UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS TX 75202-2733

MEMORANDUM

SEP 26 2011

SUBJECT: Request for a Time-Critical Removal Action, at the Hogan Mine Area Site, near San Mateo Village, McKinley County, New Mexico

FROM: Warren Zehner, On-Scene Coordinator
Removal Team (6SF-PR)

Jon Rinehart, On-Scene Coordinator
Removal Team (6SF-PR)

THRU: Ragan Broyles, Associate Director
Prevention and Response Branch (6SF-P)

TO: Samuel Coleman, P.E., Director
Superfund Director

I. PURPOSE

This memorandum requests approval for a time-critical removal action, pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. § 9601 et seq., at the Hogan Mine Area (HMA) Site (the "Site") in San Mateo, McKinley County, New Mexico. The proposed actions for this Site include the excavation, consolidation, and removal of radiologically contaminated soil/debris from a residential property.

As described in Section III of this memorandum, the factors described in Section 300.415 of the National Contingency Plan (NCP), 40 CFR § 300.415, have been considered, and, based on those factors, a determination has been made that a removal action at the Site is appropriate. This Removal Action is not expected to exceed the statutory twelve-month time limit, nor is it expected to exceed the statutory $2,000,000 cost ceiling.

II. SITE CONDITIONS AND BACKGROUND

CERCLIS ID: NMN000607182
Category of Removal: Time Critical
Site ID: A6BZ
Latitude: 35. 355716 N
Longitude: -107. 758851 W

642804

A. Site Description

1. Removal Site Evaluation

In March 2009, the Environmental Protection Agency, Region 6 Prevention and Response Branch (EPA PRB) received a request for assistance in the evaluation of the former uranium mines and adjacent residential properties near the Village of San Mateo for potential removal action(s) from the State of New Mexico Environment Department (NMED). Documentation provided by the NMED indicated that a resident owned and resided on the property (HMA) adjacent to the former Hogan Mine (HM) underground uranium mine. The HM is currently abandoned and scheduled for closure and/or reclamation activities to be conducted by the New Mexico Mining and Minerals Division (NMMMD). The HMA was thought to be potentially contaminated with uranium mine waste originating from the mining operations that occurred on the HM during its operational period from 1959 - 1962. The mine was operated by Four Corners Exploration. The mine has a maximum depth of 340 feet and produced ore from the uraniferous Poison Canyon Sandstone. According to NMMMD records,129,551 tons of uranium ore were produced from the mine during its operational history. Based on this request for assistance, the Superfund Technical and Response Team (START) III contractors were tasked by EPA PRB to conduct a Radiation Removal Assessment on the Site. As part of this radiological assessment a quality assurance sampling plan (QASP) was developed for the project documenting standard operating procedures (SOPs), assessment protocols, and data decisions tree consistent with current EPA guidance and other best management practices. Based on the results of the Radiation Removal Assessment, the NMED made a written request to the PRB for assistance in conducting a removal action on the affected residential properties in the Village of San Mateo on August 25, 2011 (*See* Attachment 2).

The elevated concentrations of several radio-isotopes and their associated progeny in various uranium mine waste streams are contaminants of concern on this Site primarily from gamma and other forms of ionizing radiation associated with these radio-isotopes. Uranium mine waste streams include, but are not limited to: overburden, sub-economic ore, and broken/replaced infrastructure/mechanical elements, and/or soil/debris that have become contaminated with radioactive waste materials ("waste materials"). Principally, the contaminant of concern is radium-226 (^{226}Ra, hereafter to mean isotope and progeny) from the mining operations and/or subsequent mine closure operations conducted in the Ambrosia Lake Sub-District (ALSD) of the Grants Mineral Belt. In addition to ^{226}Ra contamination, uranium-238 (^{238}U, hereafter to mean, all the isotopes and their progeny) generated from the various uranium mining operations is also a contaminant of concern. These radio-isotopes have been potentially dispersed by the aforementioned uranium mining operations in the ALSD, including the Hogan Mine during its previous operational history and by various anthropogenic means throughout the Site. The anthropogenic activities include, but are not limited to the utilization of waste materials in residential landscaping (rock borders, rock gardens, etc.), re-use of contaminated materials (i.e. salvaged piping used in a residential fence) and re-use as construction materials on

