Savannah River Remediation

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Application of Feed and Bleed Operations to Remove High Level Waste Tank Heels

Presentation to:

EM Waste Processing Technical Exchange

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Overview

- History of Tank 5 Waste Removal Efforts
- History of Tank 6 Waste Removal Efforts
- Process Identification
- Feed & Bleed Process
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- Feed & Bleed Process with Recirculation
  - Overview
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History of Tank 5

- Tank 5 was the receiver of F-PUREX waste from F Canyon from March 1959 – February 1969.
- In 1973, initiated waste removal from Tank 5 when the tank contained 730,000 gallons of waste.
- At initiation of mechanical cleaning, there was a total of ~34,000 gallons of sludge in Tank 5.
- Through 2008, Tank 5 has undergone the following cleaning phases:
  - Mechanical (utilizing 3 mixer pumps)
  - Chemical

Cleaning Method	Phase	Date	Approximate Solids Volume (gal)
Mechanical	0	Initial Vol.	34,000
	1	11/5/2005	18,000
	2	12/10/2005	16,000
	3	2/25/2008	14,000
	4	3/15/2008	N/A*
	5	4/12/2008	4,800
	6	4/25/2008	3,500
	7	5/9/2008	3,500
Chemical	1	6/23/2008	2,700
	2	10/11/2008	3,600
	3	12/23/2008	3,300

*Note: Fourth mechanical run was terminated due to a tornado warning, and no volume estimate was obtained.

History of Tank 6

- Tank 6 was the receiver of F-PUREX waste from F Canyon from November 1964 – March 1972.
- In 1973, initiated waste removal from Tank 6 when the tank contained 730,000 gallons of waste.
- At initiation of mechanical cleaning, there was a total of ~25,000 gallons of sludge in Tank 6.
- Through 2008, Tank 6 has undergone the following cleaning phases:
  - Mechanical (utilizing 2 mixer pumps)
  - Chemical

Cleaning Method	Phase	Date	Approximate Solids Volume (gal)
Mechanical	0	Initial Vol.	25,000
	1	6/10/2006	N/A*
	2	7/9/2006	17,000
	3	8/12/2006	14,000
	4	9/2/2006	12,000
	5	9/22/2006	8,600
	6	12/8/2006	7,000
	7	3/23/2007	6,900
	8	4/29/2007	6,600
	9	5/9/2007	5,800
	10	5/29/2007	5,400
	11	8/5/2007	6,000
Chemical	1	7/14/2008	2,400
	2	10/11/2008	3,300
	3	11/12/2008	3,500

*Note: Final liquid volume was not low enough to map and estimate the solids volume.

