G-AES-S-00004
Revision 0

Future Saltstone Disposal Units Siting

Systems Engineering Evaluation

Savannah River Remediation
AECOM | BECHTEL | CH2M | BWXT

Savannah River Site
Aiken, SC 29808

Prepared for the U.S. Department of Energy Under
Contract Number DE-AC09-09SR22505

DISCLAIMER

APPROVAL PAGE

Prepared By:
Gavin Winship
Facilitator
5/31/18
Date

Approved By:
J.P. THOMPSON
Sergio Mazul FOR S. MAZUL PER TDA
6.5.18
Date

Arthur Stackpole
Arthur Stackpole
Estimating Manager
05JUN18
Date

Noel Chapman
Noel Chapman
Engineering Manager
6/1/18
Date

FOR K.H. ROSENBERGER PER TELECON
Kent Rosenberger
Waste Disposal Authority
6/5/18
Date

Michael Hart
DWPF and Saltstone Operations
6-5-18
Date

Jog Mann
SDU Project Manager
6/4/18
Date

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of Acronyms and Abbreviations

AHP	Analytical Hierarchy Process
DA	Design Authority
DE	Design Engineering
DOE	Department of Energy
DSA	Documented Safety Analysis
DSS	Decontaminated Salt Solution
HLW	High Level Waste
LW	Liquid Waste
SCDHEC	South Carolina Department of Health and Environmental Control
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit
SPF	Saltstone Production Facility
SEE	Systems Engineering Evaluation
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions
SRR	Savannah River Remediation (LLC)
SRS	Savannah River Site
SWPF	Salt Waste Processing Facility
TF	Tank Farm
WAC	Waste Acceptance Criteria

Summary of Revision

Revision Number	Date	Description of Change
A	5/24/18	Issue for team review
0	5/31/18	Issue for Approval

Executive Summary

As Liquid Waste Operation progresses, construction of more Saltstone Disposal Units (SDUs) will be required. Multiple candidate sites exist for future SDUs, each with advantages and disadvantages. The Conceptual Designs for future SDUs must show their planned location, therefore future SDU sites must be selected.

This Systems Engineering Evaluation (SEE) investigates and recommends preferred future SDU sites.

The SEE process used for this evaluation was a structured alternative analysis with weighted evaluation criteria. Ten (10) potential options were initially identified. The evaluation of these 10 options resulted in identifying the four (4) most preferred future SDU sites. Risks were assessed on all four options and the team arrived at a consensus to recommend SDU site options S1, N1, N2 and S6.

An additional observation by the team was that if contaminated soil were not allowed to be disposed of on site and shipping off site was required, there would be little or no impact to the selected options as the volume of contaminated material expected is either small or zero. Three of the selected sites have no known contamination and the 4th site has the least contamination of the remaining sites. Therefore, shipping contaminated material off site will only strengthen the scoring of the sites selected.

This report documents in detail the activities and recommendations of the team.

1.0 Background

SDUs are large reinforced concrete tanks approximately 375 feet in diameter and 43 feet high with a capacity of approximately 33 Mgal. SDUs are constructed in the vicinity of the Saltstone Processing Facility and receive a stabilized grout waste form for permanent disposal. As closure progresses, construction of more SDUs will be required to receive this waste. Multiple candidate sites exist for future SDU sites, each with advantages and disadvantages. The Conceptual Designs for future SDUs must show location, therefore future SDU sites must be selected. In addition, the Performance Assessment (PA) must model all SDUs anticipated by the Program and dose predictions can be impacted by the precise location of each unit.

A team was subsequently chartered to perform a SEE to identify and examine options for future SDU siting and provide a recommendation. This report documents the activities and recommendations of the team.

2.0 Process

The process used for this evaluation was a structured alternative analysis with weighted evaluation criteria. The team used alternative study methods defined in E7 Manual Procedure 2.15 (Reference 5.1) and *Alternative Studies and System Engineering Methodology Guidance Manual*, WSRC-IM-98-000033, Appendix A (Reference 5.2). This methodology is commonly used to select an alternative from two or more options which would be available to meet specific functions, selection criteria, and requirements.

The SEE process is shown in Figure 2-1 and is described in detail within the following sections.

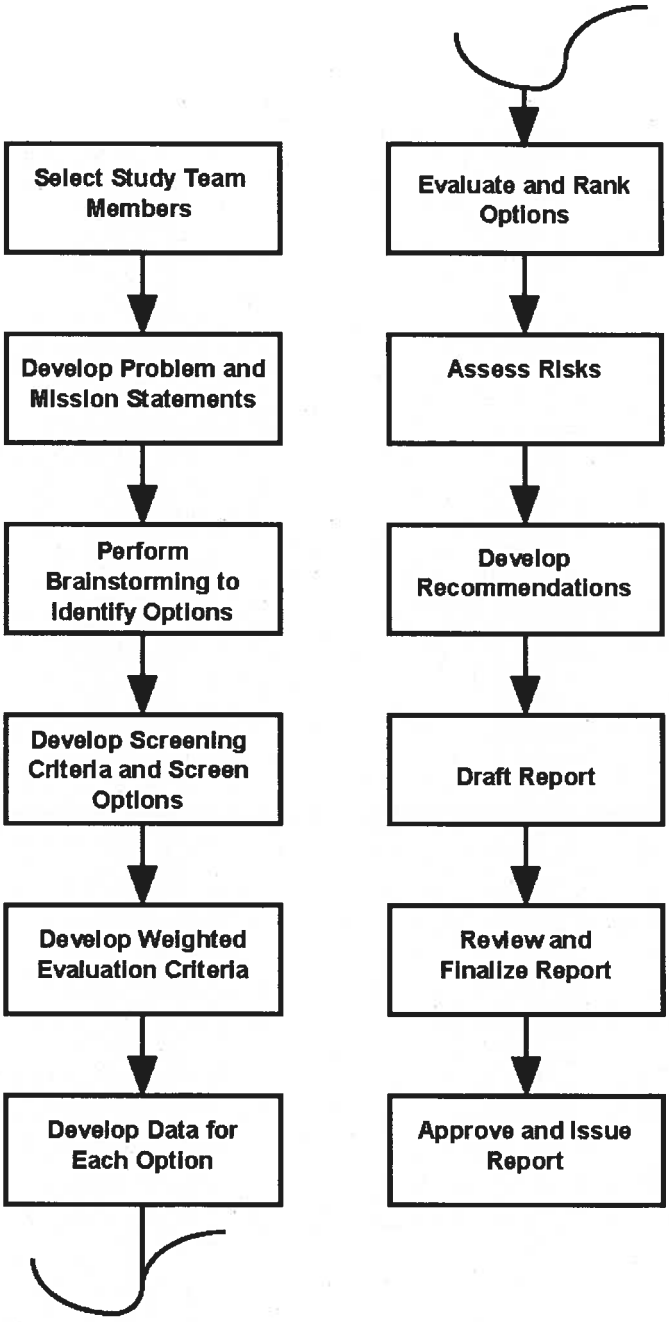


Figure 2-1: SEE Process

2.1 Selection of Study Team Members

The initial activity of the study was to identify SEE team members and resources. SEE team members were selected for their experience, expertise, and history in the design, construction, permitting and operation of SDUs and the Liquid Waste Program at SRS.

