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Tank 19 Volume Estimation Following Mantis™ Cleaning Operations

Author:	Wm. Clifton Ludwig W. C. Ludwig	12/15/09 Date
Verifier:	B. A. Martin B. A. Martin	12/16/09 Date
Approver:	W. L. Isom W. L. Isom	12/16/09 Date

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Purpose

The purpose of this report is to document the estimated volume of material left in Waste Tank 19 after Mantis™ Cleaning Operations. Characterization of the remaining material will be discussed in a later report after sample analysis.

Background

From September 2000 to August 2001, heel removal was performed on the material inside Tank 19. In this campaign, three submersible turbine mixers installed in the east, west, and southwest risers operated in varying orientations to suspend solids from the heel into the liquid. A centrifugal transfer pump in the northeast riser was used to transfer the slurry from Tank 19 to Tank 18. Decanted liquid from Tank 18 was recycled back to Tank 19 as the slurry media for each transfer. After this campaign small amounts of liquid, residual zeolite, aluminum hydroxides, and iron oxides that could not be practically removed using the mixers were left in Tank 19. The solid waste material was located in mounds. The depth of the solid waste material varied from less than 1 inch to several inches deep. Tank 19 had approximately 15,100 gallons of wet solids still in the tank prior to Mantis™ operations (Ref 1).

Mantis™ operation in Tank 19 began on December 4, 2008. On December 8, the Mantis™ experienced a system failure and was shut down for evaluation and repairs. The Mantis™ was repaired on March 6, 2009 and cleaning operations were restarted on March 31. Mantis™ operations were completed on April 22, 2009. During operation, the Mantis™ also experienced several minor shutdowns (see Attachment A) which contributed to a longer than anticipated cleaning operation.

Material Mapping

Material mapping is a method for determining the volume of materials inside of a waste tank. This method relies on video and still images to capture the relative depth of material across a tank in relation to known landmarks. These depths can then be plotted over an area to give an estimate of the volume. Following Mantis™ operations over 175 photographs were taken of the interior of tank 19 using a high quality digital camera at various locations and elevations inside the tank. The pictures were inspected by an evaluation team consisting of William Ludwig (Closure Engineering), Bruce Martin (Closure and Waste Determination Authority) and Billy West (Camera Inspection Group) for signs of the lifting plates and other known depth measurements.

The floor of a Type IV waste tank has 69 1 foot by 1 foot by 1/2 inch lifting plates arrayed in a grid pattern across the floor (Attachment B). Each plate has a 1/4 inch weld bead affixing it to the floor and the remnant of the lifting rod attached to the top of the plate during tank construction. (Figure 1). These lifting plates were used as landmarks for material mapping.

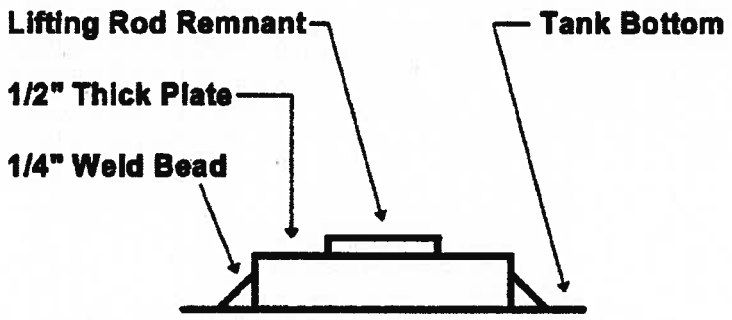


Figure 1: Lifting Plate Elevation View. (Not to Scale)

The evaluation team used a wide screen high definition monitor and picture enhancement software to adjust color, contrast and brightness to provide the best views possible. Thirty-four lifting plates were identified, and the criteria in Table 1 were used to assign depths of residual solids. Identified lifting plates are listed in attachment C. Photographic examples of material depths are shown in Attachment D. The solid depths in regions surrounding the identified lifting plates were plotted onto an Excel map to generate a volume estimate.

