FINAL Report

Remediation and Final Status Survey Bomb Throwing Device Site - Structures

Aberdeen Proving Ground, Aberdeen, Maryland

Contract Number

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Prepared for:

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AMSIO-ACE-D Bldg. 350, 5th Floor

Rock Island, IL 61299-6000

Prepared by:

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

473 Silver Lane

East Hartford, Connecticut 06118

Cabrera Project No: 01-3030.39

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EXECUTIVE SUMMARY

Cabrera Services, Inc. (CABRERA), under contract to the U.S. Army Field Support Command (FSC), performed remedial activities, remedial support surveys, and Final Status Surveys (FSS) for the Bomb Throwing Device (BTD) site at the Aberdeen Proving Ground (APG), Maryland. This document provides the results of post-remediation final status surveys for the structures associated with the BTD site. These surveys were designed so that the results of the individual integrated static measurements could be compared to the release criteria (DCGLw) by survey unit. If all of the survey units associated with a structure meet the criteria for unrestricted release, then the structure as a whole is considered a viable candidate for unrestricted release.

CABRERA conducted survey activities in accordance with the U.S. Nuclear Regulatory Commission (NRC) approved FSS work plan, prepared by CABRERA. This FSS Report addresses final status surveys performed on five BTD structures. The five structures are: the BTD Armor Reclamation Facility, Wash Rack #2, Wash Rack #3, Concrete Pad #2 located behind Building 701, and Concrete Pad #1 located behind the DU Test Enclosure Building.

FSS activities were designed in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance (NRC, 2000).

The project had several major activities associated with the remediation and FSS including:

- Remediation of soils, debris, and structures within the confines of the BTD site,
- Deconstruction of structures on the BTD site,
- Removal of plate steel for on-site recycling,
- Removal and shipment of remediated soils and debris to Envirocare of Utah (the disposal site),
- Designation of the BTD land areas into 25 MARSSIM Class 1 Survey Units,
- FSS of the BTD site soils and structures, and
- Determination that the dose from residual contamination at the site is not greater than the release criterion for each Survey Unit.

The radiological contaminant of concern was depleted uranium (DU). The derived concentration guideline (DCGLw) for fixed (or total) DU activity was determined to be 100 disintegrations per minute alpha per 100 square centimeters (dpm/100cm^2). The maximum measurements from all of the survey units associated with the five structures were well below the DCGLw value.

Smear samples for gross transferable alpha contamination were collected and analyzed to determine if transferable activity is less than 10% of total activity, to confirm assumptions in the release criterion. The maximum smear measurements from all of the survey units associated with the five structures were below 10% (i.e., 10 dpm/100cm^2) of total activity.

The FSS data indicates that the five structures are suitable for release for unrestricted use, without regard for former operations with licensed radioactive material.

FSSs were also performed over a land area of approximately 46,000 square meters and on access roads and several support buildings situated on the BTD site. Discussions of the surveys over land areas are addressed in a separate FSS document.

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ACRONYMS AND ABBREVIATIONS

AFSC	U.S. Army Field Support Command
ALARA	As Low As Reasonably Achievable
APG	Aberdeen Proving Ground
ARL	Army Research Laboratory
ATC	Aberdeen Test Center
BARF	BTD Armor Reclamation Facility
BTD	Bomb Throwing Device
CABRERA	Cabrera Services, Inc.
CFR	Code of Federal Regulations
cm	Centimeters
DCGL or DCGLw	Derived Concentration Guideline Level
dpm alpha/100cm^2	Disintegrations per minute alpha per 100 square centimeters
DU	Depleted Uranium
FSC	U.S. Army Field Support Command
FSS	Final Status Survey
HEPA	High Efficiency Particulate Air filter
LAB	Liquid Abrasive Blaster
LBGR	Lower Bound of the Grey Region
m	Meters
m^2	Square Meters
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mrem/yr	Millirem per year
NAD	Normalized Absolute Difference
NIST	National Institute of Standards and Technology
NRC	U. S. Nuclear Regulatory Commission
PSA	Plate Storage Area
QA	Quality Assurance
QC	Quality Control

ROPC	Radionuclides of Potential Concern
σ	Sigma
S/N	Serial Number
SU	Survey Unit
^{234}U	Uranium-234
^{235}U	Uranium-235
^{238}U	Uranium-238

1.0 INTRODUCTION

Cabrera Services, Inc. (CABRERA) is under contract to the United States Army Field Support Command (AFSC) to provide support to the Aberdeen Test Center (ATC) at the Aberdeen Proving Ground (APG) in Aberdeen, Maryland. CABRERA performed facility demolition, remediation, and site wide radiological surveys of the Bomb Throwing Device (BTD) site to support consideration for unrestricted release. The BTD site consists of approximately 46,000 square meters (m^2) of land on the APG used for the testing of Depleted Uranium (DU) munitions. The BTD site also contains a number of structures used to support operations.

For consistency with other decommissioning activities at APG, radiologically impacted soils and structures are addressed separately. This document presents the Final Status Survey (FSS) activities for five structures on site – the BTD Armor Reclamation Facility (BARF), Wash Rack #2, Wash Rack #3, Concrete Pad #2 located behind Building 701, and Concrete Pad #1 located behind the DU Test Enclosure Building. The Final Status Survey conducted on soils is addressed in a separate document titled, "*Remediation and Final Status Survey, Bomb Throwing Device Site – Soils*," (CABRERA, 2004). These final status surveys are designed in accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance (U.S. Nuclear Regulatory Commission [NRC], 2000).

1.1 Site History

APG, located in Aberdeen, Maryland, is an active U.S. Army testing and research facility. The APG lies along the western shore of the Chesapeake Bay in Harford and Baltimore Counties, Maryland, approximately 15 miles northeast of Baltimore. The APG covers a total of 72,516 acres (land and water) and consists of two distinct areas: the northern portion of APG, referred to as the Aberdeen Area; and the southern portion of APG, referred to as the Edgewood Area. The Aberdeen Area became a formal military post, designated as the APG, in 1917.

The BTD site was used between 1982 and 1993 for the testing of DU munitions. In 1993, the site consisted of the BTD ARMOR RECLAMATION FACILITY, the DU Test Enclosure Building, the Enclosure Building High Efficiency Particulate Air (HEPA) system, the Plate Storage Area (PSA), Wash Racks #2 and #3, access roads, and several support buildings situated on approximately 46,000 square meters (m^2) (11.4 acres) of land. During operations, DU munitions were fired at steel plate and other targets placed inside the DU Test Enclosure Building. The High Efficiency Particulate Air (HEPA) ventilation system equipment was located outside the DU Test Enclosure Building on a concrete pad (Concrete Pad #1). Its function was to collect and filter potentially contaminated air exiting the DU Test Enclosure Building after the firing of DU munitions.

Prior to site remediation, approximately 40 tons of DU-contaminated armor plate was located within the DU Test Enclosure Building and surrounding grounds. Heavy equipment was used to transport the armor plates between the DU Test Enclosure Building and the PSA. As part of the remedial activities and subsequent to the removal of the armor plates, the DU Test Enclosure Building, the HEPA ventilation system, the footings for the DU Test Enclosure Building, the "White" Building, the "Rust" Building, and the Sabot Stripper were removed in their entirety from the site and processed separately from this report.

The BTD site decommissioning consisted of structure demolition, soil excavation, and removal of contaminated soil and demolition debris. As physical decommissioning actions were completed, FSSs were performed on both structures and land areas (this report addresses only five structures previously mentioned). Much of the plate steel that was generated during site cleanup and demolition (primarily the DU Test Enclosure Building) was transferred to the Army Research Laboratory (ARL) facility, at APG Spesutie Island, for decontamination and recycling. A cost analysis performed by the Army indicated that recycling was a less expensive option than offsite disposal of the material and that there was a beneficial reuse for the plate steel in support of APG's mission. Other demolition debris and excavated soil was considered unwanted radioactive material and was shipped via rail to Envirocare of Utah, an NRC licensed disposal facility, for shallow land burial.

During initial mobilization in February 2003, the CABRERA field crew entered the BARF and dismantled, surveyed, and removed the DU armor plate reclamation machine (the LAB) housed within the BTD Armor Reclamation Facility.

In May 2003 CABRERA re-mobilized to perform a FSS on the inside of the BTD Armor Reclamation Facility, and demolish the DU Test Enclosure building. Most of the steel plate removed from the DU Test Enclosure Building was shipped across APG to the ARL Spesutie Island Facility for decontamination and beneficial reuse. Other steel/debris was containerized in intermodals for future rail shipment to Envirocare of Utah.

During June 2003, the CABRERA team performed remediation/FSS of Wash Racks 2 and 3, which included dismantling and ship out of the floor grids and left the scrap steel piled for transfer to ARL or other use, as instructed by ATC personnel. Concurrent to the dismantling operations and through the month of August 2003, the CABRERA team completed the majority of the gamma walkover survey, excavated contaminated soils, and stockpiled the remediated soil (approximately 1,200 cubic yards) into a lay down area within Survey Units 16 and 25. CABRERA demobilized at the end of August 2003.

In February and March 2004, the CABRERA team returned to the BTD site, performed data collection for survey gaps, and accomplished 95% of the remediated soil load out. The soil was packed into intermodal containers, and the intermodals were shipped via rail to Envirocare of Utah.

In June 2004, the remainder of the soil was loaded/shipped to Envirocare for disposal and both Concrete Pad #1 and Concrete Pad #2 surfaces were remediated with a steel ball blast/HEPA vacuum system. Following cleaning, the surfaces were surveyed and the FSSs were performed.

As of the time of this writing, all soil/debris shipped via rail to Envirocare of Utah has been transferred to Envirocare of Utah and final disposition documentation is forthcoming.

In the Figures section of this report, Figure 1 shows the location of the BTD Site relative to APG and surrounding towns. Figure 2 shows the relative locations of the five structures specifically addressed in this FSS Report. Appendix A contains site photos of the structures discussed below.

1.1.1 BTD Armor Reclamation Facility

The BARF is a steel beam and sheet metal constructed building with insulated walls and roof. The insulation is covered with a flexible protective plastic cover. The floor is a concrete pad. The interior of the BARF is approximately 12 meters (m) long by 14.8 m wide with a ceiling height of 6 m. The building is bisected by a sheetrock wall with doors leading from one side to the other. There are no drains, sumps, or ventilation system penetrations other than the liquid abrasive blaster (LAB) HEPA ventilation system. A small heating system with insulated ductwork, rollup doors for equipment entry, smaller doorways for personnel entry, and electrical circuit boxes are other general features found in the building.

The northern portion of the BARF contained the LAB decontamination equipment and a small capacity crane used to help lift and load steel plates into the LAB. The southern part of the building was used to store clean unused HEPA filters and small amounts of containerized contaminated trash. Routine radiation contamination surveys were executed on all floor areas within the BTD Armor Reclamation Facility, on stored boxes and containers, and occasionally on wall surfaces.

The ATC utilized the BARF to house the LAB. The LAB was an enclosed system used to decontaminate pieces of steel plate and other small objects with water jets and abrasive. A ventilation system with a pre-filter demister and a HEPA filter removed airborne particulates prior to ventilation release to the environment. A hopper attached to the LAB retained spent abrasive and removed contamination.

No contamination was found on either the LAB HEPA filter or areas downstream in the ventilation system ducts during removal of the LAB. Minor contamination was found within the LAB enclosure, the hopper which contained water and abrasive, the HEPA pre-filter, and small areas on the outside of the LAB enclosure near loading points. The lack of activity downstream of the HEPA filter indicates a well-designed system that did not release airborne radioactivity to the environs. Other general surveys do not show contamination on the walls of the BARF. Scan surveys showed only occasional activity on the floor areas surrounding the LAB. Surveys of selected areas overhead and on the crane are also negative with respect to contamination.

1.1.2 Wash Rack #2

Wash Rack #2 consists of a steel beam frame and sheet metal walls with no interior insulation or wallboard. The interior is approximately 17 m long by 8 m wide with a ceiling height of 6 m. The floor consists of steel plate with a recessed trough running the length of the facility. The trough area is approximately 6 m wide by 10 centimeters (cm) deep. The trough area contains multiple raised (approximately 3 inches) steel beams, which were used to support steel floor grating. The grating, which was removed prior to this FFS, was flush with the surrounding floor plate. There are no drains, sumps, heating, cooling, or ventilation systems present. Steel rollup doors for equipment entry are located at both ends of the structure. Previously documented routine surveys identified minor levels of DU contamination on the floor area of Wash Rack #2.

Since the construction of Wash Rack #2 in 1992, the ATC has utilized this facility as a warehouse. Wash Rack #2 has never been used as a wash rack. Instead, it was used to store items and equipment, some of which were contaminated with DU. Wash Rack #2 housed DU in the form of penetrators, floor sweepings, liquid abrasive residue from previous decontamination activities, and range debris (e.g., paper, plastic, wood).

Since the wash rack was used as a storage facility for contaminated materials, the primary area of investigation is the floor, trough area, and lower wall surfaces (2 m and below).

1.1.3 Wash Rack #3

Wash Rack #3 is identical to Wash Rack #2, was also built in 1992, and was used for the storage of uncontaminated Navy accelerator parts and the temporary housing of a cutting table contaminated with DU. Contamination left by the cutting table was identified in the southwest corner of the facility. This contamination was removed though decontamination activities prior to the initiation of the FSS. Past routine surveys of this structure have identified minor levels of DU contamination on the floor.

Since the wash rack was used as a storage facility for contaminated materials, the primary area of investigation is the floor, trough area, and lower wall surfaces (2 m and below).

1.1.4 Concrete Pad #2 (Located Behind Building 701)

This concrete pad is located behind Building 701. Pad dimensions are approximately 22 m by 15 m. The pad was confirmed to have alpha contamination and therefore would not pass release criteria. Its purpose was to stage or store heavy armored vehicles.

1.1.5 Concrete Pad #1 (Located Behind the DU Test Enclosure Building)

Concrete Pad #1 is located adjacent to the DU Test Enclosure Building. It is somewhat smaller than Concrete Pad #2 and is approximately 10 m by 12 m. Its purpose was to provide a foundation for the HEPA system associated with the DU Test Enclosure Building.

1.2 Radionuclides of Potential Concern

The following three Final Status Survey Plans were utilized in producing this consolidated FSS report:

- *Final Status Survey Plan For BTD Armor Reclamation Facility, Aberdeen Proving Ground, Aberdeen, MD* (provided in Appendix B)
- *Final Status Survey Plan For Wash Rack Facilities #2 and #3, Aberdeen Proving Ground, Aberdeen, MD* (provided in Appendix C)
- *Final Status Survey Plan Bomb Throwing Device (BTD) Site, Aberdeen Proving Ground, Aberdeen, MD* (provided in Appendix D)

Section 2.2 of each FSS Plan identifies the site Radionuclides of Potential Concern (ROPC) as being limited to DU and its short-lived uranium progeny (decay products). The uranium ratios are based on isotopic uranium weight ratios used for shipments of routine DU waste from APG

(BARG, 1995). The activity fractions are calculated from the isotopic weight ratios and the specific activity of each uranium isotope. The result of the activity fraction calculation is a Uranium-234 (^{234}U):Uranium-235 (^{235}U):Uranium-238 (^{238}U) ratio of 0.084:0.012:0.904.

1.3 Derived Concentration Guideline Levels

As described by MARSSIM, a Derived Concentration Guideline Level (DCGL) is a calculated radionuclide activity concentration within a designated survey unit that corresponds to a defined release criterion in radiation dose or risk units. Per the license requirement of 10 Code of Federal Regulations (CFR) 20 Subpart E, a release criterion of 25 millirem per year (mrem/yr) will be used for the buildings and structures included in this FSS Report. Doses from residual radioactivity will be kept as low as reasonably achievable (ALARA) whenever possible. Using MARSSIM Section 4.3.4 (equation below) and knowing that there is one alpha decay per decay of each uranium isotope, a single total uranium $DCGL_W$ of 100 disintegrations per minute alpha per 100 square centimeters (dpm alpha/100cm^2) was calculated for DU. This $DCGL_W$ was calculated using the values provided by the NRC screening guidelines of 90.6 dpm/100cm^2, 97.6 dpm/100cm^2, and 101 dpm/100cm^2 for U^{234}, U^{235}, and U^{238}, respectively, as presented in Table 5.19 of NUREG/CR-5512 (volume 3, October 1999), NUREG 1757, and the DU activity fractions discussed in Section 1.2. The $DCGL_W$ is calculated as follows:

$$DCGL_W = \frac{1}{\left(\frac{f_1}{DCGL_1}\right)+\left(\frac{f_2}{DCGL_2}\right)+\left(\frac{f_3}{DCGL_3}\right)} = \frac{1}{\left(\frac{0.084}{90.6}\right)+\left(\frac{0.012}{97.6}\right)+\left(\frac{0.904}{101}\right)} = 100 \text{ dpm alpha/100cm}^2$$

Where: $DCGL_w$ = Combined gross activity DCGL (i.e., release limit).

f_n = Activity fraction of radionuclide *n*

$DCGL_n$ = DCGL of radionuclide *n*

The total uranium $DCGL_W$ of 100 dpm alpha/100cm^2 was used as the action level for both static and scanning measurements in the buildings and on the structures.

