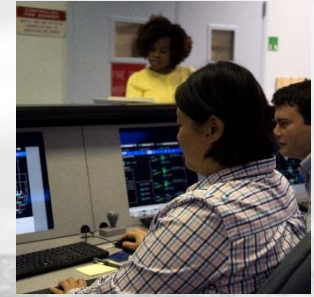




October 28, 2019

TANK 10H BULK WASTE REMOVAL EFFORTS (BWRE)

Larry Romanowski
Waste Disposal Authority



SRR-CWDA-2019-00112

- Inform SCDHEC and EPA of the Bulk Waste Removal Efforts (BWRE) completion for Tank 10
- Preliminary notification of Federal Facility Agreement Appendix L, Item 5 commitment for completion of BWRE for Tank 10 by 11/30/19
- Preliminary notification for requested reuse post BWRE complete for Tank 10, as well as Tank 11, to support Tank 9 BWRE in accordance with Federal Facility Agreement Appendix L BWRE definition

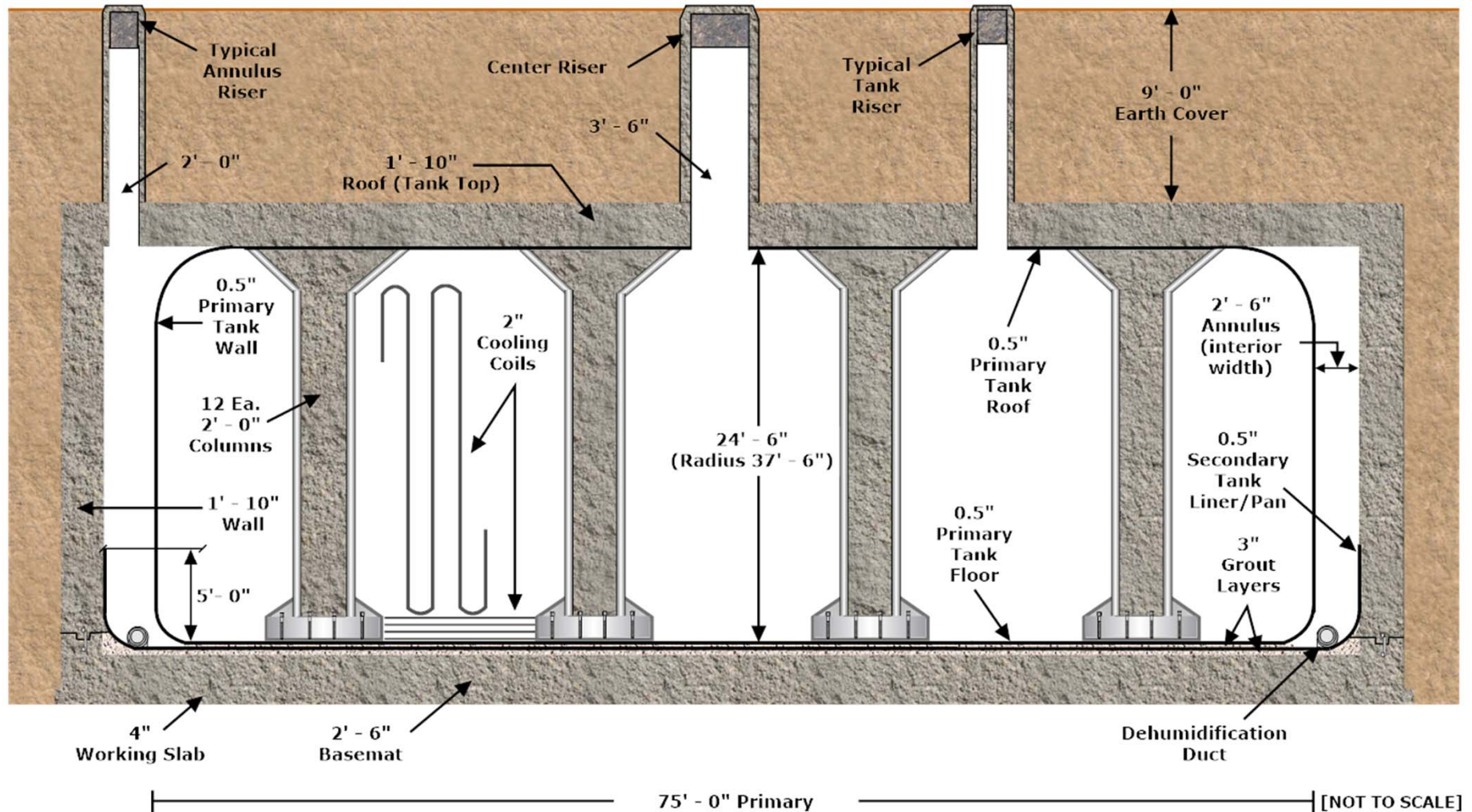
- BWRE milestones are an interim step designed to demonstrate environmental risk reduction and show progress of cleanup activities toward ultimate closure
- The Federal Facility Agreement states in part:
 - DOE will determine when BWRE are complete
 - DOE will keep SCDHEC/EPA informed throughout the waste retrieval activities

Per the Federal Facility Agreement,

- Completing efforts to remove the bulk of waste (waste includes salt, sludge solids, and contaminated liquids) from a tank leaving only a residual heel;
- Sufficient liquid may be added subsequent to this point to facilitate heel cleaning and removal; and
- Any further addition of contaminated liquids after completion of BWRE may occur with concurrence by SCDHEC and EPA.

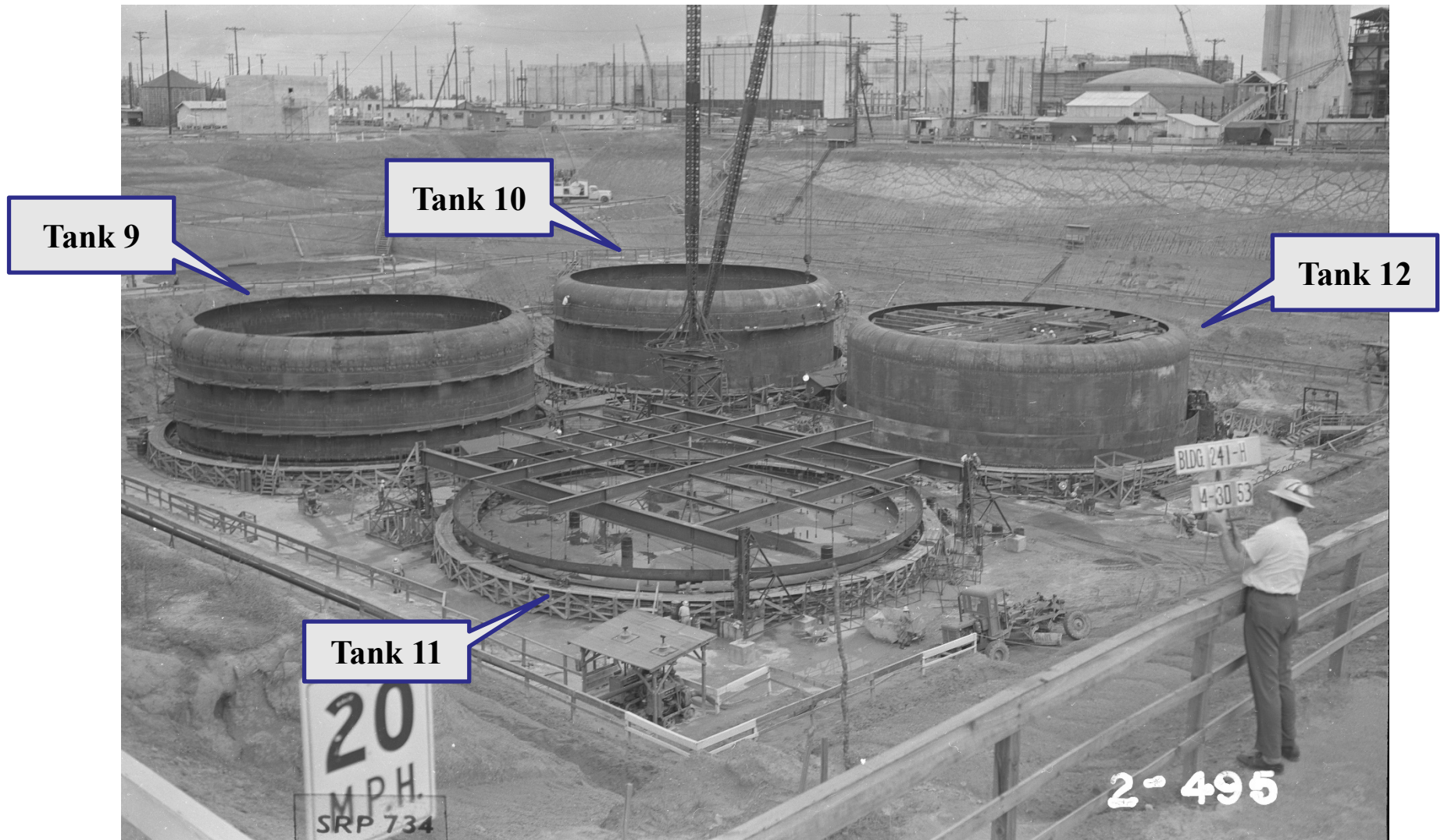
- BWRE reduce the risk of storing waste in old-style tanks on an interim basis
- BWRE reduce the risk of storing waste in any tank by transferring that waste to the appropriate treatment (sludge or salt processing)

Tank 10 - Type I Tank Design



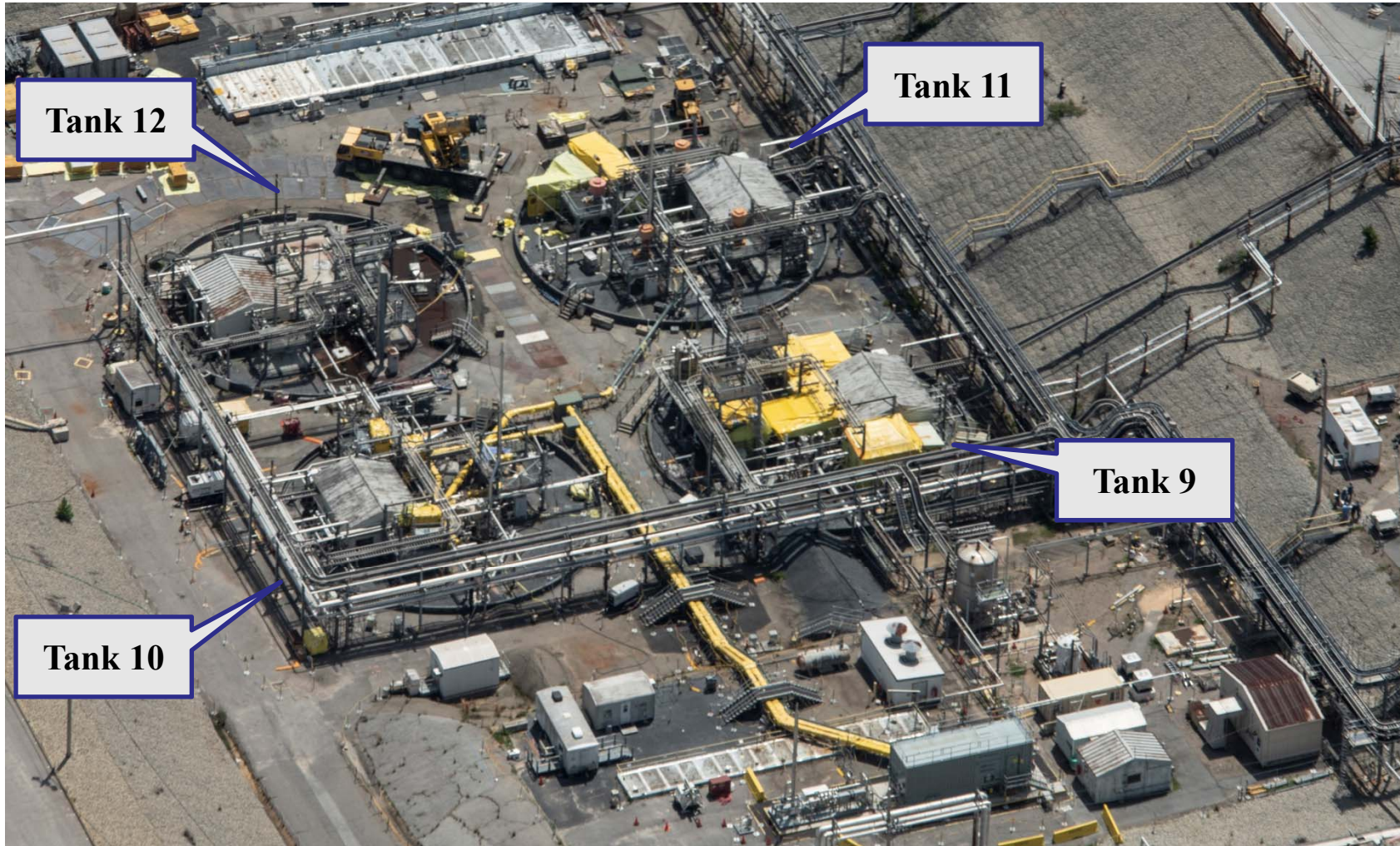
Nominal working capacity: 750,000 gallons
For a Type I Tank, 1" of waste equals 2,710 gallons