Depth (Inches)	Criteria
1/8	Dusting of Solids evident with some clean steel floor visible.
1/4	Sides of lifting plate visible. Solids are mostly well below the top of lifting plate.
1/2	The shape of the lifting plate is clearly visible but the material appears to be the same depth as the top of the lifting plate.
3/4	Shape of lifting plate can be discerned through solids.
1	Lifting plate not discerned. No evidence of significant material depth change from regions where lifting plates were discerned.

Table 1: Material Depth Criteria

Consideration was given to restoration of the driving capabilities to Tank 19's Mantis™ in order to use the Mantis™ as a mobile reference point to gather more information about the indeterminate regions. This method was used in Tank 18 with limited success. Tank 18's reactivated Mantis™ was only partially able to survey Tank 18 due to a loss of traction caused by material building up inside of the Mantis™' wheels and the drag weight of the hose and tether system. Based on Tank 18 experience it was expected that

the Mantis™ inside of Tank 19 would face similar limitations. Engineering predicted the range of travel for the Tank 19 Mantis™, excluded the possibility of gathering data from the outer regions of the tank and showed that only a portion of the central indeterminate region would be surveyed (Attachment E).

Digital photographs taken on August 8, 2009 (Photograph ID P0916801 through P0916854) were used to assess the depths of residual solids in regions where plates were not discernable. Analysis of the photographs showed little to no evidence of material height changes inside of the indeterminate regions. In addition, the appearance of tank floor welds across some of these regions lead engineering to believe that a material height estimate of 1 inch would be conservative.

After Mantis™ cleaning, but before final mapping, the walls of Tank 19 were water washed to remove material from the stiffening bands. The digital photographs show no appreciable material on either the vertical surfaces or stiffening bands of the walls.

Material Mapping Findings

The material depths derived from lifting plates in the digital still photos are listed in Attachment C. The measured and estimated material depth values were then entered into an Excel sheet (Attachment F). Each cell in the sheet represents a 2 foot by 2 foot section of tank floor. Material mapping volumes for each cell were summed giving a final value of 1960 gallons of material remaining in Tank 19.