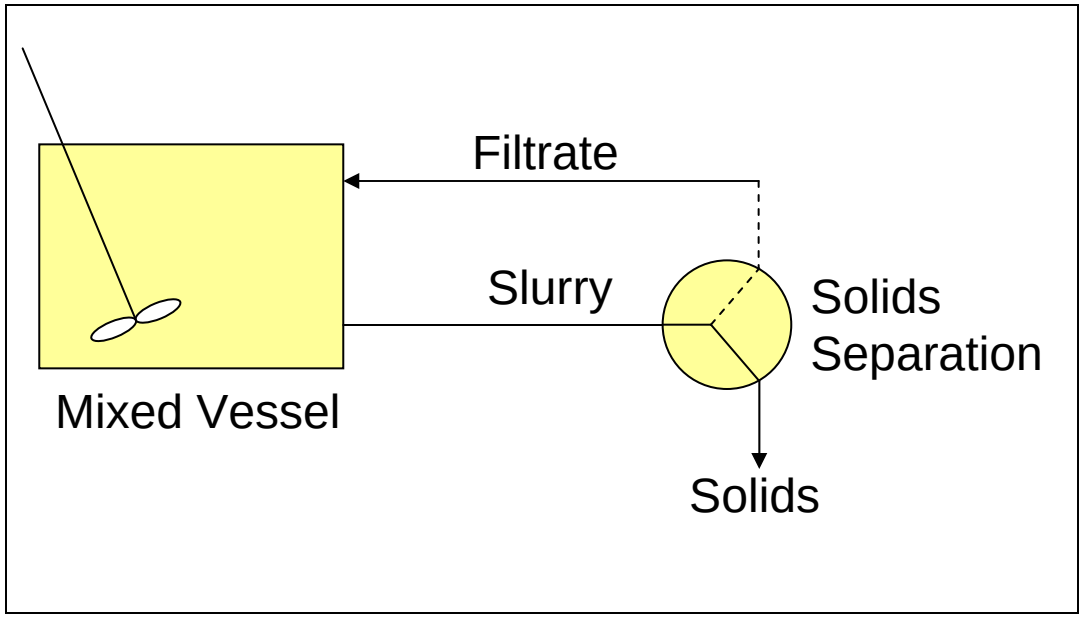
Process Identification

- After Mechanical Sludge Removal and Chemical Cleaning:
  - Tank 5 contained ~3,300 gallons of heel material
  - Tank 6 contained ~3,500 gallons of heel material.
- Determined that the primary difficulty in removing the solids/sludge material was the inability to maintain the material in suspension
- Two factors that heavily influenced the suspension of the material:
  - Tank configuration and the number of mixing devices
  - Lack of mixing at low levels in the tank due to pump operating parameter restrictions below 42”

