ 596,615,588	$ 596,615,588
2	100,000,000	$ 2.00	$ 1.00	6	206	299	2,056,062	10	20,560,619	$ 1,032,041	79,439,381	20,705,943	58,733,437	$ 9.98	$ 586,313,120	$ 587,345,161
3	100,000,000	$ 4.00	$ 2.00	11	211	315	2,169,136	10	21,691,361	$ 4,325,566	78,308,639	20,705,943	57,602,696	$ 9.98	$ 575,025,365	$ 579,350,931
2	100,000,000	$ 4.50	$ 2.25	13	213	320	2,197,879	10	21,978,794	$ 5,512,985	78,021,206	20,705,943	57,315,263	$ 9.98	$ 572,156,039	$ 577,669,023
2	100,000,000	$ 4.75	$ 2.38	13	213	322	2,212,322	10	22,123,222	$ 6,162,279	77,876,778	20,705,943	57,170,835	$ 9.98	$ 570,714,267	$ 576,876,546
4	100,000,000	$ 8.00	$ 4.00	22	222	350	2,404,400	10	24,043,997	$ 18,061,676	75,956,003	20,705,943	55,250,060	$ 9.98	$ 551,539,912	$ 569,601,588
5	100,000,000	$ 9.98	$ 4.99	28	228	367	2,525,515	10	25,255,149	$ 28,583,067	74,744,851	20,705,943	54,038,908	$ 9.98	$ 539,449,454	$ 568,032,521
6	100,000,000	$ 19.97	$ 9.98	55	255	463	3,180,738	10	31,807,385	$ 122,574,563	68,192,615	20,705,943	47,486,672	$ 9.98	$ 474,041,026	$ 596,615,588
7	100,000,000	$ 72.96	$ 36.48	203	403	1,153	7,929,406	10	79,294,057	$ 2,180,145,486	20,705,943	20,705,943	-	$ 9.98	$ (0)	$ 2,180,145,486

Sources and Notes:

\1 US EPA Office of Solid Waste indicated that the total tonnage of chat at the four sites is approximately 100,000,000 tons

\2 Additional mileage is estimated by dividing the maximun tranport cost by the unit hauling cost of chat ($0.36/ ton mile). This cost was provided by Mark Doolan of US EPA.
Option seven's additional and total mileage were based on the following equation: total mileage (set at 226 miles) is equal to 0.0068*(total asphalt pavement^2.0075). This equation was derived from a trendline imposed on 5 data points from the GIS analysis. The R^2 value is 0.9997. See Appendix C-2.

\3 Total asphalt pavement on roads for option 1 is a direct output from the GIS analysis. For options two through six, total asphalt pavement was calculated based on the following equation: total mileage (set at 226 miles) is equal to 0.0068*(total asphalt pavement^2.0075). This equation was derived fı trendline imposed on 5 data points from the GIS analysis. The R^2 value is 0.9997. See Appendix C-2 for details. For option seven, total asphalt pavement was calculated based on the following equation: chat demand under expanded market scenario= 6875.8(total asphalt pavement) - 3E-09. This equation was derived from a trendline imposed on 5 data points from the GIS analysis.The R^2 value is 1. See Appendix C-5.