2.0 FINAL STATUS SURVEY DESIGN

The FSS performed at the BTD site was designed in accordance with Final Status Survey guidance from MARSSIM (NRC, 2000). FSS activities consisted of scanning surveys over 100% of the accessible structure surfaces. Integrated direct surface measurements were performed at frequencies based on MARSSIM guidance. Survey activities also included direct and biased smear sample collection. The FSSs were designed conservatively in that the radiological background present in the structure materials is neglected and the measured total activity is used for direct comparisons to the $DCGL_W$.

2.1 General Structure Classification Based on Contamination Potential and Survey Unit Identification

Using MARSSIM Section 5.3 as guidance, the five structures were subdivided into survey units and designated as Class 1, Class 2, or Class 3 survey units. The following subsections describe how each structure was subdivided and classified. Appendix E presents individual SU schematic diagrams along with direct (integrated) measurement/smear locations.

2.1.1 BTD Armor Reclamation Facility

The BARF was subdivided into four Class 1 SUs and one Class 3 SU as listed in Table 2-1. The floor and lower walls of the northern room of the BARF share similar contamination potential because this area housed the LAB decontamination equipment and was where the decontamination process was performed. Although the lab system was self-contained and surveys did not routinely identify transferable contamination on the floor or walls, contaminated materials were moved through this room via the south rollup door to be loaded in and out of the LAB system. In accordance with MARSSIM guidance, the south room floor and lower walls were considered Class 1 SUs as well because this area was once used to store containerized contaminated trash.

Since the upper wall and ceiling surfaces of the north and south rooms share similar potential for contamination, these areas were combined into one Class 3 SU. The potential for contamination on the upper walls and ceiling surface in the north room is small because no contamination was identified on the LAB HEPA filter or at downstream areas in the ventilation system. The lack of activity downstream of the HEPA filter indicates a well-designed system that did not release airborne radioactivity to the environs. In addition, transferable contamination was not identified during routine surveys in the BTD Armor Reclamation Facility, and the primary mechanism for transport (i.e., ventilation system) was not contaminated.

Maps presenting the BARF SU delineations and the reference coordinate system are presented in Appendix E.

Table 2-1: BTD Armor Reclamation Facility Survey Units

Description	Area (m^2)	Material	MARSSIM Survey Class
North Room Floor	88.8	Concrete	1
South Room Floor	88.8	Concrete	1
North Room Lower Walls	76.6	Foam / Sheet Metal	1
South Room Lower Walls	76.6	Foam / Sheet Metal	1
Ceilings and Upper Walls	488	Foam / Sheet Metal	3

2.1.2 Wash Rack #2

Wash Rack #2 was divided into three Class 1 SUs and one Class 2 SU as listed in Table 2-2. The floor and lower walls of Wash Rack #2 has a history of contamination and contamination potential because this structure was used to store DU waste. DU contamination has been identified previously on the floor of this facility during past routine surveys. The floor area in Wash Rack #2 was remediated for DU contamination prior to the initiation of the FFS.

The ceiling and upper walls of Wash Rack #2 are classified as Class 2 due to remediation activities being performed previously on the floor of this facility.

Maps presenting the Wash Rack #2 SU delineations and the reference coordinate system are presented in Appendix E.

Table 2-2: Wash Rack #2 Survey Units

Description	Area (m^2)	Material	MARSSIM Survey Class
Floor South Side	68	Metal	1
Floor North Side	68	Metal	1
Lower Walls	90	Metal	1
Ceiling and Upper Walls	346	Metal	2

2.1.3 Wash Rack #3

Wash Rack #3 was divided into three Class 1 SUs and one Class 2 SU as listed in Table 2-3. The floor and lower walls of Wash Rack #3 has a history of contamination and contamination potential because this structure was used to store DU waste. DU contamination has been identified previously on the floor of this facility during past routine surveys. The floor area in Wash Rack #3 was remediated for DU contamination prior to the initiation of the FFS.

The ceiling and upper walls of Wash Rack #3 are classified as Class 2 due to prior remediation activities performed on the floor of this facility.

Maps presenting the Wash Rack #3 SU delineations and the reference coordinate system are presented in Appendix E.

Table 2-3: Wash Rack #3 Survey Units

Description	Area (m^2)	Material	MARSSIM Survey Class
Floor South Side	68	Metal	1
Floor North Side	68	Metal	1
Lower Walls	90	Metal	1
Ceiling and Upper Walls	346	Metal	2

2.1.4 Concrete Pad #2

Concrete Pad #2 was designated a Class 1 survey unit. Due to its size, the pad was divided into two survey units – North and South. Each survey unit is approximately 107 m^2.

2.1.5 Concrete Pad #1

Concrete Pad #1 was designated a Class 1 survey unit. Due to its size, the pad was divided into two survey units – North and South. Each survey unit is approximately 60 m^2.

2.2 Survey Instrumentation and Survey Techniques

Instrumentation used in the survey consisted of direct alpha scan and integrated surface detectors, and alpha/beta smear counters. A number of both types of instruments were used due to the extended duration of the surveys. All instruments were properly calibrated (appendix I), QC checked (appendix F), and operated in accordance with standard operating procedures (section 4.0).

2.2.1 Direct Surface Alpha Radioactivity Scan Surveys and Integrated Direct Surface Alpha Radioactivity Measurements

Direct alpha scanning was performed to identify surface locations on structures where contaminant concentrations may exceed the criterion for unrestricted release. Integrated direct measurements (i.e., static measurements) of surface alpha radioactivity were performed during the FSS to compare contaminant levels at discrete sampling locations on building interior surfaces to the release criterion and to facilitate statistical testing, if necessary. Scanning and integrated direct surface measurements were performed using the instruments listed in Table 2-4.

Table 2-4: Instruments Used for Scanning and Integrated Direct Surface Measurements

Instrument Used (Meter and Probe)	Dates Used	Building or Structure Where Used
Ludlum Model 2224-1 portable alpha/beta scaler/ratemeter (serial number [S/N] 162425) with the Ludlum model 43-93 100 cm^2 alpha/beta detector (S/N 182403)	5/28/03, 5/29/03, 6/4/03 6/11/03, 6/12/03, 6/13/03, 6/19/03, 6/20/03 6/27/03 7/9/03, 7/10/03 8/12/03	Wash Rack #2 Wash Rack #3 Wash Racks #2 and #3 Wash Rack #3 DU Test Enclosure Building
Ludlum Model 2224-1 portable alpha/beta scaler/ratemeter (S/N 162426) with the Ludlum model 43-89 126 cm^2 alpha/beta detector (S/N 193921)	5/5/03, 5/14/03, 5/15/03 5/19/03, 5/20/03, 5/22/03, 5/28/03, 5/29/03. 6/6/03 6/9/03 6/10/03 6/11/03, 6/12/03, 6/13/03 6/19/03 6/20/03 6/26/03, 6/27/03, 7/9/03, 7/10/03 3/30/04 3/31/04	BTD Armor Reclamation Facility Wash Rack #2 Wash Racks #2 and #3 DU Test Enclosure Building DU Test Enclosure Building and Wash Rack #3 Wash Rack #3 DU Test Enclosure Building and Wash Rack #3 Wash Racks #2 and #3 Wash Rack #3 Wash Rack #2
Ludlum Model 2224 portable alpha/beta scaler/ratemeter (S/N 183048) with the Ludlum Model 43-68 large area (126 cm^2) gas proportional detector (S/N 161781)	5/8/03	BTD Armor Reclamation Facility
Ludlum Model 2360 alpha/beta data logger (S/N 193675) with the Ludlum Model 43-37 area floor monitor (S/N 161687)	5/7/03, 5/8/03, 5/9/03, 5/12/03, 5/13/03, 5/14/03, 5/15/03, 6/2/03 6/4/03, 6/5/03, 6/6/03 6/9/03 6/11/03, 6/12/03, 6/16/03, 6/19/03 6/20/03, 6/23/03, 6/24/03 6/25/03	BTD Armor Reclamation Facility Wash Rack #2 Wash Racks #2 and #3 Wash Rack #3 Wash Racks #2 and #3
Ludlum Model 2360 alpha/beta data logger (S/N 184938) with the Ludlum Model 43-37 area floor monitor (S/N 178371)	6/8/04, 6/9/04, 6/10/04	Concrete Pads #1 and #2
Ludlum Model 2360 alpha/beta data logger (S/N 202398) with the Ludlum model 43-93 100 cm^2 alpha/beta detector (S/N 211706)	6/8/04, 6/9/04, 6/10/04	Concrete Pads #1 and #2

2.2.2 Smear Sample Collection and Analysis

Gross transferable alpha contamination was collected and analyzed to determine if transferable activity is less than or equal to 10% of total activity as assumed in the NUREG/CR-5512 and NUREG 1757 documents for screening level guidelines.

Smear samples were collected over approximately 100 cm^2 areas at systematic and biased locations identified during scanning activities. Smear samples were analyzed for alpha and beta radioactivity using a Ludlum Model 2929 alpha/beta scintillation counter. Three different units were used during the field activities, as summarized in Table 2-5.

Table 2-5: Alpha/Beta Scintillation Counter Used for Transferable Activity Measurements

Instrument Used (Meter and Probe)	Dates Used	Building or Structure Where Used
Ludlum Model 2929 alpha/beta scintillation counter (S/N 163827) with attached 43-10-1 probe (S/N 171322)	5/5/03, 5/8/03, 5/9/03, 5/12/03, 5/13/03, 5/14/03	BTD Armor Reclamation Facility
	5/15/03	BTD Armor Reclamation Facility, Wash Rack #2
	5/19/03, 5/20/03, 5/21/03, 5/22/03, 5/28/03, 5/29/03, 5/30/03	Wash Rack #2
	6/2/03, 6/3/03, 6/4/03, 6/6/03, 6/9/03	DU Test Enclosure Building and Wash Rack #2
	6/10/03	DU Test Enclosure Building
	6/11/03, 6/12/03, 6/16/03	Wash Rack #3
	6/26/03, 6/27/03	Wash Racks #2 and #3
	7/8/03	Wash Rack #2
	7/9/03, 7/10/03	Wash Rack #3
Ludlum Model 2929 alpha/beta scintillation counter (S/N 180830) with attached 43-10-1 probe (S/N 207849)	3/30/04	Wash Rack #3
	3/31/04	Wash Rack #2
Ludlum Model 2929 alpha/beta scintillation counter (S/N 171590) with attached 43-10-1 probe (S/N 174813)	6/8/04, 6/9/04, 6/10/04	Concrete Pads #1 and #2

2.3 Number of Static Measurements

MARSSIM provides a method to determine the number of measurement locations required in a given survey unit. A minimum number of measurement locations are required in each survey unit to obtain sufficient statistical confidence that the conclusions drawn from the measurements are correct. The following subsections describe the bases for and derivation of the minimum required measurement locations per survey unit.

2.3.1 Estimation of Relative Shift

The minimum number of measurement locations required is dependent on the distribution of site residual radionuclide concentrations relative to the $DCGL_w$ and acceptable decision error limits (α and β).

The relative shift describes the relationship of site residual radionuclide concentrations to the $DCGL_w$ and is calculated using the guidance found in Section 5.5.2.3 of MARSSIM. The relative shift is calculated as follows:

$$\Delta/\sigma = \frac{DCGL_w - LBGR}{\sigma}$$

Where: $DCGL_w$= Derived Concentration Guideline Level

LBGR = concentration at the lower bound of the gray region. The Lower Bound of the Grey Region (LBGR) is the concentration at which the survey unit has an acceptable probability of passing the statistical tests.

σ = an estimate of the standard deviation of the concentration of residual radioactivity in the survey unit (which includes real spatial variability in the concentration as well as the precision of the measurement system).

As previously stated, the $DCGL_w$ for surface alpha radioactivity is 100 dpm/100cm^2. The LBGR was conservatively estimated at 70 dpm alpha/100 cm^2 based on previous studies with similar instruments on concrete. Without prior survey, it is reasonable to assume a coefficient of variation on the order of 30 percent (MARSSIM Section 5.5.2.2). Using a coefficient of variation of 30 percent and the LBGR as an estimate of the sample mean, a sigma value of 21 dpm/100cm^2 is estimated. Using the parameters discussed above, the relative shift is calculated as 1.4.

2.3.2 Determination of N (Number of Required Measurement Locations)

The final number of required measurement locations per survey unit is 20 as per MARSSIM (Table 5.5) given a relative shift of 1.4 and an error rate for both Type I and Type II errors of five percent (i.e., $\alpha = \beta = 0.05$). The actual number of measurements taken in each survey unit ranges from 20 to 24 samples based on the size of the survey area.

2.4 Elevated Measurement Criterion ($DCGL_{EMC}$)

MARSSIM states that, for Class 1 survey units, a dose area factor should be used to evaluate the magnitude by which the concentration within a small area of elevated activity can exceed the $DCGL_w$ while maintaining compliance with the release criterion. For the purpose of ALARA, the $DCGL_W$ will be used as the $DCGL_{EMC}$, which corresponds to an area factor of one. Since the scan minimum detectable concentration of the instrumentation is sensitive enough to identify the $DCGL_W$ with a 90% confidence limit (refer to Appendices B, C, and D), it is unlikely that small areas of elevated activity exceeding the $DCGL_W$ would be missed during surface scans.

2.5 Static Measurement Locations

Measurement locations in Class 1 and Class 2 survey units were established using a random start point in a systematic rectangular grid. The Class 3 survey unit measurement locations were randomly selected. The grid spacing for Class 1 and Class 2 survey units was determined, based on the measured area of the survey unit, using the following equation (Equation 5-7 from MARSSIM).

$$L = \sqrt{\frac{\mathrm{A}}{0.866\mathrm{N}}}$$

Where: L = rectangular grid spacing for survey unit

A = area of survey unit

N = number measurement locations

Measurement spacing results (L) using the equation above are presented in Table 2-6. Maps presenting the SU delineations are presented in Appendix E.

Table 2-6: Summary of Area, Number of Data Points, and Grid Spacing by SU

Survey Unit Description	Survey Unit Class	Area, A (m^2)	Number of Data Points, N	Grid Spacing, L (m)
BARF – North Room Floor	1	88.8	24	2.058
BARF – South Room Floor	1	88.8	24	2.058
BARF – North Room Lower Walls	1	76.6	24	1.920
BARF – South Room Lower Walls	1	76.6	24	1.920
BARF – Ceilings and Upper Walls	3	488	21	5.180
Wash Rack #2 – Floor South Side	1	68	20	1.859
Wash Rack #2 – Floor North Side	1	68	20	1.859
Wash Rack #2 – Lower Walls	1	90	24	2.134
Wash Rack #2 – Ceiling and	2	346	20	4.176

Survey Unit Description	**Survey Unit Class**	**Area, A (m^2)**	**Number of Data Points, N**	**Grid Spacing, L (m)**
Upper Walls				
Wash Rack #3 – Floor South Side	1	68	20	1.859
Wash Rack #3 – Floor North Side	1	68	20	1.859
Wash Rack #3 – Lower Walls	1	90	24	2.134
Wash Rack #3 – Ceiling and Upper Walls	2	346	20	4.176
Concrete Pad #2 – North	1	107	20	2.486
Concrete Pad #2 -- South	1	107	20	2.486
Concrete Pad #1 -- North	1	60	20	1.861
Concrete Pad #1 -- South	1	60	20	1.861

3.0 RESULTS

Field activities took place during three separate mobilizations. The first mobilization began May 3, 2003 and ended August 27, 2003. The second mobilization began February 10, 2004 and ended March 31, 2004. The third mobilization began June 8, 2004 and ended June 15, 2004. Appendix F contains a table that documents every day that CABRERA personnel were on-site, the instruments used, and the activities performed.

All raw data collected on Radiological Survey Maps for each SU (survey unit) are provided in Appendix G. Scan survey results are provided graphically in the Figures section of this FSS Report and are referenced in the following sub-sections. Additional data for each SU include worksheets that convert the raw data (recorded in counts per minute) to dpm/100cm^2 for integrated direct measurements (integrated one minute counts) from each one meter square grid with cross-reference to grid numbers) and 100 cm^2 smear results from each one meter square grid with cross-reference to grid numbers. These worksheets are provided in Appendix H.

3.1 BTD Armor Reclamation Facility

3.1.1 Surface Alpha Radioactivity Scan Surveys

The floors and the lower walls were surveyed for surface alpha radioactivity in the BTD Armor Reclamation Facility. All of these areas are designated MARSSIM Class 1. The ceiling and upper walls are designated MARSSIM Class 3. In the Figures section, Figures 3 through 11 graphically depict the results of the scan surveys. As can be observed in the figures, no alpha scanning measurements exceeded the DCGL of 100 dpm/100cm^2.

3.1.2 Integrated Direct Surface Alpha Radioactivity Measurements

The BARF was divided into five SUs – the North Floor Room, the South Floor Room, the North Room Lower Walls, and the South Room Lower Walls were Classified MARSSIM Class 1 SUs. The Ceiling and Upper Walls were classified MARSSIM Class 3 SUs. Twenty-four integrated direct surface alpha measurements were taken on the North Floor Room and the maximum reading was 30.1 dpm/100cm^2. Twenty-four integrated direct surface alpha measurements were taken on the South Floor Room, and the maximum reading was 20.0 dpm/100cm^2. Twenty-four integrated direct surface alpha measurements were taken on the North Room Lower Walls and the maximum reading was 12.0 dpm/100cm^2. Twenty-four integrated direct surface alpha measurements were taken on the South Room Lower Walls and the maximum reading was 10.0 dpm/100cm^2. Twenty-one integrated direct surface alpha measurements were taken on the Ceiling and Upper Walls and the maximum reading was 14.3 dpm/100cm^2. Since all measurements were below the DCGL, no further statistical analysis of the data was performed.