the residential properties (i.e. foundations). The elevated concentrations of radio-isotopes and associated radioactivity above normal background levels, expressed in counts per minute (CPM) and micro-roentgens per hour (μR/hr) present on the residential property on this Site appear to be the direct result of the mining operations, and/or the utilization of waste materials generated during the uranium mining and/or milling operations conducted in the Ambrosia Lake Sub-District of the Grants Mineral Belt.

The fine and sandy/dusty texture of the contaminated soils on the Site makes it easy for these waste materials to adhere to humans and animals that come into direct contact with them. For humans and especially children, the wastes may be subsequently ingested during normal hand-to-mouth (or plaything-to-mouth) activity, or it may be inhaled. Moreover, the dry climate and sparse vegetative cover in these areas may cause the fine-grained waste materials to become wind-borne. Given the frequent dust storms taking place seasonally on the Site potential for exposure is greatly increased. These dust storms can also cause indoor contamination (the dust is so fine that it can blow through small cracks), increasing the likelihood that humans, and especially children, may be exposed. In addition, during the brief wet periods following precipitation events, contaminated mud may be tracked into residences and/or vehicles. When the mud dries and is disturbed during human activities, such as routine cleaning, the airborne fraction of the dust contributes to further inhalation exposure.

2. Physical Location

The Site is located near the unincorporated Village of San Mateo, in rural McKinley County, New Mexico (*See* Attachment 3). Geomorphologically, the Site is in semi-arid grassland with some mixed piñon-juniper stands. Density of vegetative cover is variable across the Site, with the areas of rocky outcropping having the least amount of cover vegetation. The Site is composed of one residential structure located on one residential lot (*See* Attachment 4).

3. Site Characteristics

The EPA has completed investigating the extent of residential radiological contamination on this Site. Based on the Removal Assessment it appears that the source of the radiological contamination on this Site is waste material salvaged from the historic uranium mining operations at the HM and/or the numerous other uranium mines located within the ALSD of the Grants Mineral Belt.

The ALSD is a large sub-district on the Grants Mineral Belt located in Cibola and McKinley counties in northwest New Mexico. Based on the review of federal and State government regulatory records, there were up to a 103 uranium mining operations and four uranium mills operating in the sub-district from the early 1950s until 2002, with most active operations ceasing in the 1980s (*See* Attachment 5). These mines and mills, including the HM, were the single largest source of employment in Cibola and McKinley counties, NM.

As part of the overall operations at the mines and mills in the ALSD, the mines maintained overburden and/or sub-economic ore waste piles and at least one waste/debris area for general infrastructure/ mechanical wastes. It appears based on several conversations with residents and former mine workers throughout the Removal Assessment study areas in the ALSD that "salvage" of the aforementioned waste piles and/or waste storage areas for residential re-utilization was common and if not approved by the mine operator, it was condoned. Reportedly, no warning signs or potential health impact information about the use of these waste materials were present in these waste areas during the operational history of the mines. Since the various uranium mines, including the HM, in the ALSD were the largest employers in Cibola and McKinley counties for a significant number of years, a disproportionally large fraction of the adult residents of these counties, including the HMA had easy and ready access to the various aforementioned waste storage areas in the ALSD. Several examples of residential re-utilization of radioactive waste materials were observed during the Removal Assessment on the Site, including but not limited to building materials, fill, landscaping (rock gardens), and souvenirs.

During the course of the Removal Assessment the EPA OSCs had discussions with the property owner and resident of the Site regarding the residential re-utilization of various mine and mine operations wastes streams on his residence. The resident was vague and tentative in his responses, but did admit to bringing some materials from one or more of the source mines in the ALSD onto his property for various uses.