H-Tank Farm Type I Tanks



- During construction in 1953

H-Tank Farm Type I Tanks



- Recent aerial photograph

- Constructed between 1951 and 1953
- Received first waste in 1955
- Received H-Canyon waste from 1955 through 1959
- Maximum historical waste level in 1959
 - 268" or ~726,000 gallons (combination of sludge and supernate)
- Waste removal performed in 1967
- Served as 242-H (1H) Evaporator concentrate receipt tank from 1967 through 1974
 - Saltcake level reached an estimated 186" or ~500,000 gallons
- Waste storage / waste retrieval activities 1974 to present
- Tank 10 has at least one known leak site (location unknown)

- There are 2 -3 inches (760 - 1,140 gallons) of dry salt waste in the Tank 10 annulus*

* ~ 380 gallons/inch

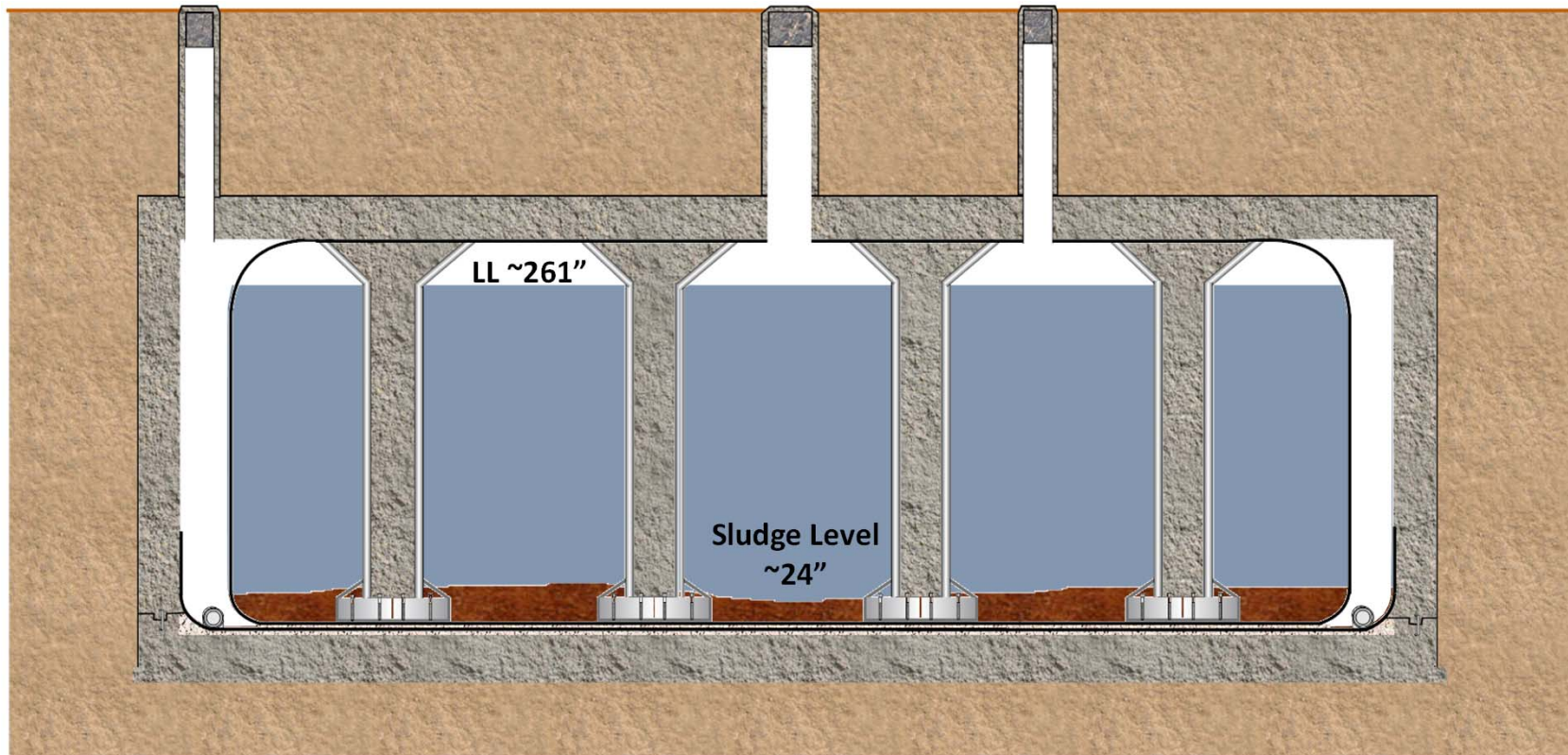


[C-ESR-G-00003]



[C-ESR-G-00003]

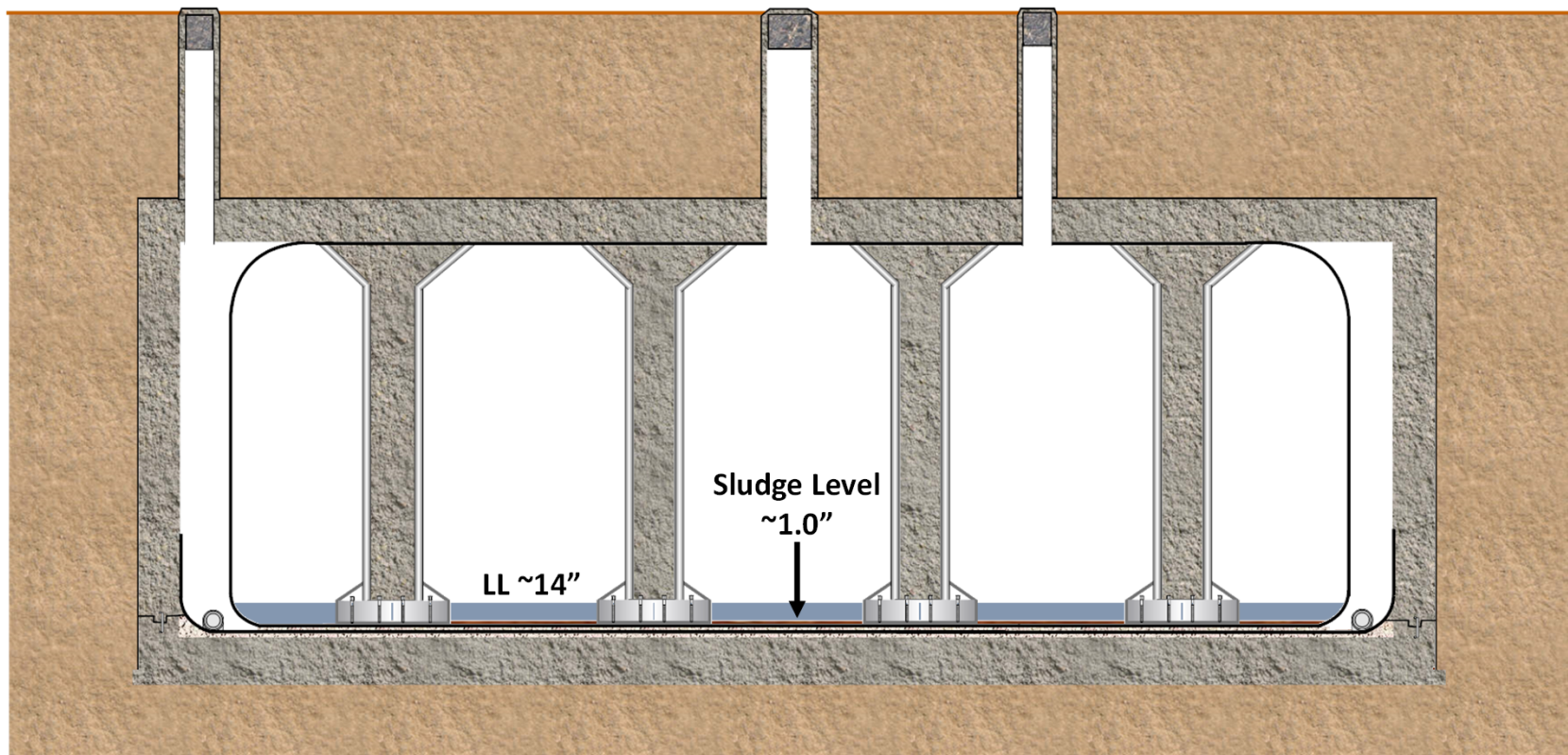
- At the start of Campaign 1 (January 1967)