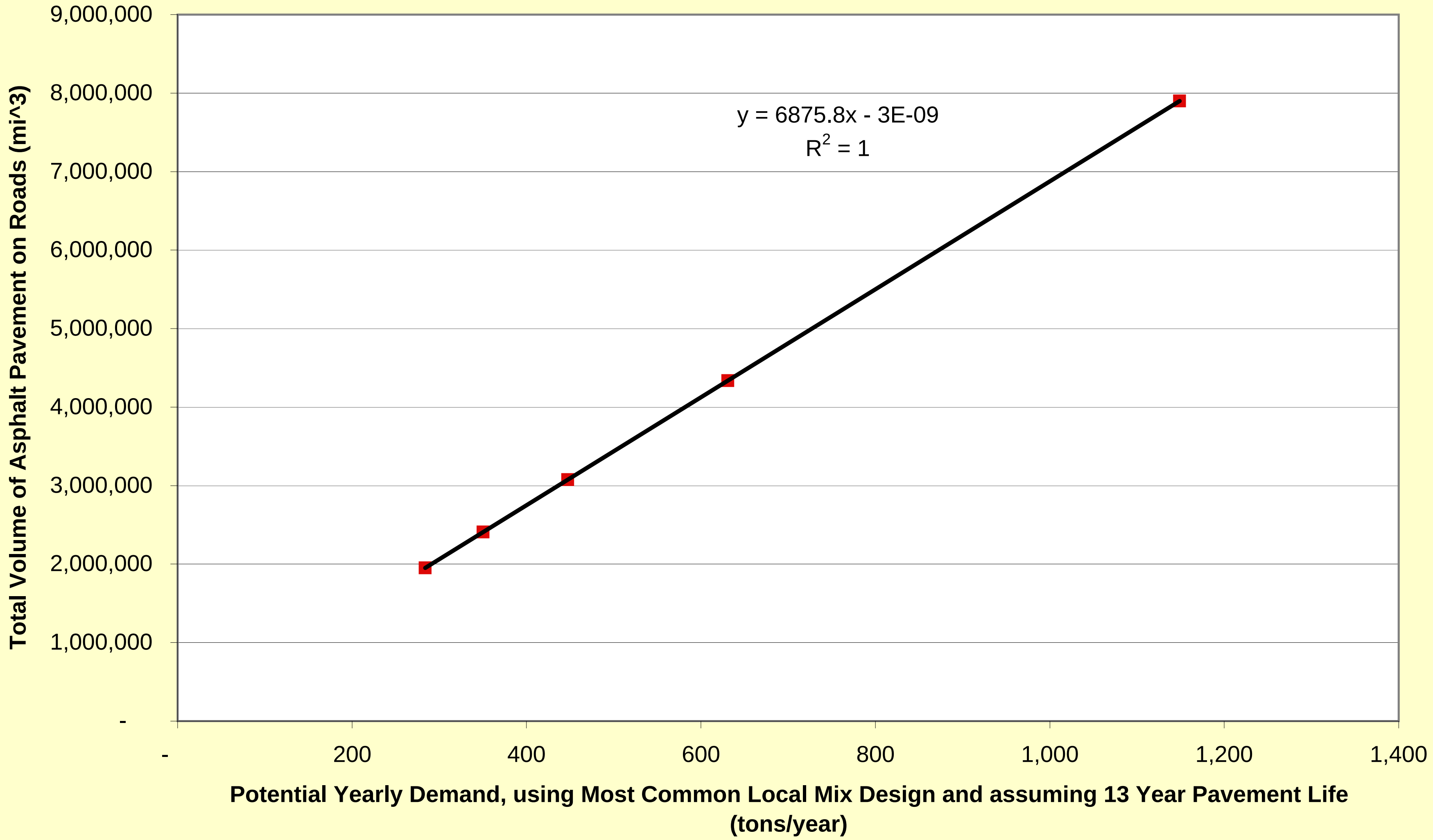
\4 We assume that any road growth experienced by both current and potential demand will be equivalent and likely considerably lower than two percent per year, as discussed with John D'Angelo (USDOT) in October, 2005.

\5 We assume 21 percent based on Jasper County ROD (See Appendix B-2).

\6 Unit disposal costs based on remediation option 1. See Appendix B-1.

\7 Total costs to EPA include (a) disposal costs associated with remediating chat (above the action threshold) that remains after 20 years, assuming realization of all potential demand within the relevant mileage away from Bingham and (b) transportation costs associated with transporting chat beyond th mile radius away from Bingham.