As mentioned above, the EPA has completed the surface soil and structural (indoor) Removal Assessment on the Site. Surface radiological surveys were conducted on the residence utilizing a 2"x 2" gamma scintillation detector. Gamma radiations levels around and near the residences were as high as 83,018 CPM, as compared to the San Mateo Village specific background of 12,484 CPM. This data indicated gamma radiation levels as high as 83,018 CPM as compared to the aforementioned Village specific background (*See* Interim Status Report, Attachment 6).

4. Release or Threatened Release Into the Environment of a Hazardous Substance, Pollutant or Contaminant

Uranium-238 and ^{226}Ra are also principal contaminants of concern on this Site based primarily on the gamma and other forms of ionizing radiation associated with these radio-isotopes. Radiological dose is measured in milli-rem per year (mrem/year). The *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, August 22, 1997 (OSWER Directive 9200.4-18) established a general, maximum acceptable radiological dose level of 15 mrem/year above background level for non NRC licensed facilities. Further, this guidance document states that the total effective dose equivalent (TEDE) of 15 mrem/year represents an excess cancer risk of $3x10^{-4}$, and is considered essentially equivalent to the CERCLA presumptively protective excess cancer risk level of $1x10^{-4}$. The referenced risk calculation utilizes a 30-year exposure period per lifetime and a 24 hour/day exposure rate. The risk

calculation is based upon a risk conversion factor of 7% cancer incidence per 100 rem of exposure and comes from the National Academy of Sciences report on *The Biological Effects of Ionizing Radiation (BEIR V), 1990.* The *Protocol for Uranium Home Site Assessment, Grants Mineral Belt Uranium Project; Cibola and McKinley Counties, New Mexico, December 2009,* documents the regulatory consistency with EPA 1997, OSWER 9200.4-18 and the process used for conducting the radiological assessment on this property. The START III Certified Health Physicists (CHPs) have evaluated the radiological data from the Removal Assessment on the Site and have determined that the residence on the Site has exceeded the acceptable TEDE of 15 mrem/year. The excess cancer risk level of $3x10^{-4}$ is exceeded by a similar factor.

As previously stated, the primary contaminants of concern at the Site, ^{238}U and ^{226}Ra and their associated progeny, are hazardous substances as defined in Section 101(14) of CERCLA, 42 U.S.C. § 9601(14) and 40 CFR § 302.4. The following are the known health effects associated with exposure to the aforementioned hazardous substances on the Site.

Radium-226

Radium-226 is principally a source of alpha and gamma radiation, although some beta radiation is also produced during the decay process. According to the ATSDR *ToxFAQs for Radium* (July 1999) document, exposure to ^{226}Ra can cause adverse effects to the eyes (cataracts) and blood (anemia). Radium-226 has been identified by the EPA and the National Academy of Sciences as a known human carcinogen, being specifically linked to cancers of the bone, and breast, and leukemia.

The exposure pathways of concern for Radium-226 at the Site are described below:

- The predominant exposure pathway related to ^{226}Ra was determined to be external gamma radiation, contributing over 90% of the total effective dose equivalent (TEDE) in the ResRad modeled scenario.

- A significant amount of the surface area of the residence on this Site is contaminated with elevated concentrations of ^{226}Ra at or near the surface. The contaminated soils are fine grained and have a high probability of adherence to skin, clothing and fur as a result of direct contact. For humans, incidental ingestion of the contaminants adhering to skin or clothing can occur through normal hand-to-mouth activities such as play or mealtime.

- Inhalation is another exposure pathway at this Site. As discussed above a significant amount of the surface soils on this Site are contaminated with ^{226}Ra. The contaminated soils tend to be fine grained and dusty, are easily airborne after wind or mechanical disturbances, and subject to inhalation by humans or livestock. Inhalation and ingestion combined for a total of approximately 5% of the TEDE estimate in the ResRad modeled scenario for this Site.