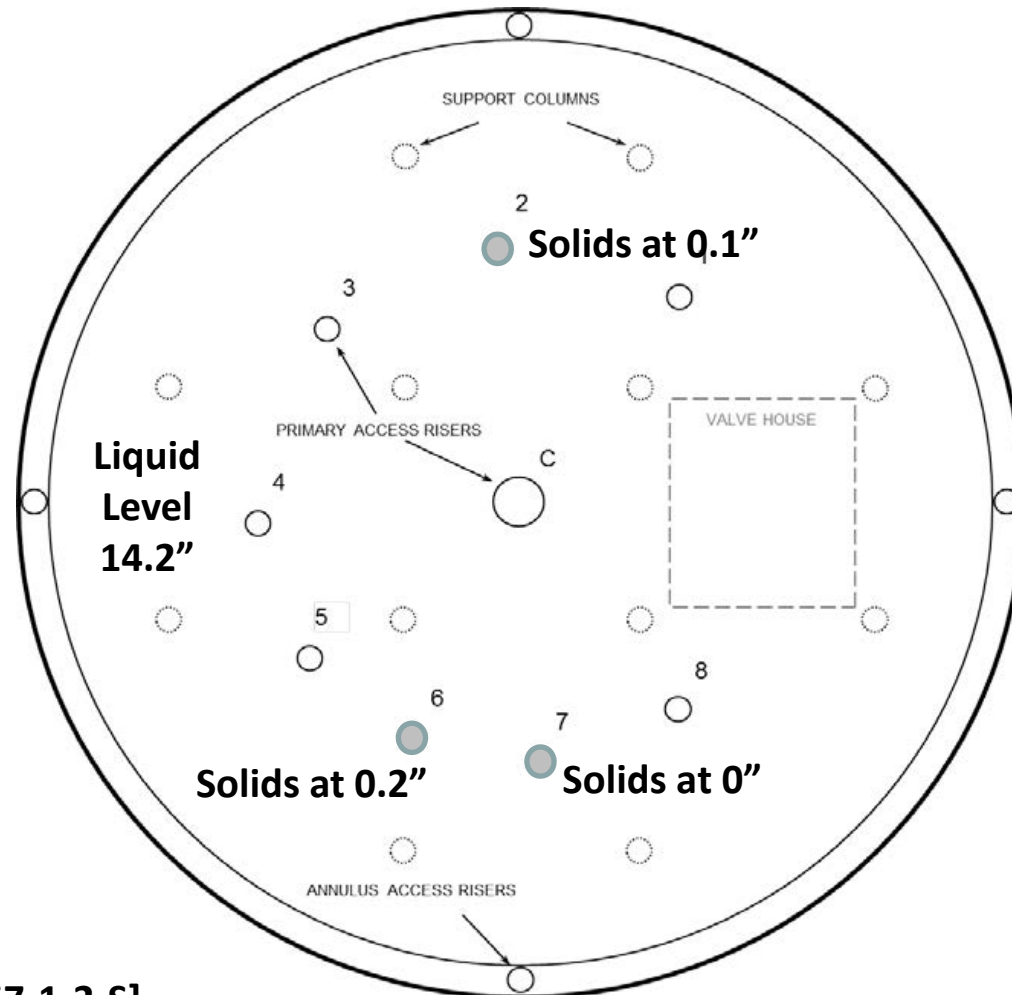
LL - Liquid Level

- Supernate and sludge solids were removed in 1967 to prepare Tank 10 to be a 242-H Evaporator concentrate receipt tank
- Supernate above the sludge solids was removed
- After supernate removal, a single BWRE sludge slurry transfer was made in February 1967
 - Sludge BWRE used five sluicers and multiple transfer pumps
 - Removed ~232,000 gallons of sludge slurry (~63,000 gallons of sludge) [DPSP 67-1-2-S]
- Sludge soundings in February and December 1967 estimated remaining solids levels of less than one inch; approximately 2,700 gallons of sludge/solids remained. [DPSP 67-1-2-S, DPSPU 78-11-11]

- At the completion of Campaign 1 (February 1967)

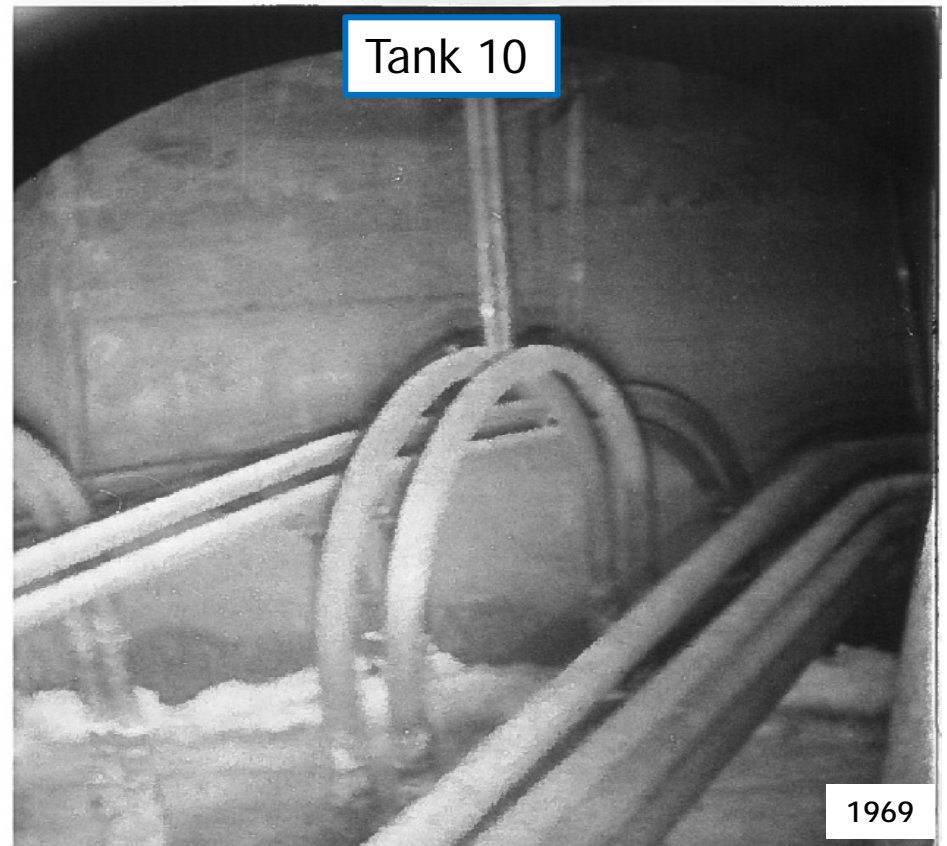
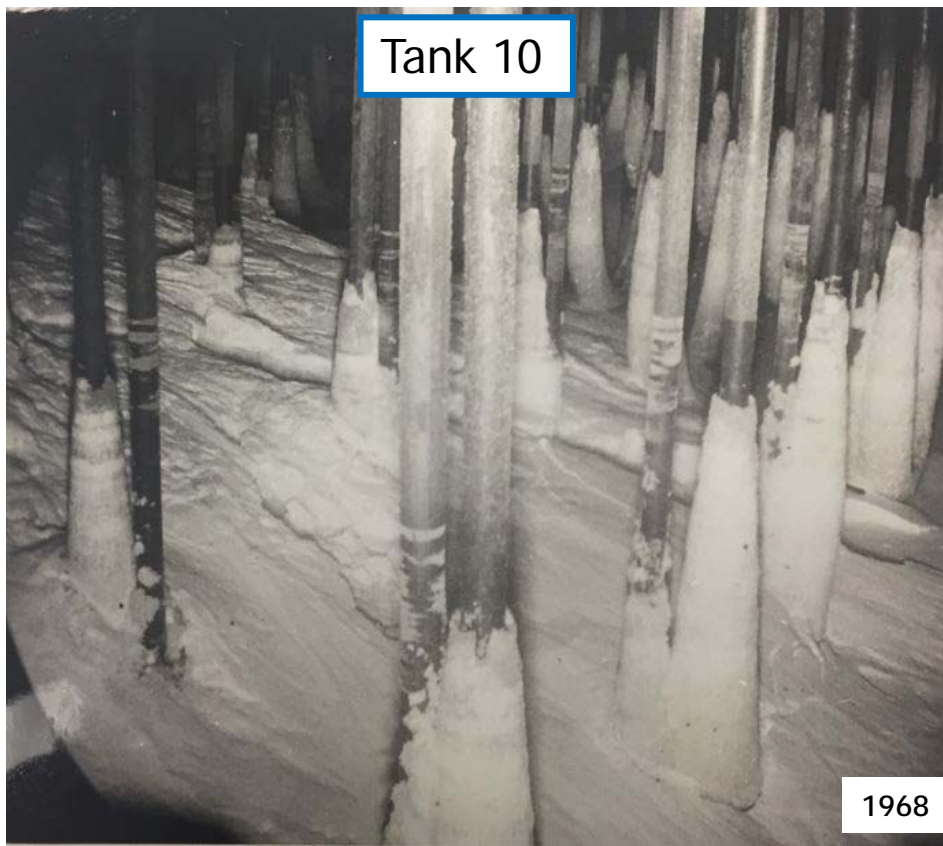


- Soundings after Campaign 1 (February 1967)

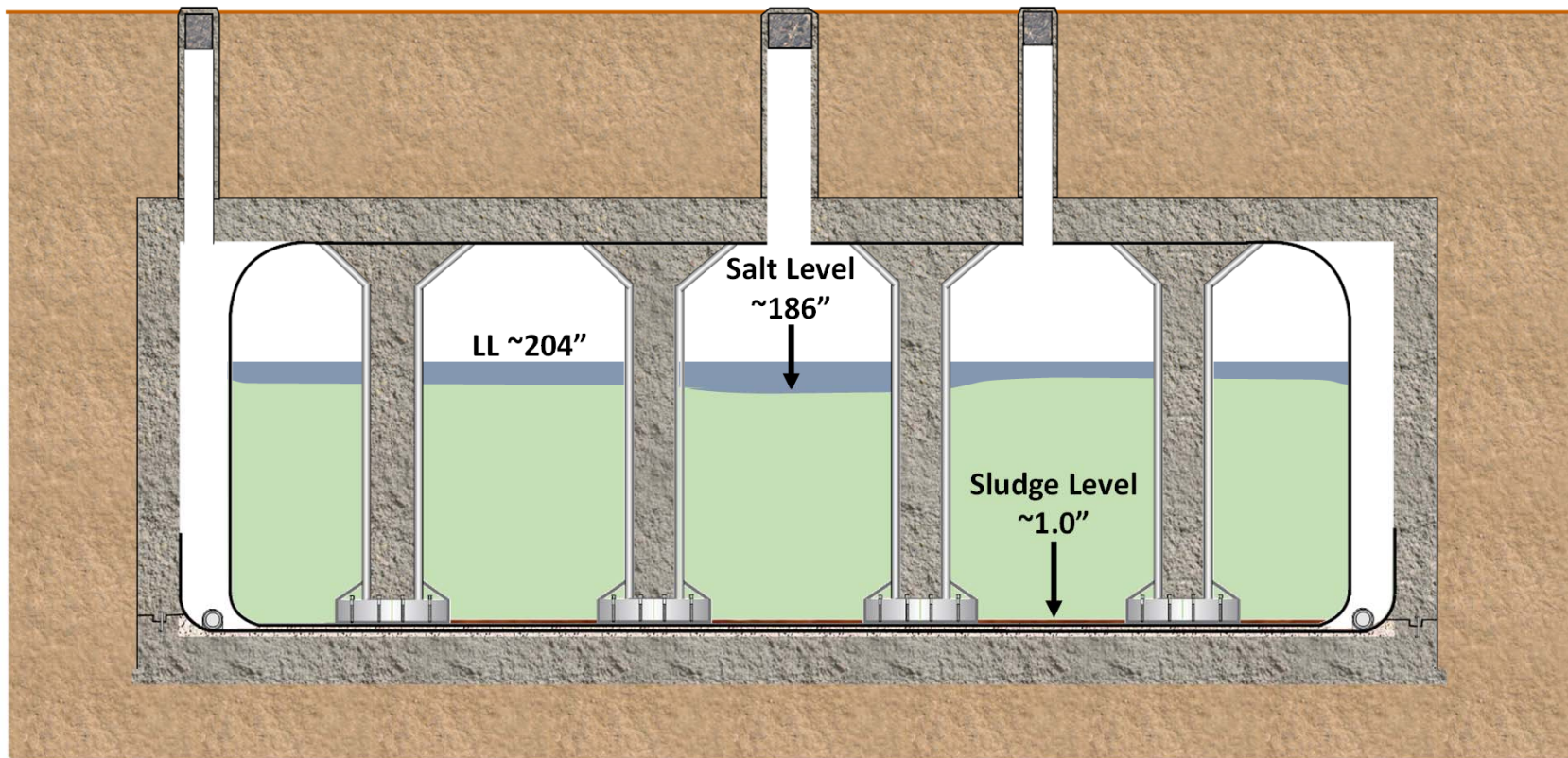


[DPSP 67-1-2-S]

- Saltcake accumulated in Tank 10 while it served as the 242-H Evaporator concentrate receipt tank from 1967 through 1974