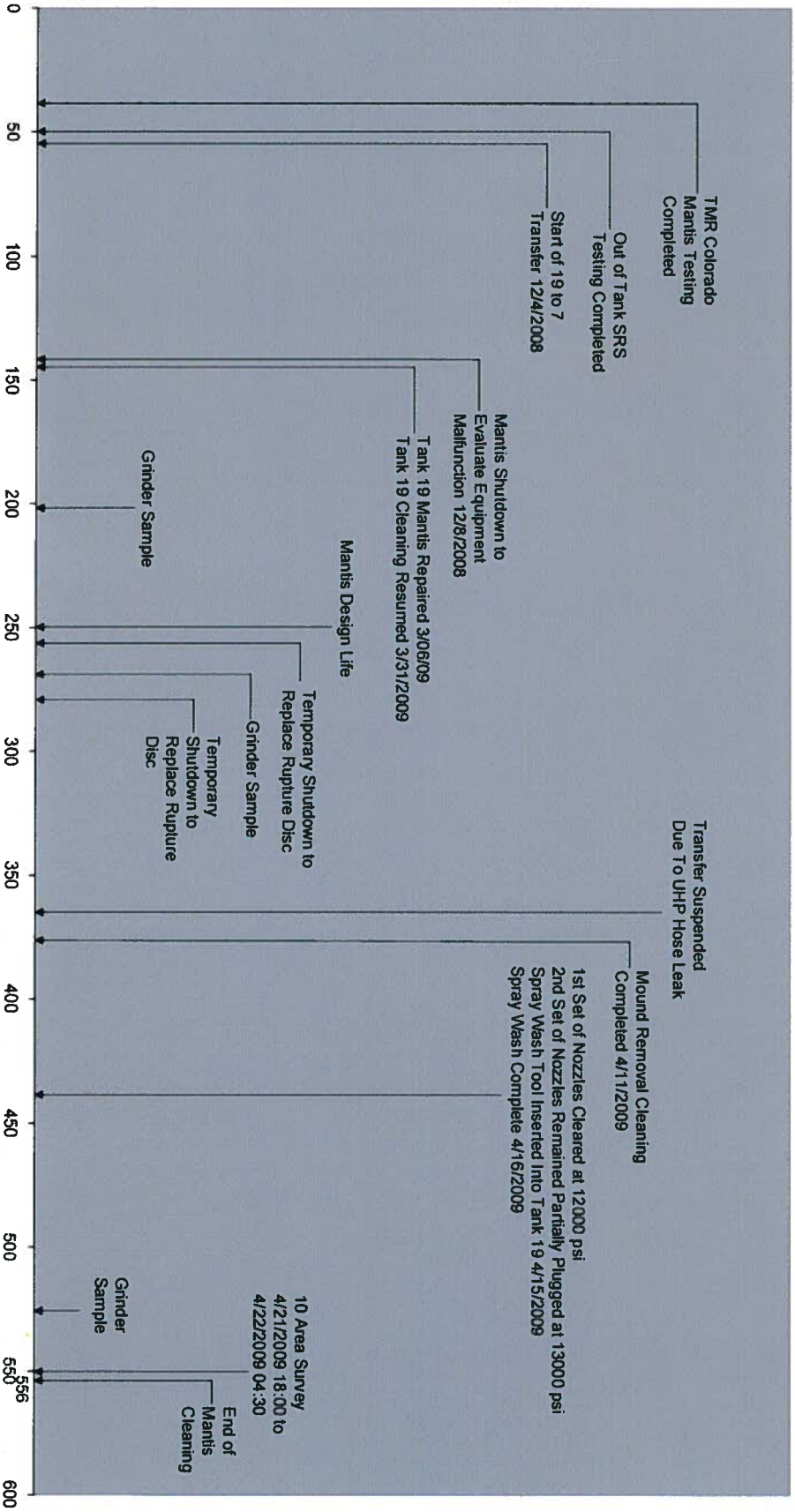
Summary

The Mantis™' activities have successfully removed the remaining waste material mounds inside of Tank 19. Using still digital photographs in combination with known landmarks and conservative estimations the material depth across Tank 19 was determined. The mapping was used to determine that the total volume of material remaining inside of Tank 19 is approximately 2000 gallons.