The list of SEE team members is shown in Table 2.1-1:

Table 2.1-1: Team Members

Name	Organization
Jon Lunn	SRR SDU Project Manager
Charles Comeau	DOE SDU Federal Project Manager
Sergio Mazul	SRR SDU Project Engineering Manager
J.P. Thompson	SRR SDU Design Authority
Michael Hart	SRR DWPF and Saltstone Operations
Don Baston	SRNS Civil Engineering Lead
Austin Welch	SRNS Civil Engineer
Kent Rosenberger	SRR Waste Disposal Authority
F. Malcolm Smith	SRR Waste Disposal Authority
Art Stackpole	SRR Estimating Manager
Ronny McIver	SRR Project Controls
Noel Chapman	SRR Project Engineering Manager
Will Wigington	SRR Principal Estimator
Jim McNulty	SRR Construction
Gavin Winship	SRR Risk Management (Facilitator)

2.2 Problem and Mission Statement

The initial step of this SEE was to identify and succinctly state the problems associated with future SDU site selection, define a mission and goal for the study. These were defined by the team as follows:

Problem Statement

> **"Multiple candidate sites exist for future SDU sites, each with advantages and disadvantages. The Conceptual Designs for future SDUs must show their planned location, therefore SDU sites must be selected."**

Mission Statement

"Prioritize the potential SDU sites by preference to enable selection of remaining SDUs to be performed."

2.3 Brainstorming

Using the Problem and Mission/Charter statements, the team performed brainstorming to identify potential options. Ten (10) potential option sites were identified (see Table 2.4-1). Location plot plans of option sites are presented in Appendix A (Note: Site N3 is not shown as it was removed during the evaluation process. See Table 2.4-1). Additional information on distances from SPF and pump capacities is presented in Appendix C.

2.4 Screening

A single screening criterion was developed by the team. To consider SDUs outside of the boundary fence and current South Carolina Department of Health and Environmental Compliance (SCDHEC) Landfill Operating Permit requirements would be a paradigm shift which at present is not under consideration as significant legal action may be required with extremely uncertain results. So simply stated the screening criterion was:

> No candidate SDU site location shall have a physical footprint outside the Saltstone boundary fence or current SCDHEC Landfill Operating Permit requirements.

All options passed this initial screening criterion and are summarized in below in Table 2.4-1:

Table 2.4-1: Brainstorming and Screening Results

#	Option	Screening Results	Remarks
SDU-S1	Location per South Site Plan (Appendix A)	Pass	None
SDU-S2	Location per South Site Plan (Appendix A)	Pass	None
SDU-S3	Location per South Site Plan (Appendix A)	Pass	None
SDU-S4	Location per South Site Plan (Appendix A)	Pass	None
SDU-S5	Location per South Site Plan (Appendix A)	Pass	None

#	Option	Screening Results	Remarks
SDU-S6	Location per South Site Plan (Appendix A)	Pass	None
SDU-S7	Location per South Site Plan (Appendix A)	Pass	None
SDU-N1	Location per North Site Plan (Appendix A)	Pass	None
SDU-N2	Location per North Site Plan (Appendix A)	Pass	None
SDU-N3	Located south of N2	Pass	While this option passed screening and was initially ranked with all 10 options, it was removed during the final evaluation to ensure higher ranking options N1 and N2 were evaluated fairly without the negative impacts from N3 as it was clear N3 would not be chosen (see Results)

2.5 Develop Evaluation Criteria

Evaluation criteria were developed based on those specific attributes that the team considered critical to mission success and of specific interest to stakeholders. The evaluation criteria were also considered to be discriminating between options in that each option would vary in how well they perform against each criterion. The evaluation criteria developed by the team and topics associated with the criterion were as follows:

Life Cycle Cost

This criterion addresses the entire cost of the SDU: Project Cost; Operations Cost and Closure Cost. As Operations Cost was directly linked to Operations Impacts this criterion was deleted to avoid double usage. Life Cycle Cost was therefore split into two sub-criteria:

Project Cost

This criterion addresses the total cost of the SDU project. Those SDU locations with a cheaper SDU total project cost will be preferred.

Closure Cost

This criterion addresses the cost of closure for the SDU. For example, sites near the edges of the Saltstone Disposal Facility (SDF) footprint may be more costly to install a closure cap than sites in the middle of the footprint. Those SDUs having lower closure costs will be preferred.

Operations Impacts
This criterion addresses the impacts to operations during construction and SDU filling operation. During construction, the potential for interruption to grout production during SDU construction and related outages is considered. During operation of the SDU impacts are amplified as the distance of a candidate SDU site from the Saltstone Production Facility (SPF) increases, e.g., operator time required to attend to a site, the amount of infrastructure requiring maintenance such as new booster pumps, and existing equipment capacity such as the grout pumping and pigging operation, etc. The lower potential for operations impacts the more preferred the alternative.

Performance Assessment Preference
Certain sites will be preferred based on known aquifer flow paths and distance from the point of compliance.

2.6 Data Development

After the development of the evaluation criteria, options were investigated further and matured to provide an understanding of how they would perform for each of those criteria. The data developed for the options are presented in Appendix B.

2.7 Evaluation

A software package specifically designed for alternative analyses was used to perform the evaluation. The software, Expert Choice Pro© provides an analytical platform capable of recording data in the form of weighted criteria and scoring and performing a synthesis of these data to arrive at rankings. Secondary features are the ability to modify criteria weights and show in real time, ranking changes. Using the data developed for each option and weighted criterion, the options were scored, ranked, and a sensitivity analysis performed. After interpreting the results, risks were assessed for top options as discussed below.