3.1.3 Smear Sample Collection and Analysis

All smear samples taken from the BARF resulted in alpha measurements of less than 10 dpm/100cm^2. Twenty-four smear samples were taken on the North Floor Room and the maximum alpha reading was 6.5 dpm/100cm^2. Twenty-four smear samples were taken on the

South Floor Room and the maximum alpha reading was 6.5 dpm/100cm^2. Twenty-two smear samples were taken on the North Room Lower Walls and the maximum alpha reading was 5.8 dpm/100cm^2. Twenty-five smear samples were taken on the South Room Lower Walls and the maximum reading was 4.1 dpm/100cm^2. Twenty-three smear samples were taken on the Ceiling and Upper Walls and the maximum reading was 4.2 dpm/100cm^2.

3.1.4 Recommendation

In accordance with the BARF FSS Work Plan and consistent with MARSSIM guidance, a SU can be cleared for release where all scans and integrated direct measurements are below the DCGL of 100 dpm/100cm^2 and all smear measurements are less than the DCGL of 10 dpm/100cm^2. Therefore, the North Room Floor, the South Room Floor, the North Room Lower Wall, the South Room Lower Wall, and the Ceiling and Upper Walls SUs are recommended for unrestricted release.

3.2 Wash Rack #2

3.2.1 Surface Alpha Radioactivity Scan Surveys

The floor and the lower walls were surveyed for surface alpha radioactivity in Wash Rack #2. All of these areas are designated MARSSIM Class 1. The ceiling and upper walls are designated MARSSIM Class 2 and approximately 10% of the total area was scanned for alpha activity. All scans of ceiling and upper walls resulted in alpha counts that were equal to or below background, so results of these scans were not recorded on official CABRERA forms. In the Figures section of this FSS, Figures 12 through 16 graphically depict the results of the scan surveys on the floor and lower walls. As can be observed in the figures, no alpha scanning measurements exceeded the DCGL of 100 dpm/100cm^2.

3.2.2 Integrated Direct Surface Alpha Radioactivity Measurements

Wash Rack #2 was divided into four SUs – the North Floor, the South Floor, and the Lower Walls were classified Class 1 and the Ceiling and Upper Walls were classified Class 2. Twenty integrated direct surface alpha measurements were taken on the North Floor and the maximum reading was 15.0 dpm/100cm^2. Twenty integrated direct surface alpha measurements were taken on the South Floor and the maximum reading was 11.9 dpm/100cm^2. Twenty-four integrated direct surface alpha measurements were taken on the Lower Walls and the maximum reading was 13.9 dpm/100cm^2. Twenty integrated direct surface alpha measurements were taken on the Ceiling and Upper Walls and the maximum reading was 10.0 dpm/100cm^2. Since all measurements were below the DCGL, no further statistical analysis of the data was performed.

3.2.3 Smear Sample Collection and Analysis

Twenty smear samples were taken on the North Floor and the maximum reading was 2.7 dpm/100cm^2. Twenty smear samples were taken on the South Floor and the maximum reading was 2.7 dpm/100cm^2. Twenty-four smear samples were taken on the Lower Walls and the maximum reading was 2.7 dpm/100cm^2. Twenty integrated direct surface alpha measurements were taken on the Ceiling and Upper Walls and the maximum reading was 2.7 dpm/100cm^2. Since all measurements were below the DCGL, no further statistical analysis of the data was performed.

3.2.4 Recommendation

In accordance with the Wash Rack FSS Work Plan and consistent with MARSSIM guidance, a SU can be cleared for release where all scans and integrated direct measurements are below the DCGL of 100 dpm/100cm^2 and all smear measurements are less than the DCGL of 10 dpm/100cm^2. Therefore, the North Floor SU, the South Floor SU, the Lower Walls SU, and the Ceiling and Upper Walls SU of Wash Rack #2 are recommended for unrestricted release.

3.3 Wash Rack #3

3.3.1 Surface Alpha Radioactivity Scan Surveys

The floor and the lower walls were surveyed for surface alpha radioactivity in Wash Rack #3. All of these areas are designated MARSSIM Class 1. The ceiling and upper walls are designated MARSSIM Class 2 approximately 10% of the total area was scanned for alpha activity. All scans of ceiling and upper walls resulted in alpha counts that were equal to or below background, so results of these scans were not recorded on official CABRERA forms. In the Figures section of this FSS, Figures 17 through 21 graphically depict the results of the scan surveys on the floor and lower walls. As can be observed in the figures, no alpha scanning measurements exceeded the DCGL of 100 dpm/100cm^2.

3.3.2 Integrated Direct Surface Alpha Radioactivity Measurements

Wash Rack #3 was divided into four SUs – the North Floor, the South Floor, and the Lower Walls were classified Class 1 and the Ceiling and Upper Walls were classified Class 2. Twenty integrated direct surface alpha measurements were taken on the North Floor and the maximum reading was 14.9 dpm/100cm^2. Twenty integrated direct surface alpha measurements were taken on the South Floor and the maximum reading was 6.8 dpm/100cm^2. Twenty-four integrated direct surface alpha measurements were taken on the Lower Walls and the maximum reading was 8.8 dpm/100cm^2. Twenty integrated direct surface alpha measurements were taken on the Ceiling and Upper Walls and the maximum reading was 10.0 dpm/100cm^2. Since all measurements were below the DCGL, no further statistical analysis of the data was performed.

3.3.3 Smear Sample Collection and Analysis

Twenty smear samples were taken on the North Floor and the maximum reading was 0.9 dpm/100cm^2. Twenty smear samples were taken on the South Floor and the maximum reading was -0.6 dpm/100cm^2. Twenty-four smear samples were taken on the Lower Walls and the maximum reading was 2.4 dpm/100cm^2. Twenty integrated direct surface alpha measurements were taken on the Ceiling and Upper Walls and the maximum reading was 0.9 dpm/100cm^2.

Since all measurements were below the DCGL, no further statistical analysis of the data was performed.

3.3.4 Recommendation

In accordance with the Wash Rack FSS Work Plan and consistent with MARSSIM guidance, a SU can be cleared for release where all scans and integrated direct measurements are below the DCGL of 100 dpm/100cm^2 and all smear measurements are less than the DCGL of 10 dpm/100cm^2. Therefore, the North Floor SU, the South Floor SU, the Lower Walls SU, and the Ceiling and Upper Walls SU of Wash Rack #3 are recommended for unrestricted release.

3.4 Concrete Pad #2

This 22- by 15-m pad was cleaned by shot blasting it with a Blastrac^{tm}. Then the pad was surveyed with a floor monitor and Total Station. The pad was divided into two survey units (under MARSSIM requirements, this Class 1 structure was treated similar to a building interior). Systematic fixed count surveys with alpha/beta meter were completed along with smears at those locations.

3.4.1 Surface Alpha Radioactivity Scan Surveys

One hundred percent of the surface of Concrete Pad #2 was surveyed for surface alpha radioactivity. Concrete Pad #2 is designated MARSSIM Class 1. In the Figures section of this FSS, Figures 22 and 23 graphically depict the results of the scan survey. As can be observed in the figures, no alpha scanning measurements exceeded the DCGL of 100 dpm/100cm^2.

3.4.2 Integrated Direct Surface Alpha Radioactivity Measurements

Concrete Pad #2 was divided into two Class 1 SUs and they were designated North and South. Twenty integrated direct surface alpha measurements were taken on both the North SU and the South SU. The maximum measurement taken on the North SU was 27.1 dpm/100cm^2 and the maximum measurement taken on the South SU was 18.0 dpm/100cm^2. Since all measurements were below the DCGL, no further statistical analysis of the data was performed.

3.4.3 Smear Sample Collection and Analysis

Twenty smear samples were taken on both the North SU and the South SU. The maximum measurement taken on the North SU was 2.9 dpm/100cm^2 and the maximum measurement taken on the South SU was 1.6 dpm/100cm^2. Since all measurements were below the DCGL, no further statistical analysis of the data was performed.

3.4.4 Recommendation

In accordance with the BTD FSS Work Plan and consistent with MARSSIM guidance, a SU can be cleared for release where all scans and integrated direct measurements are below the DCGL of 100 dpm/100cm^2 and all smear measurements are less than the DCGL of 10 dpm/100cm^2.

Therefore, both the North SU and the South SU of Concrete Pad #2 are recommended for unrestricted release.

3.5 Concrete Pad #1

This pad is somewhat smaller than the pad behind Building 701. As with Concrete Pad #2, the pad was divided into two survey units. Systematic fixed count surveys with alpha/beta meter were completed along with smears at those locations.

3.5.1 Surface Alpha Radioactivity Scan Surveys

Concrete Pad #1 is designated MARSSIM Class 1. In the Figures section of this FSS, Figures 24 and 25 graphically depict the results of the scan survey. As can be observed in the figures, no alpha scanning measurements exceeded the DCGL of 100 dpm/100cm^2.

3.5.2 Integrated Direct Surface Alpha Radioactivity Measurements

Concrete Pad #1 was divided into two Class 1 SUs and they were designated North and South. Twenty integrated direct surface alpha measurements were taken on both the North SU and the South SU. The maximum measurement taken on the North SU was 33.2 dpm/100cm^2 and the maximum measurement taken on the South SU was 16.3 dpm/100cm^2. Since all measurements were below the DCGL, no further statistical analysis of the data was performed.

3.5.3 Smear Sample Collection and Analysis

Twenty smear samples were taken on both the North SU and the South SU. The maximum measurement taken on the North SU was 4.2 dpm/100cm^2 and the maximum measurement taken on the South SU was 1.6 dpm/100cm^2. Since all measurements were below the DCGL, no further statistical analysis of the data was performed.

3.5.4 Recommendation

In accordance with the BTD FSS Work Plan and consistent with MARSSIM guidance, a SU can be cleared for release where all scans and integrated direct measurements are below the DCGL of 100 dpm/100cm^2 and all smear measurements are less than the DCGL of 10 dpm/100cm^2. Therefore, both the North SU and the South SU of Concrete Pad #1 are recommended for unrestricted release.

4.0 FINAL STATUS SURVEY INSTRUMENT QUALITY ASSURANCE AND QUALITY CONTROL

The purpose of this section is to document the calibration of the radiological survey instruments used during the FSS, and the quality control tracking of each instrument as specified in the Work Plans (as documented in Appendices B, C, and D). Data collection activities were performed in accordance with written procedures and/or protocols in order to ensure consistent, repeatable results. The Project Engineer ensured that individuals were appropriately trained to use project instrumentation and other equipment, and that instrumentation met the required detection sensitivities.

Scanning and integrated direct measurements were performed to measure surface radioactivity levels for total uranium. These measurements were based solely on alpha emissions due to high specificity and sensitivity, and low background interference. For smear measurements, beta measurements were collected in tandem with alpha measurements as a qualitative assessment to confirm survey assumptions. Prior to the initiation of alpha survey activities, surfaces of interest were cleaned to remove dirt and grime that could shield alpha emissions from detection.

Current calibration/maintenance records were kept on site for review and inspection (included in Appendix I). The records include, at a minimum, the following:

- name of the equipment
- equipment identification (model and serial number)
- manufacturer
- date of calibration
- calibration due date

Instrumentation was maintained and calibrated to manufacturers' specifications to ensure that required traceability, sensitivity, accuracy and precision of the equipment/instruments were maintained. Instruments were calibrated at a facility possessing appropriate NRC and/or Agreement State licenses for performing calibrations using National Institute of Standards and Technology (NIST) traceable sources. Copies of the calibration certificates for the sources are also provided in Appendix I. A chronological summary of field activities at each structure/SU and instrumentation is presented in Appendix F.

QC measurements were performed on all deployed field instruments each day, before and after each use at a minimum. A controlled area was used to perform these checks. The QC investigation levels for count rate instruments used during the FSS were ±2-sigma (2σ) (warning) and $\pm 3\sigma$ (fail). Exposure rate and other radiation detection instruments were evaluated using a qualitative ±20% against the indicated check source response on the meter. If any single measurement was found to be outside of its investigation level, the measurement was repeated. If the second count was also found to be outside of this criterion, the instrument was investigated to assess whether any external biases or instrument physical damage was present. If response checks were found to be outside of $\pm 3\sigma$, the instrument was taken out of service unless evaluated and approved by the Field Radiological Engineer or the Project Manager. Control charts for check source response, background count rates (where applicable), and copies of the daily check source logs for all instruments are provided in Appendix I.

Gross transferable alpha contamination was collected and analyzed to determine if transferable activity is less than or equal to 10% of total activity as assumed in the NUREG/CR-5512 and NUREG 1757 documents for screening level guidelines.

Smear samples were collected over approximately 100 cm^2 areas at systematic and biased locations identified during scanning activities. Smear samples were analyzed for alpha and beta radioactivity using a Ludlum Model 2929 alpha/beta scintillation counter.

Control charts for check source response, background count rates (where applicable), and copies of the daily check source logs for all instruments are provided in Appendix I.

5.0 REFERENCES

(BARG, 1995) Specific Manufacturing Capability Program, Depleted Uranium Constituents and Decay Heating, Lockheed, Idaho presentation, dated October 3, 1995.

(CABRERA, 2003) CABRERA Work Plan, "Final Status Survey Plan for the Bomb Throwing Device (BTD) Site, Aberdeen Proving Ground, Aberdeen, MD", Contract DAAA09-00-G-0002/0039.

(CABRERA, 2004) CABRERA Report, "Remediation and Final Status Survey, Bomb Throwing Device Site – Soils," Contract DAAA09-00-G-0002/0039.

(NRC, 2000) NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), U.S. Nuclear Regulatory Commission, dated August, 2000.

(NRC, 2003) NUREG-1757, Consolidated NMSS Decommissioning Guidance, Rev. 1, U.S. Nuclear Regulatory Commission, September 2003.

FIGURES

0	900	1,800	3,600	5,400	7,200

Meters

● BTD Site

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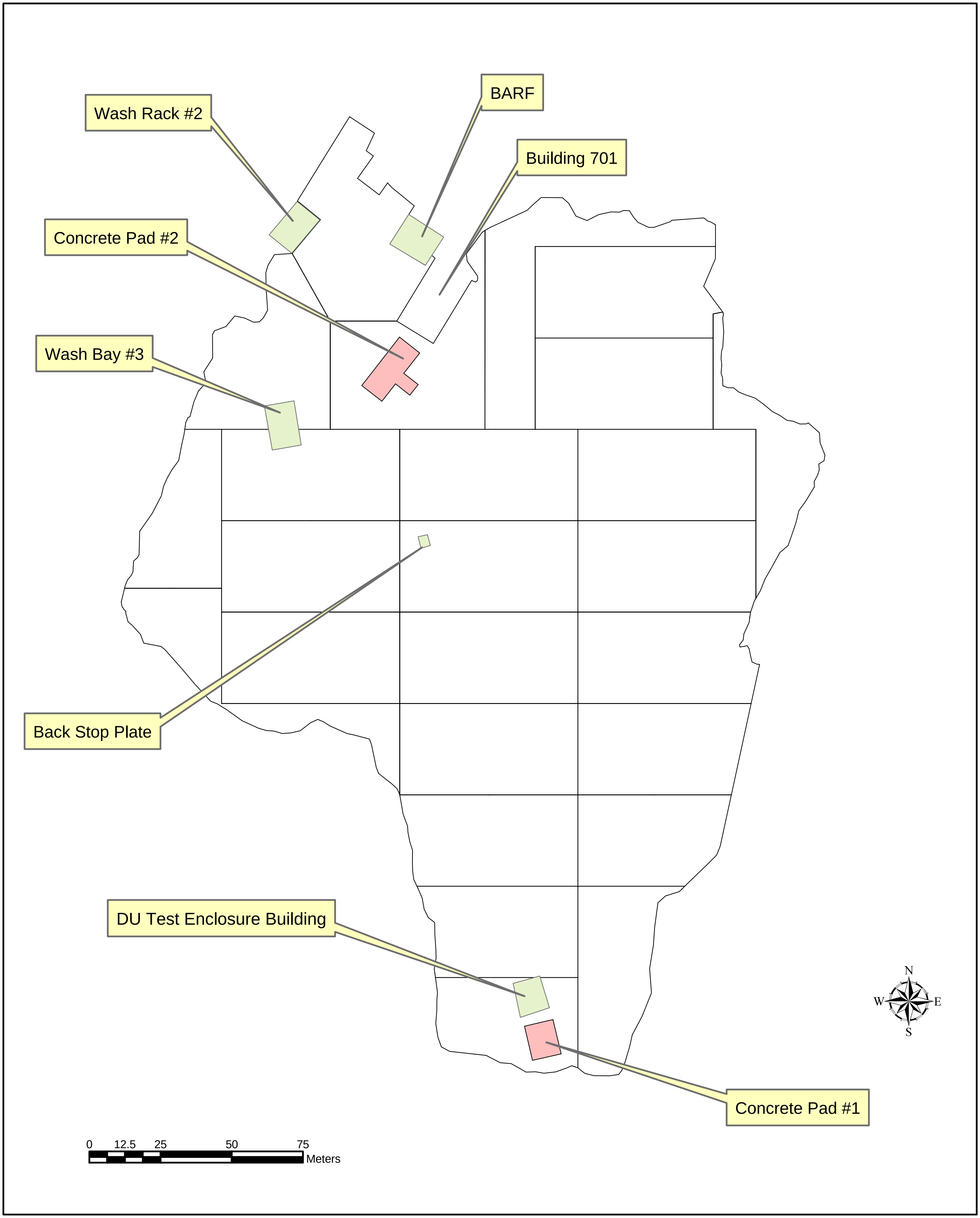
Site Location of APG