Process Identification (Cont'd)

- To address the suspension factors associated with the solids heels, sludge removal was approached differently
  - Engineering evaluation was completed in which a "feed and bleed" method was identified as the most effective process for removing the residual heels from Tanks 5 and 6

Block Diagram



Follows the solution to the 1st Order Differential Eq.

$$C(t) = C_0 \exp(-Qt/V)$$

Where:

$C(t)$ = the solids concentration at any time (t)

C_0 = the initial solids concentration

Q = is the slurry flowrate

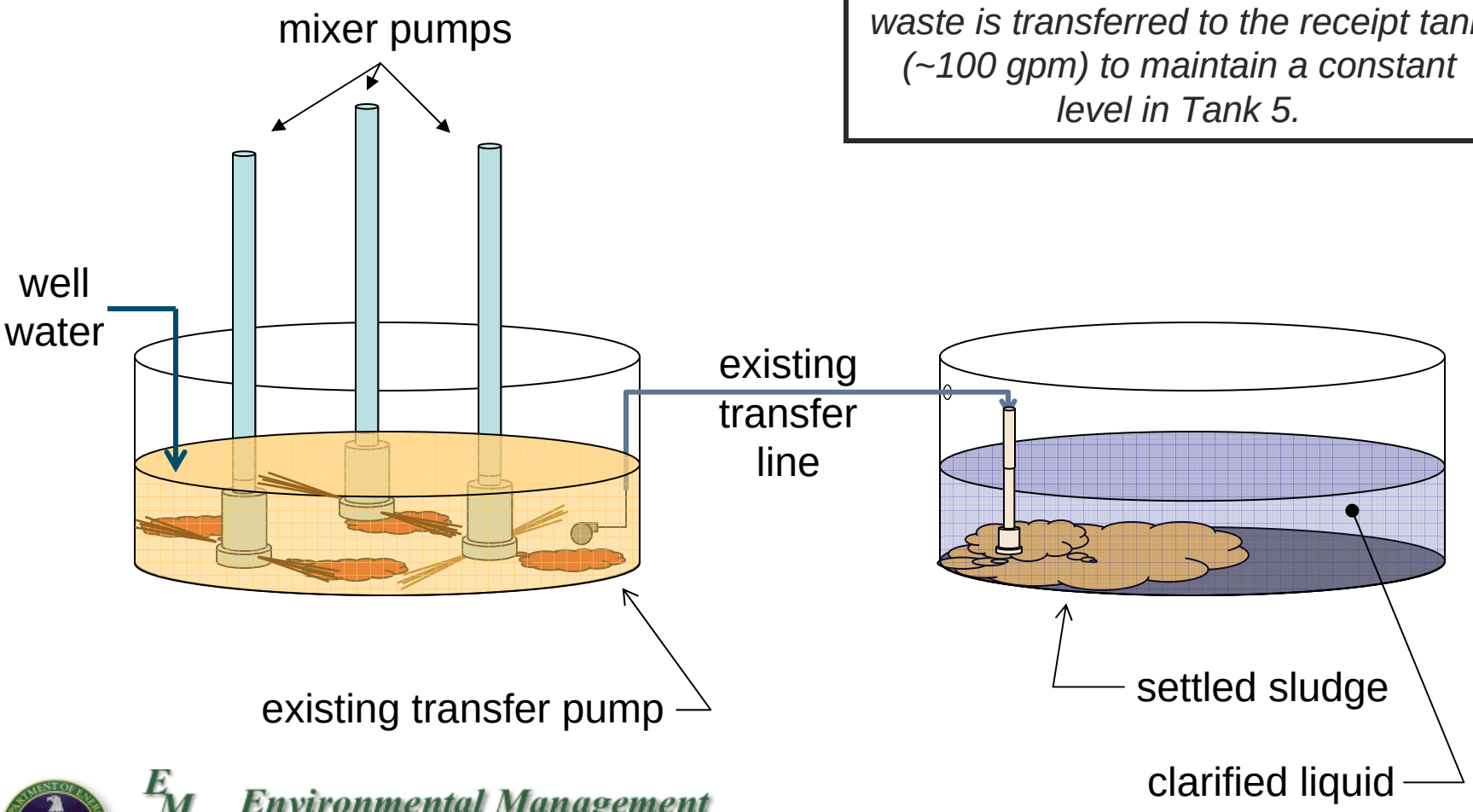
V = is the mixed volume.