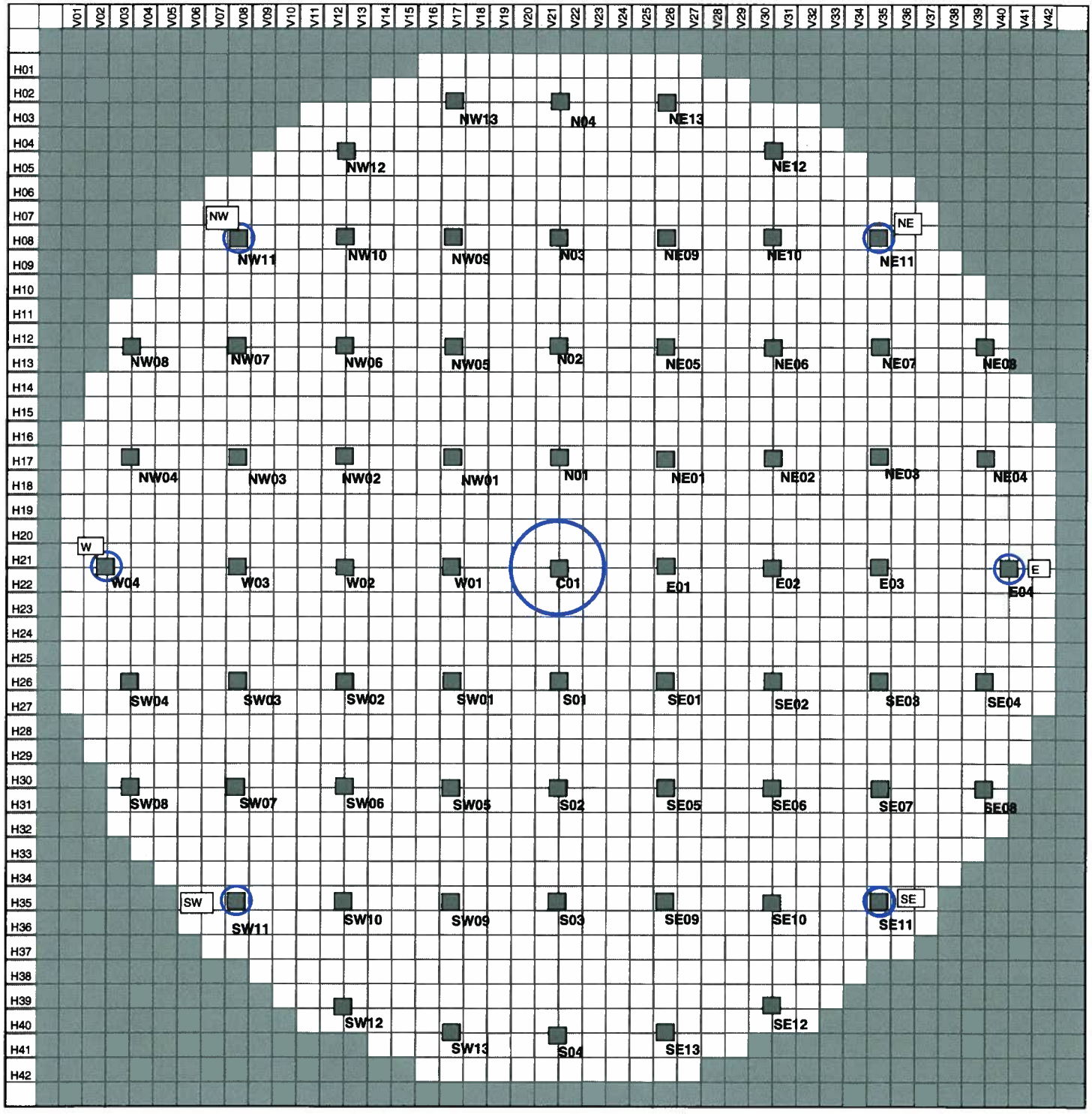
Reference

1. WSRC-TR-2002-00052 Rev. 3, Characterization of Tank 19 Residual Waste
2. Pictures are stored with Site I&SE Group. Digital Pictures used for this report include P0906301 though P0906387 and P0916801 through P0916854.