2.7.1 Criteria Weighting

After the completion of criteria development, an analysis hierarchy was developed using Expert Choice Pro© . A pairwise comparison process was used to weight the evaluation criteria during which the preference of each criterion was compared against criterion of that level. The preference was arrived at by team consensus. The software provided a visual representation in each of the preference decisions, an example of which is shown in Figure 2.7.1-1:

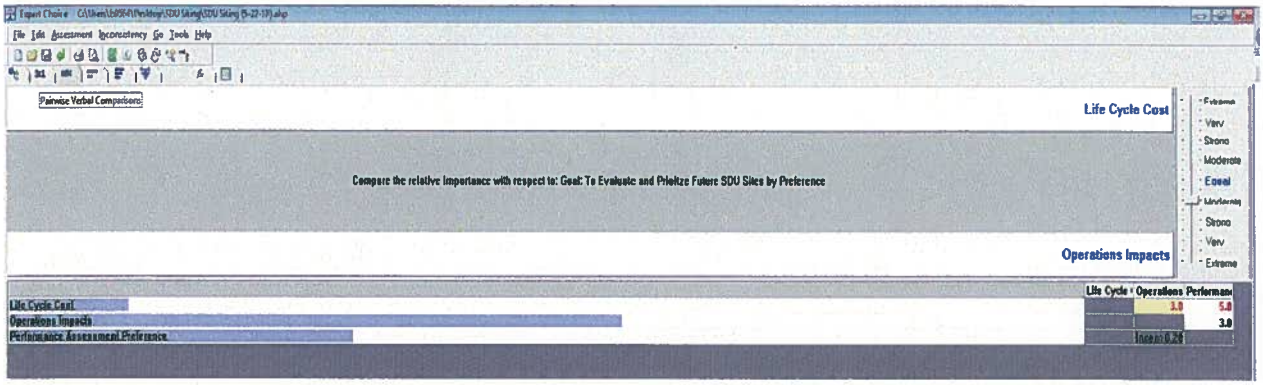


Figure 2.7.1-1: Pairwise Comparison Input Screen

The resulting hierarchy and criteria weights are shown in Figure 2.7.1-2:

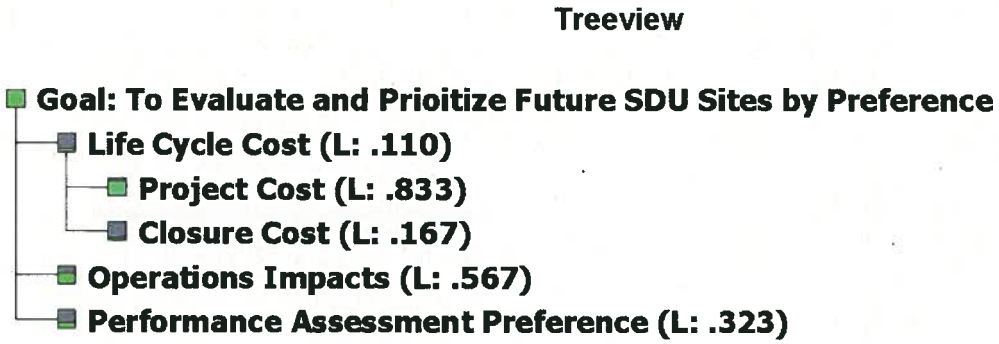


Figure 2.7.1-2: Analytical Hierarchy and Criteria Weights

Operations Impacts were weighted highest as impacting Saltstone production during construction or having frequent or extended outages during operations which could result in SWPF being forced into an outage with significant impact to the overall System Plan.

Performance Assessment Preference was the second most weighted criterion. While all of the options will be deployable, it is important to select sites that maximize both the margin to dose limits and flexibility to accommodate potential future design changes or changing field conditions.

Life Cycle Cost was the lowest weighted criterion as when Life Cycle Cost is compared to the cost incurred to the Program from operational impacts or regulatory delays. Within Life Cycle Cost, the project cost was weighted more than the future closure costs as yearly funding for the Liquid Waste Program is not unlimited and is generally constrained by continuing resolutions which can have significant impact on New Start Project Authorizations and schedule performance.

2.7.2 Scoring

As with the criteria weighting process, pairwise comparisons were made, this time between each option for each of the criterion. These pairwise comparisons recorded how much an option was preferred or not preferred over each of the other options. This was repeated for each evaluation criteria. The preference judgements were arrived at by consensus of the team. Expert Choice Pro© then calculated a score for each of the options based on these pairwise comparisons for each criterion. Each score was then multiplied by the weight of that criterion and summed to give a total score for each option. The scores were used to develop a ranking of options.

2.7.3 Ranking

The results of the option ranking is shown in Figure 2.7.3-1:

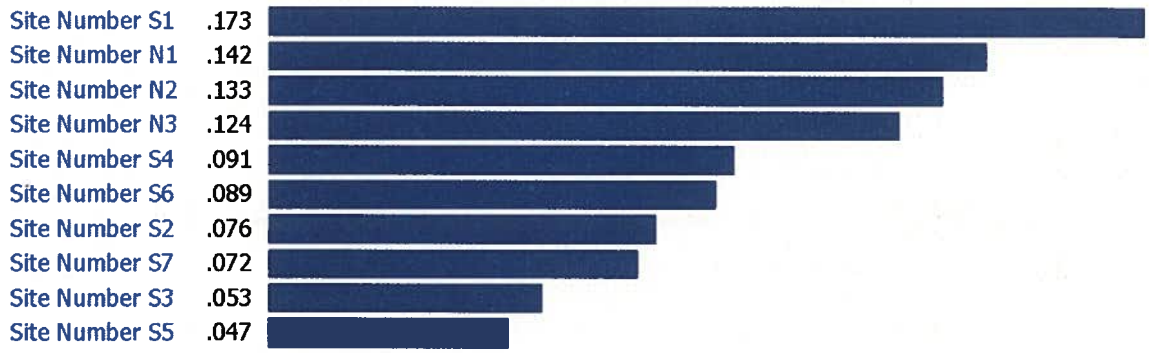


Figure 2.7.3-1: Option Ranking

As can be seen from Figure 2.7.3-1, Option S1 is the highest-ranking option.