Appendix C-5
Potential Demand Per Year versus Total Volume of Asphalt on Roads



Appendix C-6.a:

Remediation Option 2: Chat Consolidation, In-Place Containment, and Revegetation
Breakeven Cost Analysis - Expanded Chat Market Scenario - 20 YEAR DISPOSAL PERIOD

Option	Current tonnage on all Superfund sites (tons) \1	Maximum unit transportation cost ($/ton mile)	Average unit transportation cost ($/ton mile)	Additional mileage (miles) \2	Radius from Bingham Sand & Gravel (miles) \2	Total asphalt pavement on roads, based on GIS analysis (sq mi) \3	Potential chat demand (tons/year)	Time frame (years)	Total chat used for asphalt (tons) \4	Total transportation cost to EPA ($)	Total chat not used for transport (tons)	Total chat left on-site (tons) \5	Chat disposed by Superfund remediation (tons)	Disposal cost ($/ton) \6	Disposal cost ($)	Total cost to EPA ($) \7
1	100,000,000	$ -	$ -	0	200	284	1,952,858	20	39,057,156	-	60,942,844	24,797,294	36,145,550	$ 25.01	$ 904,137,018	$ 904,137,018
2	100,000,000	$ 5.00	$ 2.50	14	214	324	2,226,812	20	44,536,250	13,697,734	55,463,750	24,797,294	30,666,456	$ 25.01	$ 767,084,149	$ 780,781,883
3	100,000,000	$ 10.00	$ 5.00	28	228	367	2,526,590	20	50,531,806	57,373,250	49,468,194	24,797,294	24,670,900	$ 25.01	$ 617,112,589	$ 674,485,839
4	100,000,000	$ 25.01	$ 12.51	69	269	515	3,540,965	20	70,819,305	397,245,788	29,180,695	24,797,294	4,383,401	$ 25.01	$ 109,645,443	$ 506,891,231
5	100,000,000	$ 27.96	$ 13.98	78	278	547	3,760,135	20	75,202,706	505,309,407	24,797,294	24,797,294	-	$ 25.01	$ -	$ 505,309,407
6	100,000,000	$ 30.63	$ 15.32	85	285	577	3,964,703	20	79,294,057	616,281,537	20,705,943	20,705,943	-	$ 25.01	$ (0)	$ 616,281,537

Sources and Notes:

\1 US EPA Office of Solid Waste indicated that the total tonnage of chat at the four sites is approximately 100,000,000 ton

\2 Additional mileage is estimated by dividing the maximun tranport cost by the unit hauling cost of chat ($0.36/ ton mile). This cost was provided by Mark Doolan of US EPA.

Option seven's additional and total mileage were based on the following equation: total mileage is equal to 0.0068*(total asphalt pavement^2.0075). This equation was derived from a trendline imposed on 5 data points from the GIS analysis. The R^2 value is 0.9997. See Appendix C-2.

\3 Total asphalt pavement on roads values in option one is a direct output from the GIS analysis. For options two through four, total asphalt pavement was calculated based on the following equation: total mileage is equal to 0.0068*(total asphalt pavement^2.0075). This equation was derived from a trendl imposed on 5 data points from the GIS analysis. See Appendix C-2 for details. For options five and six, total asphalt pavement was calculated based on the following equation: potential chat demand = 6875.8(total asphalt pavement) - 3E-09. This equation was derived from a trendline imposed on 5 data points from the GIS analysis. See Appendix C-5 for details.

\4 We assume that any road growth experienced by both current and potential demand will be equivalent and likely considerably lower than two percent per year, as discussed with John D'Angelo (USDOT) in October, 2005.

\5 We assume 20 percent (based on personal communication with Mark Doolan (EPA) in October, 2005) of total chat falls below the action threshold for Superfund remediation and can be left on-site as is.

\6 Disposal cost per ton based on scenario 1 disposal costs. See Appendix A-1.

\7 Total costs to EPA include (a) disposal costs associated with remediating chat (above the action threshold) that remains after 20 years, assuming realization of all potential demand within the relevant mileage away from Bingham and (b) transportation costs associated with transporting chat beyond the mile radius away from Bingham.