Attachment A
Tank 19 Mantis™ Operation Timeline



Attachment B
Tank 19 Lifting Plate Layout



Attachment C
Observed Material Depths

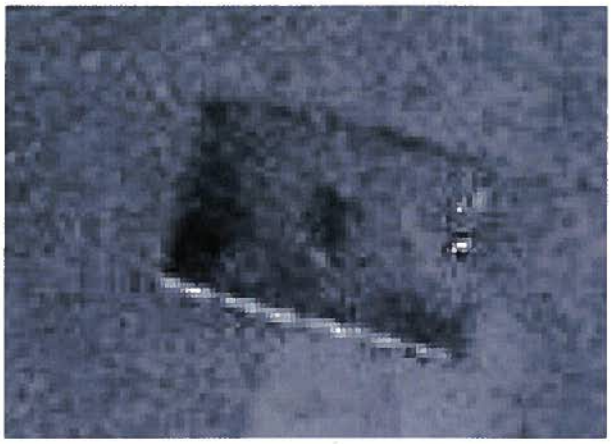
Point	Depth	Location	Quadrant	Depth Method	Lifting Plate ID Number	Picture Identified In
P01	0.25	H08-V12	NW	Lifting Plate	NW10	P0916847
P02	0.25	H08-V17	NW	Lifting Plate	NW09	P0916820
P03	0.125	H08-V21	N	Lifting Plate	N03	P0916824
P04	0.25	H08-V26	NE	Lifting Plate	NE09	P0916824
P05	0.25	H08-V31	NE	Lifting Plate	NE10	P0906315
P06	0.25	H12-V08	NW	Lifting Plate	NW07	P0916843
P07	0.5	H12-V12	NW	Lifting Plate	NW06	P0916843
P08	0.25	H12-V21	N	Lifting Plate	N02	P0906312
P09	0.5	H12-V26	NE	Lifting Plate	NE05	P0906315
P10	0.5	H12-V31	NE	Lifting Plate	NE06	P0906318
P11	0.5	H12-V35	NE	Lifting Plate	NE07	P0906318
P12	0.25	H17-V08	NW	Lifting Plate	NW03	P0906309
P13	0.5	H17-V12	NW	Lifting Plate	NW02	P0906309
P14	0.5	H17-V21	N	Lifting Plate	N01	P0916840
P15	0.5	H17-V26	NE	Lifting Plate	NE01	P0906318
P16	0.5	H17-V31	NE	Lifting Plate	NE02	P0906318
P17	0.5	H17-V35	NE	Lifting Plate	NE03	P0906318
P18	0.125	H21-V08	W	Lifting Plate	W03	P0916304
P19	0.25	H21-V12	W	Lifting Plate	W02	P0916304
P20	0.5	H21-V31	E	Lifting Plate	E02	P0906319
P21	0.125	H21-V35	E	Lifting Plate	E03	P0906319
P22	0.25	H26-V08	SW	Lifting Plate	SW03	P0906303
P23	0.75	H26-V12	SW	Lifting Plate	SW02	P0906303

Attachment C
Observed Material Depths (Continued)

Point	Depth	Location	Quadrant	Depth Method	Lifting Plate ID Number	Picture Identified In
P24	0.5	H26-V26	SE	Lifting Plate	SE01	P0906321
P25	0.25	H26-V31	SE	Lifting Plate	SE02	P0906321
P26	0.125	H26-V35	SE	Lifting Plate	SE03	P0906321
P27	0.5	H31-V08	SW	Lifting Plate	SW07	P0906303
P28	0.5	H31-V12	SW	Lifting Plate	SW06	P0906303
P29	0.75	H31-V17	SW	Lifting Plate	SW05	P0906301
P30	0.125	H31-V35	SE	Lifting Plate	SE07	P0906321
P31	0.25	H35-V17	SW	Lifting Plate	SW09	P0906301
P32	0.75	H35-V21	W	Lifting Plate	S03	P0906301
P33	0.25	H35-V26	SE	Lifting Plate	SE09	P0906387
P34	0.5	H35-V31	SE	Lifting Plate	SE10	P0906385