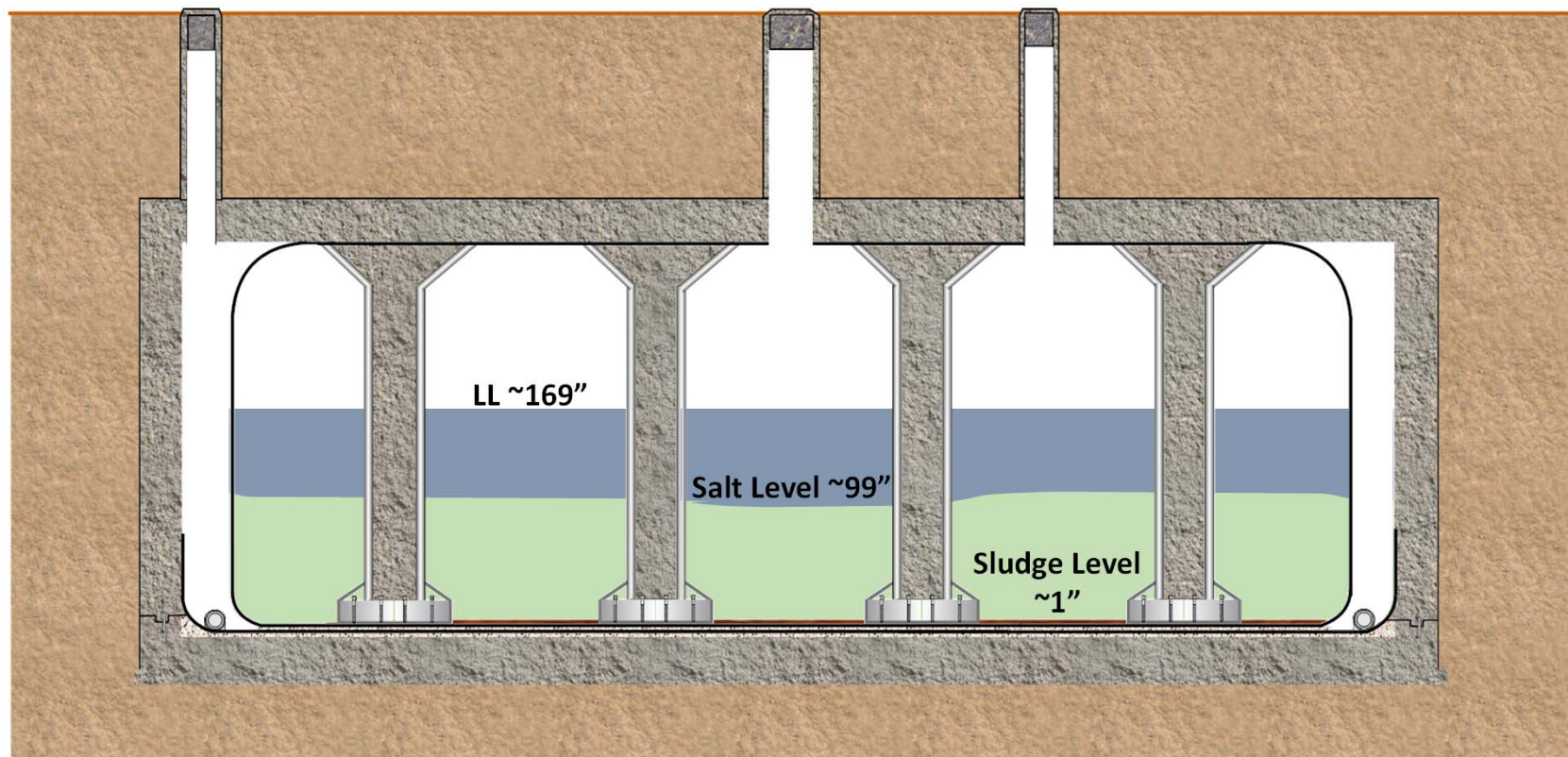


- At the start of Campaign 2 (May 1979)

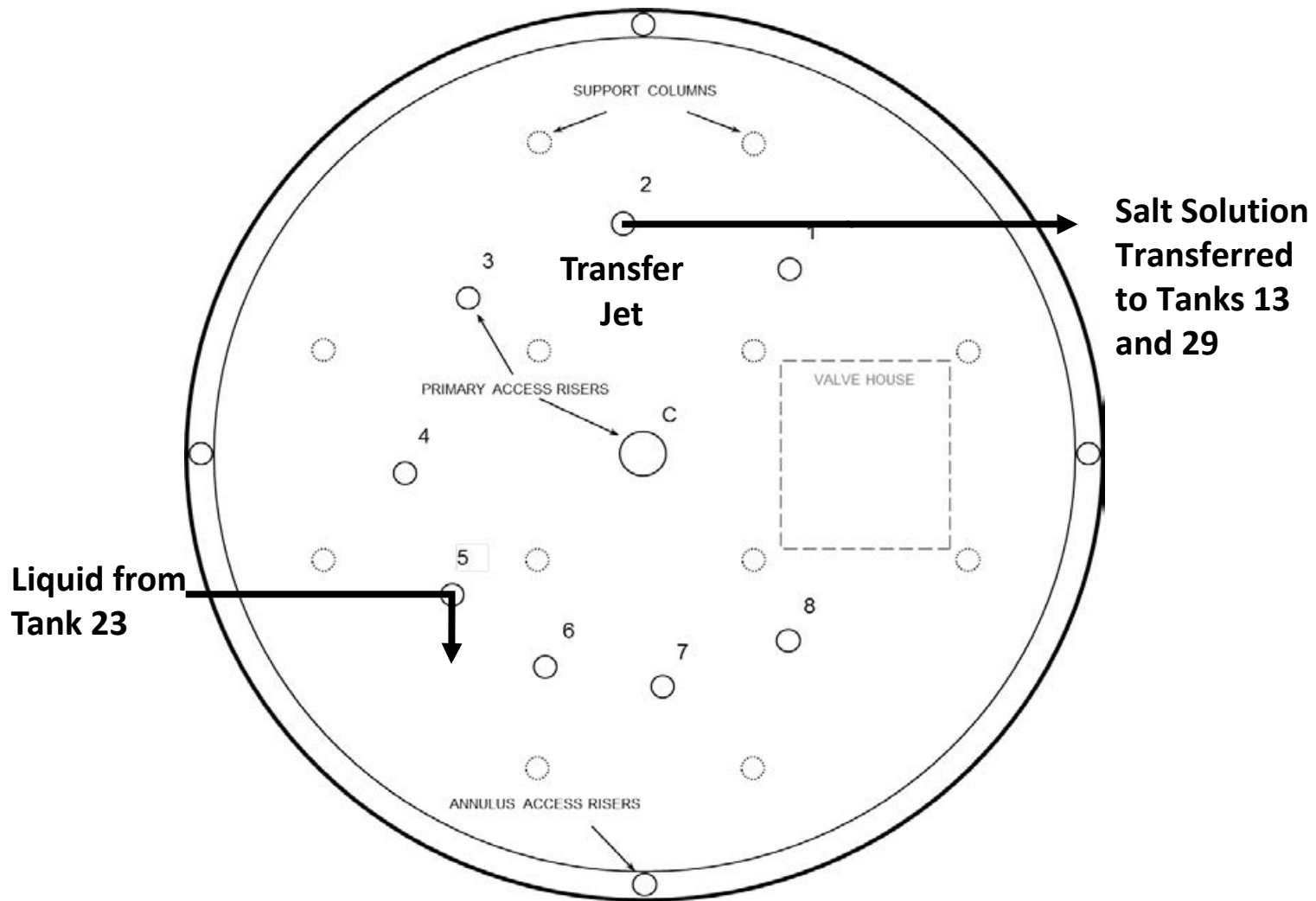


- Saltcake removal demonstration using density gradient dissolution method was performed from 1979 to 1982 [DPSP 79-17-11, DPSP 82-21-11]
- Liquid from Tank 23 was transferred into Tank 10 while a low flow transfer of salt solution was transferred from Tank 10 to Tanks 13 and 29 using a transfer jet that had been mined into the saltcake
- Prior to saltcake removal, it was estimated that Tank 10 contained approximately 500,000 gallons (~185") of saltcake [DPSP 82-21-11]
- An estimated 235,000 gallons (~87") of saltcake were removed during this BWRE campaign [DPSP 83-21-3]
- Approximately 265,000 gallons (~98") of saltcake remained in Tank 10 after Campaign 2

- At the completion of Campaign 2 (November 1982)



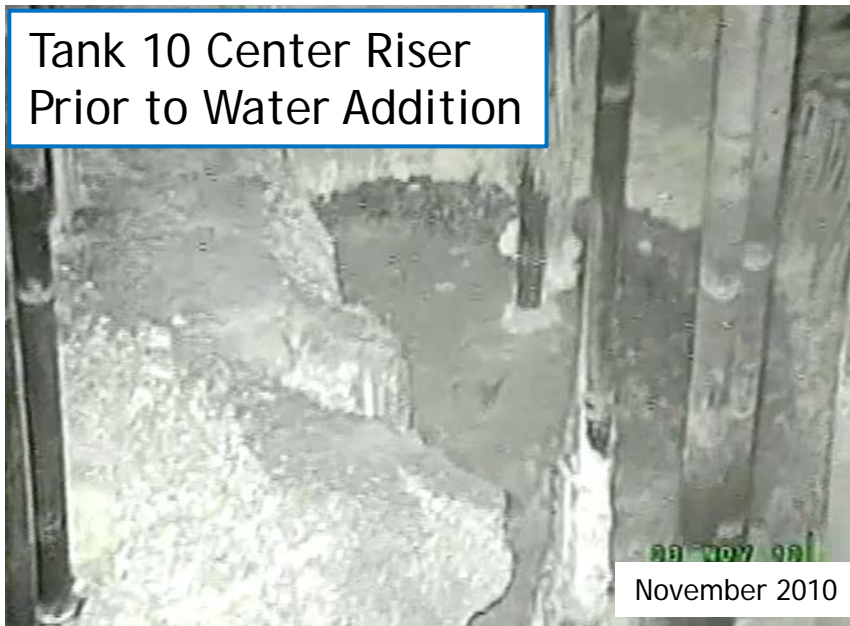
- Salt Removal Process (Density Gradient)



- Following Campaign 2 approximately 300,000 gallons of liquid (water and supernate) was transferred into and out of Tank 10 from the mid-1980's through the early 1990's to support various operational needs [WSRC-TR-93-425]
- These transfers likely removed saltcake from Tank 10, but saltcake removal volume was not assessed
- The change in the saltcake level at the end of Campaign 2 (~99") to the beginning of Campaign 3 (~90") is likely attributed to these liquid additions/transfers

- Saltcake removal resumed using Semi-Continuous Dissolution (SCD) in May 2013
- Well water was added to Tank 10 through three Low Volume Mixing Jets (LVMJs)