Process Identification (Cont'd)

- The feed and bleed process was implemented in two stages:
  - First, Tank 5 was cleaned utilizing a feed and bleed method with the filtrate (feed) being supplied by the well water system.
    - This would allow the theory to be tested in a 750,000 gallon tank with cooling coils
    - Completed using a predetermined volume of water based on available space in the receipt tank
  - Secondly, Tank 6 was cleaned utilizing a feed and bleed method with the filtrate (feed) being supplied by a recirculation loop between the receipt tank and Tank 6.
    - Allowed for the process to be completed over a longer period of time with indefinite transfer volume and no impact on available tank space
    - Utilized existing low-activity supernate as the transfer media during the waste removal campaign to minimize the generation of new waste

Feed and Bleed Process (Tank 5)

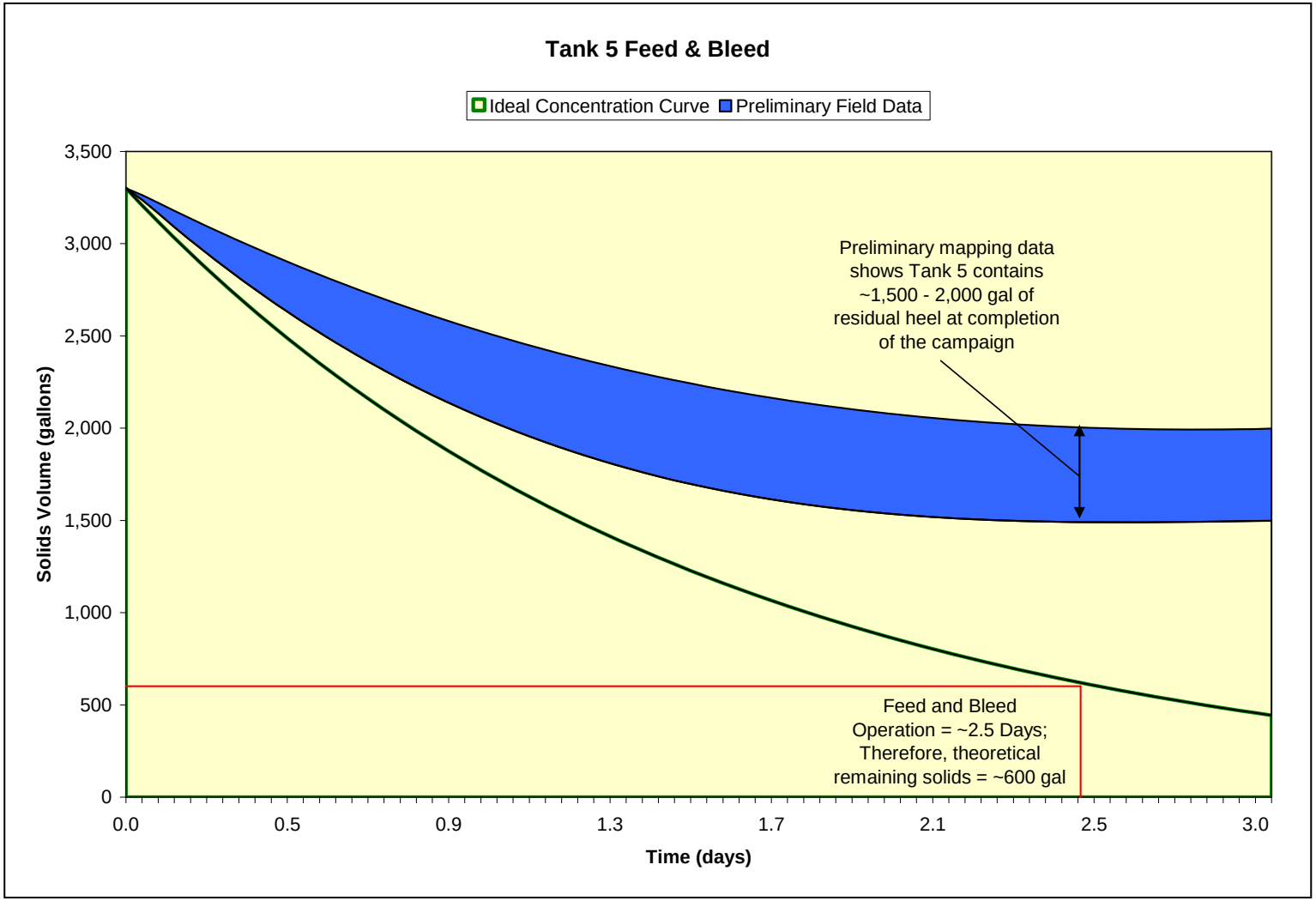
Well water is added to Tank 5 at approximately the same rate as the waste is transferred to the receipt tank (~100 gpm) to maintain a constant level in Tank 5.



Feed and Bleed Process (Tank 5)