Attachment D
Examples of Lifting Plate Depths

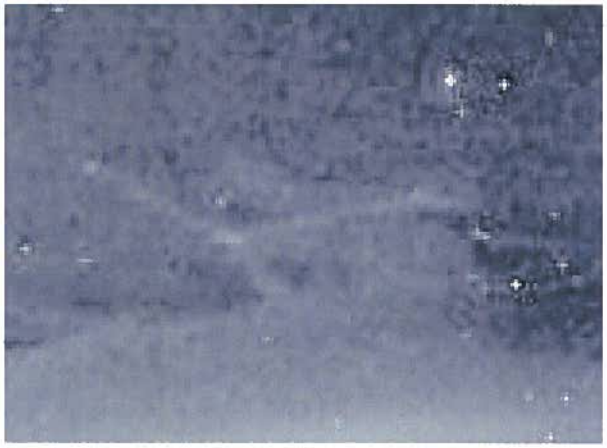
1/8 Inch



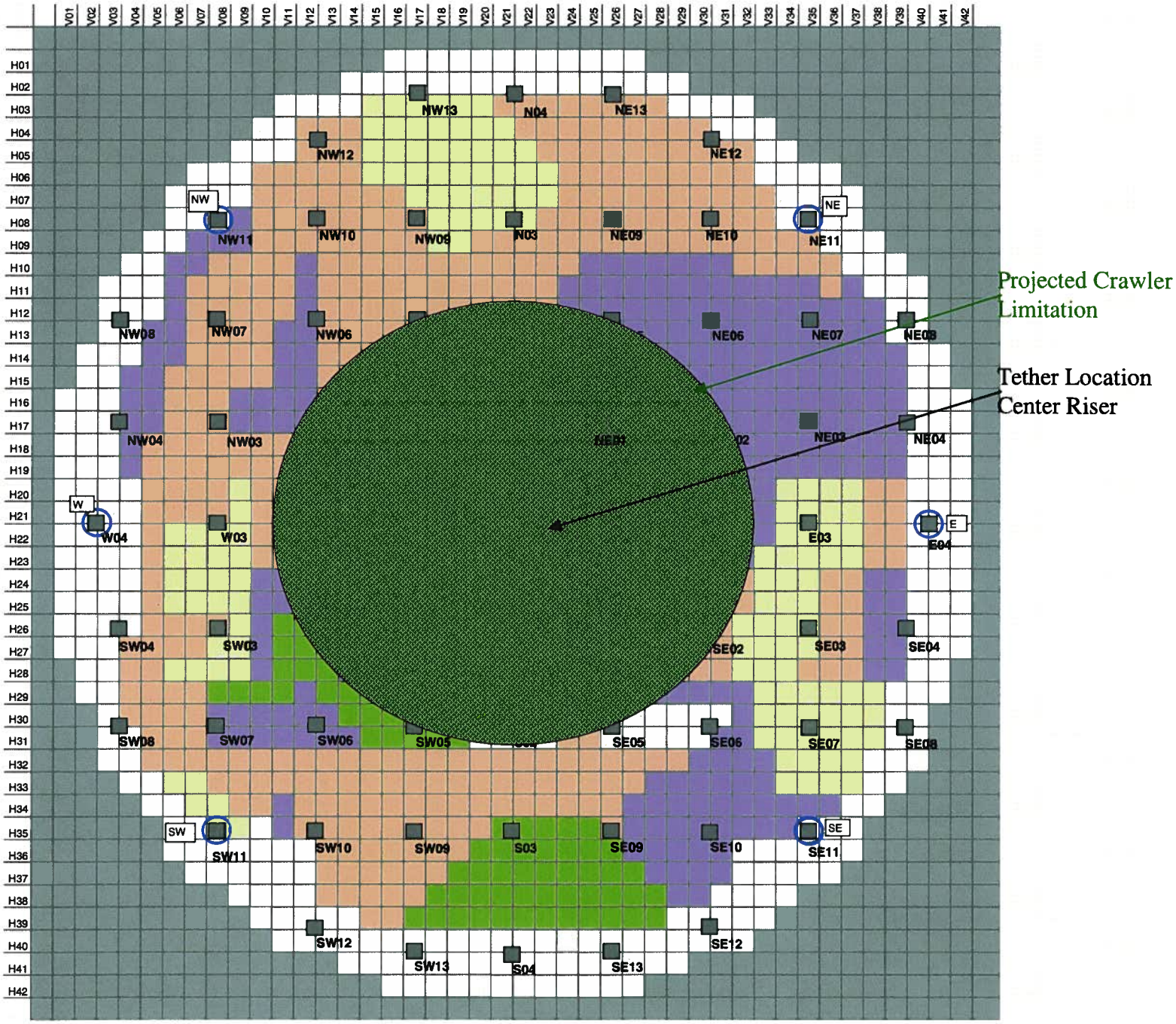