2.7.4 Sensitivity Analysis

A model's results are considered robust if evaluation criteria weights can be altered by ± 10% and the top ranking option(s) is not displaced. A sensitivity analysis was performed by increasing and decreasing the weight of a single criterion, resulting in the increase or decrease being proportionally distributed to the other criteria. This changed the scores of the options. It was observed that significant weight change (greater than 30%) was required to displace any of the top three options.

This model and result were therefore considered extremely robust.

3.0 Results

The Analytical Hierarchy Process (AHP) evaluation results show that Options S1, N2 and N3 are the top-ranking options. The team discussed potential interactions of these SDUs with each other and determined there was no detrimental interactive effect from the sites chosen. Based on modeling the entire set of options, S1 was selected as the most preferred option. S1 through S4 have a significantly positive influence on meeting PA performance objectives. However, after a single S1 through S4 location was selected, the PA impact was drastically reduced. Thus, the team arrived at the consensus that S1 will be recommended, and furthermore the remaining options should be re-evaluated for the criterion of PA preference assuming Site S1 will be used. S1 was removed from the AHP to determine the changes to PA pairwise comparison. N3 was also deleted as it was extremely undesirable due to position over the sanitary sewage leach field and infrastructure difficulties and was negatively impacting the second highest ranking options N1 and N2. By deletion of N3, N1 and N2 were also allowed more flexibility in location. This improved the overall scoring for both N1 and N2 locations.

3.1 Refining Evaluation

The refined evaluation was performed with S1 and N3 removed from the AHP. The results are shown below in Figure 3.1-1:

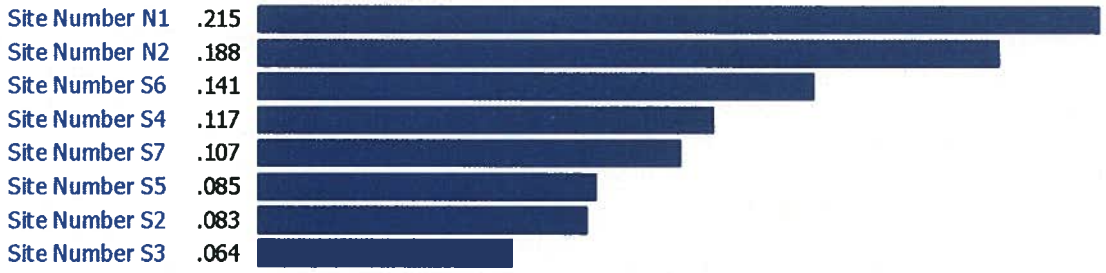


Figure 3.1-1: Option Ranking (Final)

The results of this model showed N1, N2 followed by S6 to be the next most preferred options after S1. Based on both model results the top-ranking set of options are: S1, N1, N2 and S6.

3.2 Risk Assessment

The risks associated with the top-ranking options could have an impact on any recommendation made by the team, therefore an assessment of the risks associated with these options was performed. The identified risks are shown below in Table 3.2-1:

Table 3.2-1: Identified Risks

Option	Risks
S1	• Soil contamination may be greater than the assumed 1200 cubic yards
S6	• No significant risks
N1	• If elevation can be raised, this could tie-in to SDU 8 drainage system thereby eliminating the need for a sump pump (Opportunity) • Laydown areas may be further from construction than assumed. • Operational events may impact construction
N2	• If elevation can be raised, this could tie-in to SDU 6/7 drainage system thereby eliminating the need for a sump pump (Opportunity) • Laydown areas may be further from construction than assumed. • Operational events may impact construction

4.0 Recommendation

It is the recommendation of the team that SDU site options S1, N1, N2 and S6 be used.

An additional observation by the team was that if contaminated soil were not allowed to be disposed of on site and shipping off site was required, there would be little or no impact to the selected options as the volume of contaminated material expected is either small or none.

Subsequent to the meetings a proposal to move the location of N-1 85' to the North was raised with the goal of further improving the PA properties. This proposal was accepted by the team and the location shown for N-1 in Appendix A is the revised location.

5.0 References

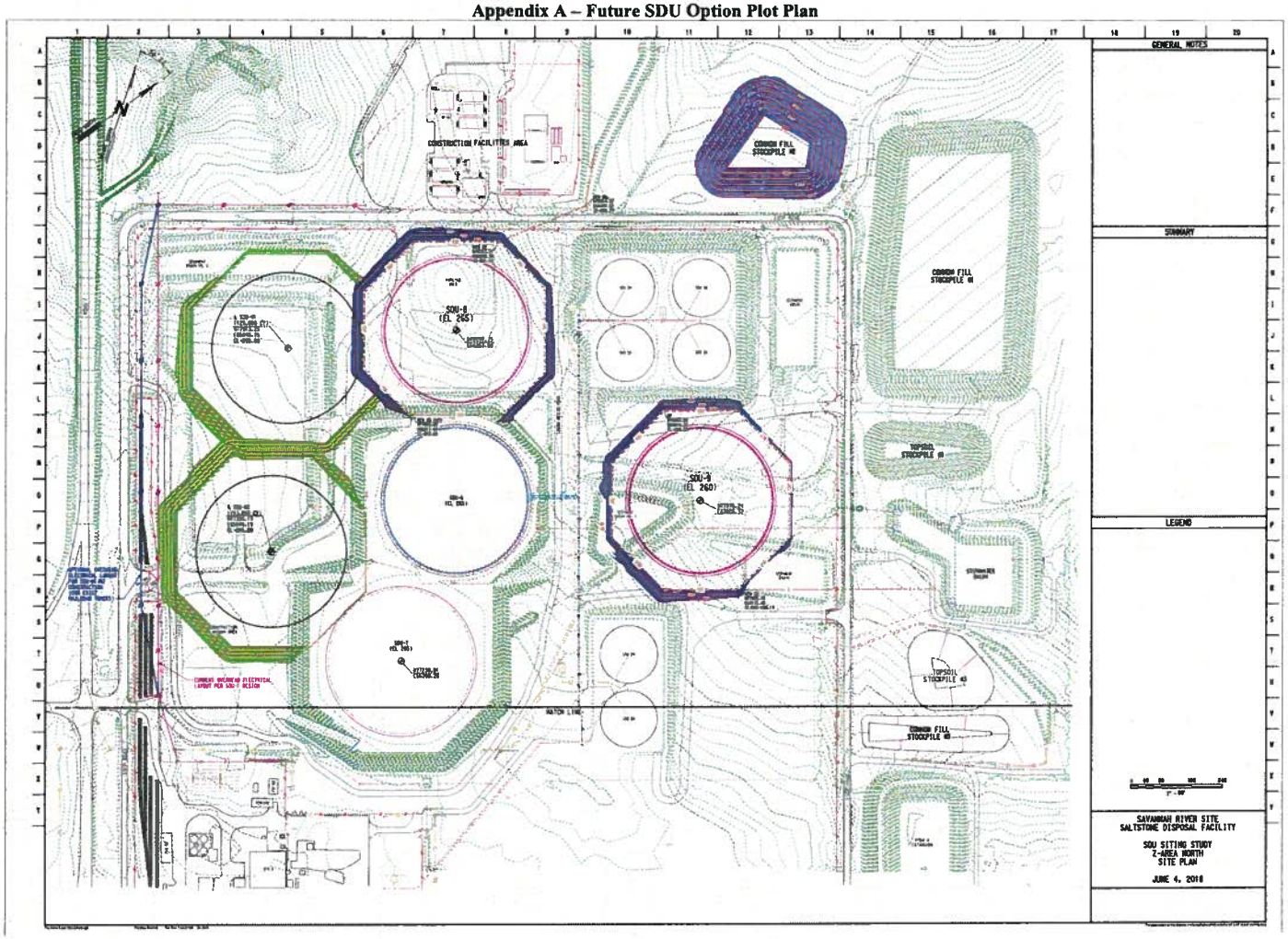
5.1 Manual E7, Procedure 2.15, Alternative Studies.