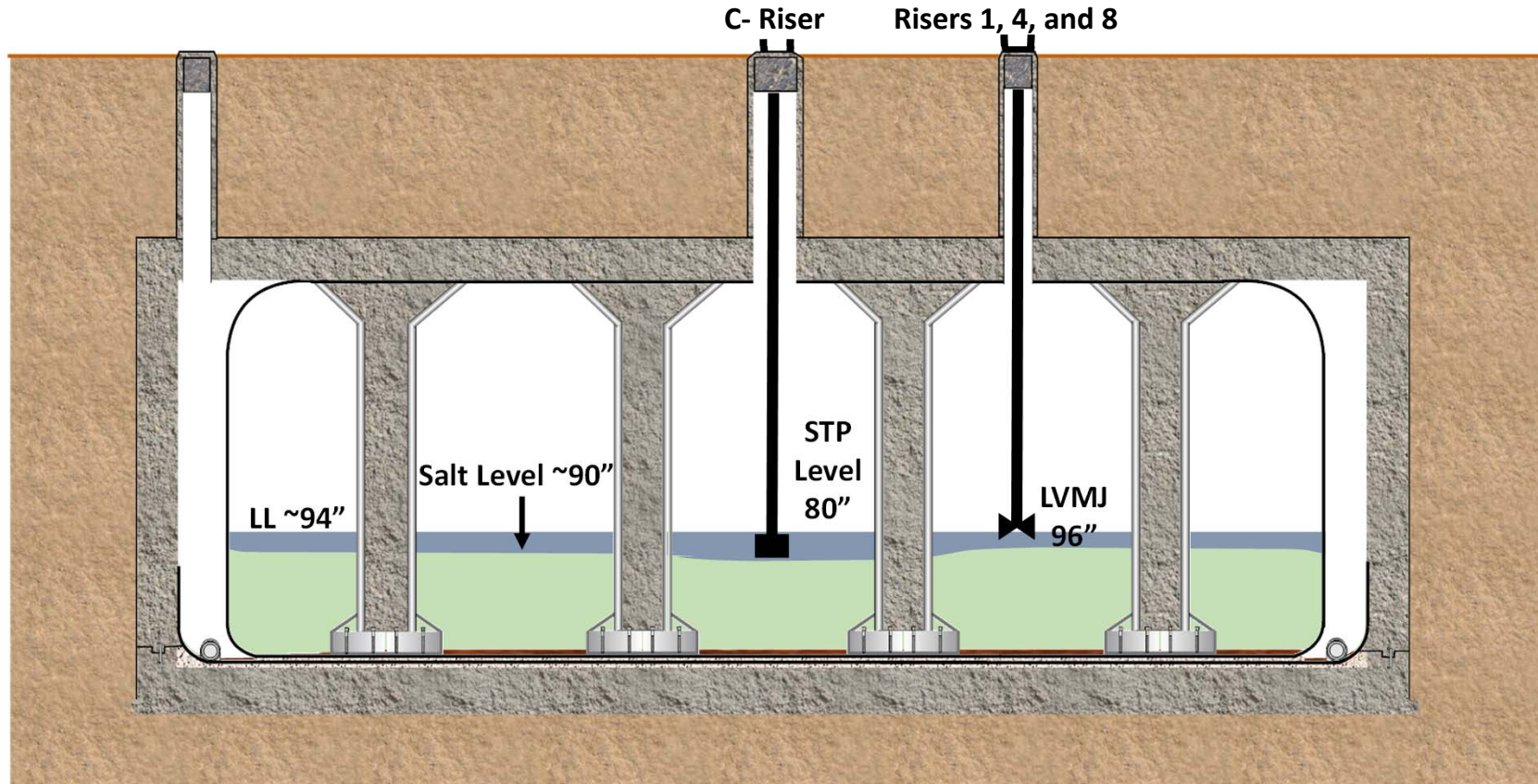
Tank 10 Center Riser
Prior to Water Addition



Tank 10 Center Riser
After Water Addition



- At the start of Campaign 3 (May 3, 2013)



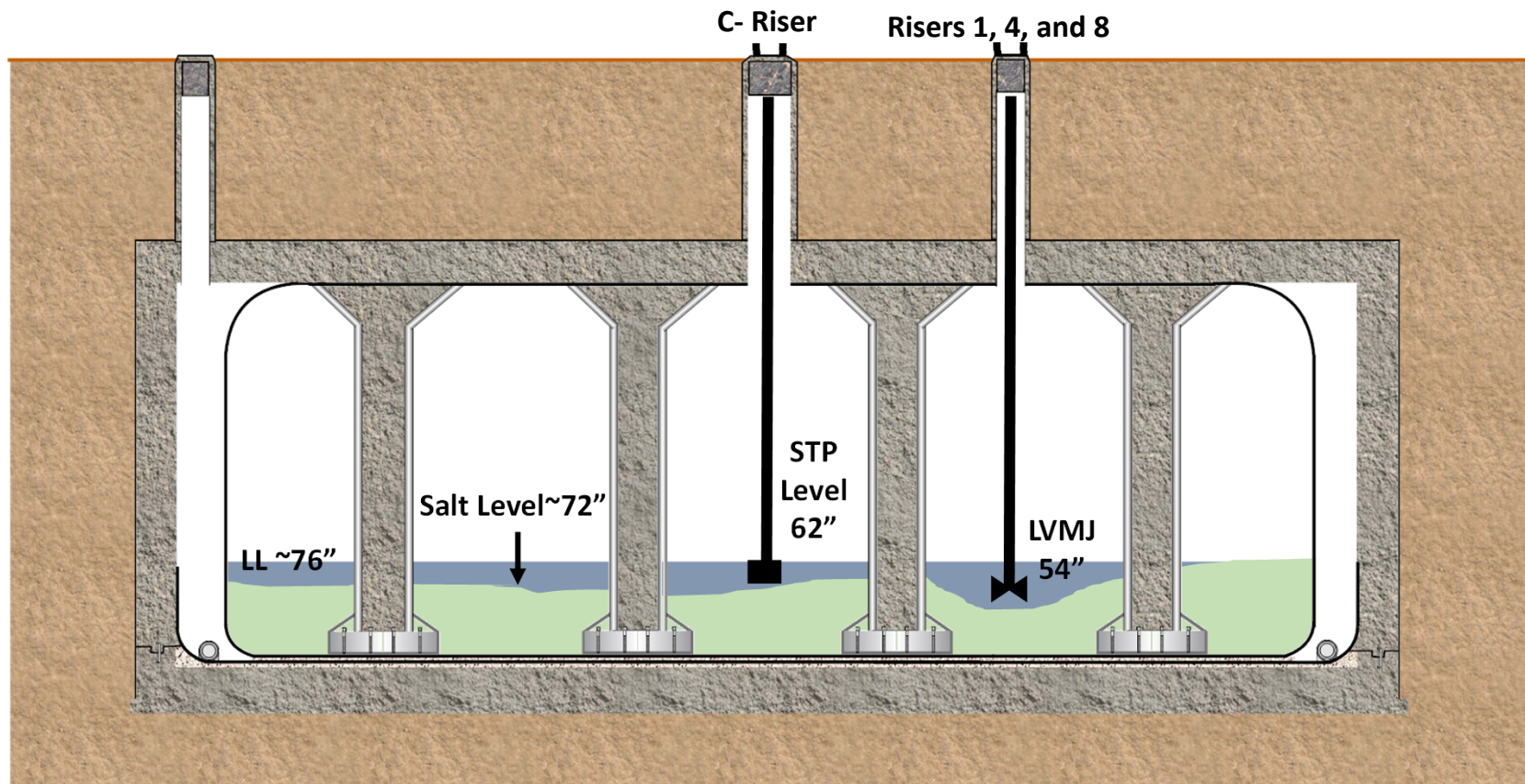
Note: The initial saltcake level represents the final saltcake level after Campaign 3 plus the volume of saltcake estimated to be removed during the campaign.

- A submersible transfer pump (STP) transferred approximately 96,000 gallons of salt solution from Tank 10 to Tank 11 to support Salt Batch 7
- There were no saltcake level measurements or mapping following Campaign 3 [G-TRT-H-00046]
- Based on a saltcake level measurement in October 2014, the SRR Engineering Data Integrity Review Team (DIRT) estimated that the saltcake level was ~72" (195,000 gallons) in Tank 10 after Campaign 3 [G-TRT-H-00046]
- An estimated 49,000 gallons of saltcake were removed [SRR-LWE-2013-00099]
- No waste removal activity after Campaign 3 until November 2018

Tank 10 Riser 3 After
SCD Saltcake Removal

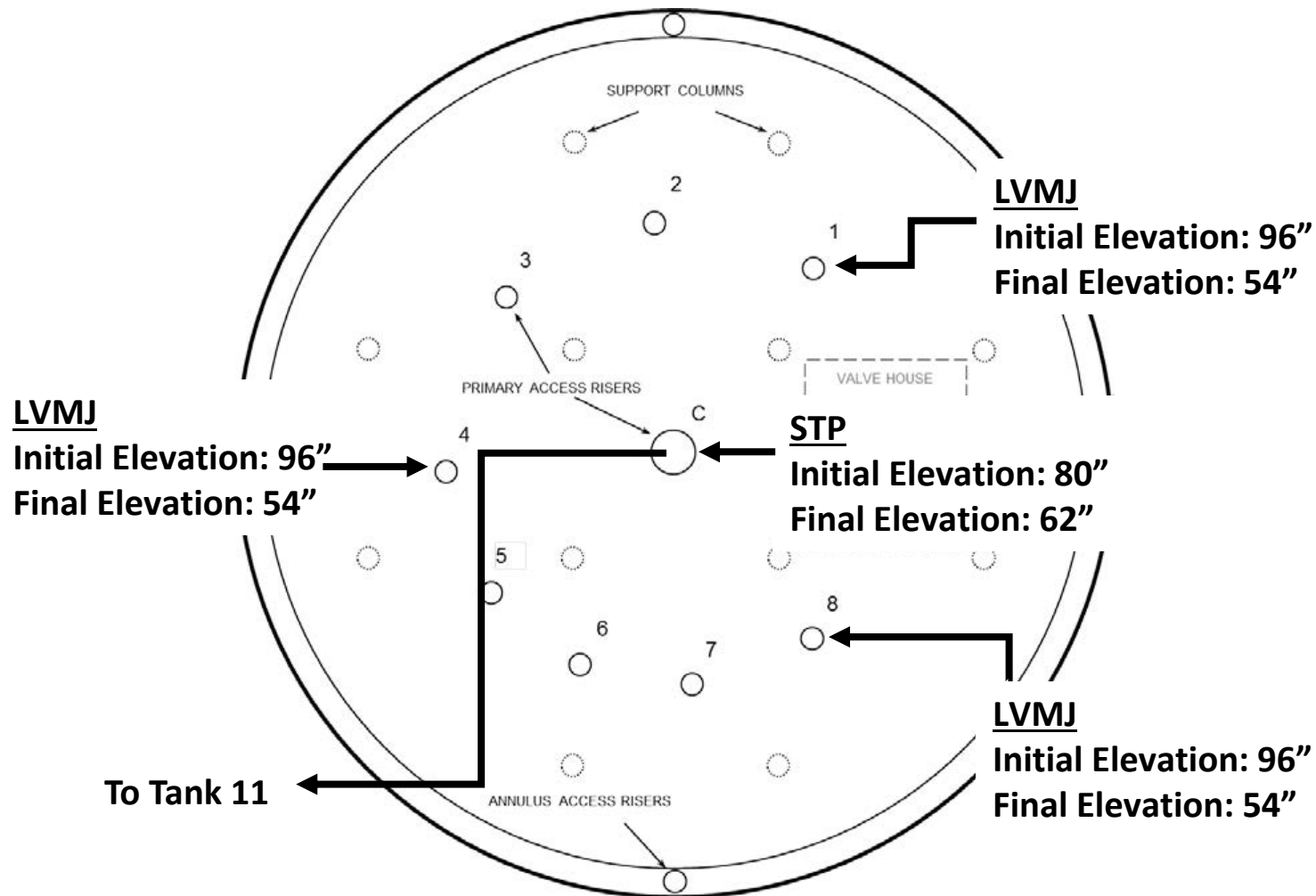


- At the completion of Campaign 3 (May 10, 2013)

