environmental
properties management, LLC

June 4, 2020

Mr. Ken Kalman
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Mr. Paul Davis
Oklahoma Department of Environmental Quality
707 North Robinson
Oklahoma City, OK 73101

Mr. Robert Evans
U.S. Nuclear Regulatory Commission
1600 East Lamar Blvd; Suite 400
Arlington, TX 76011-4511

Re: Docket No. 70-925; License No. SNM-928
May 19, 2020 Presentation on Decommissioning Strategies to Address Biomass Disposal

Dear Sirs:

Solely as Trustee for the Cimarron Environmental Response Trust (CERT), Environmental Properties Management LLC (EPM) submits herein a summary of the May 19, 2020 virtual meeting in which EPM presented alternate approaches to the processing and disposal of biomass. The meeting was conducted with US Nuclear Regulatory Commission (NRC), Oklahoma Department of Environmental Quality (DEQ), and EPM personnel.

The meeting was conducted to discuss:

1. The impact to the cost of processing and waste disposal should biosolids generated during biodenitrification (referred to herein as biomass) contain detectable concentrations of uranium or Tc-99.
2. Alternative approaches to the processing and disposal of biomass and the regulatory considerations and cost savings that the implementation of each approach would entail.
3. A revised range of magnitude (ROM) of potential costs for several alternative approaches based on updated schedule, regulatory agency fee, and biomass processing and disposal costs.

The evaluation of alternative approaches was needed because of the potential for significant additional costs related to the disposing of biomass at a licensed facility if Tc-99 is found to be present. In addition, changes to the schedule to achieve decommissioning plan approval and an increase in projected regulatory agency fees required a re-evaluation of the cost to achieve license termination with or without the added cost of processing and disposing of biomass at a licensed facility.

The presentation demonstrated that without compression of schedule and relief in regulatory fees, additional funding will be required to achieve license termination even if all biomass can be disposed of locally as non-hazardous industrial waste. It also demonstrated that if biomass contains detectable Tc-99 an economical approach that enables the disposition of biomass as non-hazardous industrial waste, while maintaining compliance with regulatory requirements, must be identified so that design and plans for processing the biomass can be developed.

The PowerPoint slides which EPM presented during the meeting are included as Attachment 1 to this letter. Notes documenting the discussions conducted during the presentation are included as Attachment 2. Attachment 3 contains preliminary calculations of the concentration factor for Tc-99 (the factor by which the concentration of Tc-99 in influent to the biodenitrification system is increased in the biomass).

If you have questions or desire clarification, please contact me at jlux@envpm.com or at 405-642-5152.

Sincerely,

Jeff Lux

Jeff Lux, P.E.
Trustee Project Manager

Attachments

cc: NRC Public Document Room (electronic copy only)

ATTACHMENT 1
PRESENTATION OF DECOMMISSIONING STRATEGIES TO ADDRESS BIOMASS DISPOSAL
MAY 19, 2020

DECOMMISSIONING STRATEGIES TO ADDRESS BIOMASS DISPOSAL

CIMARRON ENVIRONMENTAL RESPONSE TRUST

MAY 2020

Tc-99 IN BIOMASS

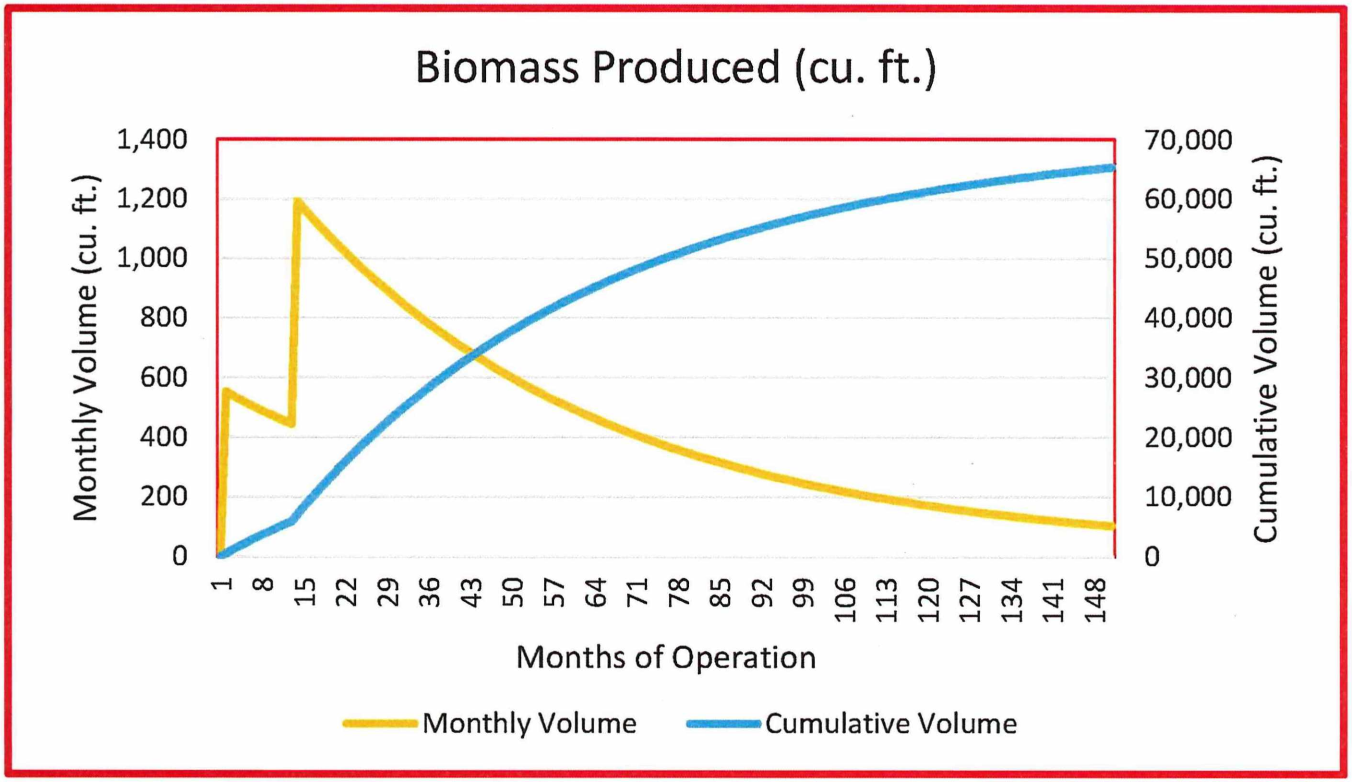
- Tc-99 in biomass may render it ineligible for disposal as industrial waste in Oklahoma.