Uranium

Uranium is a widespread mineral forming heavy metal that in nature is composed of three isotopes, ^{238}U, ^{235}U, and ^{234}U, with the ^{238}U isotope generally composing over 98% of the mixture. All of these isotopes are the same chemically, but they have different energy and decay properties. According to the ATSDR *ToxFAQs for Uranium* (October 1999) document, U is an alpha ionizing radiation emitter and in general, weakly radioactive. Exposure to excess levels of U can cause human tissue damage, primarily in the kidneys. Cancer risk from exposure to excess U levels appears to be low to none. The primary risk on this Site from U is cancer caused by exposure to the progeny generated by its decay.

5. NPL Status

This Site is not presently on the NPL. However, should the Site rank on the NPL, the current removal action will be consistent with any subsequent remedial activities that might be taken due to the fact that the proposed actions constitute source control measures.

6. Maps, Pictures and Other Graphic Presentations

Attachment 1 - Enforcement Addendum (Enforcement Confidential/FOIA Exempt)
Attachment 2 - NMED Referral Letter
Attachment 3 - Site Location Map
Attachment 4 - Site Sketch
Attachment 5 - Historic Mines in ALSD
Attachment 6 - Interim Status Report, San Mateo and Poison Canyon Communities Radiation Structures Removal Assessment, August 4, 2011

B. Other Actions to Date

1. Previous actions

No previous response actions have occurred on this Site to date.

2. Current Actions

Based on the Removal Assessment data and the health based dose calculations utilizing the ResRad model and a ration of dose to excess cancer risk assumed at the TEDE of 15 mrem/year level per risk of $3x10^{-4}$ discussed above, in Section II.A.4, the EPA has determined that current conditions on this Site pose an unacceptable health risk to the resident residing within the boundaries of the Site.

C. State and Local Authorities' Roles

1. State and Local Actions to Date

The State of New Mexico, through the NMED (or its predecessor NMEID), has been involved in the previous and current regulatory activities associated with the HM. EPA has coordinated all Removal Assessment activities on the Site with NMED. After completion of this Action Memorandum, this Site will be referred back to the state for any operations and maintenance.

2. Potential for Continued State/Local Response

Neither the NMED nor the NMMMD of the Energy, Minerals and Natural Resources Department will be able to provide a response action to physically address the actions described in this memorandum.

III. THREAT TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT

A. Threats to Public Health

The factors described in Section 300.415 of the National Contingency Plan (NCP), 40 CFR § 300.415, have been considered, and, based on those factors, a determination has been made that a removal action is appropriate to address the hazardous substances present in the contaminated wastes at the Site. Any or all of these factors may be present at a site yet any one of these factors may determine the appropriateness of a removal action.

1. Actual or Potential Exposure to Nearby Human Populations, Animals, or the Food Chain from Hazardous Substances or Pollutants or Contaminants. 40 CFR § 300.415(b)(2)(i).

As discussed above, in Section II.A.3-4, the Removal Assessment identified levels of ionizing gamma radiation in the soils/debris surrounding or in close proximity to the one residential structure on the Site in excess of the referenced EPA acceptable exposure, dose and/or risk limits.

2. High Levels of Hazardous Sbstances or Pollutants or Contaminants in Soils Largely at or Near the Surface That May Migrate. 40 CFR § 300.415(b)(2)(iv).

As discussed above, and in the results of the Interim Status Report, San Mateo and Poison Canyon Radiation Structures Removal Assessment (*see* Attachment 5) indicates high levels of radiological contamination in the surface and near surface soils (< 12 inches) on a significant

portion of this Site.

3. Weather Conditions That May Cause Hazardous Substances or Pollutants or Contaminants to Migrate or be Released. 40 CFR § 300.415(b)(2)(v).

As referenced above, the Site is located in north-west New Mexico. This part of the State routinely experiences severe weather of varying degrees of intensity during the Spring and Summer. Given that the referenced radiological contamination is located at or near the surface of the Site, and because the Site is located in semi-arid area, with limited vegetative cover, there is a high potential for subsequent off-site migration of the aforementioned hazardous substances in surface soils from the Site via the flash flooding rains in the Summer and/or strong wind storms that are associated with strong low pressure systems in the Spring.

4. The Availability of Other Appropriate Federal or State Response Mechanisms to Respond to the Release. 40 CFR § 300.415 (b)(2)(vii).