Appendix C-6.b:

Remediation Option 2: Chat Consolidation, In-Place Containment, and Revegetation
Breakeven Cost Analysis - Expanded Chat Market Scenario - 10-YEAR DISPOSAL PERIOD

Option	Current tonnage on all Superfund sites (tons) \1	Maximum unit transportation cost ($/ton mile)	Average unit transportation cost ($/ton mile)	Additional mileage (miles) \2	Radius from Bingham Sand & Gravel (miles) \2	Total asphalt pavement on roads, based on GIS analysis (sq mi) \3	Potential chat demand (tons/year)	Time frame (years)	Total chat used for asphalt (tons) \4	Total transportation off-set cost ($)	Total chat not used for transport (tons)	Total chat left on-site (tons) \5	Chat disposed by Superfund remediation (tons)	Disposal cost ($/ton) \6	Disposal cost ($)	Total cost to EPA ($) \7
1	100,000,000	$ -	$ -	0	200	284	1,952,858	10	19,528,578	$ -	80,471,422	24,797,294	55,674,128	$ 25.01	$ 1,392,620,675	$ 1,392,620,675
2	100,000,000	$ 5.00	$ 2.50	14	214	324	2,226,812	10	22,268,125	$ 6,848,867	77,731,875	24,797,294	52,934,581	$ 25.01	$ 1,324,094,240	$ 1,330,943,107
3	100,000,000	$ 10.00	$ 5.00	28	228	367	2,526,590	10	25,265,903	$ 28,686,625	74,734,097	24,797,294	49,936,803	$ 25.01	$ 1,249,108,460	$ 1,277,795,085
4	100,000,000	$ 25.01	$ 12.51	69	269	515	3,540,965	10	35,409,653	$ 198,622,894	64,590,347	24,797,294	39,793,053	$ 25.01	$ 995,374,887	$ 1,193,997,781
5	100,000,000	$ 69.18	$ 34.59	192	392	1,094	7,520,271	10	75,202,706	$ 1,925,808,372	24,797,294	24,797,294	-	$ 25.01	$ -	$ 1,925,808,372
6	100,000,000	$ 72.96	$ 36.48	203	403	1,153	7,929,406	10	79,294,057	$ 2,180,145,486	20,705,943	20,705,943	-	$ 25.01	$ (0)	$ 2,180,145,486

Sources and Notes:

\1 US EPA Office of Solid Waste indicated that the total tonnage of chat at the four sites is approximately 100,000,000 tons

\2 Additional mileage is estimated by dividing the maximun tranport cost by the unit hauling cost of chat ($0.36/ ton mile). This cost was provided by Mark Doolan of US EPA.
Option seven's additional and total mileage were based on the following equation: total mileage is equal to 0.0068*(total asphalt pavement^2.0075). This equation was derived from a trendline imposed on 5 data points from the GIS analysis. The R^2 value is 0.9997. See Appendix C-2.

\3 Total asphalt pavement on roads values in option one is a direct output from the GIS analysis. For options two through four, total asphalt pavement was calculated based on the following equation: total mileage is equal to 0.0068*(total asphalt pavement^2.0075). This equation was derived from a trendline impo 5 data points from the GIS analysis. See Appendix C-2 for details. For options five and six, total asphalt pavement was calculated based on the following equation: potential chat demand = 6875.8(total asphalt pavement) - 3E-09. This equation was derived from a trendline imposed on 5 data points from the GIS analysis. See Appendix C-5 for details.

\4 We assume that any road growth experienced by both current and potential demand will be equivalent and likely considerably lower than two percent per year, as discussed with John D'Angelo (USDOT) in October, 2005.

\5 We assume 20 percent (based on personal communication with Mark Doolan (EPA) in October, 2005) of total chat falls below the action threshold for Superfund remediation and can be left on-site as is.

\6 Disposal cost per ton based on scenario 1 disposal costs. See Appendix A-1.

\7 Total costs to EPA include (a) disposal costs associated with remediating chat (above the action threshold) that remains after 20 years, assuming realization of all potential demand within the relevant mileage away from Bingham and (b) transportation costs associated with transporting chat beyond the 200 mile away from Bingham.