- We cannot be certain that this will occur, but we must plan for this contingency.

THE PROBLEM

- The DL for Tc-99 in groundwater is <<< the DL for Tc-99 in solids.
- The biodenitrification system is expected to greatly increase the concentration of Tc-99 in the biomass to >>> than in the influent.

BIOMASS QUANTITY ESTIMATE



DISPOSAL OPTIONS

- **Waste Control Specialists (WCS) will not accept biodegradable material.**
- **Perma-Fix Northwest (WA) will accept biomass for $4.50 per lb. for thermal treatment & disposal.**
- **Energy*Solutions* – will accept biomass for disposal or solidification $210/cu. ft. if < 30% moisture - $475/cu. ft. if > 30% moisture.**

COST ESTIMATING BASIS – 4 PRIMARY FACTORS

1. Biomass volume based on NO_3 influent concentration decline.
2. Disposal cost including processing, packaging, shipping, and disposal fees.
3. Duration of remediation taken from Figure 9-3 of the 2018 D-Plan.
4. Vendor capital cost estimates for biomass processing equipment/facilities.

HANDOUT #1 - DURATION OF REMEDIATION

Remediation Area	Time (Mo)	Years of Operation (1–13)
BA1-A	150	
	>150	
BA1-B	45	
	63	
BA1-C	0	
	41	
WAA U>DCGL	38	
	>150	
WAA-WEST	0	
	>150	
1206 NORTH	5	
	10	
WU-1348	0	
	127	
WU-PBA	0	
	>150	
WAA-BLUFF	0	
	1	
WAA-EAST		
	>150	
WU-BA3	49	
	83	
WU-UP1	0	
	1	
WU-UP2-SSA	0	
	57	

HANDOUT #2 - COST ESTIMATES

Scenario	Cost Components	Costs in Thousands of Dollars																					
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	Total
Biomass to Energy*Solutions*	Biomass Mgt/Disp Cost					$ 1,068	$ 4,153	$ 5,860	$ 4,664	$ 3,727	$ 2,986	$ 2,402	$ 1,939	$ 1,575	$ 1,279	$ 1,052	$ 867	$ 717	$ 110				$ 32,398
	Total Year Cost	$5,416	$ 5,416	$ 5,416	$ 10,783	$25,878	$ 7,538	$ 9,064	$ 7,975	$ 6,932	$ 6,231	$ 5,565	$ 5,143	$ 4,820	$ 4,484	$ 4,257	$ 4,009	$ 3,860	$ 2,822	$ 1,947	$ 1,482	$ 2,112	$131,149
	Total Project Cost	$5,416	$ 10,831	$ 16,247	$ 27,030	$52,908	$60,446	$69,511	$77,486	$84,417	$90,649	$96,214	$ 101,357	$ 106,177	$ 110,661	$ 114,918	$ 118,928	$ 122,787	$ 125,609	$ 127,556	$ 129,038	$ 131,149	
Biomass to Energy*Solutions* Early Shutdown	Biomass Mgt/Disp Cost					$ 1,068	$ 4,153	$ 5,860	$ 4,664	$ 3,727	$ 2,061												$ 21,532
	Total Year Cost	$5,416	$ 5,416	$ 5,416	$ 10,783	$25,878	$ 7,538	$ 9,064	$ 7,975	$ 6,932	$ 5,267	$ 1,954	$ 1,968	$ 1,981	$ 1,968	$ 1,968	$ 1,947	$ 1,947	$ 1,837	$ 1,947	$ 1,482	$ 2,112	$110,793
	Total Project Cost	$5,416	$ 10,831	$ 16,247	$ 27,030	$52,908	$60,446	$69,511	$77,486	$84,417	$89,684	$91,638	$ 93,606	$ 95,587	$ 97,555	$ 99,522	$ 101,469	$ 103,416	$ 105,253	$ 107,200	$ 108,682	$ 110,793	
Biomass Dried to Energy*Solutions*	Biomass Mgt/Disp Cost					$ 1,841	$ 595	$ 834	$ 669	$ 538	$ 434	$ 350	$ 288	$ 234	$ 195	$ 164	$ 140	$ 114	$ 272				$ 6,668
	Total Year Cost	$5,416	$ 5,416	$ 5,416	$ 10,783	$26,719	$ 3,981	$ 4,039	$ 3,980	$ 3,742	$ 3,679	$ 3,513	$ 3,493	$ 3,480	$ 3,400	$ 3,369	$ 3,282	$ 3,257	$ 2,984	$ 1,947	$ 1,482	$ 2,112	$105,486
	Total Project Cost	$5,416	$ 10,831	$ 16,247	$ 27,030	$53,748	$57,729	$61,768	$65,748	$69,490	$73,170	$76,683	$ 80,175	$ 83,655	$ 87,055	$ 90,424	$ 93,706	$ 96,963	$ 99,946	$ 101,893	$ 103,374	$ 105,486	
Biomass Dried to Energy*Solutions* Early Shutdown	Biomass Mgt/Disp Cost					$ 1,841	$ 595	$ 834	$ 669	$ 538	$ 550												$ 5,027
	Total Year Cost	$5,416	$ 5,416	$ 5,416	$ 10,783	$26,719	$ 3,981	$ 4,039	$ 3,980	$ 3,742	$ 3,728	$ 1,944	$ 1,958	$ 1,972	$ 1,958	$ 1,958	$ 1,938	$ 1,938	$ 1,843	$ 1,947	$ 1,482	$ 2,112	$ 94,268
	Total Project Cost	$5,416	$ 10,831	$ 16,247	$ 27,030	$53,748	$57,729	$61,768	$65,748	$69,490	$73,218	$75,163	$ 77,121	$ 79,093	$ 81,051	$ 83,010	$ 84,948	$ 86,885	$ 88,728	$ 90,675	$ 92,156	$ 94,268	
Biomass Bulked to NHIW Facility	Biomass Mgt/Disp Cost					$ 314	$ 171	$ 163	$ 168	$ 173	$ 177	$ 179	$ 179	$ 178	$ 178	$ 180	$ 178	$ 179	$ 30				$ 2,448
	Total Year Cost	$5,416	$ 5,416	$ 5,416	$ 10,783	$25,191	$ 3,557	$ 3,367	$ 3,480	$ 3,378	$ 3,423	$ 3,342	$ 3,383	$ 3,423	$ 3,383	$ 3,384	$ 3,321	$ 3,321	$ 2,742	$ 1,947	$ 1,482	$ 2,110	$101,264
	Total Project Cost	$5,416	$ 10,831	$ 16,247	$ 27,030	$52,221	$55,778	$59,145	$62,625	$66,003	$69,426	$72,767	$ 76,150	$ 79,574	$ 82,957	$ 86,341	$ 89,662	$ 92,983	$ 95,726	$ 97,672	$ 99,154	$ 101,264	
Biomass Bulked to NHIW Facility Early Shutdown	Biomass Mgt/Disp Cost					$ 314	$ 171	$ 163	$ 168	$ 173	$ 118												$ 1,108
	Total Year Cost	$5,416	$ 5,416	$ 5,416	$ 10,783	$25,191	$ 3,557	$ 3,367	$ 3,480	$ 3,378	$ 3,296	$ 1,944	$ 1,958	$ 1,972	$ 1,958	$ 1,958	$ 1,938	$ 1,938	$ 1,843	$ 1,947	$ 1,482	$ 2,112	$ 90,349
	Total Project Cost	$5,416	$ 10,831	$ 16,247	$ 27,030	$52,221	$55,778	$59,145	$62,625	$66,003	$69,299	$71,243	$ 73,202	$ 75,174	$ 77,132	$ 79,090	$ 81,028	$ 82,966	$ 84,809	$ 86,755	$ 88,237	$ 90,349	