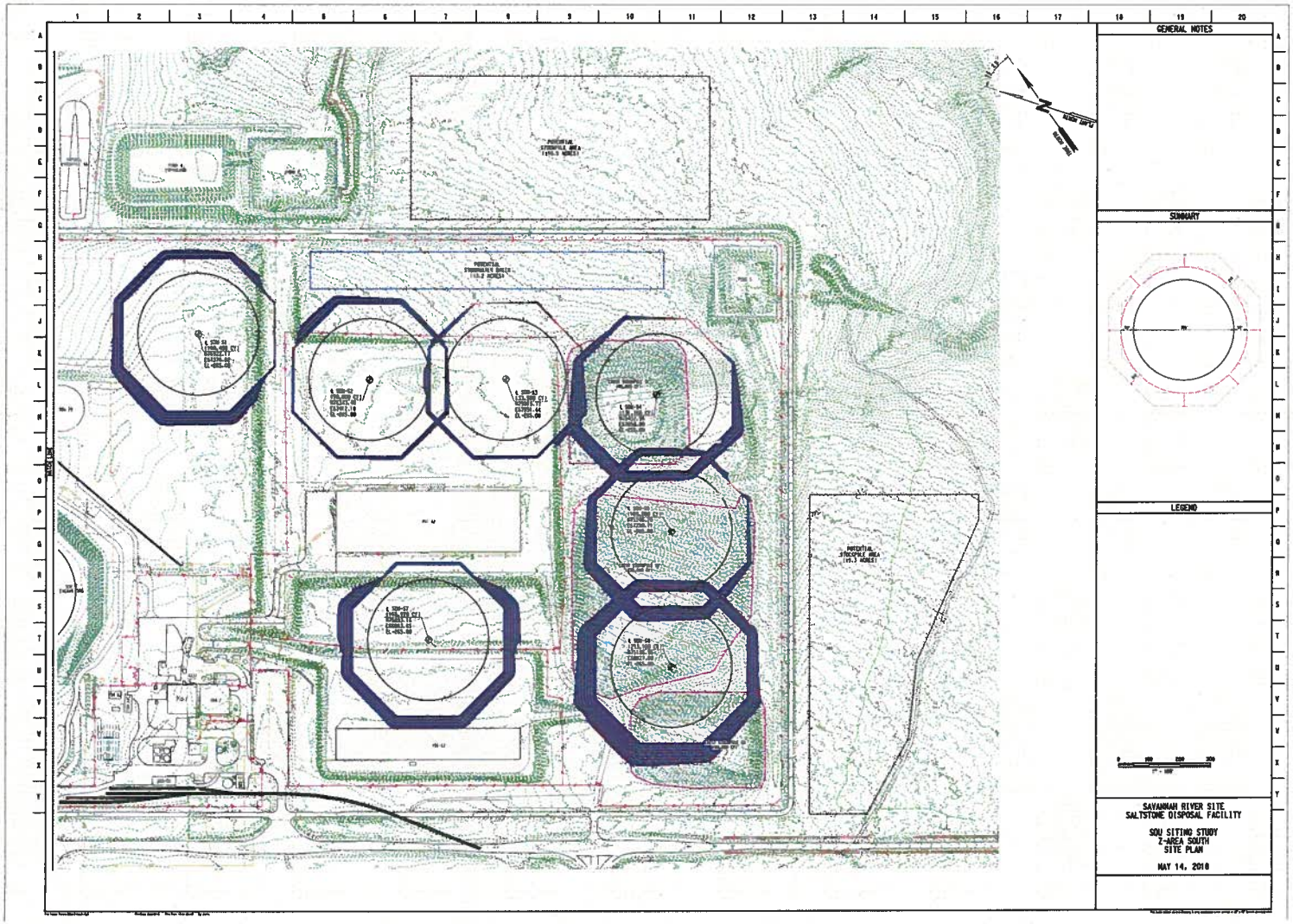
5.2 *Alternative Studies and Systems Engineering Methodology Guidance Manual*, WSRC-IM-98-00033, Appendix A.

6.0 Appendices

Appendix A – Future SDU Option Plot Plans
Appendix B – Option Data
Appendix C - Location Distances and Pump Data

Appendix A – Future SDU Option Plot Plan




GENERAL NOTES
SUMMARY
LEGEND
SAVANNAH RIVER SITE
SALTSTONE DISPOSAL FACILITY
SDU SITING STUDY
Z-AREA SOUTH
SITE PLAN
MAY 14, 2018

Appendix B – Option Data

Project Cost Data

ROM SEE Estimating Methodology

The cost basis for certain factors (BOP bridge length and Site Preparation costs) variation was the recently completed SDU 7 CD 2/3 estimate. The weighted percentages that were derived by members of the Site Evaluation Selection Team are based on very preliminary evaluation of the selected SDU locations and are not based on any applicable design. They are derived by applying weighting factors to various aspects of each site location as it compares to SDU 7 to extrapolate $ values for each location to be input into the selection software model. Based on the layout for the future SDUs (see Appendix A), and determination of existing site conditions, weightings were applied to the Option Data (see Appendix B) for actual SDU 7 costs, which included both direct, indirect, escalation, program support, and contingency.