Remediation and FSS Report
BTD - Buildings
Aberdeen Proving Ground, MD

Date: 10-29-04
Project #: 01-3030.39
File Name:
Prepared By: JTM

Figure 1



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Site Survey Units

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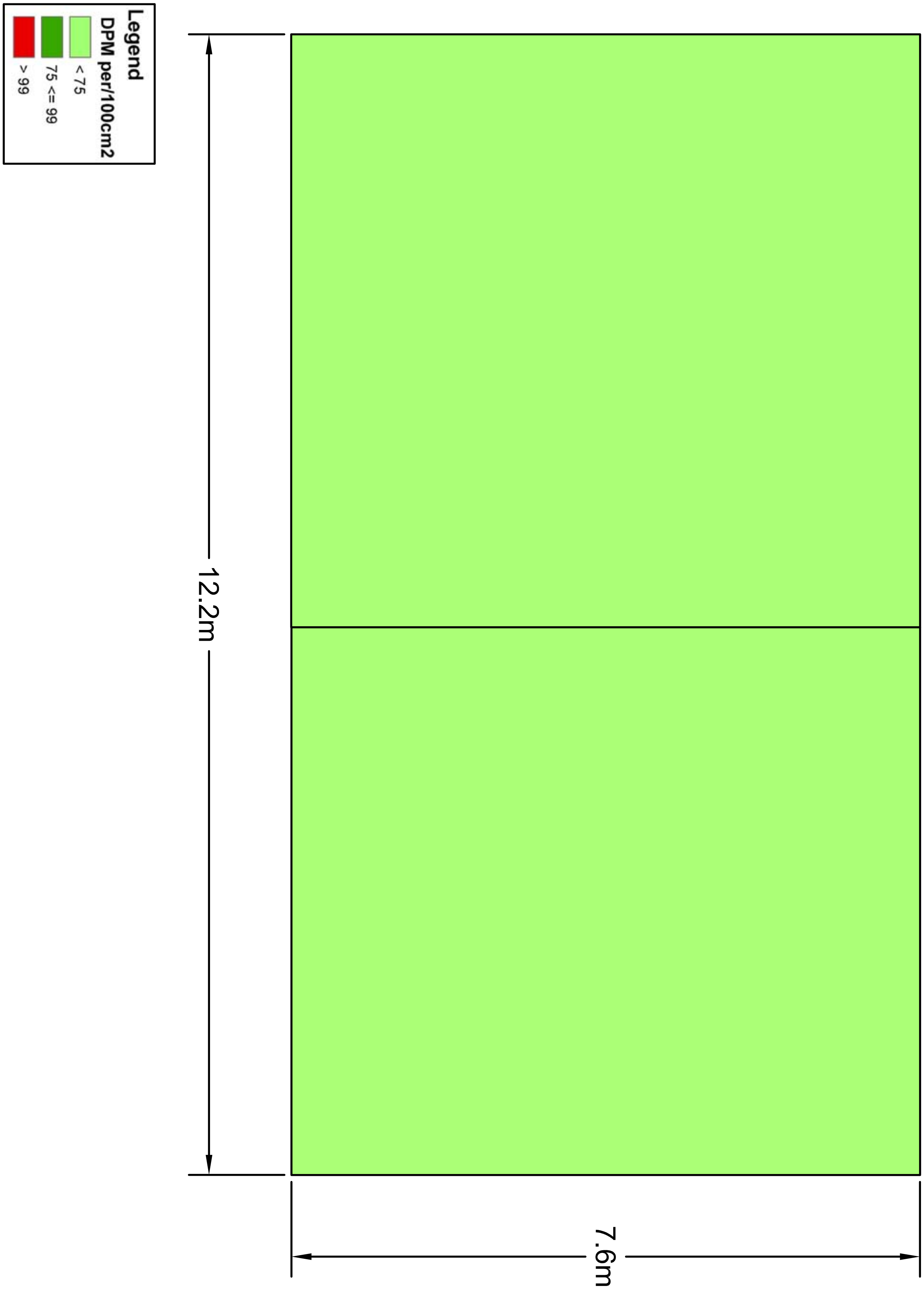
Date: 11-1-04
Project #: 01-3030-39
File Name:
Prepared By: JTM

Figure 2



BARF Building - Alpha Scan
North Room - Floor Survey Units A & B

Figure: 3	Remediation and FSS Report BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	10/29/2004 Scale: N.T.S.

BARF Building - Alpha Scan
South Room - Floor Survey Units A & B

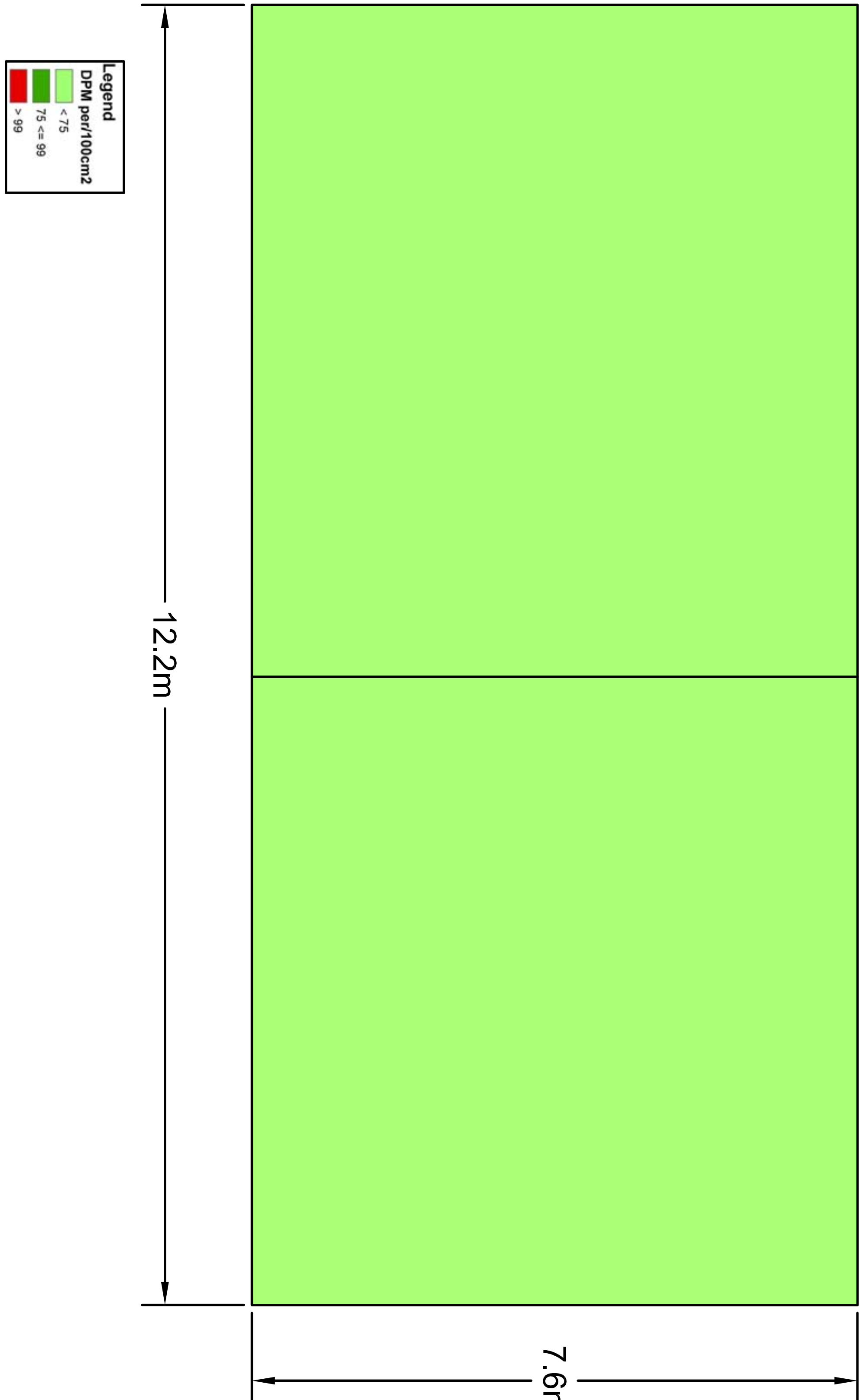


Figure: 4	Remediation and FSS Report BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	10/29/2004 Scale: N.T.S.

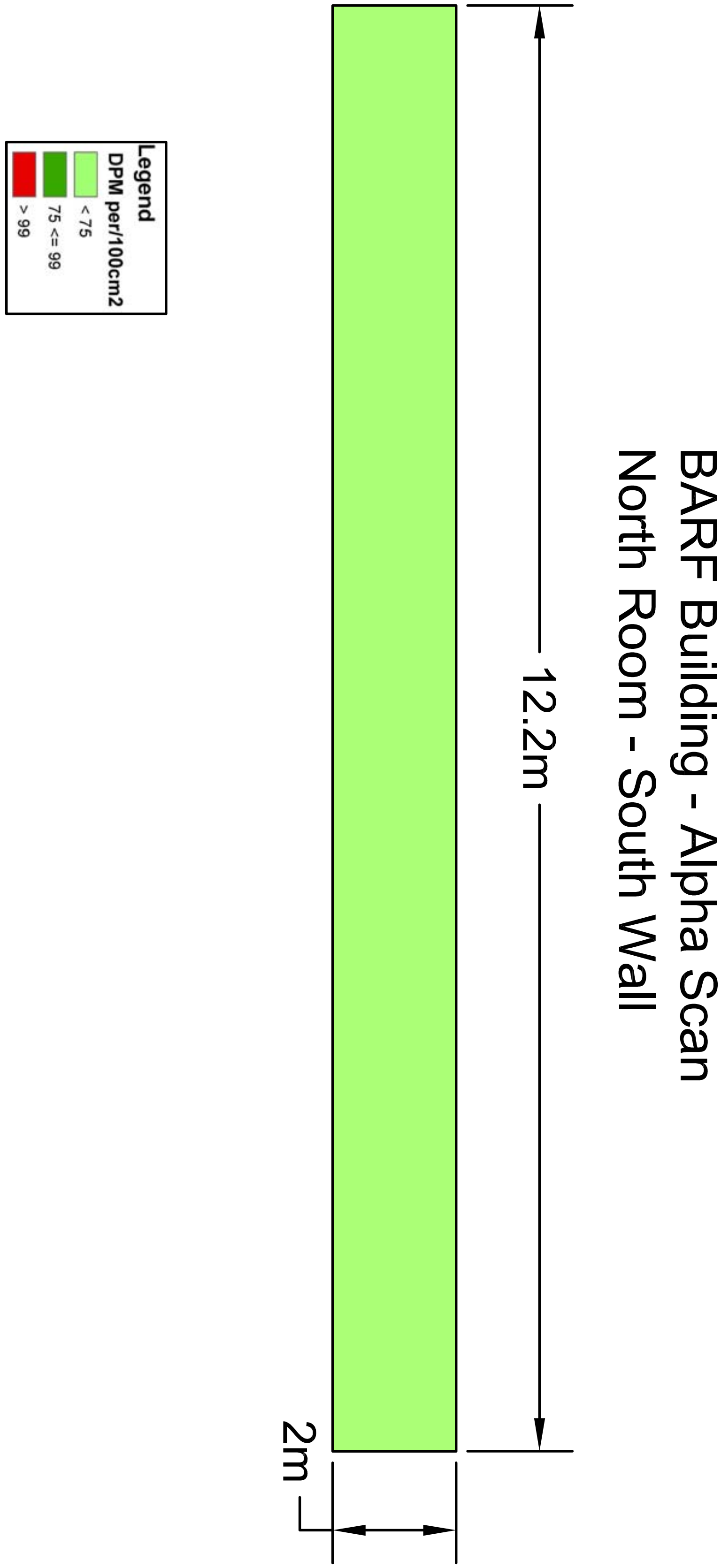


Figure: 5	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM

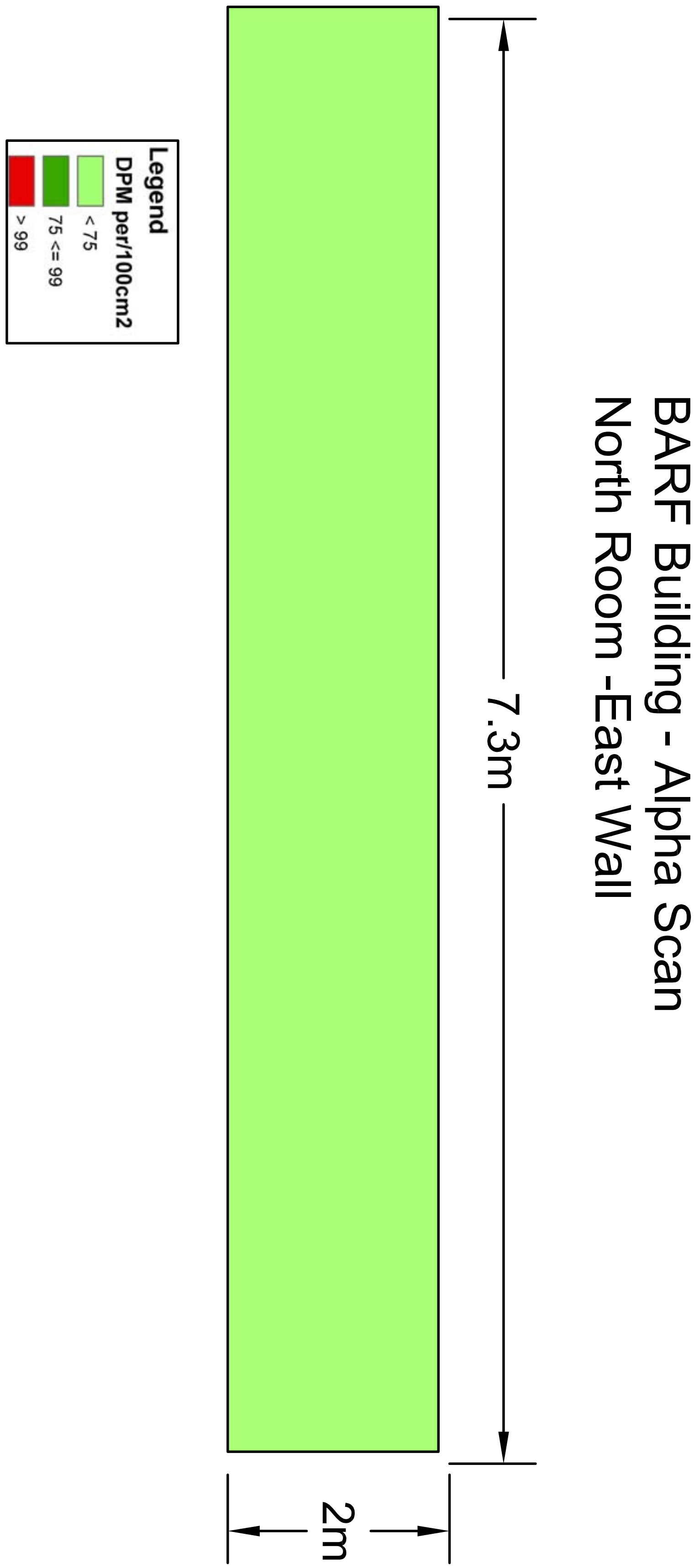
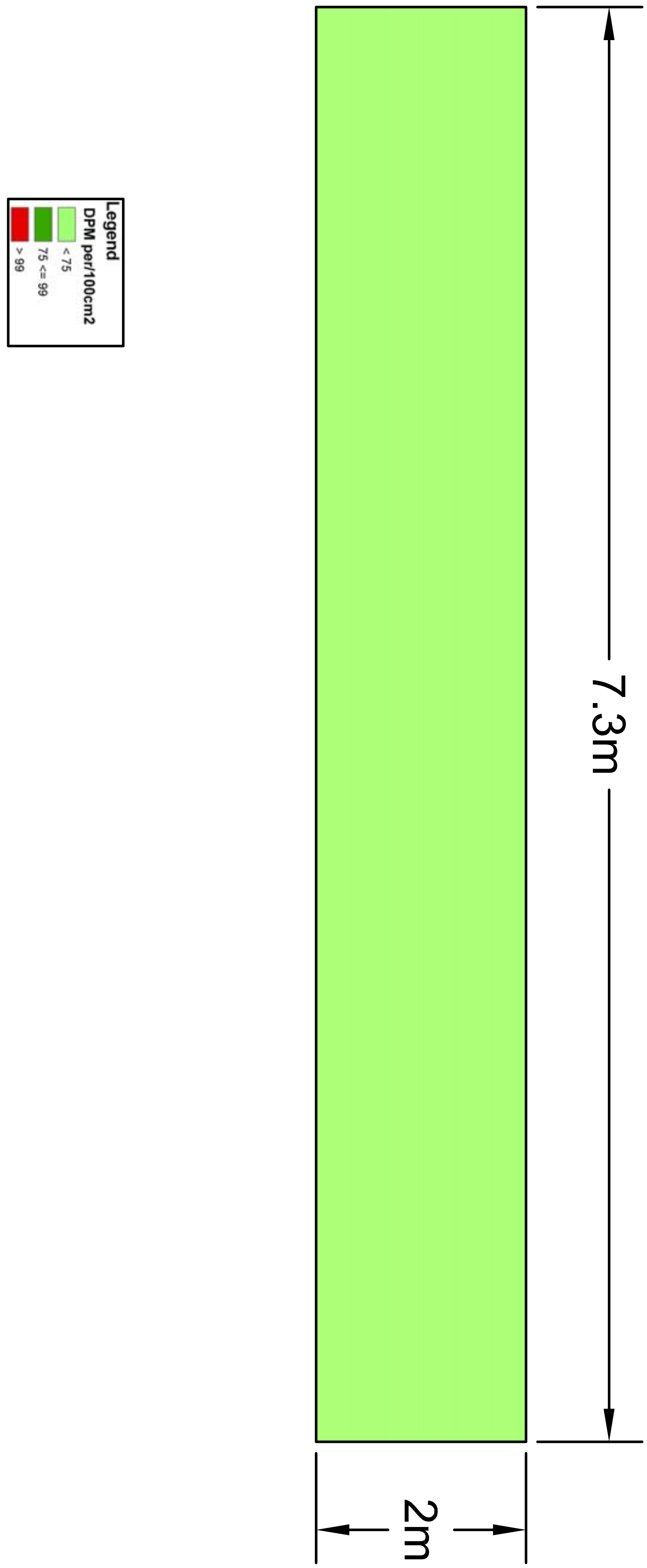