ALTERNATIVES EVALUATED

- #1 – Baseline – No additional processing.
- #2 – Baseline with Early Shutdown.
- #3 – Biomass Drying.
- #4 – Biomass Drying With Early Shutdown.
- #5 – Biomass Bulking.
- #6 – Biomass Bulking With Early Shutdown.
- #7 – Onsite Disposal was Rejected

ALTERNATIVE #1 - BASELINE

- Biomass is taken from filter press and loaded into 96 cu. ft. supersacks with no additional processing.
- Biomass is packaged and shipped "as is" to Energy*Solutions* for solidification and disposal at $475 per cu. ft.

ALTERNATIVE #1 – BASELINE (+/-)

- Simplest process.
- No additional capital cost.
- No delay due to construction or remediation.
- Cost of biomass disposal is ~ $32 million
- Total project cost is ~ $130 million.

ALTERNATIVE #2 – BASELINE WITH EARLY SHUTDOWN

Same as Alternative #1, but ...

Western Area remediation ends when all Western Area wells comply with DCGL.

ALTERNATIVE #2 – BASELINE WITH EARLY SHUTDOWN (+/-)

- Simplest process.
- No additional capital investment
- No delay due to construction or remediation.
- Cost of biomass disposal is ~ $21 million
- Total project cost is ~ $110 million.
- Less U, NO_3, F, and Tc-99 mass reduction.

ALTERNATIVE #3 - BIOMASS DRYING

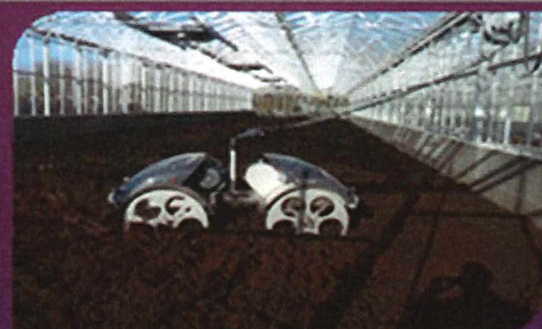
- A solar drying facility is constructed near WATF, expanding the controlled area.
- Biomass is dried and shipped to Energy*Solutions* for $210 per cu. ft.
- Vendor indicates solar drying achieves < 30% moisture & volume reduction of 70%.

ALTERNATIVE #3 - BIOMASS DRYING

2 hours

Several weeks

1 hour



ALTERNATIVE #3 - BIOMASS DRYING (+/-)

- Cost of biomass disposal is ~ $6.7 million
- Total project cost is ~ $105 million.
- Significant capital cost and additional material handling.
- Drying facility will require decommissioning and final status survey.

ALTERNATIVE #4 - BIOMASS DRYING WITH EARLY SHUTDOWN

Same as Alternative #3, but ...

Western Area remediation ends when all Western Area wells comply with DCGL.

ALTERNATIVE #4 - BIOMASS DRYING WITH EARLY SHUTDOWN

- Cost of biomass disposal is ~ $5.0 million
- Total project cost is ~ $94 million.
- Additional capital cost and material handling.
- Drying facility will require decommissioning and final status survey.
- Less U, NO_3, F, and Tc-99 mass reduction.

ALTERNATIVE #5 – BIOMASS BULKING

- Pug mill/mixer and cement hopper is installed in WATF.

- Biomass is mixed with cement and disposed of as non-hazardous industrial waste at $9.90 per cu. yd.

ALTERNATIVE #5 – BIOMASS BULKING

- Cost of biomass disposal is ~ $2.4 million
- Total project cost is ~ $101 million.
- Increased capital cost and material handling.

ALTERNATIVE #6 – BIOMASS BULKING WITH EARLY SHUTDOWN

Same as Alternative #5, but ...

Western Area remediation ends when all Western Area wells comply with DCGL.

ALTERNATIVE #6 – BIOMASS BULKING WITH EARLY SHUTDOWN

- Cost of biomass disposal is ~ $1.1 million
- Total project cost is ~ $90 million.
- Less U, NO_3, F, and Tc-99 mass reduction.

#7 - ON-SITE DISPOSAL - REJECTED

- Cost and schedule delay associated with design, permitting, and construction of an on-site industrial waste landfill.
- Unlikely public acceptance.
- Only area with > 5' separation between waste and groundwater means landfill would be constructed <u>over</u> Burial Area #4.