Requirements for including a Booster Pump building was based on a location basis evaluation performed by Design Authority. A parametric estimate was developed to design, fabricate and install a building to house the booster pump and any associated electronics and piping, along with tying into existing systems.

Soil remediation costs were based on amounts of contaminated soil that needed to be excavated and hauled near existing Vault 4 location, if applicable, or in the case of the North locations, hauling of non-contaminated soil south of future SDU S6 location (see Appendix A). These costs also include both direct, indirect, escalation, program support, and contingency.

These preliminary weighted values were then applied to the overall TPC costs for the SDU 7 CD 2/3 Estimate and were then included into the Evaluation Criteria. The costs values included in this report are not intended to be validated estimated costs for a specific site location, but order of magnitude costs relative to the costs for SDU 7 used solely for comparative analysis of each possible site location.

The results of this methodology are presented in the Project Cost table below:

5/31/2018				Factor 1	Factor 2	Factor 3	Factor 4		
		Description	Project Specifics	BOP (Add or deduct from SDU 7 Cost)	Booster Pump, Bldg, & Services (Add to SDU 7 cost)	Site Prep (Add or deduct from SDU 7 Cost)	Remediation (Add to SDU 7 Costs)	Total Project Costs Deltas from SDU 7 (Present Day TPC $s at ROM Level)	TPC Cost for SDU 7 at each Site
No.	Option	SDU location per North and South Site Plans	Project scope beyond Standard SDU Cell and BOP construction i.e., new equipment. Construction scope increase due to site prep scope (depth of excavation, contaminated earth, tree removal, removal of interferences)	Assume $5M TPC for Bridge cost on SDU 7	Assume $22M TPC for Pump Bldg. cost	Assume $8M TPC for Site Preparation cost (includes 50% of Stormwater Reroute Subcontract cost)	Assume $0.250M TPC per 100 CY of remediated soil excavated and placed on Site near Vault 4 + $260K for replacement Construction Equipment	$159M for SDU 7 adjusted by the deltas from the previous 4 columns	
1	SDU-S1	SDU location per South Site Plan	Achievable grout delivery w/ existing grout pump and bridge. Limted soil contamination. Inside existing RBA. Excavation ~160K cu yd.(incl. replacement of contaminated excavation and haul equip.) Excavated elevation @ 265'. No impact to SDU7 re-routed SW line. Access ramps from the east rd.	60% of SDU7 60% of $5M = $3M $3M - $5M = -$2M ($2M Less than SDU 7)	$0	Approximately the same as SDU7. Site prep factor 1.0= $8M $8M - $8M = 0 (Same as SDU 7)	10K sf at 3' depth = 1200 cu. Yds = (1200/100) *$250K = $3M + $260K = ~$3.3M	($2M) + $0M + $0M +$3.3M ======== +$1.3M	$159M + $1.3M = $160.3M
2	SDU-S2	SDU location per South Site Plan	Significant soil contamination. Introduces a soil remediation risk. Bridge infrastructure modifications reqired. More than those required to the S1 location. Inside existing RBA. Excavation ~50K cu yds. (incl. replacement of contaminated excavation and haul equip.) Not a wet area therefore overexcavation will not be required. Excavated elevation @ 265'. Access ramps from the east road.	140% of SDU7 140% of $5M = $7M $7M - $5M = +$2M ($2M More than SDU 7)	$0	Site Prep Factor 0.40 0.4 * $8M = $3.2M $3.2M - $8M = -$4.8 ($4.8 Less than SDU7)	190K sf at 4' depth = 30K cu. yds. under most of the footprint. (30,000 / 100) * $0.25M = $75M + $0.26M = ~$75.3M	+$2.0M +$0.0M ($4.8M) +$75.3M ======== + $82.1M	$159M + $82.1 = $241.1M

5/31/2018				Factor 1	Factor 2	Factor 3	Factor 4		
		Description	Project Specifics	BOP (Add or deduct from SDU 7 Cost)	Booster Pump, Bldg, & Services (Add to SDU 7 cost)	Site Prep (Add or deduct from SDU 7 Cost)	Remediation (Add to SDU 7 Costs)	Total Project Costs Deltas from SDU 7 (Present Day TPC $s at ROM Level)	TPC Cost for SDU 7 at each Site
3	SDU-S3	SDU location per South Site Plan	Significant soil contamination risk. Introduces a soil remediation risk. Bridge infrastructure modifications required. More than those required for the S1 and S2 locations. Excavation ~ 34K cu yds. (incl. replacement of contaminated excavation and haul equip.) Not a wet area therefore, no over-excavation required. Excavated elevation @ 265'. Access ramps from the east road. Additional engineering required e.g., booster pump, Bldg, and Services to enable 100 gpm grout delivery.	250% of SDU7 250% of $5M = ~$13M $13M - $5M = + $8M ($8M More than SDU 7)	$22M	Requires relocation of ~10K cu yds of existing stockpile. Site Prep factor 0.50 0.5 * $8M = $4M $4M - $8M = -$4M ($4M Less than SDU7)	Majority of footprint involved ~95% of excavated soil = 32K cu yds (32,000 / 100) * $0.25M = $80M +$0.26M = $80.3M	+$8.0M +$22.0M ($4.0M) $80.3M ======== +$106.3M	$159M + $106.3 = $265.3M
4	SDU-S4	SDU location per South Site Plan	Significant soil contamination. Intoduces a soil remediation risk. Bridge infrastructure modifications required. More than those required for the S1 and S2 locations. Excavation ~132K cu yds. (incl. replacement of contaminated excavation and haul equip.) Existing stockpile to be removed ~67K cu. yds. Excavated elevation @ 255.0'. Access ramp from the south and east rd. Additional engineering required e.g., booster pump, Bldg, and Services to enable 100 gpm grout delivery.	377% of SDU7 377% of $5M = ~$19M $19M - $5M = +$14M ($14M More than SDU7)	$22M	Requires relocation of ~67K cu yds of existing stockpile. Site prep factor 1.25 1.25 * $8M = $10M $10M - $8M= +$2M ($2M More than SDU7)	New location minimizes soil contamination risk. ~ 1K cu yds. (1,000 / 100) * $0.25M = $2.5M + $0.26M = ~$2.8M	+$14.0M +$22.0M +$2.0M +$2.8M ======== +$40.8M	$159M + $40.8M= $199.8M
5	SDU-S5	SDU location per South Site Plan	Requires bridge infrastructure modifications. More than those required for the S2, S3 and S4 locations. Additional engineering required e.g., booster pump, Bldg, and Services to enable 100 gpm grout delivery. Inside existing RBA. No contamination. Excavation ~ 110K cu yds. Removal of additional existing 248K cu yds required. Not a wet area therefore, no over-excavation required. Excavation elevation @ 265'. Access ramps from the south road.	350% of SDU7 350% of $5M = ~$18M $18 - $5M = +$13M (+$13M More than SDU 7)	$22M	Requires relocation of ~ 248K cu yds existing stockpile. Site prep factor 2.20 2.20 * $8M = ~$18M $18M - $10M = +$8M ($8M More than SDU7)	$0	+$13.0M +22.0M +$8.0M +0.0M ======== +$43.0M	$159M + $43M = $202M