Figure: 6	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM



BARF Building - Alpha Scan
North Room - West Wall

Figure: 7	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM

BARF Building - Alpha Scan
South Room - North Wall

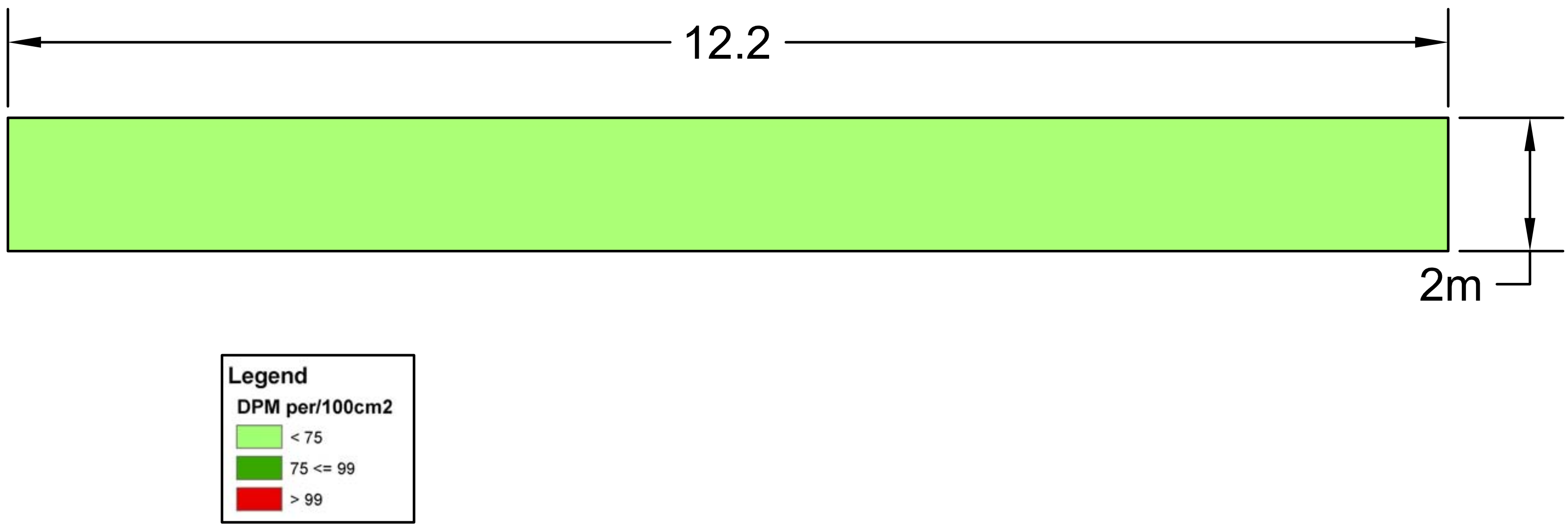


Figure: 8

Remediation and FSS
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BARF Building - Alpha Scan
South Room - South Wall

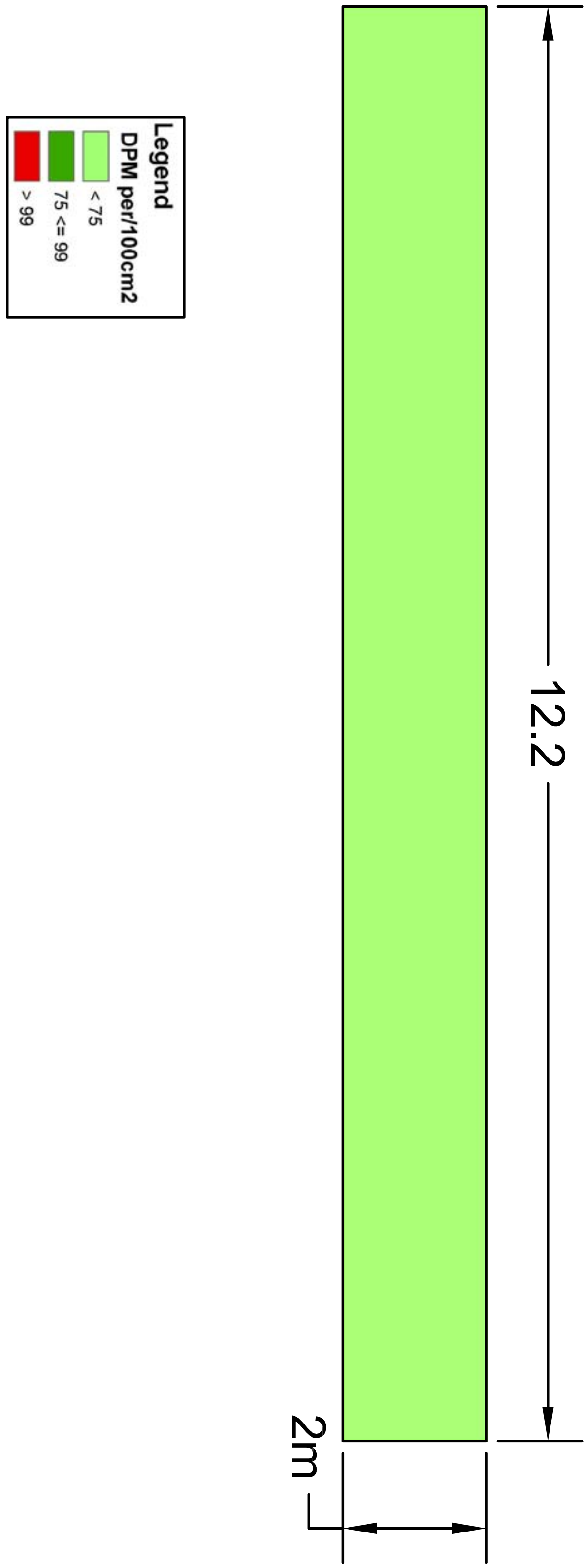

Figure: 9	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM

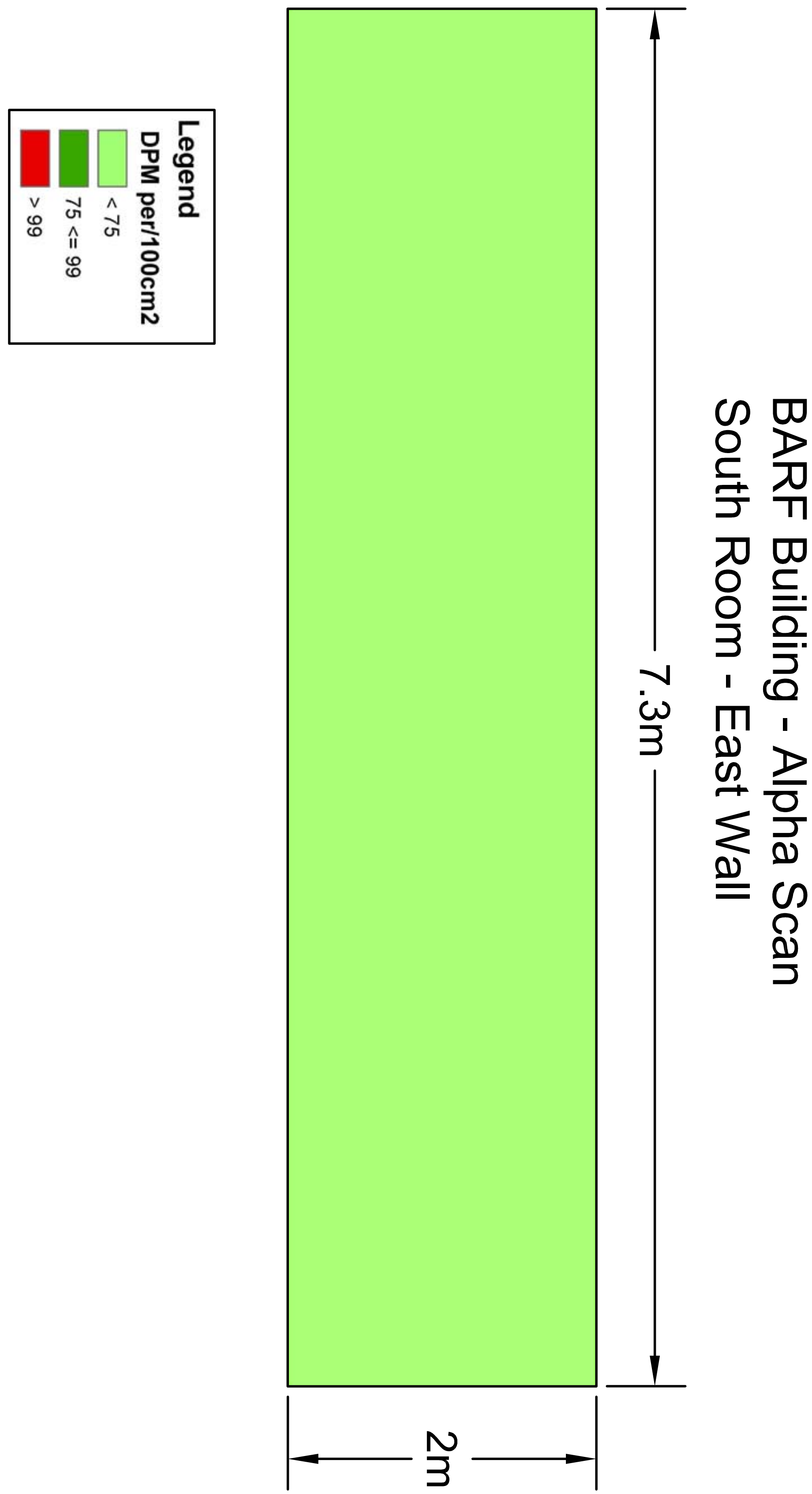

Figure: 10

Remediation and FSS
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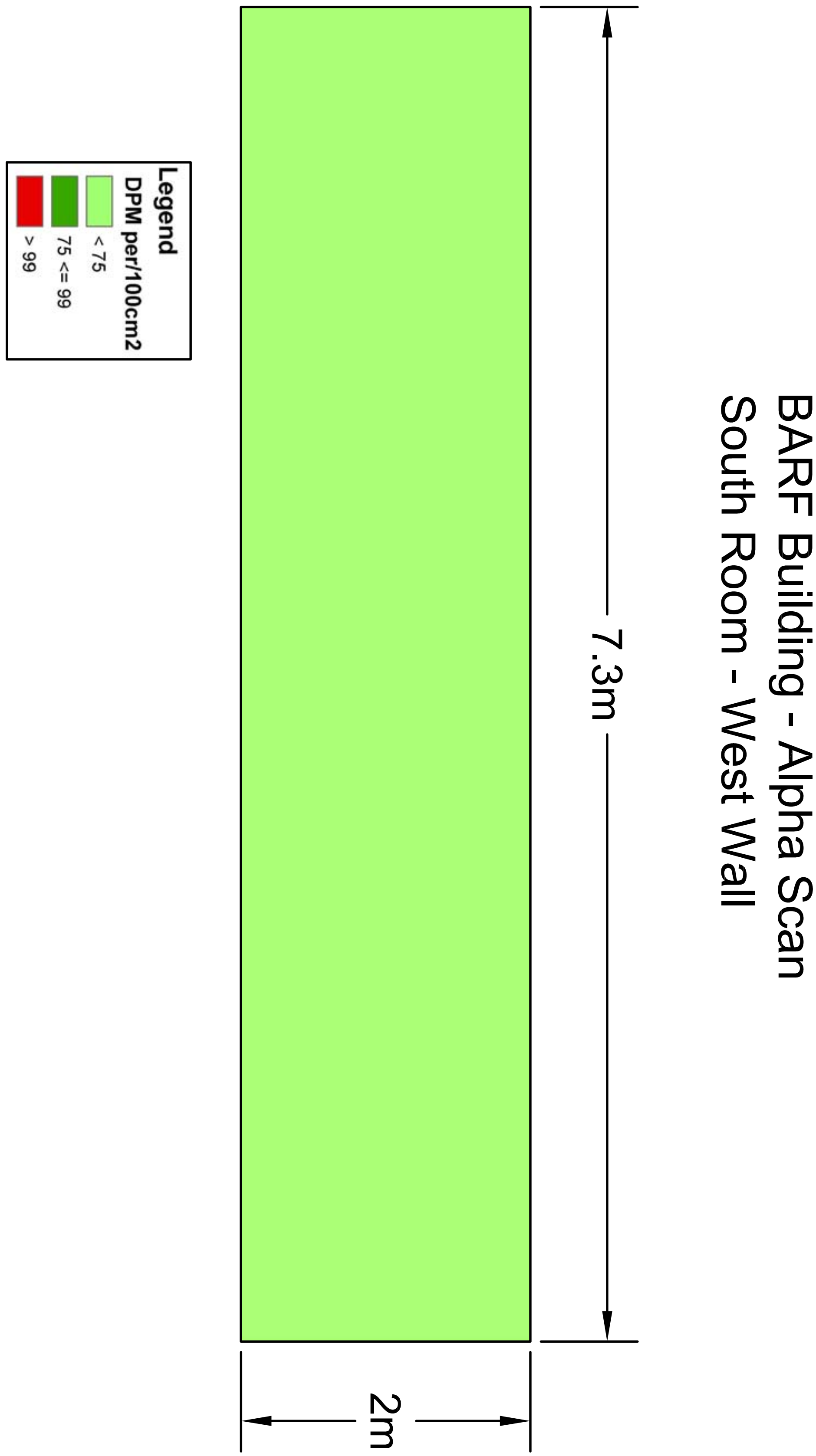

Figure: 11	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM

Wash Rack 2 - Alpha Scan
Interior Floor

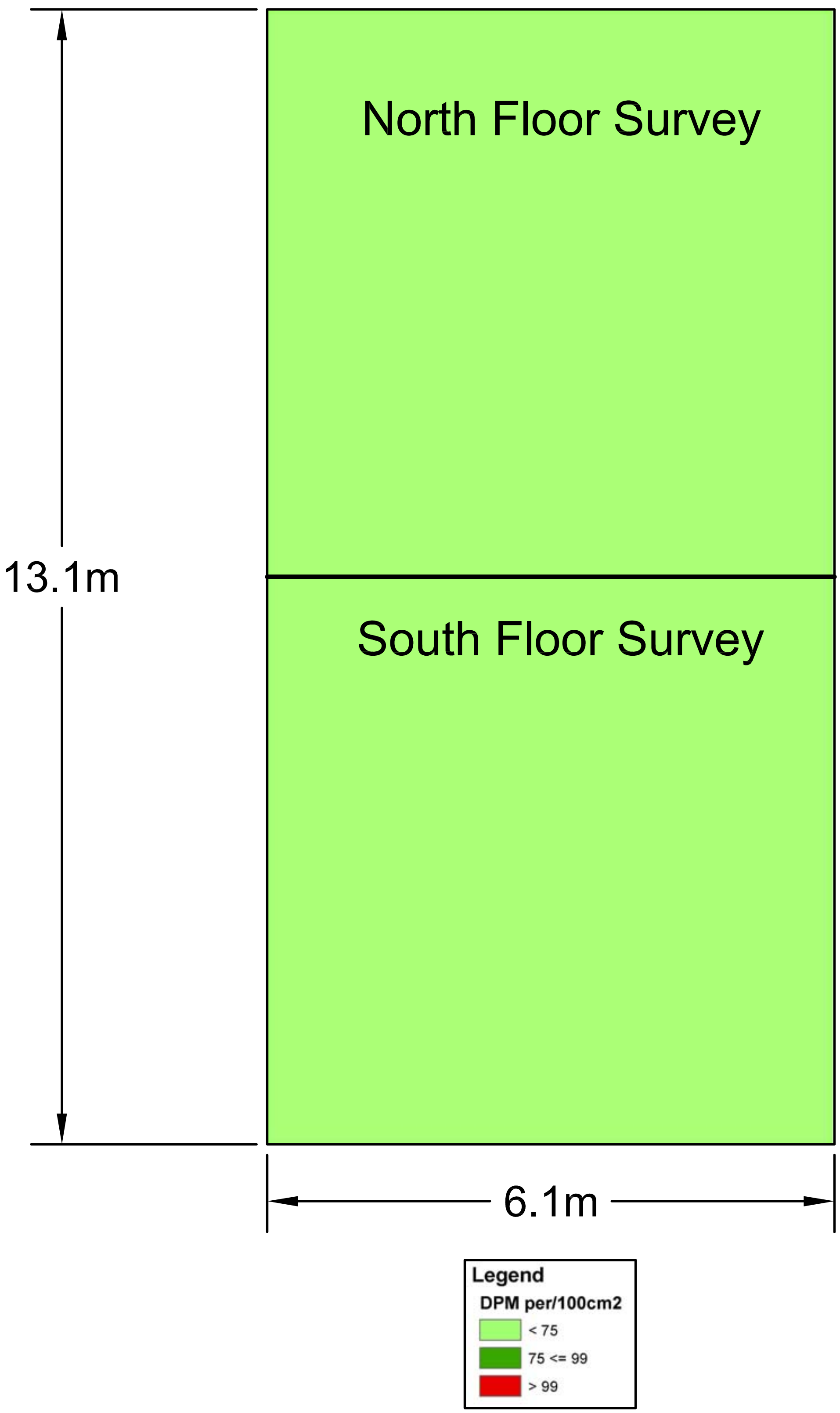

Figure: 12	Remediation and FSS Report BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	10/29/2004 Scale: N.T.S.