COST vs. FUNDING

- If biomass contains Tc-99, the cost to achieve license termination varies from ~ $90 to ~ $130 million (in 2020 dollars).
- As of January 1, 2020, the combined Trust accounts contained ~ $77 million.
- The Standby Trust contains ~ $3.7 million.

Regulatory Issues

- Disposition of biomass is not a Federal issue – the biomass will not be licensable. The cost impact is a Federal concern.

- The processing and disposition of biomass is contingent upon DEQ approval of surveying and processing options.

QUESTIONS
&
CONSIDERATIONS

ATTACHMENT 2
NOTES ON PRESENTATION OF DECOMMISSIONING STRATEGIES TO ADDRESS BIOMASS DISPOSAL
MAY 19, 2020

Attendees:

For the Oklahoma Department of Environmental Quality:

Paul Davis	Mike Broderick	Ray Roberts
Carol Paden	Ray Roberts	Jordan Caldwell
Michael Moe	Barrett Hamilton	

For the US Nuclear Regulatory Commission:

Ken Kalman	Lifeng Guo	Christine Pineda
Karen Pinkston		

For Environmental Properties Management LLC:

Bill Halliburton	Jeff Lux

Slide 1 - Introduction

On February 25, 2019, the U. S. Nuclear Regulatory Commission (NRC) issued requests for supplemental information (RFIs) based on the acceptance review of the December 2018 *Facility Decommissioning Plan – Rev 1*. One RFI read, *"Please provide an analysis by the licensee demonstrating that discharges are in accordance with the OPDES Discharge Permit and meet the requirement of 10 CFR 20.2001. This would include an analysis based on enriched uranium and the unity rule, taking Tc-99 into account. Please include a discussion of Tc-99 related to discharges into the Cimarron River."* (italics mine)

This appeared to be a simple request, requiring only a unity rule calculation for a few radionuclides, with a description of what radionuclides may be present in the discharge to the Cimarron river. The presence of technetium-99 (Tc-99) in influent groundwater had not been considered an issue, because the concentration of Tc-99 in the influent was anticipated to be less than the drinking water standard, and Tc-99 did not exceed the NRC's decommissioning criterion at any location.

However, when Environmental Properties Management LL (EPM) met with the NRC and the Oklahoma Department of Environmental Quality (DEQ) on April 4-5, 2019, to discuss responses to the RFIs, it quickly became clear that the presence of Tc-99 in the influent led to additional questions not related to the NRC effluent limits, such as:

- What is the potential impact of Tc-99 on ion exchange resin?
- What is the potential impact of Tc-99 on biomass?
- Does Tc-99 need to be addressed in the Oklahoma Pollutant Discharge Elimination System (OPDES) permit?
- Does Tc-99 need to be addressed in the Underground Injection Control program?

EPM committed to evaluating potential implications related to the presence of Tc-99 in groundwater. After conducting a review of available Tc-99 data for groundwater, the results of treatability testing performed in 2013 for uranium, and literature related to the absorption of Tc-99 on ion exchange resin and biosolids, on May 3, 2019 EPM submitted "Potential Technetium 99 Impact to Influent, Waste, and Effluent" to the NRC and the DEQ. That letter stated that:

1. Tc-99 may be removed from the groundwater by the ion exchange resin, which will be packaged and shipped for disposal as low level radioactive waste (LLRW).
2. If Tc-99 is present in the effluent from the ion exchange treatment system, some or all of it may be metabolized by microorganisms in the biodenitrification system, and Tc-99 may be present in the biosolids. If not, the biomass can be disposed of as industrial waste. If Tc-99 ***is*** in the biomass, its disposition will need to be determined.
3. If Tc-99 passes through both the ion exchange and biodenitrification systems, it will be present in the Western Area Treatment Facility (WATF) effluent. Most of the treated water will be discharged to the Cimarron River via Outfall 001, with the remainder injected into the Western Upland remediation areas.

The apparently simple inclusion of Tc-99 in the unity rule calculation turned into the most time-consuming and expensive aspect of responding to the RFIs, requiring additional field work, studies, revisions to the decommissioning plan, and preparation of numerous submittals. These included:

- Conducting a Tc-99 site-wide groundwater assessment and calculating the estimated concentration of Tc-99 in influent.
- Preparing to conduct Tc-99 treatability testing.
- Evaluating the impact of Tc-99 on the management and disposition of sediment and biomass.
- Communicating with the DEQ regarding potential modification of the OPDES permit or plans for compliance with the Underground Injection Control Program.
- Revising Section 8, "Planned Decommissioning Activities", Section 11, "Radiation Protection", and Section 13, "Radioactive Waste Management" of the decommissioning plan.

Of these, the most significant implication to the decommissioning of the Cimarron site is the potential impact of Tc-99 on sediment and biomass.

<u>Slide 2 – Tc-99 in Biomass</u>

An Oklahoma statute passed in 2012 provides for the disposal of oilfield NORM waste, but prohibits the disposal of SNM, byproduct material, or source material, or any other type of radioactive material.

(OAC) 252:515-19-31(a) provides the implementing regulation for that law. It states that the disposal of ***any*** quantity of radioactive waste at a solid waste disposal facility is prohibited.

Current (verbal) guidance from DEQ is that if Tc-99 is detectable in the biomass, it falls under the statutory provision which says that it cannot be disposed of in the State of Oklahoma.

We can't be certain that the sediment and biomass will contain detectable Tc-99, but we felt we had to consider the impact of such an occurrence on the decommissioning of the Cimarron site. Our initial evaluation was based primarily on the processing and disposal of biomass.

<u>Slide 3 – The Problem</u>

After the 2013 treatability tests, samples of resin were analyzed for several contaminants. Resin from two of the five columns was analyzed for Tc-99, and that data showed that the ion exchange resin did capture Tc-99. But no samples of influent, effluent, or resin from subsequent columns were analyzed for Tc-99, so we have no way of knowing how much of the Tc-99 was captured by the resin.

The ***mass*** concentration of uranium to the WATF is estimated to be a little over 80 micrograms per liter (µg/L). The ***activity*** concentration of Tc-99 in the influent to the WATF treatment system is estimated to be approximately 100 picoCuries per liter (pCi/L). Because these two numbers are close to each other, it may seem like there will be as much Tc-99 in the influent as there is uranium.