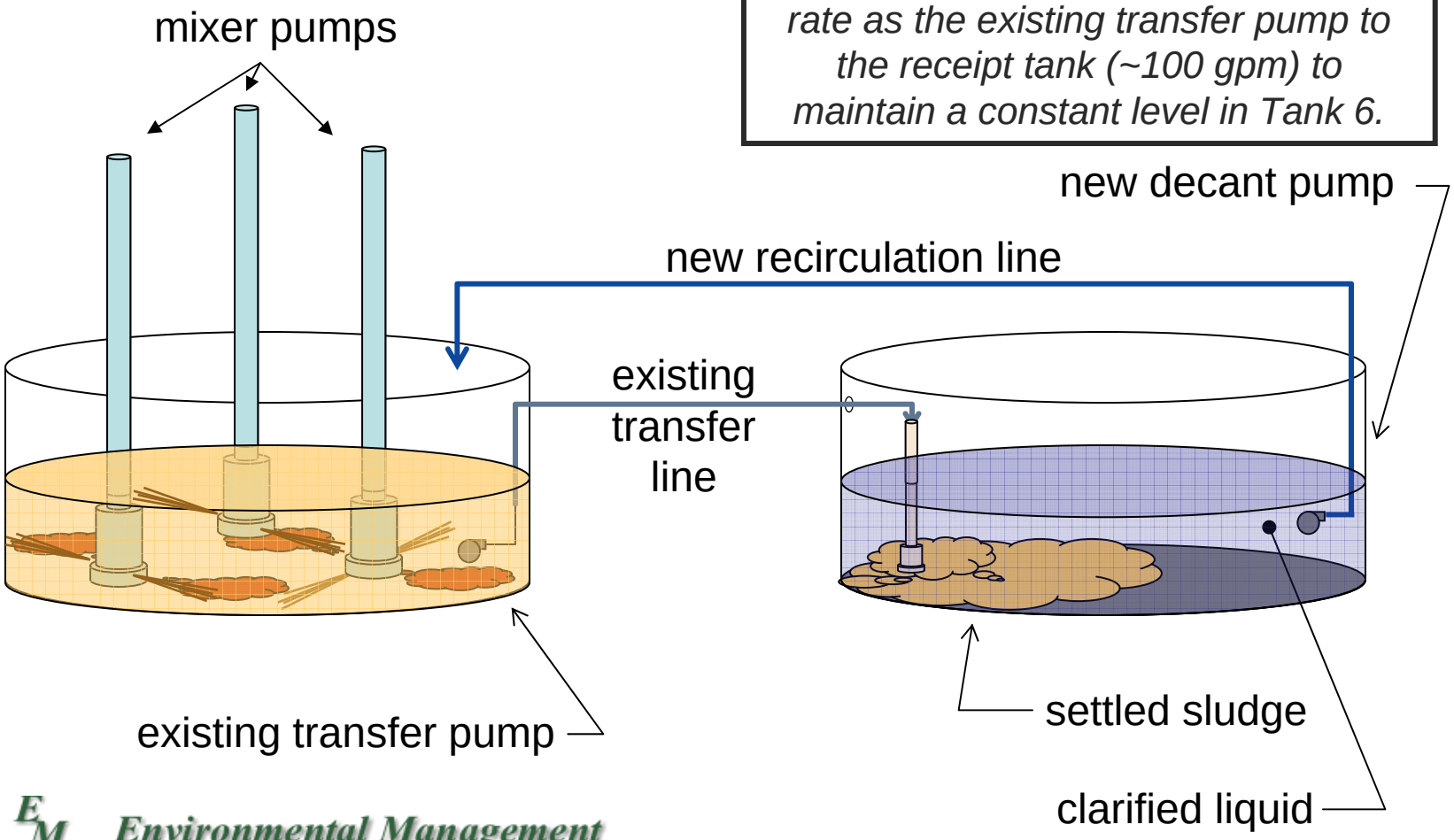
- Operational Sequence:
  - Add water to Tank 5 to a level of 62 inches using a “feed mast”
    - Allowed the water feed to be directed to the limited mixing zone which will provide additional mixing
    - Level allowed for operation of the mixing pumps at maximum speed
  - Begin operation of the mixing pumps
  - Resume well water additions to Tank 5 through the “feed mast” at ~100 gpm while transferring from Tank 5 at ~100 gpm
  - Terminate water additions when predetermined volume (~225,000 gallons) of water was added to Tank 5
  - Continue transferring from Tank 5 until the transfer pump cavitates

Tank 5 Results



Feed and Bleed with Recirculation Process (Tank 6)