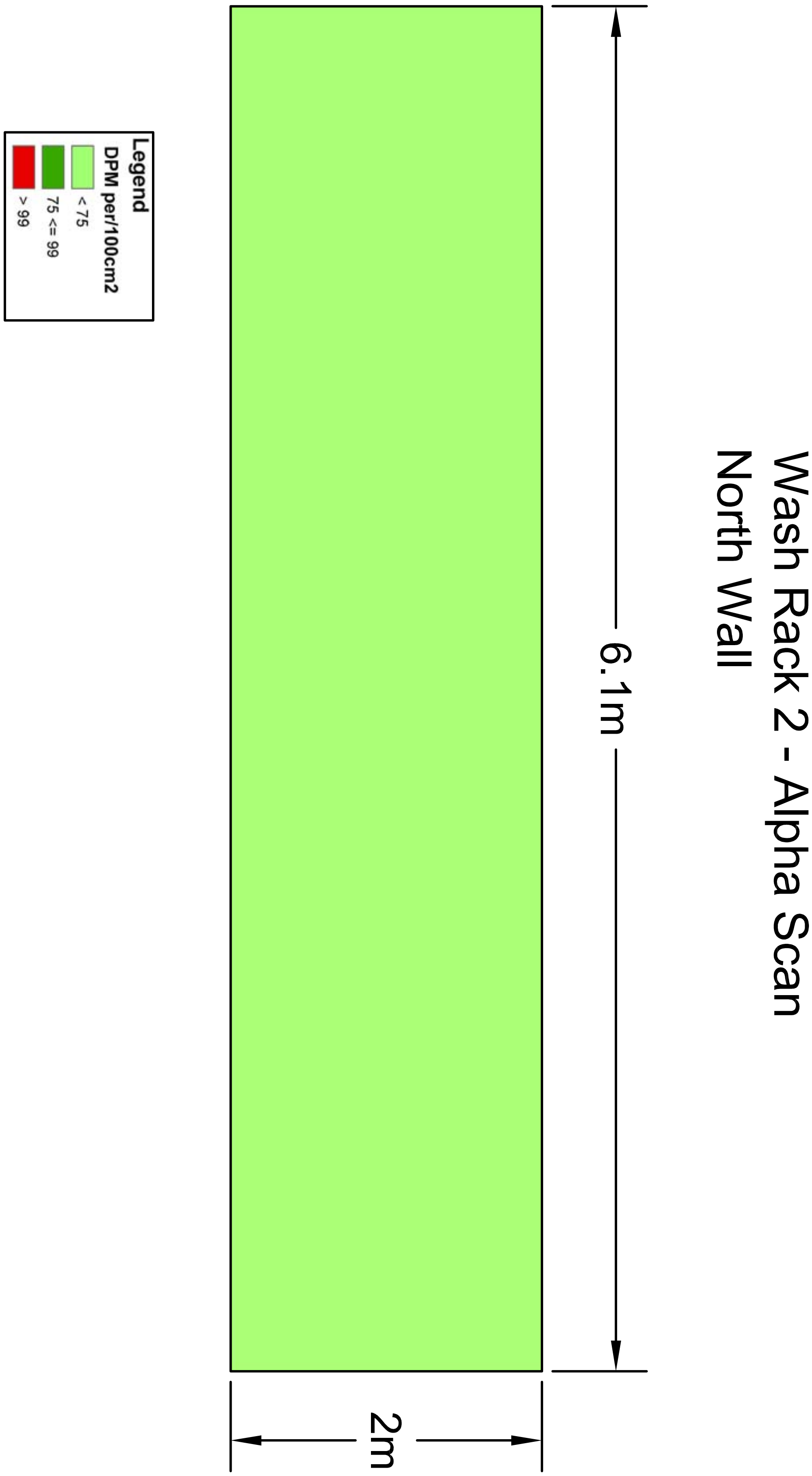

Figure: 13

Remediation and FSS
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Wash Rack 2 - Alpha Scan South Wall