However, the specific activity of Tc-99 is higher than any of the uranium isotopes. One ppm (µg/g) is approximately equal to 17,000 pCi/g. If the ***activity*** concentration of Tc-99 in the influent to the WATF is approximately 100 pCi/L, or 0.1 picoCurie per gram (pCi/g), the ***mass*** concentration of Tc-99 in the influent is extremely low – approximately 0.006 µg/L.

Because there is so little mass of Tc-99, it is possible that the IX resin will capture literally ***all*** the Tc-99. But as the concentration of contaminants in the influent decreases, the adsorption capacity of the resin decreases, so some Tc-99 may always be present in the effluent from the IX treatment system.

Veolia Nuclear Solutions – Federal Services (VNSFS) expects any uranium or Tc-99 that exits the ion exchange system to be captured in the biomass. Based on the volume of influent that will pass through the bioreactors per day, and the mass of biomass that will be generated per day, VNSFS estimates that the concentration of either in the biomass will be consistently greater than 1,000 times its concentration in the influent. ***(An example calculation was inserted following these notes for clarification.)***

Using standard methods, the detection limit (DL) for Tc-99 in water is 50 pCi/L. If Tc-99 is not detected in the effluent from the IX treatment system, it would appear there is no Tc-99 in the effluent, when the resin may have captured only half of the Tc-99 in the influent.

In the upcoming Tc-99 treatability test, GEL Laboratory will modify the test method for effluent samples (e.g., counting samples of the effluent for 500 minutes) in an effort to get as low a detection limit (DL) as possible (as low as but not guaranteeing 1 pCi/L).

However, even if GEL can get the DL as low as 1 pCi/L, and the data for the effluent coming from the treatability test indicates that the ion exchange (IX) resin captured all ***detectable*** Tc-99, Tc-99 may still be detectable in the biomass. Because the DL for Tc-99 in solids is 1 pCi/g, even if the IX resin effluent contains 1 pCi/L Tc-99 or less, it could be still be detectable in the biomass.

For this evaluation, we assumed that the concentration of Tc-99 in the influent to the biodenitrification system is 1 pCi/L and Tc-99 is therefore present in the biomass.

Slide 4 – Biomass Quantity Estimate

The nitrate concentration in the influent to the IX system starts out at approximately 80 milligrams per liter (mg/L). Initially, the nitrate concentration (and hence the quantity of biomass produced) begins to decline. When higher concentration nitrate in the Western Upland areas reaches the WAA-BLUFF Area, the concentration of nitrate jumps to an estimated maximum of 150 mg/L and biomass production increases proportionally. Then biomass production declines as the concentration of nitrate in the influent to the IX system declines.

This graph shows the estimated quantity of biomass that will be produced each month and the cumulative quantity of biomass that will be produced over the entire duration of remediation.

- Annual Max – 12,900 cubic feet (cu. ft.) – 477 cubic yards (cy)
- 3-year total – 29,100 cu. ft. – 1,080 cy
- 12-year total – 65,400 cu. ft. - 2,400 cy

Slide 5 – Disposal Options

One of the first aspects of this evaluation involved contacting multiple non-hazardous industrial Waste (NHIW) disposal facilities outside of Oklahoma. None would accept any waste that Oklahoma will not accept due to its radioactive content. In summary:

- Waste Control Specialists (WCS) will not accept biodegradable material.
- Perma-Fix Northwest (WA) will accept biomass for $4.50 per lb. for thermal treatment & disposal.
- Energy*Solutions* – will accept biomass for disposal or solidification $210/cu. ft. if < 30% moisture - $475/cu. ft. if > 30% moisture.

For the purpose of this presentation, the cost for disposal includes the cost to package, transport, and dispose of the waste, plus the cost to process the biomass after it is removed from the filter press. The tipping fee charged by the disposal facility is one component of what we refer to as the disposal cost. The cost for processing biomass through discharging from the filter press is captured in operating costs, not disposal costs.

Slide 6 – Cost Estimating Basis

The four primary components which formed the basis of the following cost estimates are:

1. Biomass volume based on the calculated NO_3 influent concentration.
2. The cost of disposal, including processing, packaging, shipping, and disposal fees.
3. The duration of remediation (taken from Figure 9-3 of the 2018 D-Plan).
4. Vendor capital cost estimates for biomass processing equipment/facilities.

An evaluation was conducted to determine the most economical methods to address several components of waste management. These include:

- The type of package (e.g., roll-off containers or supersacks – drums were rejected quickly).
- The cost for equipment and labor for packaging, loading, etc.
- The cost of transportation by distance and type of container.
- The cost of consumables and labor to process biomass post-filter press.

Certain costs were not estimated due to excessive uncertainty. Examples are:

- <u>Design</u> of additional processing facilities/equipment.
- <u>Schedule extension</u> due to design that is required prior to DP approval.
- <u>Schedule extension</u> due to construction of additional facilities and/or equipment.

Costs that are not included in these estimates could be very significant (millions of dollars).

<u>Slide 7 – Duration of Remediation</u>

This slide depicts a broadly summarized schedule for the duration of remediation, presenting only the time required for each Remediation Area to comply with the NRC and State criteria for uranium.

Handout #1, "Duration of Remediation", was provided in advance of the meeting. Handout #1 summarizes projected remediation durations ***for uranium only*** that were presented in the 2018 *Facility Decommissioning Plan – Rev 1.* Red bars indicate the time required to achieve the NRC and State criteria for uranium in each remediation area.

<u>Slide 8 – Cost Estimates</u>

This slide depicts summarized cost information for each alternative. Handout #2, "Cost Estimates", was provided in advance of the meeting. Handout #2 contains cost estimates which break down project costs into the following three components:

- The annual cost for biomass disposal.
- The total annual cost for the project (including biomass disposal).
- Cumulative project cost.

Handout #2 also contains 5 notes which are not visible on the slide. It is important to note that these are ***not*** detailed decommissioning cost estimates. They include costs taken from the 2018 decommissioning plan without accommodating the numerous changes that have been proposed or submitted to the NRC and the DEQ since the February 2019 RFIs were issued.

Examples of changes to the decommissioning plan which are not addressed include:

- The addition of Tc-99 analysis to in-process groundwater and water treatment system monitoring
- Re-routing piping, utilities, the discharge line for Outfall 001, etc.
- Addition of sediment filtration and disposal of filters.