5/31/2018				Factor 1	Factor 2	Factor 3	Factor 4		
		Description	Project Specifics	BOP (Add or deduct from SDU 7 Cost)	Booster Pump, Bldg, & Services (Add to SDU 7 cost)	Site Prep (Add or deduct from SDU 7 Cost)	Remediation (Add to SDU 7 Costs)	Total Project Costs Deltas from SDU 7 (Present Day TPC $s at ROM Level)	TPC Cost for SDU 7 at each Site
6	SDU-S6	SDU location per South Site Plan	Requires bridge infrastructure modifications. More than those required for the S2, S3 and S4 locations. Excavation ~ 253K cu yds. No contamination. Removal of additional existing 203K cu yds required. Not a wet area therefore, no over-excavation required. Excavation elevation @ 265'. Access ramps from the south rd. Furthest travel for CN. Deepest hole of all locations.	225% of SDU7 225% of $5M = ~$11M $11M - $5M = +$6M ($6M More than SDU 7)	$0	Requires relocation of ~203 cu yds of existing stockpile. Site prep factor 3.0 3.0 * $8M = ~$24M $24M - $8M = + $16M ($16M More than SDU7)	$0	+$6.0M +$0.0M +$16.0M +$0.0M ======= +$22.0M	$159M + $22M = $181M
7	SDU-S7	SDU location per South Site Plan	Contaminated soil due to proximity to SDU 4. Introduces a soil remediation risk. Bridge infrastructure along the path of the Vault 4. Consistent with the routing needed for the S1 location. Excavation ~ 169K cu yds.(incl. replacement of contaminated excavation and haul equip.) Not a wet area therefore, no over-excavation required. Excavation elevation @ 265'. Access ramps from the south rd. Requires shoring on the SDU 1 side. Contaminated soil at west side of SDU 4 (east side of the excavation)	$5M -$5M = 0 (Same as SDU 7)	$0	Shoring Issue. Most inaccesible location of the south side locations. Site prep factor 1.5 1.5 * $8M = ~$12M $12M - $8M = + $4M ($4M More than SDU7)	~18K sf at 4' depth = 2.7K cu yds along the west side of SDU 4. = (2700/100) *$0.25M = ~$6.8M + $0.26M = $7.1M	+$0.0M +$0.0M +$4.0M +$7.1M ======= +$11.1M	$159M+ $11.1M = $170.1M
8	SDU-N1	SDU location per North Site Plan	Grout delivery achievable using adjacent SDU8, bridge will be spanned across SDUs. SDU 8 has not been designed. No contamination. Required sump pump excavation to enable drainage. Excavation ~ 121K cu yds. Excavated soils have to be stockpiled at the south side. More $$ to transport soil and a wider loop road required to enable transport. Not a wet area therefore, no over-excavation required. Excavation elevation @ 265'. Access ramps from the north rd. If more than 1 SDU is located on the north side, available construction laydown near the tank is not adequate.	50% of SDU7 50% of $5M = ~$3M $3M -$5M = - $2M ($2M Less than SDU 7)	$0	Excavate drainage by sump pump to outlet of existing stormwater basin. Site prep factor 2.25 2.25 * $8M = $18M $18M - $8M = + $10M ($10M More than SDU7)	$0	(2.0M) +$0.0M +$10.0M +$0.0M ======= +$8.0M	$159M + $8.0M = $167M

5/31/2018				Factor 1	Factor 2	Factor 3	Factor 4		
		Description	Project Specifics	BOP (Add or deduct from SDU 7 Cost)	Booster Pump, Bldg, & Services (Add to SDU 7 cost)	Site Prep (Add or deduct from SDU 7 Cost)	Remediation (Add to SDU 7 Costs)	Total Project Costs Deltas from SDU 7 (Present Day TPC $s at ROM Level)	TPC Cost for SDU 7 at each Site
9	SDU-N2	SDU location per North Site Plan	Grout delivery achievable using adjacent SDU6. Bridge will be spanned across SDUs. No contamination. Requires sump pump excavation to enable drainage. Excavation ~ 152K cu yds. No contamination. Excavated soils have to be stockpiled at the south side. More $$ to transport soil and a wider loop road required to enable transport. Not a wet area therefore, no over-excavation required. Excavated elevation @ 265'. Access ramps from the north rd. If more than 1 SDU is located on the north side, available construction laydown near the tank is not adequate.	50% of SDU7 50% of $5M = ~$3M $3M -$5M = - $2M ($2M Less than SDU 7)	$0	Excavate drainage by sump pump to outlet of existing stormwater basin. Site prep factor 2.0 2.0 * $8M = $16M $16M - $8M = + $8M ($8M More than SDU 7)	$0	($2.0)M +$0.0M +$8.0M +$0.0M ======= +$6.0M	$159M + $6.0M = $165M
10	SDU-N3	SDU location per North Site Plan	Grout delivery achievable using adjacent SDU7. Bridge will be spanned across SDUs. No contamination. Requires sump pump excavation to enable drainage. Excavation ~ 171K cu yds. No contamination. Excavated soils have to be stockpiled at the south side. More $$ to transport soil and a wider loop road required to enable transport. Not a wet area therefore, no over-excavation required. Excavated elevation @ 265'.. Access ramps from the north rd. Requires abandonment of Z area sceptic tank and drain system and a sewage lift station and force main routed to S area. Impacts facility fence. Impact to 13.8 kVA power line currently being routed by the SDU7 project. Requires removal of abandoned RR track and relocation of 704-6Z and possibly 704-14Z. Excavation extends into current Op Facility boundary on the north side.	50% of SDU7 50% of $5M = ~$3M $3M -$5M = - $2M ($2M Less than SDU 7)	$0	Sceptic tank and other infrastructure impacts. Site prep factor 3.75 3.75 * $8M = $30M $30M - $8M = + $22M $22M More than SDU 7)	$0	($2.0M) +$0.0M +$22.0M +$0.0M ======== +$20.0M	$159M + $20M = $179M