Appendix D-1:

Current Market Scenario

[1]	[2]				[3]=SUM[2]*5280	[4]	[5]=[4]/27,878,400	[6]=(1,000,000*284)*[5]
Radius from Bingham Sand & Gravel (miles)	**Total Length by Road Category (miles) : ESRI GIS Analysis**							
	Major Highway	**Major Highway Connector**	**Highway**	**Major Road**	**Total Length (ft)**	**Total Surface Area (ft^2) \1**	**Total Surface Area (mi^2)**	**Chat Quantity Used for Transportation per Year (tons/year) \2**
200	2,361	274	6,548	21,676	162,937,528	7,918,019,972	284.02	1,000,000
222	2,723	300	7,972	27,222	201,782,802	9,766,613,241	350.33	1,233,467
250	3,313	373	9,861	35,441	258,659,017	12,472,955,792	447.41	1,575,262
300	4,163	468	14,242	50,421	365,865,787	17,587,207,616	630.85	2,221,162
400	7,917	712	26,128	91,256	665,344,257	32,024,043,982	1,148.70	4,044,451

Source:

1. Total length by road category based on ESRI StreetMap USA (2005 version)
2. Road width assumptions for calculating road surface areas based on personal communication with John D'Angelo (USDOT) in October, 2005.
3. Chat quantity used for transportation per year based on discussion with US EPA Office of Solid Waste in October, 2005.

Notes:

\1 For road surface area calculations, we assume major highways, major highway connectors, highways, and major roads are 68, 68, 56, and 44 feet wide, respectively. Assumptions based on personal communication (October, 2005) with John D'Angelo (USDOT). See Appendix D-3a for details.

\2 US EPA Office of Solid Waste estimated that approximately 1 million tons of chat (from all four Superfund sites) are used in transportation construction per year. We assume that the ratio between amount of chat consumed and amount of road surface area (within a certain radius from Bingham Sand & Gravel) remains constant. In addition, we assume any road growth experienced by both current and potential demand will be equivalent and likely considerably lower than two percent per year, as discussed with John D'Angelo (USDOT) in October, 2005.

Appendix D-2:

Expanded Chat Market Scenario

[1]	[2]				[3]=SUM[2]*5280	[4]		[5]	[6]	[7]=[5]*[6]*Percent of Chat Each Mix Design				
	Total Length (miles) by Road Category ESRI GIS Analysis \2									Total Chat Used for Asphalt Pavement by Mix Design Over a 12 to 15 year Period (short tons) \6				
Radius from Bingham Sand & Gravel (miles) \1	Major Highway	Major Highway Connector	Highway	Major Road	Total Length (ft)	Total Surface Area (ft^2) \3	Total Surface Area (mi^2) \3	Total Volume of Asphalt Pavement on Roads (ft^3) \4	National Percent of Roads Paved by Asphalt (versus concrete roads) \5	U.Oklahoma Study: SM40	U.Oklahoma Study: SM60	U.Oklahoma Study: SM80	Most Common Local Mix Design	Potential Yearly Demand, using Most Common Local Mix Design and assuming 13 Year Pavement Life (tons/year) \7
200	2,361	274	6,548	21,676	162,937,528	7,918,019,972	284	1,979,504,993	90%	50,774,303	76,161,455	101,548,606	25,387,152	1,952,858
222	2,723	300	7,972	27,222	201,782,802	9,766,613,241	350	2,441,653,310	90%	62,628,407	93,942,611	125,256,815	31,314,204	2,408,785
250	3,313	373	9,861	35,441	258,659,017	12,472,955,792	447	3,118,238,948	90%	79,982,829	119,974,244	159,965,658	39,991,415	3,076,263
300	4,163	468	14,242	50,421	365,865,787	17,587,207,616	631	4,396,801,904	90%	112,777,969	169,166,953	225,555,938	56,388,984	4,337,614
400	7,917	712	26,128	91,256	665,344,257	32,024,043,982	1,149	8,006,010,995	90%	205,354,182	308,031,273	410,708,364	102,677,091	7,898,238

Sources:

1. Total length by road category based on ESRI Streetmap USA (2005 Version)
2. Total surface area based on width assumptions discussed with John D'Angelo (USDOT) in October, 2005.
3. Total volume of asphalt pavement on roads based on pavement thickness assumptions discussed with John D'Angelo (USDOT) in October, 2005.
4. National percent of roads paved by asphalt based on assumptions discussed with John D'Angelo (USDOT) in October, 2005.