- Addition of HVAC throughout the processing facility.
- Addition of backup power.
- And more.

A complete decommissioning cost estimate will be prepared once the NRC and the DEQ have provided feedback on the numerous changes presented in documents that have been submitted since the February 25, 2019 RFIs.

<u>Slide 9 – Alternatives Evaluated</u>

This slide lists the primary alternatives that were included in this evaluation. Some alternatives, such as thermal desorption and incineration, were also considered, but did not make it through the first cut. Three different approaches were evaluated, and each of the three was evaluated for operating western area facilities until groundwater in Burial Area #1 complies with license criteria, and for shutting down western area remediation facilities as soon as groundwater in the western areas comply with license criteria.

Onsite disposal of the biomass was considered but rejected before attempting to develop cost estimates because the uncertainties related to onsite disposal are too great to enable preparation of a cost estimate. This was explained in more detail later.

<u>Slide 10 – Alternative #1 - Baseline</u>

The first alternative isn't really an "alternative"; it's operating the way the decommissioning plan currently describes the decommissioning of the site. However, we assumed that the biomass can't be sent to a NHIW facility because it contains Tc-99.

According to the current plan, biomass comes out of the filter press at a rate of approximately 20 cubic feet per cycle. The biomass is dumped into a cart in which it is transferred to a hopper pours the biomass into a 96 cubic foot supersack.

Loaded supersacks are stored in the secure storage facility until there is enough biomass to form a full load. The loaded supersacks are then loaded onto a truck and transported to Energy*Solutions* for disposal. It is possible that resin and biomass can be loaded on the same truck, but the cost estimates are based on separate resin and biomass shipments.

The biomass contains approximately 20% solids. It will pass the paint filter test when loaded into the supersacks and would be considered sufficiently dry for disposal at most facilities. But because it contains > 30% moisture, Energy*Solutions* will send it through their solidification process and charge a tipping fee of $475 per cubic foot for processing and placement in their facility.

<u>Slide 11 – Alternative #1 – Baseline (+ and -)</u>

This alternative provides the simplest process and the least labor.

Other than the construction of a hopper to transfer the biomass from the filter press cart to the supersack, there is no additional capital cost associated with processing the biomass.

There will be no delay associated with the design or construction of equipment or facilities.

However, (refer to Handout #2) the cost of biomass disposal for this alternative is extremely high ($32 million). Without additional funding, it would be virtually impossible to achieve license termination.

How long ***could*** the Trust operate under this scenario? Consider that the combined value of the Trust Accounts ***and*** the Standby Trust is approximately $80 million. The "Cost Estimates" handout shows that funds would be exhausted sometime in 2028. Additional funding of approximately $50 million would be required to achieve license termination under this scenario.

It is possible that remediation would not achieve the NRC Criterion in all the Western remediation areas; the schedule does not show achievement of the NRC Criterion in Burial Area #3 until late 2028. However, there is a great deal of uncertainty associated with projecting the duration of remediation in this remediation area because the impacted groundwater is in a fractured sandstone.

Slide 12 – Alternative #2 – Baseline with Early Shutdown

Alternative #2 involves the exact same process as Alternative #1 except that al western area remediation would cease once all monitor wells in all western remediation areas comply with the NRC Criterion.

The first 1 to 2 years of in-process groundwater monitoring will give us an indication of the rate at which contaminant of concern (COC) concentrations decline relative to the projected rates of decline. If uranium concentrations decline more rapidly than projected, it is possible that all wells in the western remediation areas will achieve the NRC Criterion before funding is exhausted.

According to Handout #1, achieving the NRC Criterion in all three western remediation areas in which uranium exceeds the NRC Criterion would occur sometime in the latter half of 2028. At that time, remediation operations would continue only in Burial Area #1. Because uranium treatment and biodenitrification would be terminated, production of biomass would end, and both operating and waste disposal costs would decrease significantly.

Slide 13 – Alternative #2 – Baseline with Early Shutdown (+ and -)

Alternative #2 recognizes the same benefits as Alternative #1 in terms of simplicity of process, no additional capital investment needed, and no delay to construction or remediation.

However, if uranium concentrations do not decline more quickly than anticipated, and if no additional funding is received, Alternative #2 would be no different from Alternative #1, because funding would be exhausted before all wells in western remediation areas achieve the NRC Criterion.

Even if uranium concentrations do decline more quickly than anticipated, license termination cannot be achieved with available funding. Approximately $30 million of additional funding would be required to achieve license termination under this scenario. Even if additional funding did enable us to achieve license termination under this scenario, the reduction of COC concentrations in the western areas would be greatly reduced relative to Alternative #1.

The combination of large volumes of biomass and high per-cubic-foot tipping fees makes the cost of biomass disposal a significant portion of the cost to decommission the site (> 25% for Alternative #1 and ~ 20% for Alternative #2).

Slide 14 – Alternative #3 – Biomass Drying

If the moisture content can be reduced to less than 30%, Energy*Solutions'* tipping fee would drop by over 50%, from $475/cu. ft. to $210/cu. ft. If the volume of the waste stream can be significantly reduced, that would further reduce disposal costs.

A German company, Thermo-System, has extensive experience in the design and operation of solar drying facilities. Thermo-System provided information on solar drying which indicates that solar drying could achieve significantly lower moisture content (< 30%) and reduction in volume (~ 70%).

Thermo-System also provided range of magnitude costs for the construction and operation of a solar drying system based on the maximum volume of biomass that will be generated during any single month.

Slide 15 – Alternative #3 – Biomass Drying (Pictured)

This slide depicts the solar drying process. The two pictures on the left show wet sludge being picked up from the point of origin, then hauled to and dumped into the solar drying facility.

The two pictures in the middle show a device referred to as an "electric mole" spreading the sludge. The mole continually goes back and forth through the sludge, turning it over to expose moist material to the air.

The picture on the top left shows a loader scooping up the dried sludge and loading it into a truck or roll off dumpster to be shipped for disposal.

At Cimarron, a forklift would transport the filter press cart to the solar drying facility and dump it on the floor. The hopper for loading the supersacks would be installed in the solar drying facility instead of in the WATF, and a skid-steer loader would load the dried sludge into the hopper, and then into the 96 cubic foot supersacks.