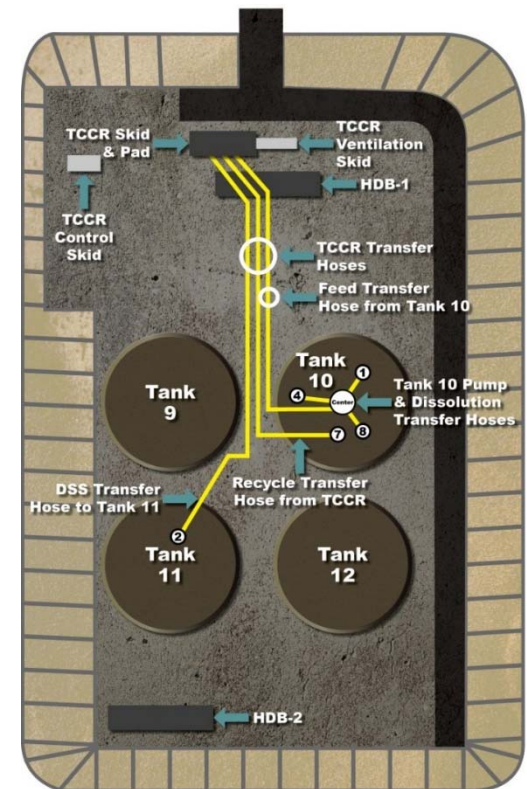


[SRR-LWE-2013-00099, G-TRT-H-00046]

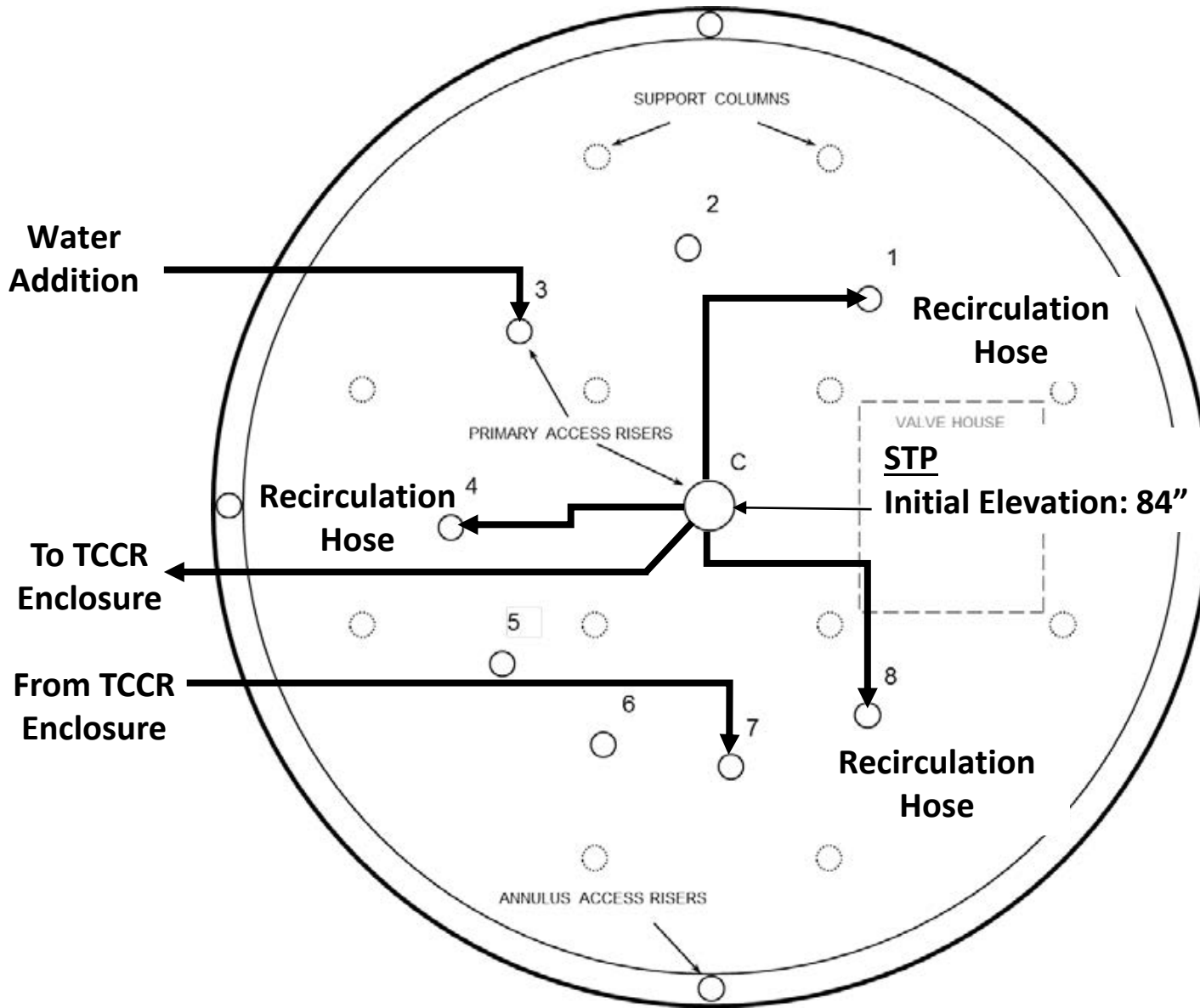
- SCD Saltcake Removal Process



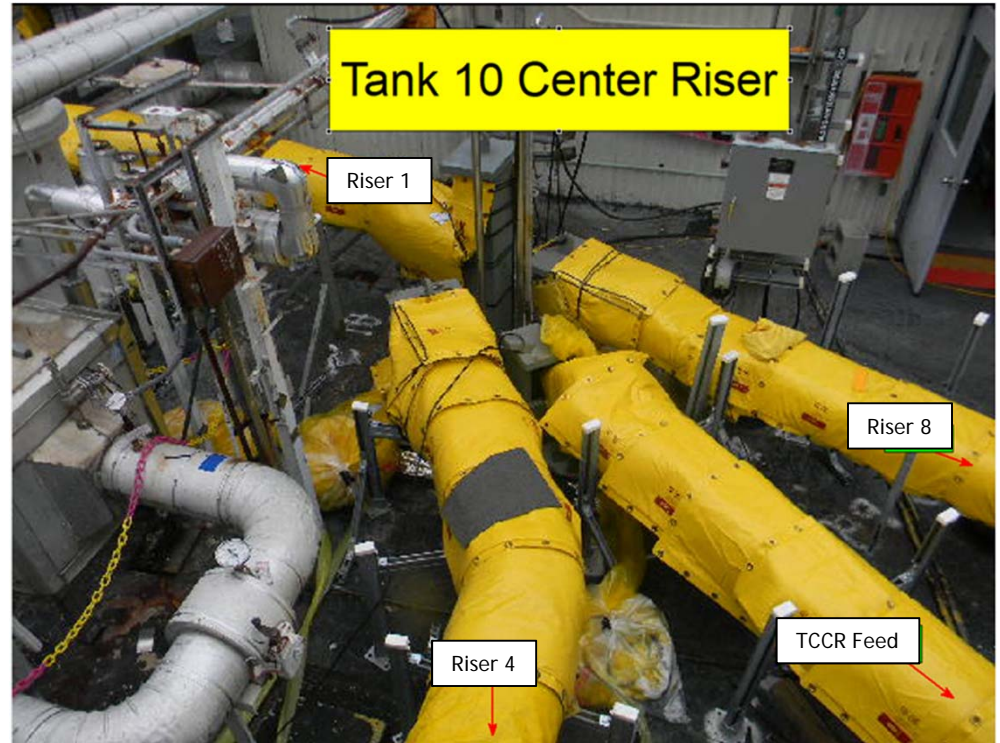
- Tank Closure Cesium Removal (TCCR) was identified as a potential new and innovative salt waste treatment technology in 2015
- Tank 10 was identified to be used as a demonstration tank for the TCCR process
 - Dissolved salt solution from continued BWRE activities in Tank 10 would serve as the feed solution for the TCCR demonstration project (i.e., TCCR Unit 1)
 - No additional waste removal post Campaign 3 during design, procurement, installation and testing of the TCCR process equipment
 - Included equipment installed on Tank 10 to support continued BWRE activities and processing of resulting salt solution through TCCR Unit 1



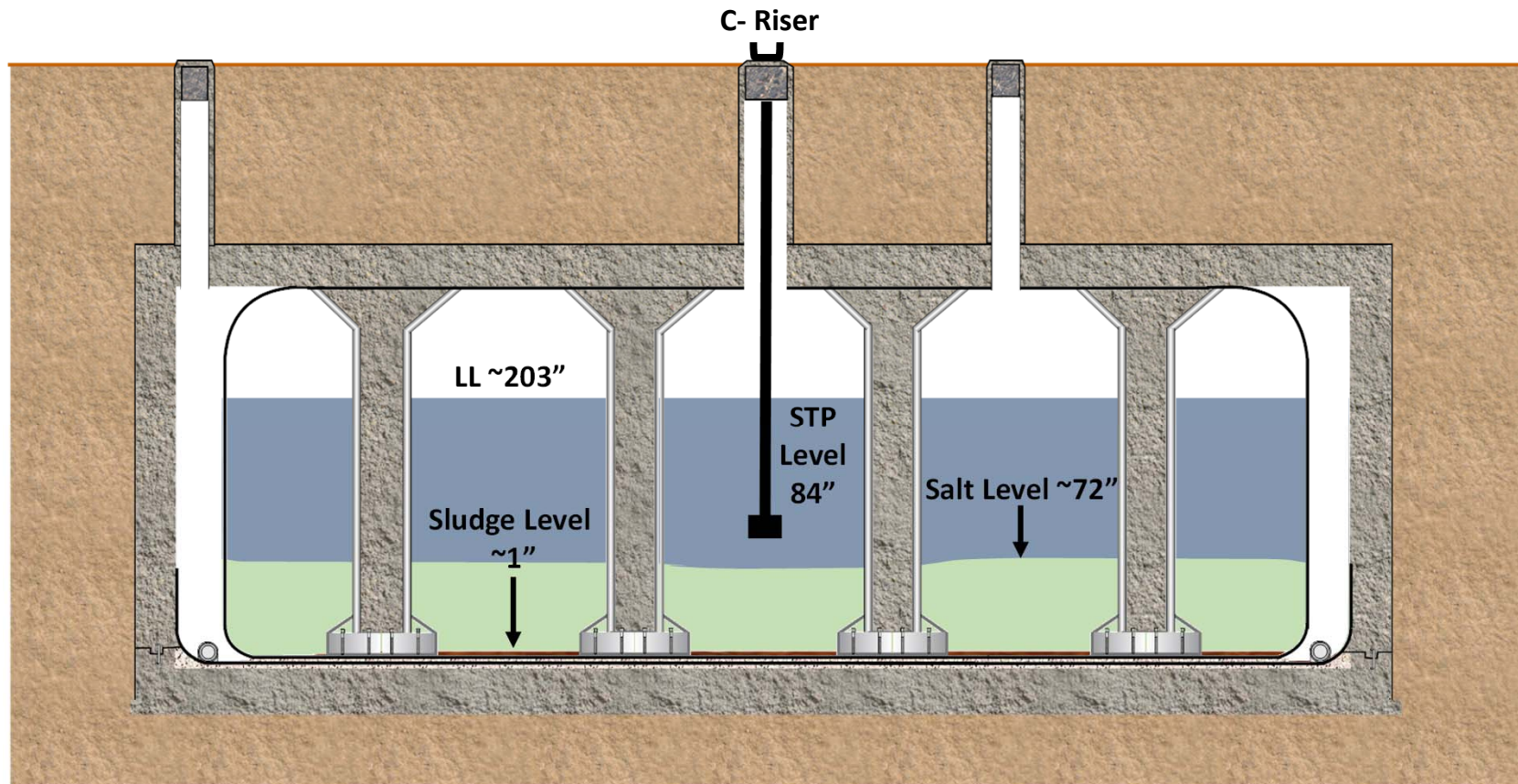
- Tank 10 was equipped with a STP and three recirculation lines that would allow for recirculation of the Tank 10 contents through three different risers simultaneously
- As planned, a typical dissolution “batch” during Campaign 4 would consist of the following major activities:
 - Add water and recirculate
 - Obtain sample and perform batch qualification
 - Process the salt solution batch through TCCR Unit 1
 - Lower transfer pump for next batch, if needed.
- Restart of BWRE activities in Tank 10 began with the addition of approximately 150,000 gallons of well water in November 2018
 - This met the Federal Facility Agreement Milestone to “restart BWRE activities (i.e., water addition) in Tank 10H by 1/31/19”