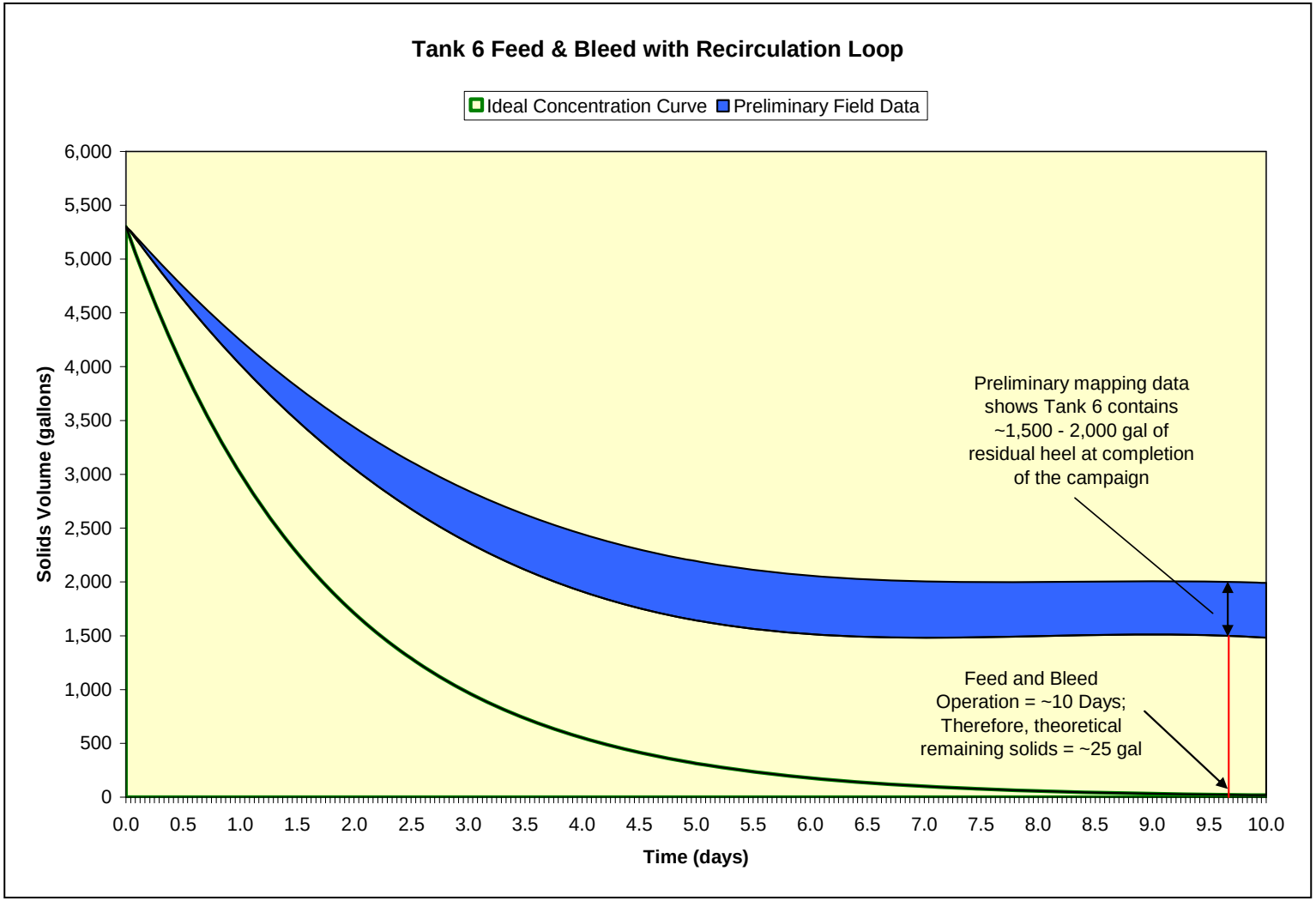
The recirculation transfer pump is operated at approximately the same rate as the existing transfer pump to the receipt tank (~100 gpm) to maintain a constant level in Tank 6.



Feed and Bleed with Recirculation Process (Tank 6)

- Operational Sequence:
  - Add water to Tank 6 System (i.e., Tank 6 plus receipt tank) to support:
    - Operation of the mixer pumps at maximum speed
    - Operation of the receipt tank recirculation transfer pump
  - Begin operation of the mixing pumps
  - Begin transfer from Tank 6 to receipt tank and receipt tank to Tank 6 at ~100 gpm
  - Shutdown receipt tank to Tank 6 transfer
  - Continue transferring from Tank 6 until the transfer pump cavitates
  - Inspect and repeat operational sequence

Tank 6 Results



Conclusions

- Successfully implemented the feed and bleed process in two stages:
  - In Tank 5 as an open system using well water as the filtrate
  - In Tank 6 as a closed system using a recirculation line and low-activity supernate as the filtrate
- Were able to remove 40 – 60% of the solids that remained after chemical cleaning
- Feed and bleed method was effective at suspending / removing additional insoluble particles in the tanks
  - Heavy particles and tank obstructions still provide a challenge in current waste removal techniques
  - Results achieved in 2.5 days of feed and bleed in Tank 5 are approximately equal to the results achieved after 10 days of operation in Tank 6
- Waste removal activities, from bulk waste transfer through feed and bleed operations, removed >99% of the waste that was stored in these tanks