The forklift would then transport the supersacks into the secure storage building until enough supersacks accumulate to create a full load for shipment to Energy*Solutions*.

Slide 16 – Alternative #3 – Biomass Drying (+ and -)

The use of solar drying reduces the cost of biomass disposal from over $32 million (Alternative #1) to less than $7 million. The disposal of biomass represents only about 6% of the total project cost for this alternative.

It is important to note that this cost estimate does not include the following elements which could require additional funding in millions of dollars:

- The cost to design expansion of the WATF controlled area and the solar drying facility and equipment.

- The cost of schedule extension should design require approval of the NRC and the DEQ prior to approval of the DP or if construction of this facility extends the construction schedule.
- Costs associated with potentially-required permitting and radiation protection program-related monitoring.
- The cost for the decontamination and final status survey of the solar drying facility and equipment.

Even without the addition of cost items not included in this cost estimate, the funding required significantly exceeds the cost to achieve license termination. But existing funding may last at least two years longer than for Alternative #1, which would yield additional reduction in COC concentrations in the western remediation areas.

<u>Slide 17 – Alternative #4 – Biomass Drying with Early Shutdown</u>

Alternative #4 involves the exact same process as Alternative #3 except that al western area remediation would cease once all monitor wells in all western remediation areas comply with the NRC Criterion.

Unlike Alternative #2, savings due to reducing the volume and moisture content of the biomass would enable operation of western area facilities until all wells in the western remediation areas achieve the NRC Criterion, while providing for remediation in Burial Area #1 for several more years.

<u>Slide 18 – Alternative #4 – Biomass Drying with Early Shutdown (+ and -)</u>

Alternative #4 recognizes the same benefits as Alternative #3. The use of solar drying reduces the cost of biomass disposal to approximately $5 million. The disposal of biomass represents only about 5% of the total project cost for this alternative.

The reduction in disposal costs for solar drying of biomass would enable remediation to continue in Burial Area #1 several years after remediation in the western areas is terminated. Operating only in Burial Area #1, production of biomass would cease, and operating costs would then decline significantly.

As for Alternative #3, this cost estimate does not include:

- The cost to design expansion of the WATF controlled area and the solar drying facility and equipment.
- The cost of schedule extension should design require approval of the NRC and the DEQ prior to approval of the DP.
- Costs associated with potentially-required permitting and radiation protection program-related monitoring.
- The cost for the decontamination and final status survey of the solar drying facility and equipment.

Even without these additional cost items, the funding required to achieve license termination still significantly exceeds existing funding. But existing funding may last another 1 to 1-1/2 years past Alternative #3, yielding still more reduction in uranium COC concentrations in Burial Area #1.

Approximately $15 million of additional funding would be required to achieve license termination under this scenario. As with Alternative #2, even if additional funding did enable us to achieve license termination, the reduction of COC concentrations in the western areas would be greatly reduced relative to Alternative #3.

Slide 19 – Alternative #5 – Biomass Bulking

Even if both moisture content and waste volume are minimized, the cost of transportation and disposal at a facility licensed to receive radioactive material is extremely high. If the biomass could be disposed of at a NHIW facility, the cost savings would be significant. The disposal cost for low-moisture material at Energy*Solutions* is $210/cu. ft. ($5,670/cy), whereas the tipping fee for a NHIW in Oklahoma City is $9.90/cu. yd.

The addition of a dense absorbent material would yield two benefits:

- The addition of dense material containing no Tc-99 could reduce the concentration of Tc-99 to less than the detection limit.
- The addition of a material that absorbs or adsorbs water would reduce the moisture content of the waste, making it more handle-able, less sloppy, and more compactable in the landfill.

Cement is dense, contains negligible radionuclides, and presumably no Tc-99, and would reduce the moisture content of biomass by 1) adding dry mass (2) adsorbing water by chemical hydration. Under this scenario, cement would be mixed with the biomass in a pug mill and poured into a 30 cu. yd. roll-off container. Once full, the roll-off container would then be transported to and unloaded in a NHIW disposal facility in Oklahoma City, and returned to the site.

Slide 20 – Alternative #5 – Biomass Bulking (+ and -)

The cost to dispose of all the Tc-99-impacted biomass generated throughout the decommissioning project is only $2.4 million, less than 3% of the total project cost for this alternative. The savings resulting from this reduced disposal cost would enable the Trust to continue groundwater remediation in Burial Area #1 to 2033, even with remedial operations continuing in the western remediation areas.

There would be increased capital cost to provide for a cement silo, a pug mill, and associated conveyors. This cost estimate does not include:

- The cost to design the biomass bulking equipment and potential modification of the WATF building (if the mixing process should not be conducted outside).
- The cost of schedule extension should design require approval of the NRC and the DEQ prior to approval of the DP.

- Costs associated with potentially-required radiation protection program-related monitoring.
- The cost for the decontamination and release survey for the additional biomass processing equipment (which should be minimal).
- The cost to dispose of all the Tc-99-impacted biomass generated throughout the decommissioning project is only $2.4 million, less than 3% of the total project cost.

Due to the increased costs associated with operating the western area groundwater remediation and water treatment facilities, the total project cost alternative (through license termination) is higher than for Alternative #4.

Slide 21 – Alternative #6 – Biomass Bulking with Early Shutdown

Alternative #6 involves the exact same process as Alternative #5 but assumes that all western area operations are terminated once the NRC Criterion is reached in all western remediation areas. Savings due to reduced biomass disposal costs would enable the Trust to continue groundwater remediation in Burial Area #1 longer than any other alternative.

Slide 22 – Alternative #6 – Biomass Bulking with Early Shutdown (+ and -)

The cost to dispose of all the Tc-99-impacted biomass generated throughout the decommissioning project is only $1.1 million, slightly over 1% of the total project cost for this alternative. The savings resulting from this reduced disposal cost would enable the Trust to continue groundwater remediation in Burial Area #1 to 2035. This is only two years from the time in which groundwater in Burial Area #1 is projected to achieve the NRC Criterion.

As with Alternative #5, there would be increased capital cost to provide for a cement silo, the pug mill, and associated conveyors.