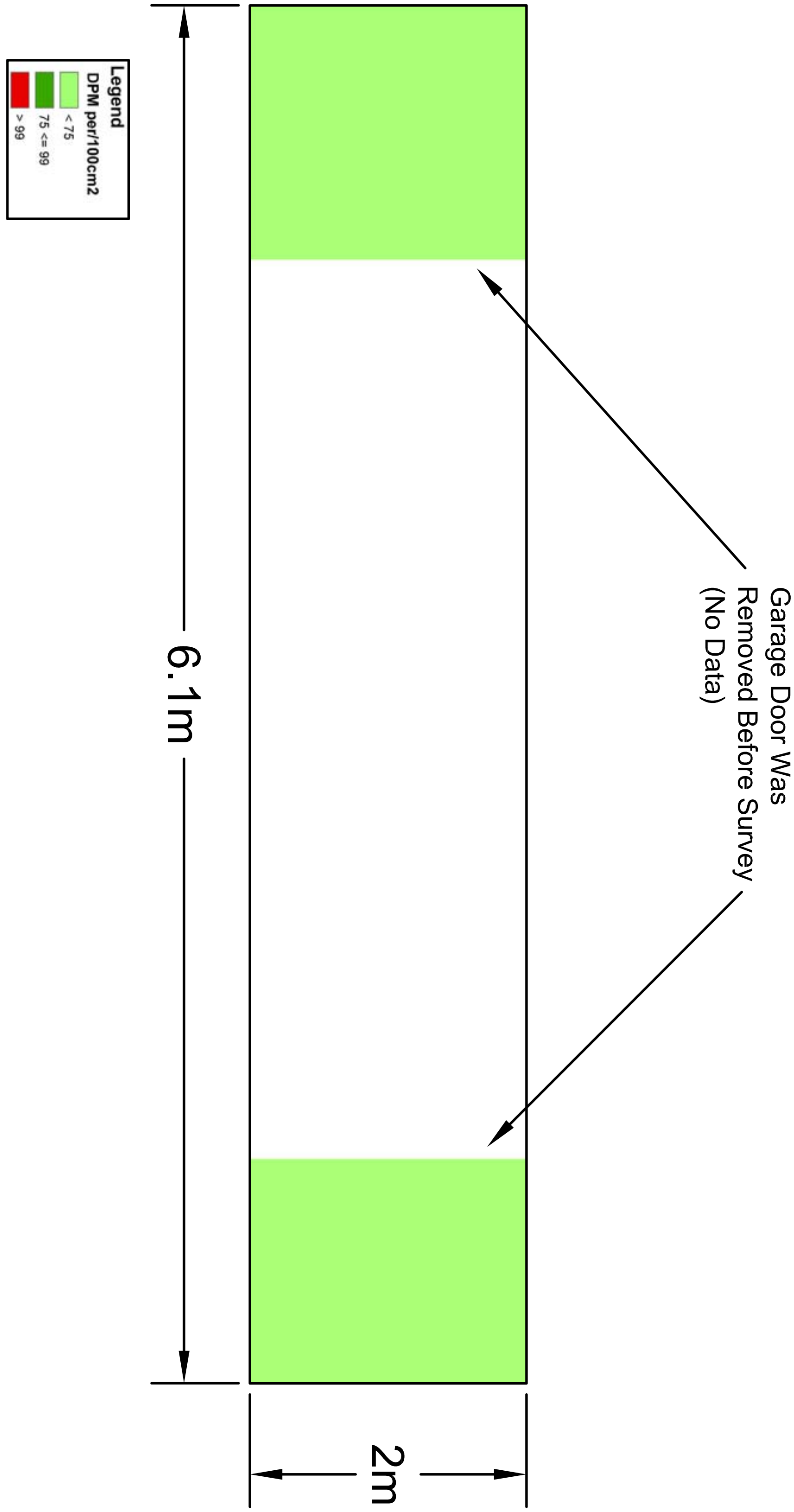


Figure:14	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM

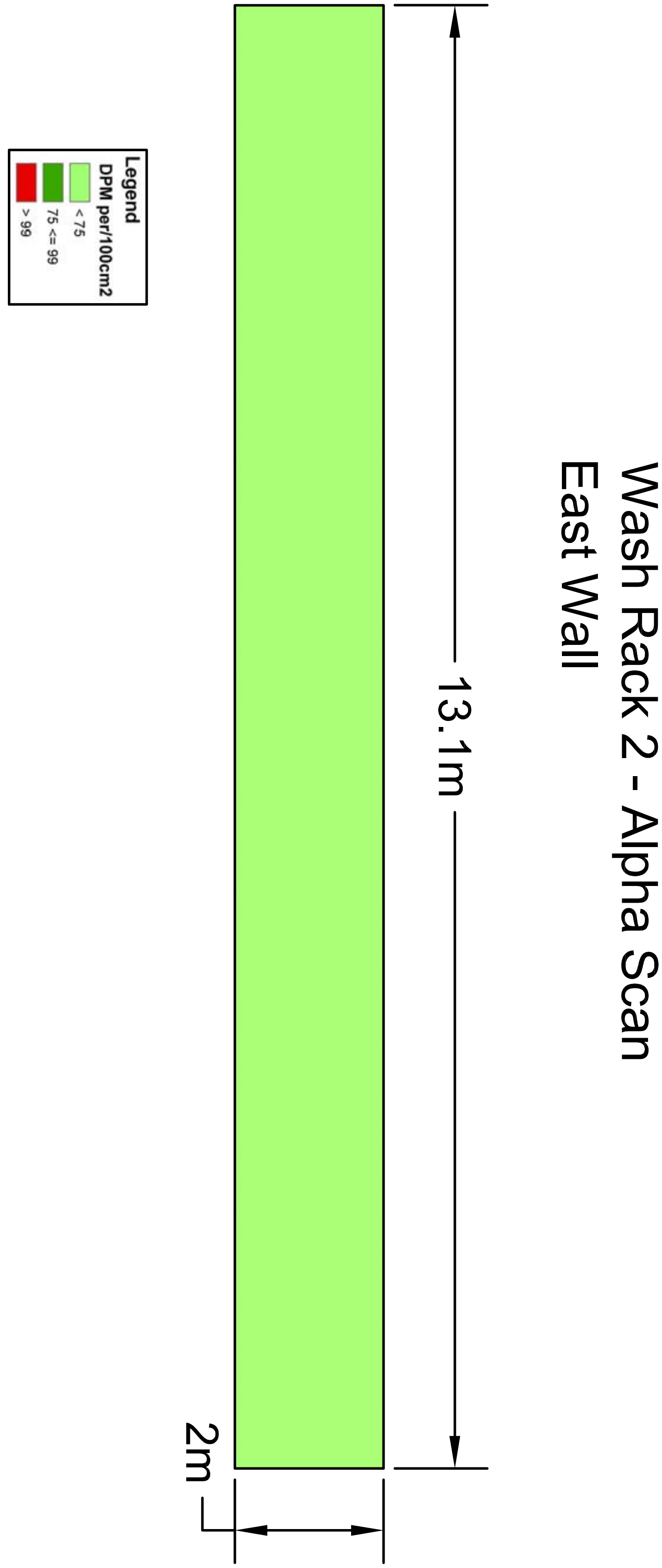


Figure:15	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM

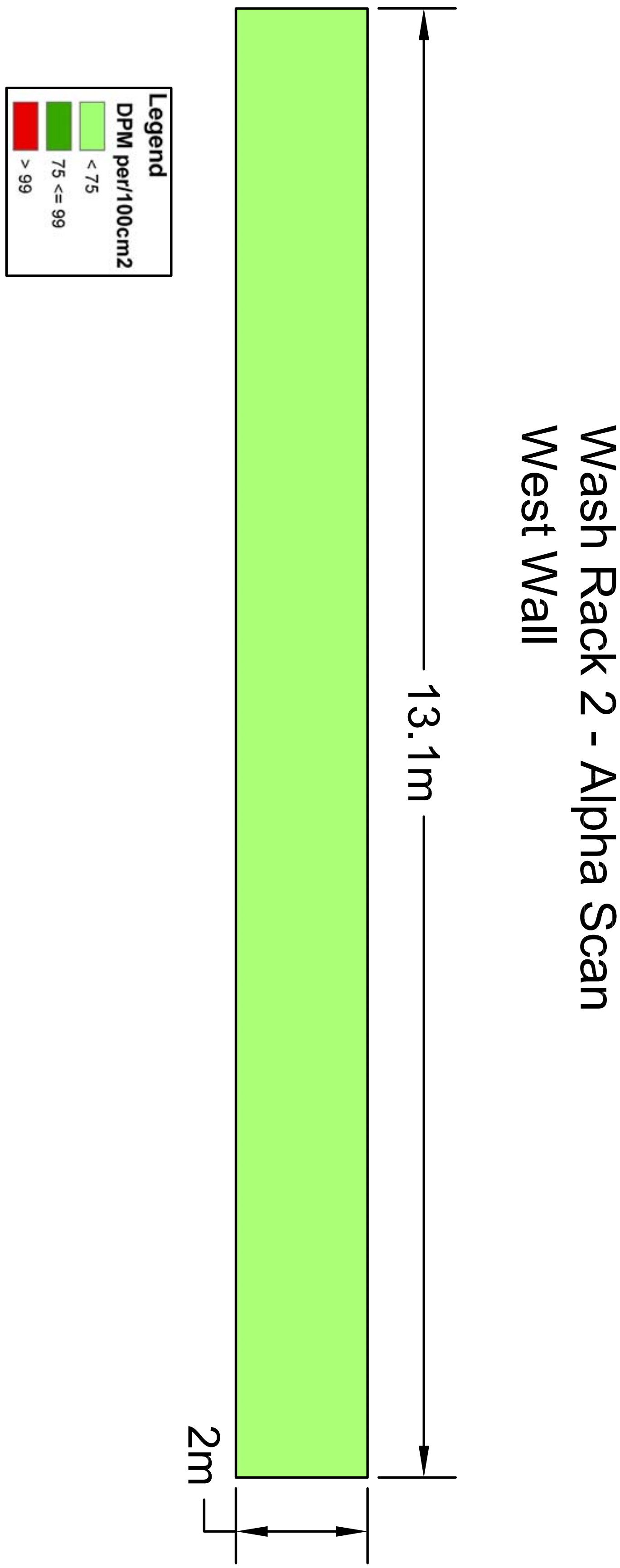


Figure: 16	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM

Wash Rack 3 - Alpha Scan
Interior Floor

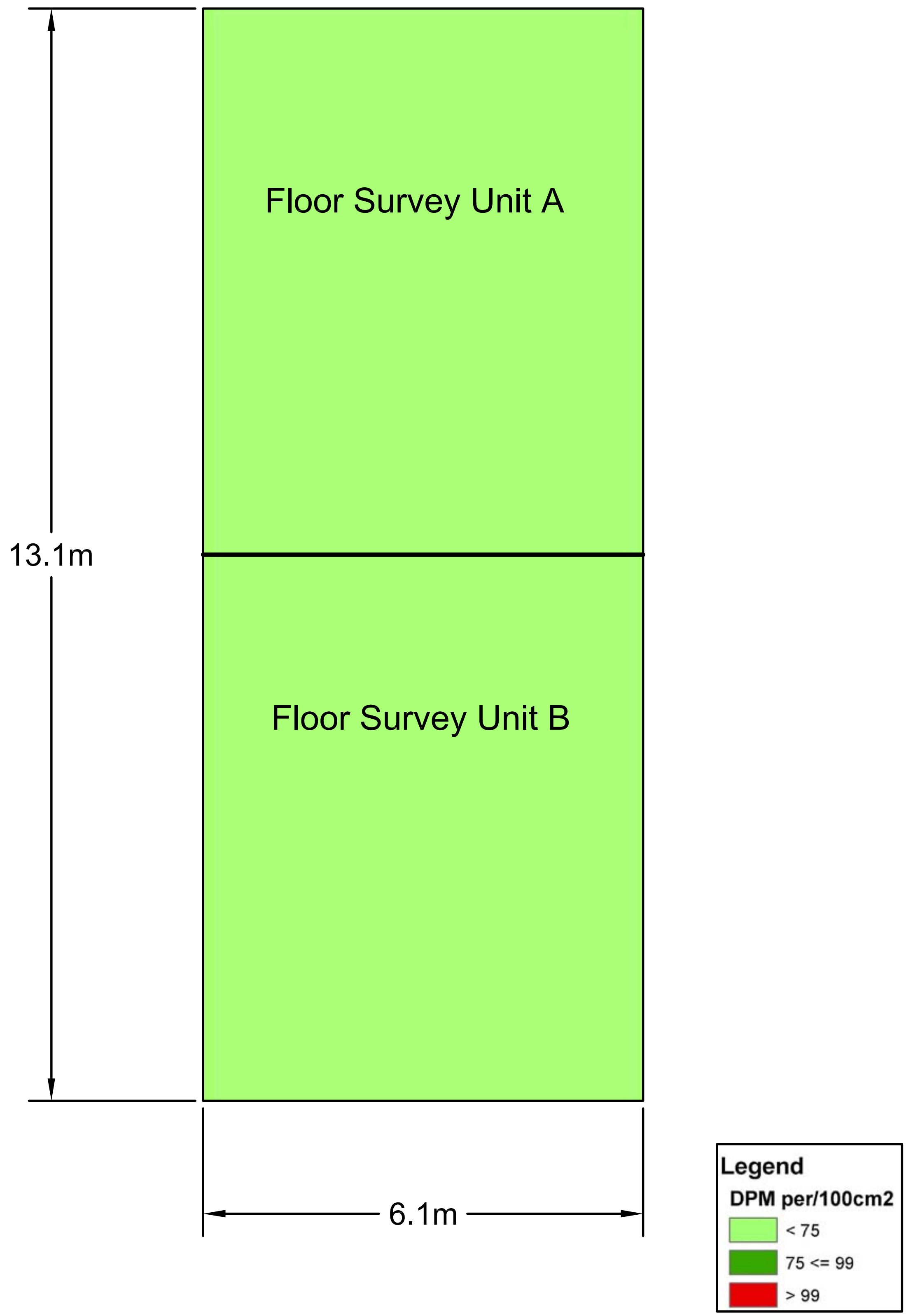


Figure: 17	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM

Wash Rack 3 - Alpha Scan
North Wall

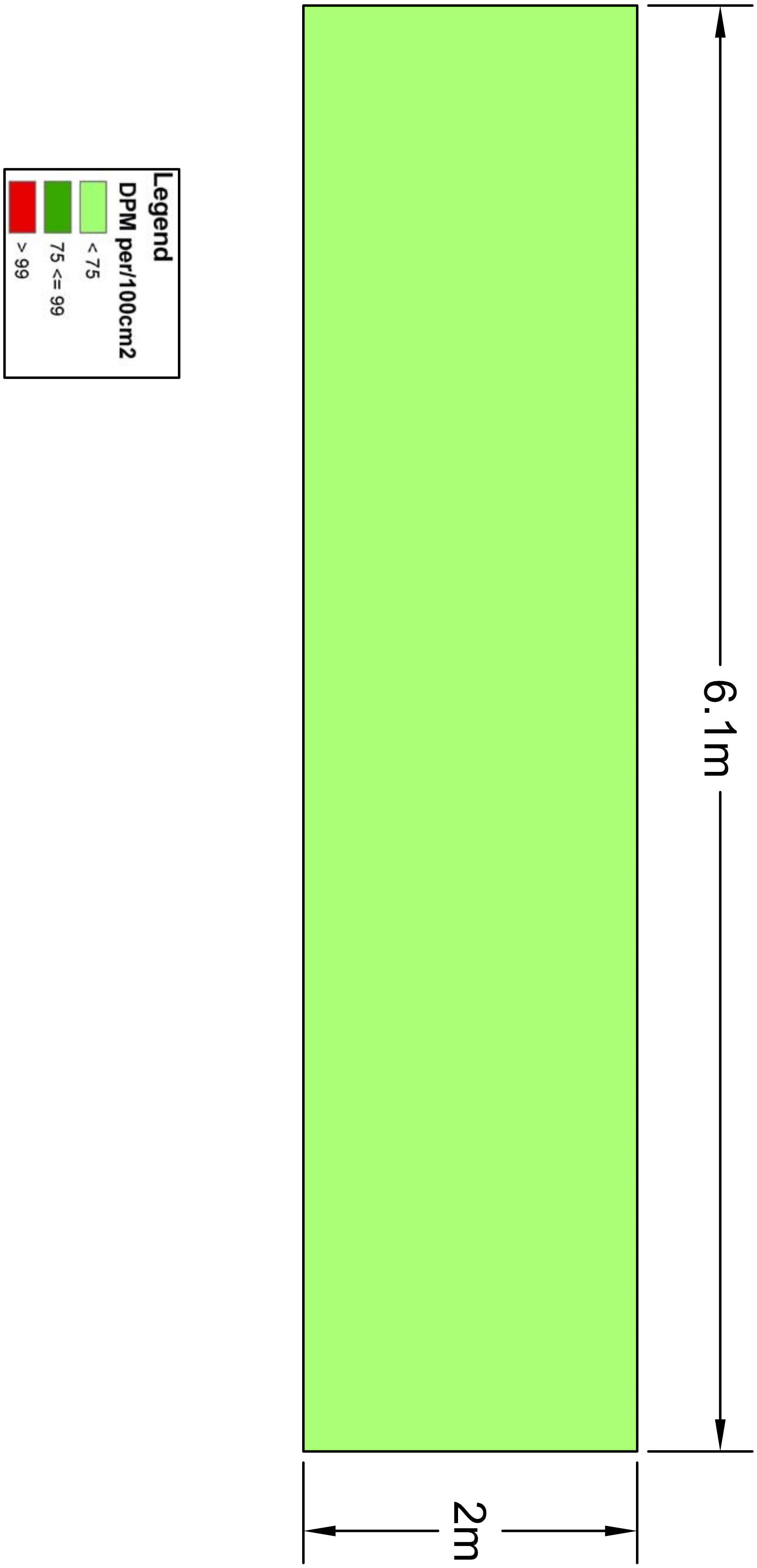


Figure:18	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM

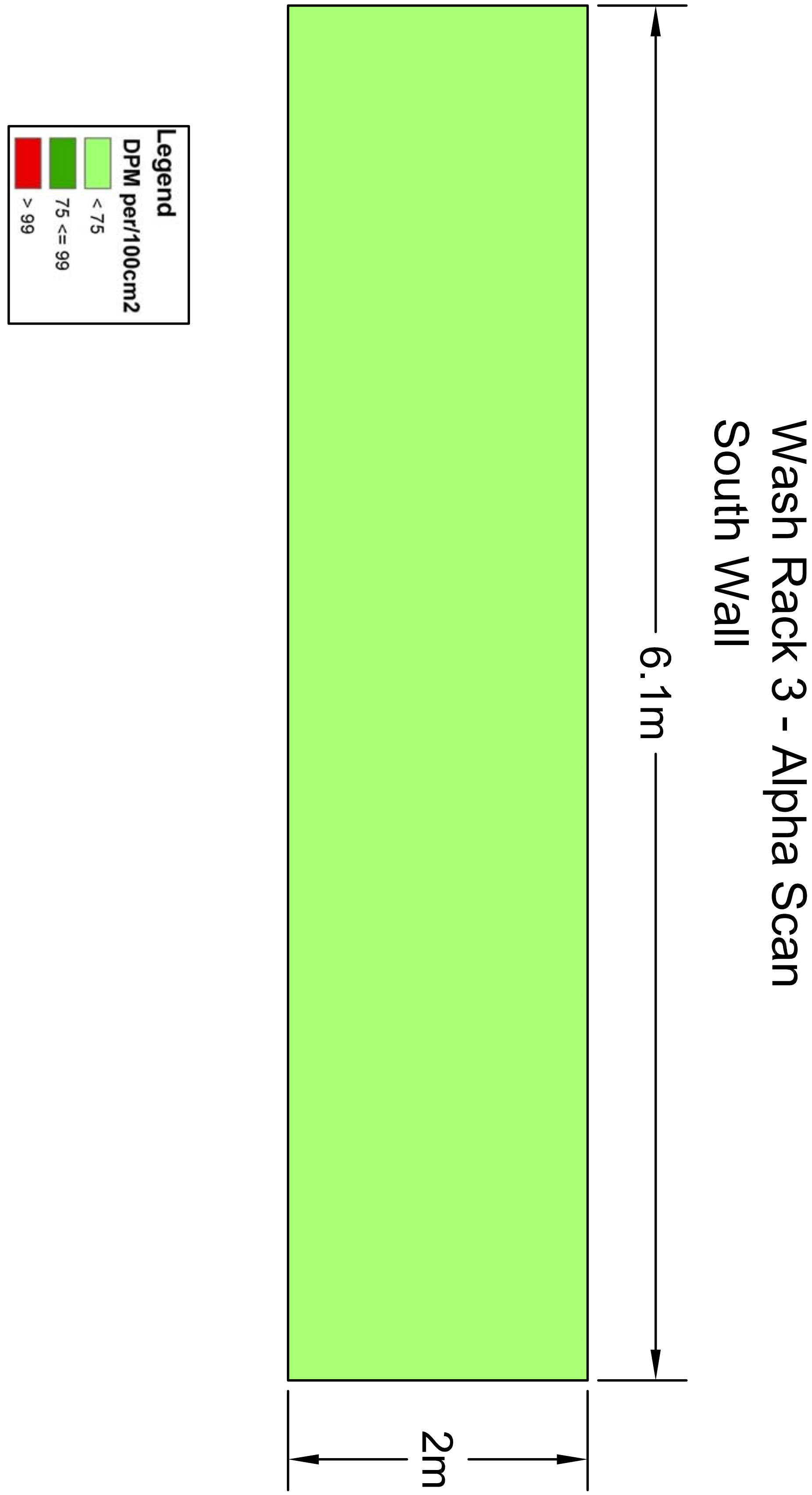


Figure: 19	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM

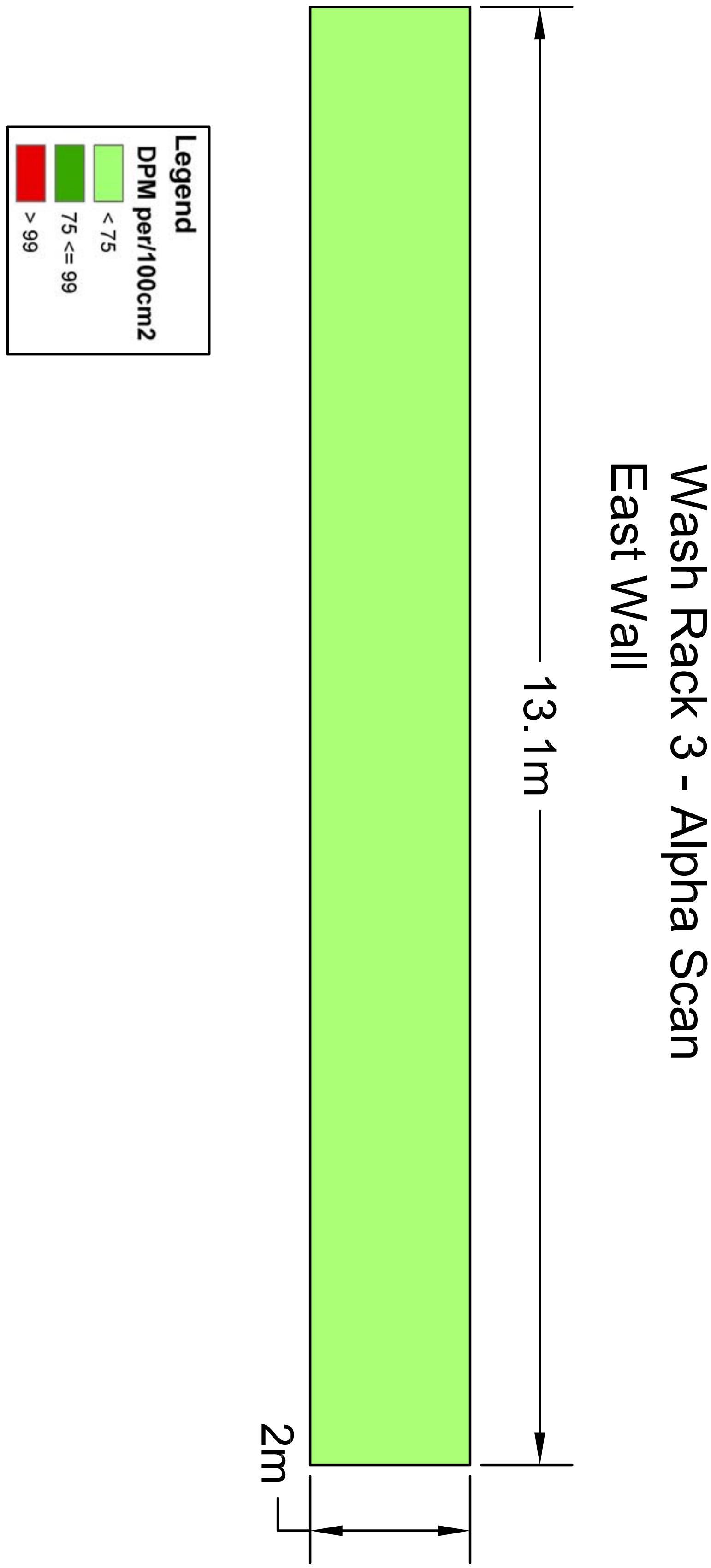


Figure: 20

Remediation and FSS
BTD - Buildings
Aberdeen Proving Ground, MD

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION
WWW.CABRERASERVICES.COM

Date: 11/2/2004

Created by: JTM

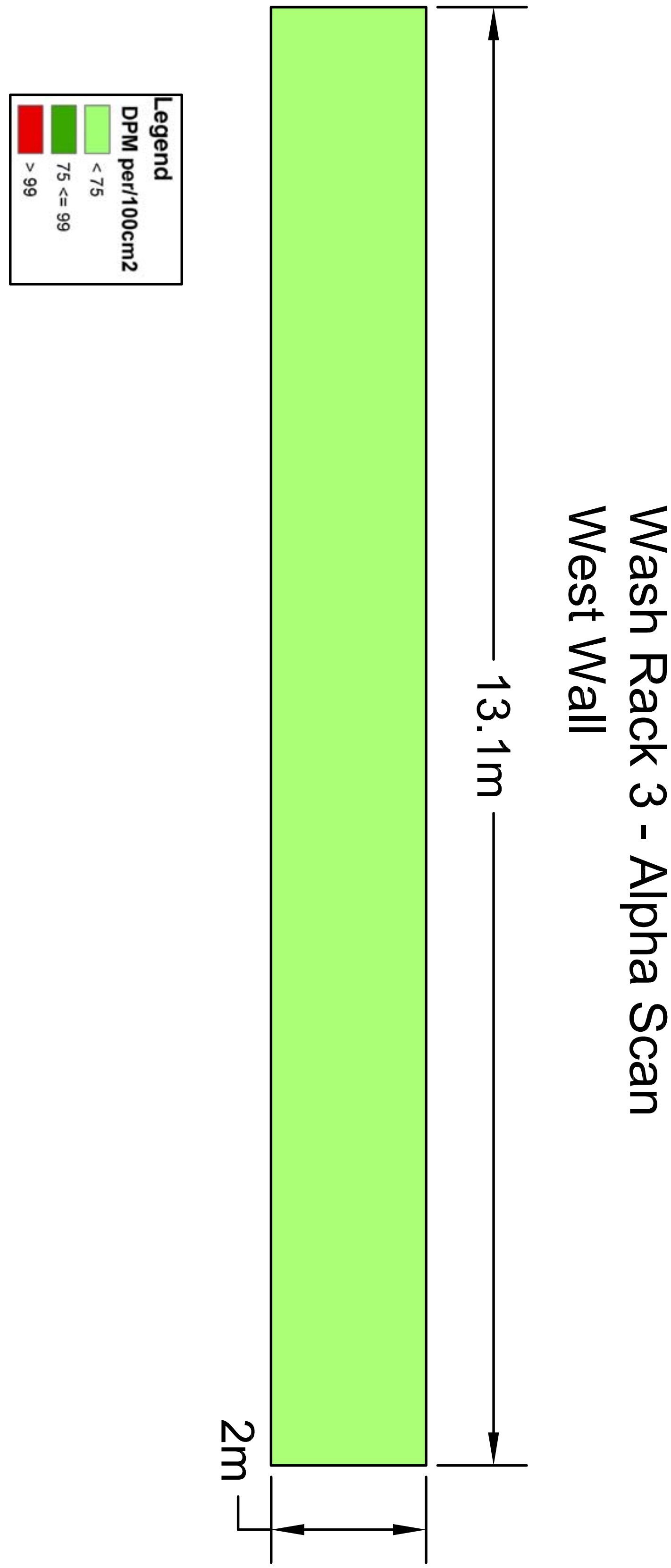
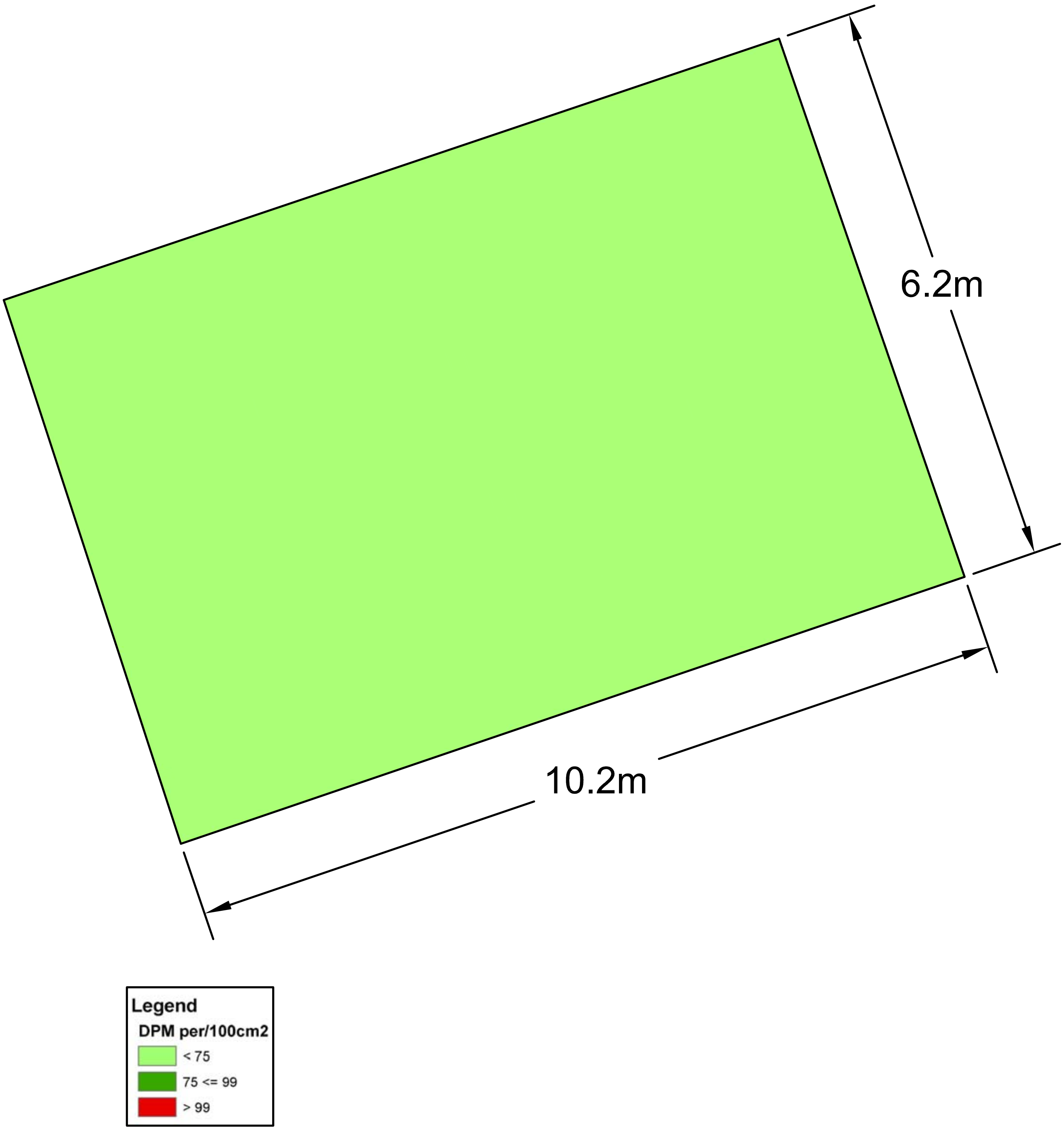


Figure: 21	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM

Concrete Pad #1 - Alpha Scan
South Survey Unit



Concrete Pad #1 - Alpha Scan