At this time, there are no other mechanisms available to respond to actions described in this memorandum in a timely manner so as to effectively reduce the imminent and substantial endangerment to public health posed by the hazardous substances located on the Site. The State and local officials do not have the resources available to address the current dangerous conditions at the Site. If other mechanisms become available during the conduct of this response action, the EPA will evaluate those mechanisms as appropriate.

B. Threats to the Environment

The actions taken during this response are designed solely to address a public health threat resulting from the hazardous substances present on the Site derived from waste materials that appear to have originated from the historic uranium mining in the ALSD of the Grants Mineral Belt.

IV. ENDANGERMENT DETERMINATION

Actual or threatened releases of hazardous substances, pollutants or contaminants from the Site, if not addressed by implementing the response action selected in this Action Memorandum, will continue to present an imminent and substantial endangerment to public health or welfare or the environment.

V. PROPOSED ACTIONS AND ESTIMATED COSTS

A. Proposed Actions Taken

1. Action Description

a. Action Levels and Clean-up Levels

The EPA uses the term "action level" to mean the contaminant concentration level in soil or groundwater at which a response action in question will be taken. Wastes that meet the definition of a hazardous waste under RCRA statutes not in a soil or groundwater matrix (i.e. the drummed wastes on a site) are usually not subject to a specific action level. They are simply removed to prevent actual or potential exposures. Action levels should not be confused with "cleanup levels." The cleanup level is the contaminant concentration level which the response action is designed to meet. That is, once EPA has identified a contaminated medium which contains concentrations of a contaminant which exceed the action level, the removal action calls for continued response until the concentration of the contaminant in the contaminated medium are below the established cleanup level. For this removal action, both the action level and cleanup level is 3.5 pCi/gram of Radium-226. This concentration value is the equivalent of a $3x10^{-4}$ excess cancer rate as calculated by the aforementioned ResRad model and EPA's PRG calculator using site specific data where possible. Further, this concentration value is also the equivalent of a 15 mrem/yr dose rate for ionizing gamma radiation generated from the decay of the aforementioned radioisotopes and their associated daughter progeny in the contaminated building materials and soils.

In developing the action levels and cleanup levels for the Site, EPA Region 6 considered the *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, August 22, 1997 (OSWER Directive 9200.4-18), EPA Region 9 Navajo Nation Radiological Structure Assessment data and procedures, and consulted with NMED to determine whether there were potential state Applicable or Relevant and Appropriate Requirements (ARARs) within the meaning of CERCLA Section 121, 42 U.S.C. § 9621. After the action levels and cleanup levels for this Site were reviewed and found to be consistent with historic action levels and cleanup levels used by the EPA on similar sites, the OSC decided to utilize the aforementioned ionizing radiation concentration of 3.5 pCi/g of Radium-226 and the equivalent dose rate as the action level and cleanup level for the radiological contamination on this Site

b. Hogan Mine Area Site

The EPA proposes to mitigate the imminent and substantial threats to human health, welfare, or the environment by taking steps to prevent the release of external ionizing radiation from the

sources on this Site. The removal action will include the following objectives to prevent direct human contact and excessive ionizing radiation exposure from the contaminated soils/debris, and contaminated re-purposed materials present on the Site:

- Remove the identified surficial residential radiological soil contamination (approximately 84cubic yards) from the Site by excavating to a level below the cleanup level or to a maximum of two feet below ground surface.
- Consolidate, transport and dispose of the radiologically contaminated soil, debris, and any other contaminated materials into an approved off-site facility.
- Replace excavated soils with clean fill and restore to pre-removal grade.
- Conduct confirmation radiological scanning, sampling, and analysis to ensure that the ionizing radiation exposure is below established EPA cleanup levels.

c. Certain Contaminated Materials Will be Taken Off-site

The contaminated soils excavated during the removal action will be consolidated with the contaminated demolition materials and taken off-site for disposal. The contamination found at the Site and discussed in this memorandum stems from waste material salvaged from the historic mining operations conducted within the ALSD. The contaminated wastes described above are a solid waste, but not a hazardous waste under the Resource Conservation and Recovery Act (RCRA), because they are derived from the extraction, beneficiation, and processing of ores and minerals within the meaning of 40 CFR § 261.4 (b)(7). Since the aforementioned materials are not a hazardous waste under RCRA, EPA does not consider the RCRA hazardous waste management requirements to be applicable or relevant and appropriate (*See* Section V 4(c) below). Although these wastes are not considered hazardous wastes under RCRA regulations, they are determined to be CERCLA hazardous substances.