BWRE History - Campaign 4



- At the start of Campaign 4 (November 2018 after water addition)



[G-TRT-H-00161]

BWRE Campaign 4 - "Batch 1A"

- After the 150,000 gallon water addition, the recirculation system was operated for seven days
- Following recirculation, salt solution was sampled and approximately 17,000 gallons of caustic was added (to condition the batch for TCCR processing) and recirculated for an additional four days
- In February 2019 approximately 152,000 gallons of salt solution was transferred out of Tank 10 and processed through TCCR Unit 1
- Less than expected saltcake dissolution occurred during this initial dissolution batch when compared with results of BWRE Campaign 3
- It was determined that a relatively insoluble layer containing burkeite - a mineral containing sodium, carbonates and sulfates - had been reached in Tank 10 impacting saltcake dissolution

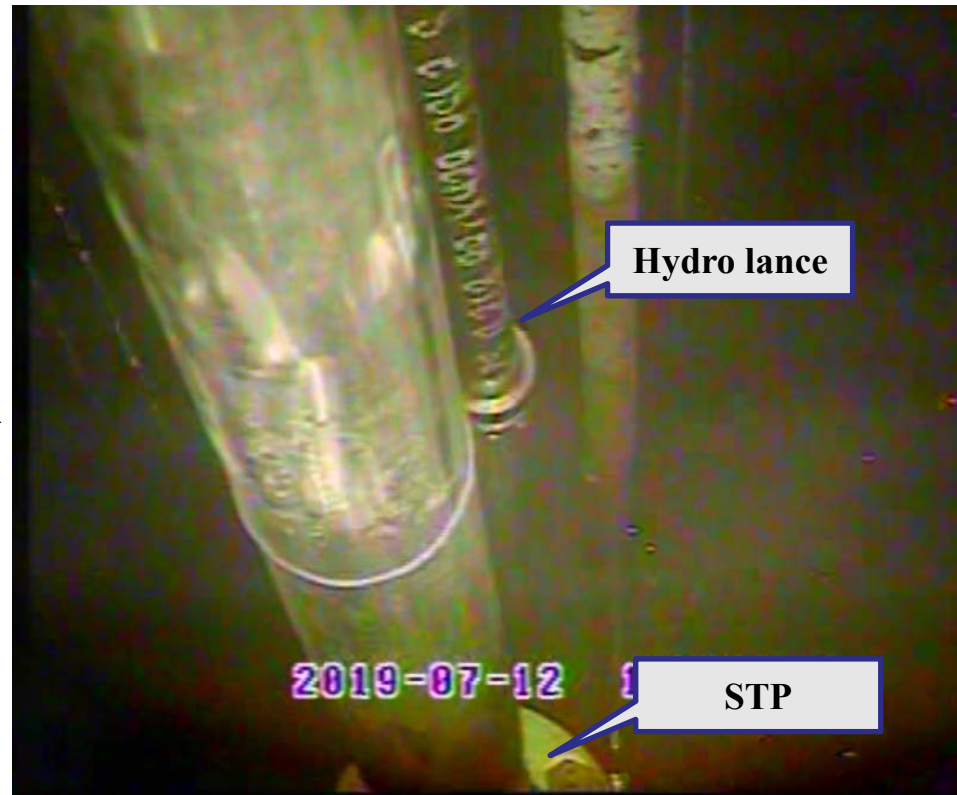
BWRE Campaign 4 - "Batch 2"

- To compensate for the burkeite, the dissolution strategy was adjusted for Batch 2
- Batch 2 began with the addition of two small additions (~25,000 gallons) of domestic water on 2/23/2019 and 3/6/2019. The liquid in Tank 10 was recirculated after the first addition and restarted after the second
- Tank 10 recirculation was temporarily stopped and a specific gravity probe was deployed multiple times between 3/12/2019 and 4/25/2019. Liquid samples were obtained on 3/26/2019 and 4/3/2019. Density measurements/sample results indicated slow progress in saltcake/burkeite dissolution

BWRE Campaign 4 - "Batch 2" (cont'd)

- Recirculation of the Tank 10 contents continued until 4/30/2019
- Based on density measurement/sample results which indicated diminishing dissolution progress, the decision was made to move forward with batch qualification and processing prior to adding additional water to Tank 10
- During June 2019, ~58,000 gallons of salt solution was transferred out of Tank 10 and processed through TCCR Unit 1

- After the completion of Batch 2, preparations to attempt additional saltcake dissolution began in July 2019 with hydro lancing below the Tank 10 transfer pump
- Hydro lancing was performed to contact/dissolve saltcake under the burkeite layer and allow for lowering of the STP to potentially improve dissolution rates during recirculation
- Following hydro lancing, the Tank 10 transfer pump was lowered to approximately 56 inches from the tank floor

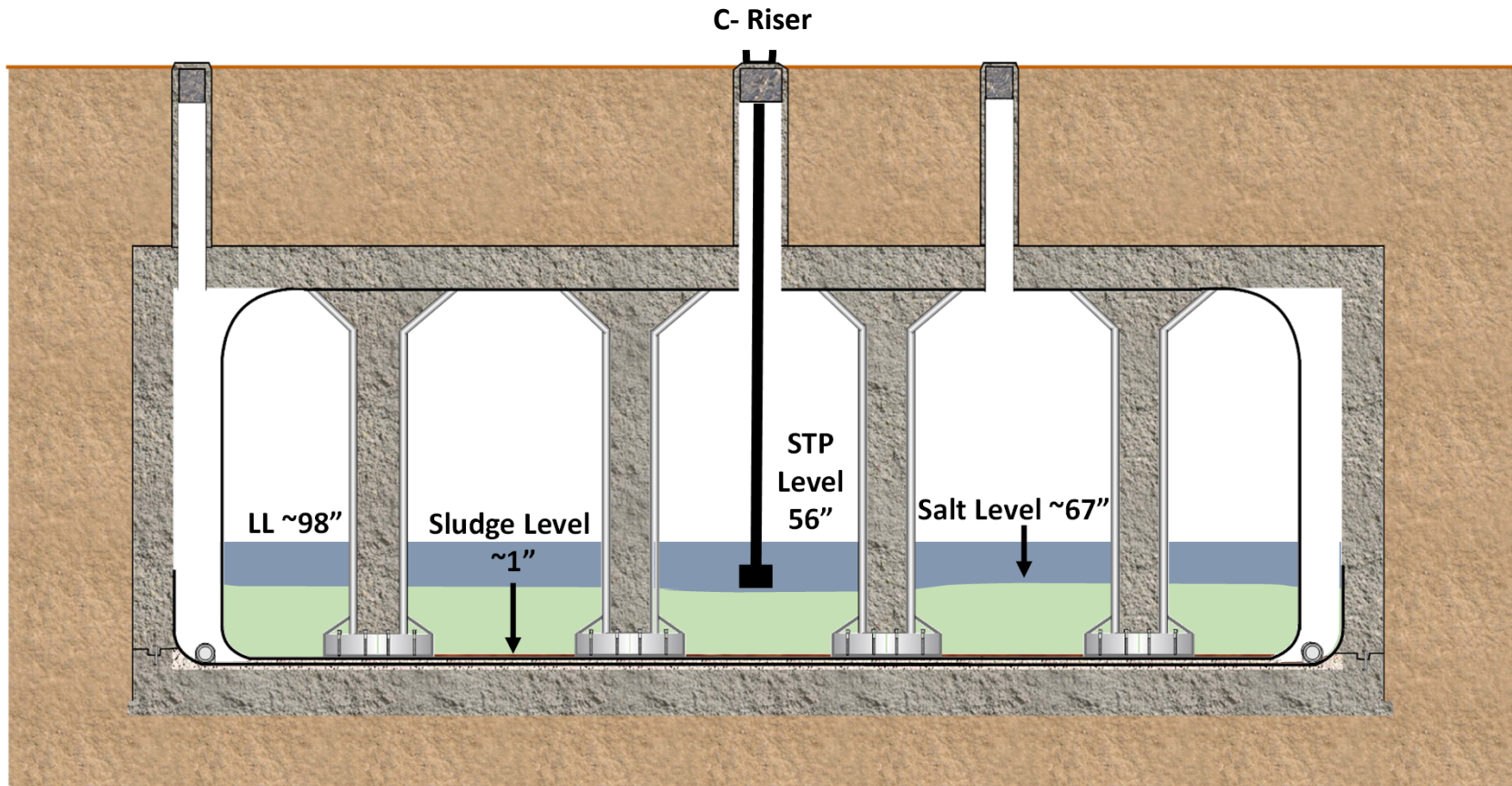


- Two small additions (~25,000 gallons) of domestic water to Tank 10 were completed on 7/23/2019 and 7/31/2019
- Recirculation of the liquid was performed after each water addition.
- Density reading within Tank 10 indicated the same slow dissolution progress as was seen in Batch 2
- On 8/8/2019, the STP failed during recirculation operation, no additional water additions or transfers out of the tank have occurred.

BWRE Campaign 4 - Saltcake Levels

- Multiple saltcake level measurements in Tank 10 associated with Campaign 4 indicated varying saltcake levels at multiple locations
- The saltcake level measurements were assessed by the SRR Engineering and it was determined that the average saltcake level prior to Campaign 4 was ~72 inches, and the average saltcake level after Campaign 4 was ~67 inches [G-TRT-H-00161, G-TRT-H-00233]
- Based on measured saltcake levels, Campaign 4 removed approximately five inches of saltcake which equates to approximately 13,500 gallons

- At the completion of Campaign 4 (July 2019)