This cost estimate does not include:

- The cost to design the biomass bulking equipment and potential modification of the WATF building (if the mixing process should not be conducted outside).
- The cost of schedule extension should design require approval of the NRC and the DEQ prior to approval of the DP.
- Costs associated with potentially-required radiation protection program-related monitoring.
- The cost for the decontamination and release survey for the additional biomass processing equipment (which should be minimal).

Slide 23 – On-Site Disposal

On-site disposal of biomass was only considered because the prohibition against disposal of radioactive material in Oklahoma applies to off-site facilities and ***does not*** apply to material buried on the owner's property.

However, there are many regulatory issues that may make on-site disposal of biomass containing Tc-99 impossible.

1. Is DEQ ***required*** to treat all waste generated in water treatment systems as NHIW? If so, wouldn't an on-site facility have to comply with all standards for an NHIW?
2. Could DEQ authorize disking this organic waste into soil to beneficiate the soil? If so, would that require a land application permit?

<u>Slide 24 – Cost vs. Funding</u>

All of these cost estimates exceed the total funding in all three Trust accounts. The decommissioning cost estimate provided in the 2018 DP (excluding contingency) was only $75 million. Why has this increased so much?

There are three primary reasons:

1. The 2018 decommissioning cost estimate (DCE) was based on a project schedule that assumed approval of the DP in 2019 and construction in 2020. We now anticipate decommissioning plan approval late 2022 or early 2023, with construction in beginning Q3 2023 and extending through Q2 2024.
2. The annual cost of NRC fees in the 2018 DCE was $200,000, and NRC fees have been increased according to the past several years' experience.
3. The 2018 DCE did not include the cost of disposal of biomass that must be shipped and disposed of at a licensed facility.

Note: Each cost estimate included the disposal cost for sediment filtered from the influent prior to treatment in the ion exchange unit. However, the estimated volume of sediment is not the same as the estimated volume of the sediment waste stream. The volume of sediment is a small fraction of the volume of the filter cartridges that contain the sediment. Based on an assumed 5 ppm TSS, all of which is > 30 microns, the calculated annual sediment volume was approximately 8 cubic feet per year.

Using the same assumptions, VNSFS estimated that approximately 850 cartridges, filling over 120 55-gallon drums would be generated each year. That's approximately 880 cubic feet, or 100 times the volume of the sediment itself. If the sediment contains a uranium concentration exceeding 2.8 pCi/g, or detectable Tc-99, the cost for sediment disposal, the sediment + cartridge would be considered radioactive material for which in-State disposal is prohibited. Disposal of this waste stream would essentially equal the cost of biomass disposal. Temper that statement with the fact that it is believed that as wells develop, the quantity of > 30-micron sediment will decline precipitously. Consequently, we don't expect the volume of that waste stream to be as consistent as that of the biomass.

<u>Slide 25 – Regulatory Issues</u>

Without the receipt of additional funds from other Trust Accounts formed when Tronox LLC emerged from bankruptcy, funding is not expected to be sufficient to achieve license termination.

Obtaining regulatory approvals are needed to dispose of biomass containing Tc-99 at an NHIW to maximize the reduction in COC concentrations that existing funding can provide.

1. Is DEQ ***required*** to treat all waste generated in water treatment systems as NHIW? If so, wouldn't an on-site facility have to comply with all standards for an NHIW?
2. Could DEQ authorize disking this organic waste into soil to beneficiate the soil? If so, would that require a land application permit?
3. Can DEQ permit the incorporation of cement into the biomass so it is not considered radioactive waste? If Tc-99 is detectable prior to mixing, does reducing it to non-detectability render it no longer radioactive?
4. NRC regulations permit the disposal of radioactive material that would yield less than 25 mrem/yr even in municipal waste facilities. The low-energy-beta-emitting Tc-99 present in such low concentrations would present far less than 25 mrem/yr potential dose to the public, to the worker, etc. Would DEQ argue to the Attorney General that this waste stream should not be considered radioactive material subject to the statutory prohibition?

Tc-99 is a weak beta emitter, and unless ingested or inhaled, cannot result in measurable radiological dose. NRC regulations allow for the disposal of radioactive material that will not result in greater than 25 mrem/yr to the worker or the public in municipal waste landfills.

Can DEQ Land Protection convince DEQ counsel or the State Attorney General to authorize the disposal of biomass and sediment that contains low concentrations of Tc-99 in a NHIW landfill?

Can DEQ Water Quality amend the OPDES permit to remove the requirement that biomass be disposed of as industrial waste?

Slide 26 – Questions & Considerations

ATTACHMENT 3
BIOMASS CONTAMINANT CONCENTRATION FACTOR
EXAMPLE CALCULATION

Quantity of Tc-99 Captured by Biomass Per Month

The volume of water produced is relatively constant each month because a flow rate of approximately 250 gallons per minute will be maintained.

$$250\frac{gal}{min} X\ 1{,}440\frac{min}{day} X\ 30\frac{days}{mo} X\ 3.78\frac{L}{gal} = 4.08\ E07\frac{L}{mo}$$

If the biomass captures all the Tc-99, over the course of a month, the biomass will capture 4.08 E+07 pCi of Tc-99 for each pCi/L of Tc-99 in the influent to the bioreactors.

Quantity of Biomass Produced Each Month

The quantity of biomass produced varies from approximately 400 to approximately 1,200 cubic feet per month.

$$400\frac{ft3}{mo} X\ 70\frac{lb}{ft3} X\ 454\frac{g}{lb} = 1.27\ E07\ g/mo$$

$$1{,}200\frac{ft3}{mo} X\ 70\frac{lb}{ft3} X\ 454\frac{g}{lb} = 3.81\ E07\ g/mo$$

Concentration of Tc-99 in Biomass

For the 400 cubic foot month, for each pCi/L of Tc-99 in the influent to the bioreactors, 4.08 E+07 pCi of Tc-99 will be distributed throughout 1.27 E+07 grams of biomass, yielding a concentration of:

$$\frac{4.08\ E07\ pCi}{1.27\ E07\ g} = 3.21\ pCi/g$$

For the 1,200 cubic foot month, for each pCi/L of Tc-99 in the influent to the bioreactors, 4.08 E+07 pCi of Tc-99 will be distributed throughout 1.27 E+07 grams of biomass, yielding a concentration of:

$$\frac{4.08\ E07\ pCi}{3.81\ E07\ g} = 1.07\ pCi/g$$