North Survey Unit

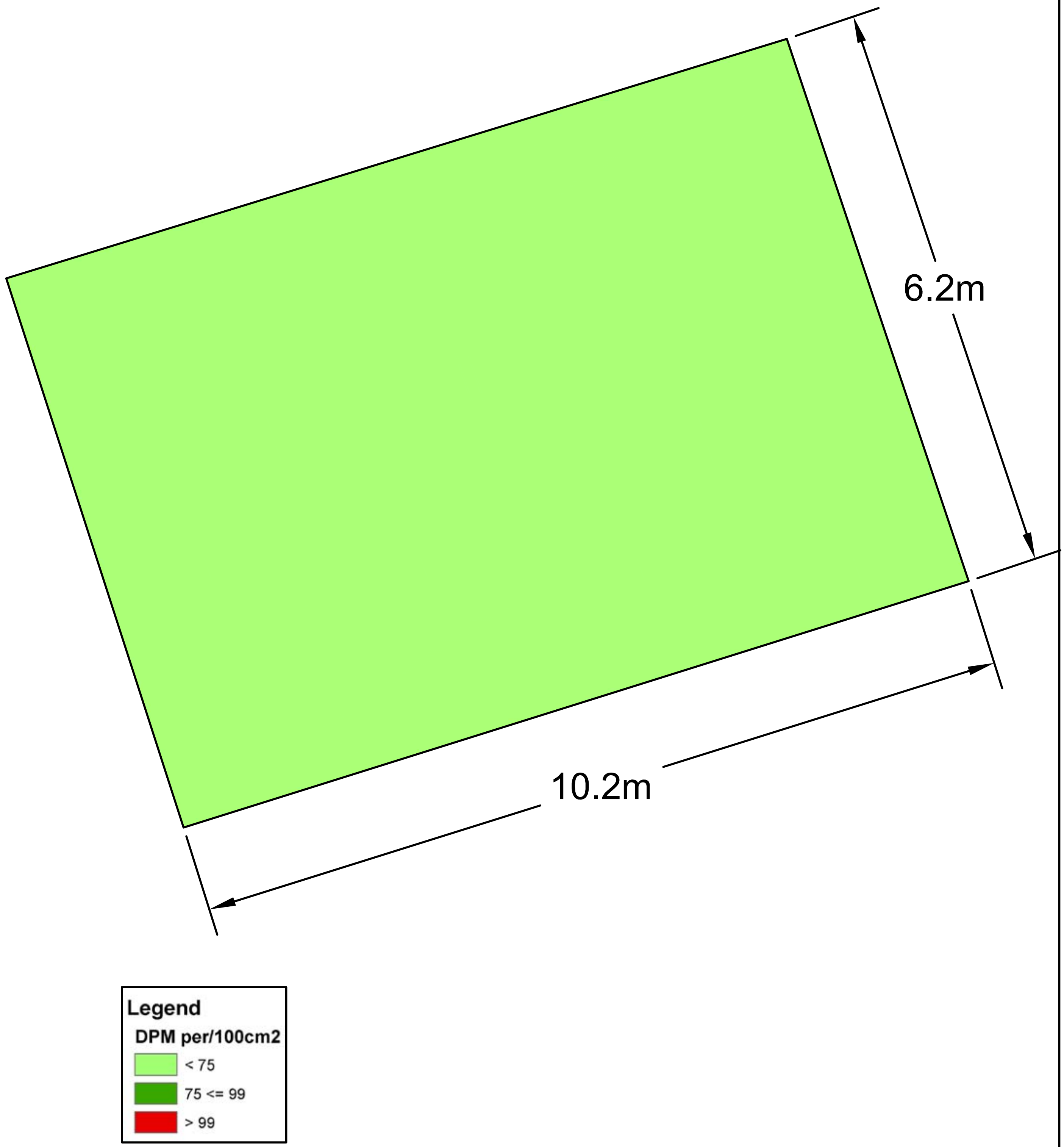


Figure: 23	Remediation and FSS Report BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	10/29/2004 Scale: N.T.S.

Concrete Pad #2 - Alpha Scan
South Survey Unit

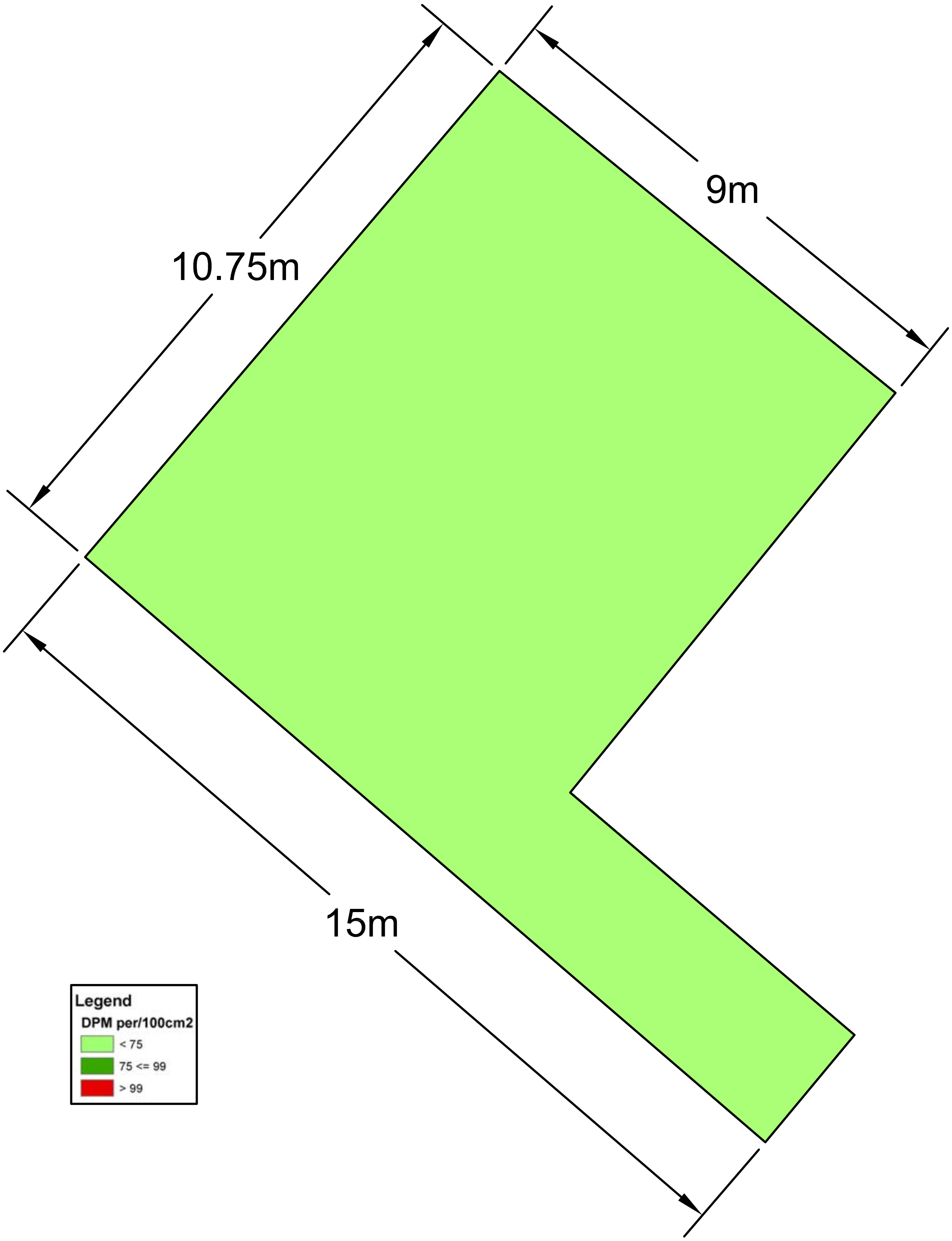
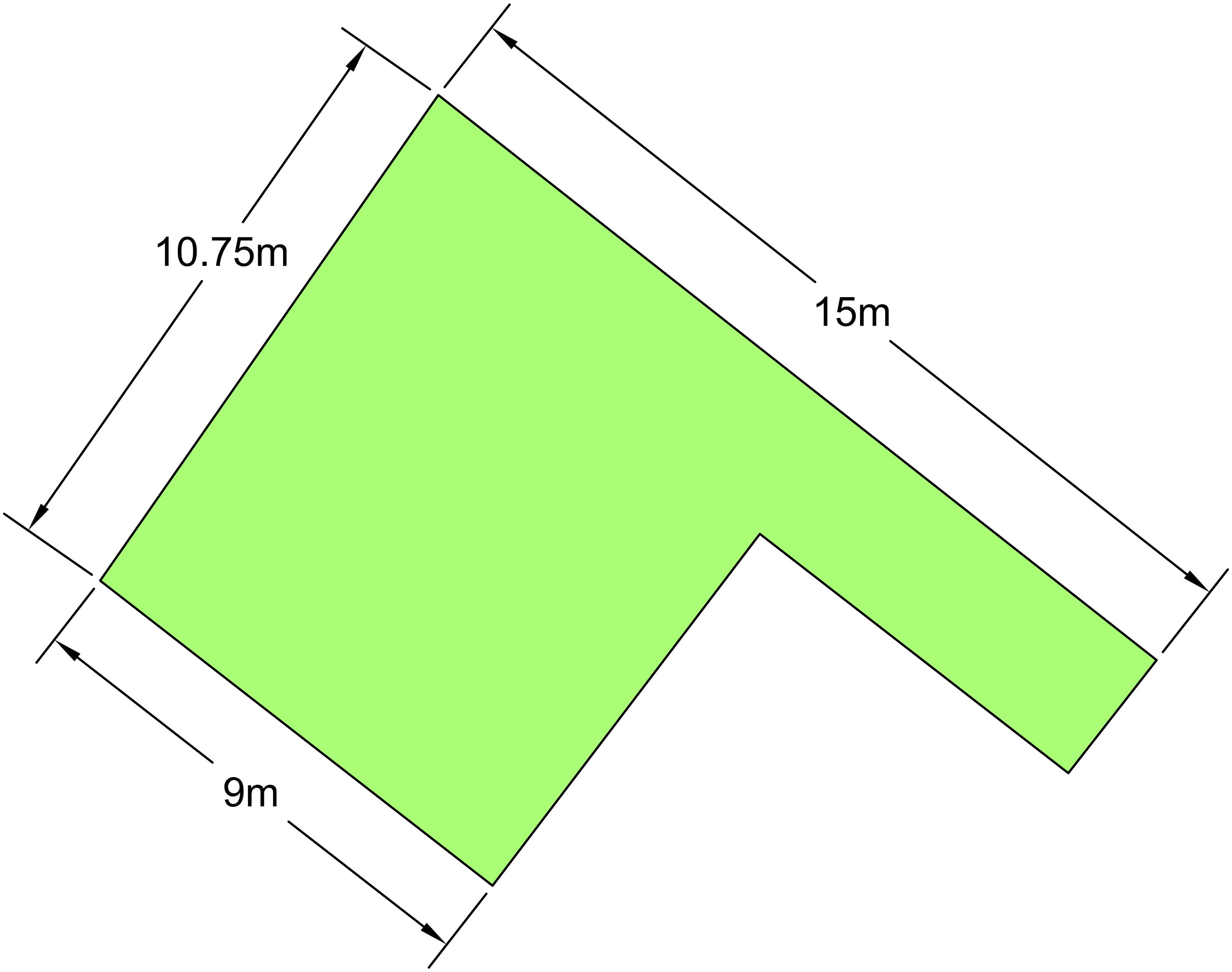


Figure: 24	Remediation and FSS Report BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION WWW.CABRERASERVICES.COM	10/29/2004 Scale: N.T.S.

Concrete Pad #2 - Alpha Scan
North Survey Unit



Legend	
DPM per/100cm2	
	< 75
	75 <= 99
	> 99

APPENDICES

Appendix A: Building Photographs

Appendix B: Final Status Survey Plan for BTD Armor Reclamation Facility, Aberdeen Proving Ground, Aberdeen, MD

Appendix C: Final Status Survey Plan For Wash Rack Facilities #2 and #3, Aberdeen Proving Ground, Aberdeen, MD

Appendix D: Final Status Survey Plan, Bomb Throwing Device (BTD) Site, Aberdeen Proving Ground, Aberdeen, MD

Appendix E: Survey Unit Maps and Sample Locations

Appendix F: Daily Instrument/Building Summary

Appendix G: Radiological Survey Maps

Appendix H: Survey Unit Worksheets and Data Summaries

Appendix I: Survey Instrument Quality Control and Calibration Certificates