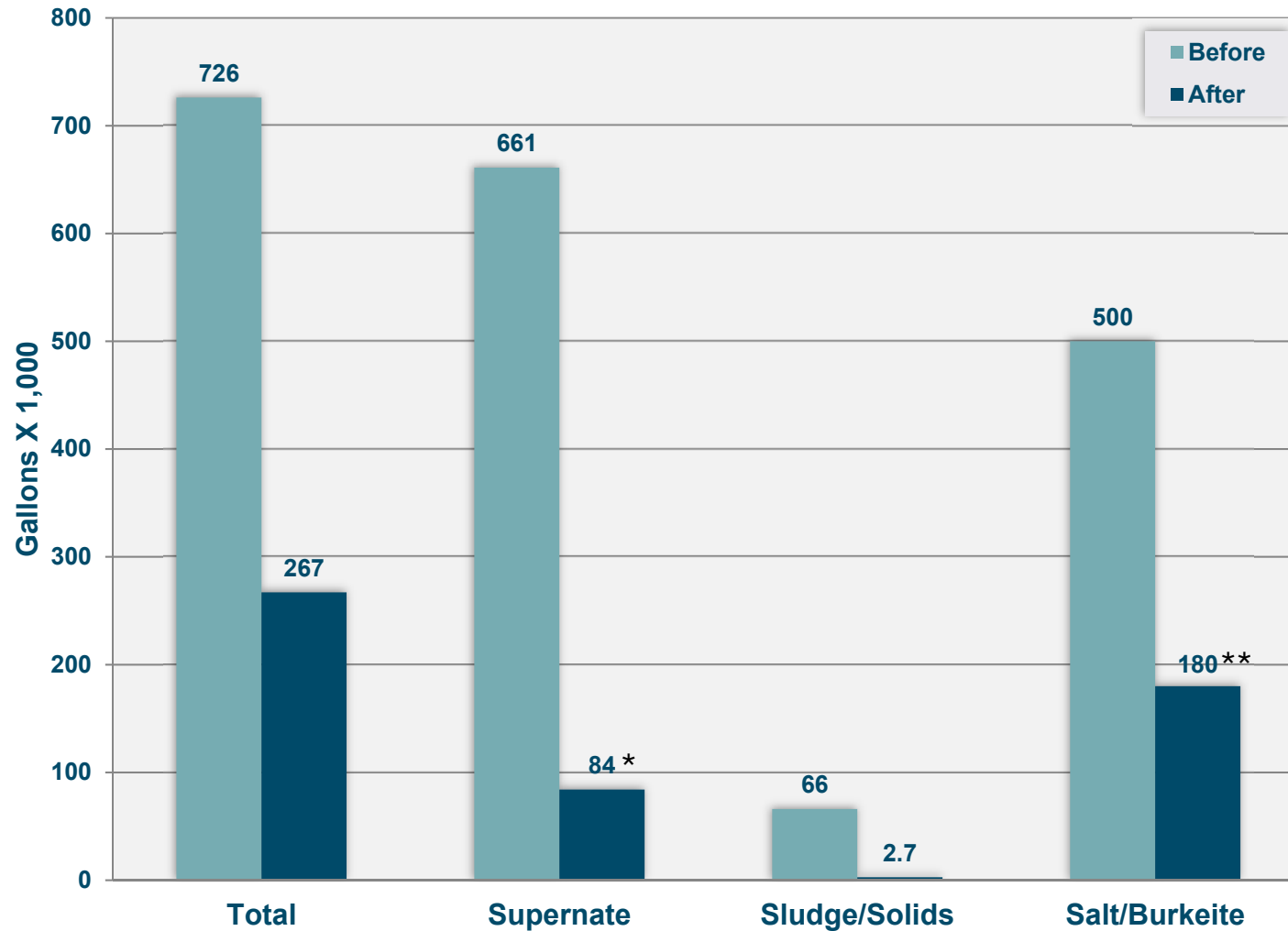


[G-TRT-H-00233]

BWRE Campaign 4 - Summary

- Approximately 210,000 gallons of salt solution was transferred out of Tank 10
- Approximately 13,500 gallons of saltcake were removed leaving a heel of approximately 180,000 gallons (~66 inches) of saltcake/burkeite and 2,700 gallons (~1 inch) of sludge/solids
 - Over a period of eight months, Campaign 4 removed approximately five inches of saltcake using a water addition/recirculation method to dissolve saltcake
- The liquid level remains at 98 inches due to failure of the STP
- A relatively insoluble layer containing burkeite has been reached in Tank 10 impacting saltcake removal; the current saltcake dissolution technique is no longer efficient or effective

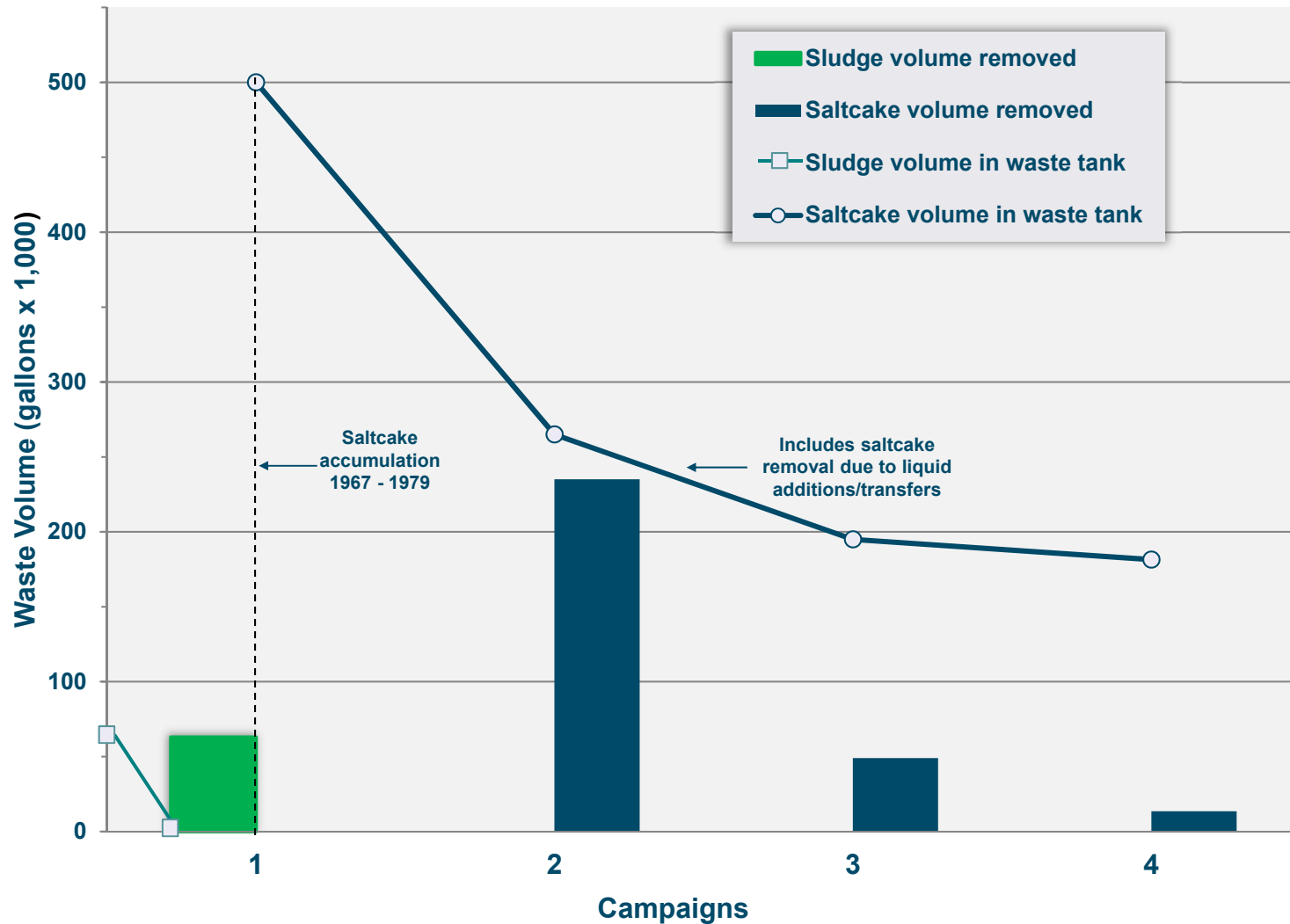
Waste Volumes Before/After BWRE



* Based on 98" Liquid Level

** Includes 1,000 gallons of salt in the annulus

Bulk Waste Removal Campaigns



- **Performed 4 waste removal campaigns**
 - #1 - Supernate and sludge removal
 - #2 - Density Gradient saltcake removal
 - #3 - Semi-Continuous Dissolution saltcake removal with LVMJs
 - #4 - Saltcake removal with recirculation
- **Removed ~63,000 gallons of sludge/solids**
 - Sludge/solids volume at end of BWRE 2,700 gallons
- **Removed ~320,000 gallons of saltcake**
 - Saltcake volume at the end of BWRE ~180,000 gallons
- **Current saltcake dissolution technique is no longer efficient or effective. A more robust dissolution technology (e.g., mixing pumps) will be required to make any significant progress with heel removal in Tank 10**

- Tank 10 STP will be replaced and current contents recirculated
- Design/procurement activities to support installation of two Commercial Submersible Mixing Pumps (CSMPs) in Tank 10 will proceed in parallel with STP replacement
- Tank 10 will support Tank 9 saltcake removal as a receipt tank for Tank 9 dissolved salt solution
 - Based on lessons learned, Tank 9 saltcake dissolution will initially be performed utilizing LVMJs. When adequate saltcake has been removed to support CSMP installation, and LVMJ effectiveness has diminished, CSMPs will be installed to complete waste removal in Tank 9.

- Tank 9 dissolved salt solution will be “batched” and qualified in Tank 10 and subsequently fed to TCCR Unit 1 from Tank 10
- The use of Tank 10 as a batch feed tank for TCCR Unit 1 significantly optimizes the overall salt waste processing capabilities of the TCCR process
- Tank 11 will continue to serve as the receipt tank for TCCR Unit 1 decontaminated salt solution
- Heel removal in Tank 10 utilizing the CSMPs will be closely coordinated with Tank 9 waste removal activities to ensure the most efficient processing of salt waste through TCCR Unit 1 and the earliest completion of all waste removal activities in both Tank 9 and Tank 10

- DOE declares BWRE complete in Tank 10
- In a 2018 update to the SRS Federal Facility Agreement, Appendix L, Item 5 was modified to read:
 - DOE shall complete bulk waste removal efforts for one tank (Tank 15H) by 10/31/17, restart BWRE activities (i.e., water addition) in Tank 10H by 1/31/19, and complete bulk waste removal efforts for Tank 10H by 11/30/19.*
- The completion of BWRE in Tank 10 fulfills the final Tank 10 portion of the milestone
- DOE-Savannah River will transmit the following letters to EPA and SCDHEC
 - Letter notifying EPA and SCDHEC of Tank 10 BWRE completion and requesting concurrence that the final milestone in FFA Appendix L, Item 5 has been met
 - Letter requesting reuse of Tank 10 and Tank 11 post BWRE complete to support processing of Tank 9 dissolved salt solution through TCCR Unit 1

BWRE	Bulk Waste Removal Efforts
CSMP	Commercial Submersible Mixing Pump
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
LL	Liquid Level
LVMJ	Low Volume Mixer Jet
SCD	Semi-Continuous Dissolution
SCDHEC	South Carolina Department of Health and Environmental Control
STP	Submersible Transfer Pump
TCCR	Tank Closure Cesium Removal

- C-ESR-G-00003, Waltz, R. and West, B., *SRS High Level Waste Tank Crack and Leak Information*, Savannah River Site, Aiken, SC, Rev. 15, April 2019.
- DPSP 67-1-2-S, *Separations Technology Section, Works Technical Department Progress Report for February 1967*, March 20, 1967
- DPSP 79-17-11, *Bailey, J. C., Tank 10 Salt Removal Demonstration Details, April 11, 1979*
- DPSP 82-21-11, *Waste Management Programs Report for November 1982*, November 21, 1982
- DPSP 83-21-3, *Waste Management Programs Report for March 1983, March 31, 1983*
- DPSPU 78-11-11, *History of Waste Tank 10 1955 Through 1974, October 1978.*
- G-TRT-H-00046, *10/8/14 DIRT Meeting Minutes*, October 9, 2014
- G-TRT-H-00161, *12/20/2018, 1//17/18 DIRT Meeting Minutes*, February 7, 2018
- G-TRT-H-00233, *7/31/2019 DIRT Meeting Minutes*, August 8, 2019
- SRR-LWE-2013-00099, *Hicks, D. V. , Tank 10 Salt Dissolution Completion in Support of Salt Batch 7*, Savannah River Site, Aiken, SC, Rev. 0, June 18 7, 2013
- WSRC-TR-93-425, *Waste Transfers and Miscellaneous Additions (U)*, Savannah River Site, Revision 1, January 21, 1994