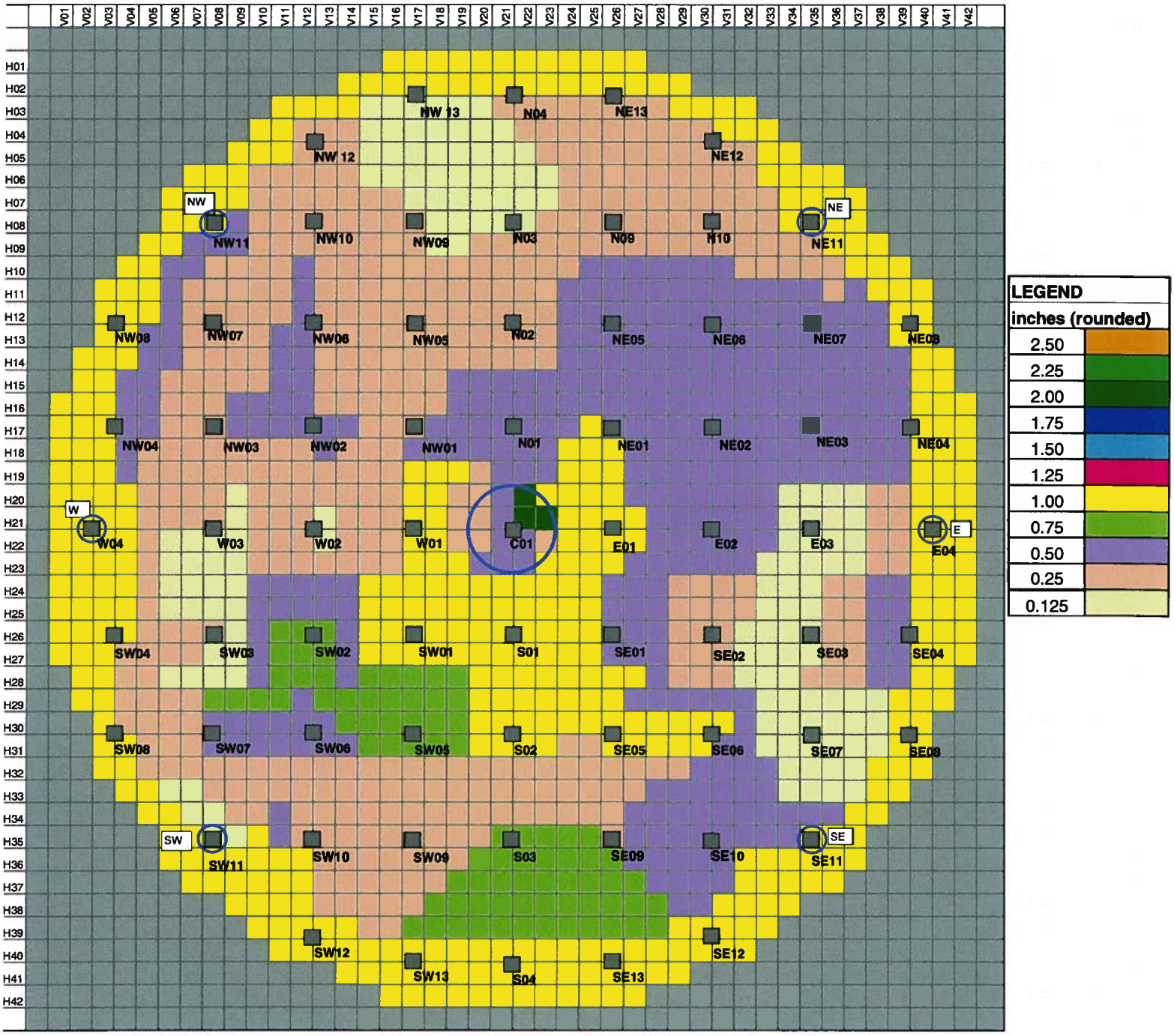
1/4 Inch

1/2 Inch

3/4 Inch



Attachment E
Projected Mantis™ Travel Limitations



Attachment F
Tank 19 Mapping After Mantis™ Operation