SDU7 = 170k cu yds = Site Prep Factor 1.0

Performance Assessment Data

		Location Ranking (POC K. Rosenberger)		
	Description	PA Impacts	Sector Rank	Overall Rank
Option	SDU location per North and South Site Plans	Items that increase calculated peak dose are (1) changes to the 100m boundary (2) distance to the 100m boundary (3) Overlapping flow with other SDUs		
SDU-S1	SDU location per South Site Plan	One of S1-S4 are required. S1 changes the PA boundary in a beneficial way. There is no overlapping flow with other SDU's. S1 is close to the 100m boundary.	4	6
SDU-S2	SDU location per South Site Plan	One of S1-S4 are required. S2 changes the PA boundary in a beneficial way. S2 overlaps existing SDU 4 flow paths. S2 is close to the 100m boundary.	5	8
SDU-S3	SDU location per South Site Plan	One of S1-S4 are required. S3 changes the PA boundary in a beneficial way. S3 overlaps existing SDU 4 flow paths. S3 is close to the 100m boundary.	6	9
SDU-S4	SDU location per South Site Plan	One of S1-S4 are required. S4 changes both the eastern and southern PA boundaries in a beneficial way. S4 partially overlaps existing SDU 4 and SDU 1 flow paths. S4 is close to the 100m boundary.	1	1
SDU-S5	SDU location per South Site Plan	S5 changes the southern PA boundary in a beneficial way. S5 slightly overlaps existing SDU 1 flow path. S5 flow is farther from the boundary than S4.	3	5
SDU-S6	SDU location per South Site Plan	S6 changes the southern PA boundary in a beneficial way. S6 does not overlap existing flow paths. S6 flow is farther from the boundary than either S4 or S5.	2	3
SDU-S7	SDU location per South Site Plan	S7 does not change the PA boundary. S7 directly overlaps existing SDU 1 and SDU 4 flow paths. S7 flow is farther from the boundary than either S1-S6.	7	10
SDU-N1	SDU location per North Site Plan	N1 changes the western PA boundary in a slightly beneficial way (moves northerly away from SDU 8). N1 slightly overlaps existing flow paths. N1 flow is close to the 100m boundary.	1	2
SDU-N2	SDU location per North Site Plan	N2 changes the western PA boundary in a non-impactive way. N2 slightly overlaps existing flow paths. N2 flow is farther from the the 100m boundary than N1.	3	7
SDU-N3	SDU location per North Site Plan	N3 changes the western PA boundary in a non-impactive way. N3 slightly overlaps existing flow paths. N3 flow is farther from the the 100m boundary than N1 and N2.	2	4

Closure Costs and Operations Impacts Data

	Description	**Closure cost**	**Operations impacts**
Option	SDU location per North and South Site Plans	Closure will require a larger Cap due to elevation and location of SDU	Cost to maintain and operate additional equipment such as booster pump.
SDU-S1	SDU location per South Site Plan	Potential negative impact on closure cap. Alters the drainage concept for the current closure cap design.	No booster pump needed.
SDU-S2	SDU location per South Site Plan	Extends the closure cap to the east. Thus increasing the cost associated with the closure cap.	No booster pump needed.
SDU-S3	SDU location per South Site Plan	Extends the closure cap to the east. Thus increasing the cost associated with the closure cap.	Booster pump and pig launching capability required above 260' elevation.
SDU-S4	SDU location per South Site Plan	Extends the closure cap to the east and south. Thus increasing the cost associated with the closure cap.	Booster pump and pig launching capability required. Longest distance from 210Z.
SDU-S5	SDU location per South Site Plan	Extends the closure cap to the south. Thus increasing the cost associated with the closure cap.	Booster pump and pig launching capability required above 260' elevation.
SDU-S6	SDU location per South Site Plan	Extends the closure cap to the south. Thus increasing the cost associated with the closure cap.	No booster pump needed.
SDU-S7	SDU location per South Site Plan	No impact to the closure cap footprint but, may increase cap elevation depending on its relative elevation to Vault 1. If lower than V1, then it raises the closure cap height and increases the slope profile. Higher or equal to V1 is prefered.	No booster pump needed.
SDU-N1	SDU location per North Site Plan	Will extend the closure cap to the West. Impacts infrastructure i.e. F road and OH power lines	No booster pump needed.
SDU-N2	SDU location per North Site Plan	Will extend the closure cap to the West. Impacts infrastructure i.e. F road and OH power lines	No booster pump needed.
SDU-N3	SDU location per North Site Plan	Will extend the closure cap to the West. Impacts infrastructure i.e. F road and OH power lines	No booster pump needed. Shortest distance from 210Z.

Appendix C – Location Distances and Pump Data

Distance From 210Z to SDU CL (Feet)		1023	1840	2341	2850	2346	1955	1150	1094	1610	637
Excavation El. (Feet)	100 gpm Grout Delivery Eq. 3" Pipe Length (Feet)	SDU-S1	SDU-S2	SDU-S3	SDU-S4	SDU-S5	SDU-S6	SDU-S7	SDU-N1	SDU-N2	SDU-N3
Ranking		4	7	8	10	9	6	5	2	3	1
250	**2387**	1023	1840	2341	X	2346	1955	1150	1610	1094	637
255	**2348**	1023	1840	2341	X	2346	1955	1150	1610	1094	637
260	**2309**	1023	1840	X	X	X	1955	1150	1610	1094	637
265	**2270**	1023	1840	X	X	X	1955	1150	1610	1094	637
270	**2231**	1023	1840	X	X	X	1955	1150	1610	1094	637
275	**2192**	1023	1840	X	X	X	1955	1150	1610	1094	637

Notes:
X = Additional Engineering Required e.g booster pump, air capacity, to enable 100 gpm grout and flushing