5. SM40, SM60, and SM80 Hot Asphalt Mix Designs based on Zaman, M. and Nairn, R. "Univeristy of Oklahoma, A Laboratory Study to Optimize the Use of Raw Chat in Hot Mix Asphalt for Pavement Applications: Final Report" Oklahoma Department of Environmental Quality. July 2004.
6. Most common local mix design based on personal communication with Mr. Richard Adams (Flint Rock, manager) in October, 2005.
7. Typical life of asphaly pavement based on conversation with John D'Angelo (USDOT) in October, 2005

Notes

\1 Bingham Sand and Gravel is one of the major chat processing companies in the Tri-State area and is located near Treece, KS. As such, we use distance from Bingham Sand and Gravel's chat washing facility as the point from which each radii extends for our GIS analysis of road lengths.
\2 ESRI road categories based on StreetMap USA (2005 version) class route numbers 0, 1, 2, 3, and 4.
\3 For road surface area calculations, we assume major highways, major highway connectors, highways, and major roads are 68, 68, 56, and 44 feet wide, respectively. Assumptions based on personal communication (October, 2005) with John D'Angelo (USDOT). See Appendix D-3 for details.
\4 For asphalt pavement volume calculations, we assume all asphalt pavements are 3 inches thick, regardless of road category. Assumption based on personal communication with John D'Angelo (USDOT) in October, 2005. See Appendix D-3b for details.
\5 Since not all roads are paved with asphalt, we decreased the total chat used for asphalt pavement by 10 percent, according to an assumption that 90 percent of roads are paved with asphalt and 10 percent are not. This ratio is a national average and based on personal communication with John D'Angelo (USDOT) in October, 2005.
\6 Because the amount of chat used as aggregate in hot mix asphalt paving jobs depends on the mix design, we provide a range of total chat estimates, based on four different mix designs. The first three (from left to right) mix designs are based on a study by the University of Oklahoma, while the last mix design is based on personal communication with Richard Adams, Flint Rock manager. See Appendix D-3 for details.
\7 Typical life of asphalt pavement is 12 to 15 years, based on conversation with John D'Angelo (USDOT) in October, 2005.

Appendix D-3a:

Geometric Assumptions

CLASS_RTE	ESRI Description	Lane Width (ft)	Shoulder Width (ft)	No. Lanes	No. Shoulders	Total Width (ft)	Total Depth of Asphalt Pavement (in)	Total Depth of Asphalt Pavement (ft)
0	Major Highway	12	10	4	2	68	3	0.25
1	Major Highway Connector	12	10	4	2	68	3	0.25
2	Highway	12	10	3	2	56	3	0.25
3	Major Road	12	10	2	2	44	3	0.25

Source:
1. All geometric assumptions based on personal communications (October, 2005) with John D'Angelo (USDOT).

Appendix D-3b:

Mix Design Assumptions

Design	Chat (percent, by weight, of hot mix asphalt)	Percent, by Weight, of Aggregate in Hot Mix Asphalt	Amount of Hot Mix Asphalt per Volume of Road Pavement (lbs/ft^3)	Amount of Chat (tons/ft^3)
SM40	40%	95%	150	0.02850
SM60	60%	95%	150	0.04275
SM80	80%	95%	150	0.05700
Most common	20%	95%	150	0.01425

Sources:
1. Design SM40, SM60, SM80 from Zaman, M. and Nairn, R. "Univeristy of Oklahoma, A Laboratory Study to Optimize the Use of Raw Chat in Hot Mix Asphalt for Pavement Applications: Final Report" Oklahoma Department of Environmental Quality. July 2004.
2. Most common design based on personal communication (October, 2005) with Richard Adams (Flint Rock Manager).
3. Percent, by weight, of aggregate in hot mix asphalt based on personal communication (October, 2005) with John D'Angelo (USDOT).
4. Amount of hot mix asphalt required per volume of raod pavement based on personal communication (October, 2005) with John D'Angelo (USDOT).