The off-site disposal of the CERCLA wastes generated from this removal will be in conformance with EPA's procedures for planning and implementing off-site response action, 40 CFR § 300.440. All off-site transportation of hazardous waste will be performed in conformance with applicable U.S. Department of Transportation (USDOT) requirements. Other requirements under the Occupational Safety and Health Act (OSHA) of 1970, 29 U.S.C. § 651 et. seq., and under the laws of States with plans approved under section 18 of the State's OSHA laws, as well as other applicable safety and health requirements, will be followed. Federal OSHA requirements include, among other things, Hazardous Materials Operation, 29 CFR Part 1910.120, as amended by 54 Fed. Reg. 9317 (March 5, 1989), all OSHA General Industry (29 CFR Part 1910) and Construction (29 CFR Part 1926) standards wherever they are relevant, as well as OSHA recordkeeping and reporting regulations, the EPA regulations set forth in 40 CFR Part 300, and other EPA policies/guidelines relating to the conduct of work at Superfund sites

2. Contribution to Remedial Performance

The actions described above for the Site will contribute to any presumed remedial cleanup alternative given that the response actions to be taken will constitute contaminant source removal.

3. Description of Alternative Technologies

At this time, there are no other proven alternative technologies that could be feasibly applied at this Site. The appropriate action is to conduct the removal action on the Site as described in this memorandum. If an equally protective and less expensive technology is later identified, it may be considered.

4. Applicable or Relevant and Appropriate Requirements (ARARs)

The proposed removal action will be conducted to eliminate the actual or potential exposure to hazardous substances pursuant to CERCLA, in a manner not inconsistent with the NCP. As per 40 CFR Section 300.415(j), Superfund-financed removal actions under CERCLA § 104 and § 106 shall, to the extent practicable considering the exigencies of the situation, attain the applicable or relevant and appropriate requirements (ARARs) under Federal environmental law.

a. Chemical-specific ARARs - There were no chemical-specific Federal or State ARARs identified that were applicable or relevant and appropriate to this removal action.

b. Location-specific ARARs - There were no location-specific Federal or State ARARs identified that were applicable or relevant and appropriate to this removal action.

c. Action-specific ARARs - The uranium, radium-226 and related daughter progeny contamination in the demolition materials and related soil/debris is from the mining of uranium which is a solid waste, but not a hazardous waste under the Resource Conservation and Recovery Act (RCRA), because it is solid waste from the extraction, beneficiation, and processing of ores and minerals within the meaning of 40 CFR § 261.4(b)(7). Since the materials are not a hazardous waste under RCRA, EPA does not consider RCRA hazardous waste management requirements to be applicable or relevant and appropriate, including without limitation the waste analysis requirements found at 40 CFR §§ 261.20 and 261.30, the RCRA manifesting requirements found at 40 CFR § 262.20, and the RCRA packaging and labeling requirements found at 40 CFR § 262.30. Since the removal action involves no on-site storage of hazardous wastes, storage requirements found at 40 CFR Part 265 are not applicable or relevant and appropriate.

Although the hazardous substances which are the subject of this removal action are solid waste and not hazardous waste under RCRA because they are solid waste from the extraction, beneficiation, and processing of ores and minerals, according to 40 CFR § 261.4(b)(7), it is useful in this Site-specific situation for EPA to use certain RCRA requirements to control and track waste sent off-site. Accordingly, RCRA waste analysis requirements found at 40 CFR §§ 261.20 and 261.30, RCRA manifesting requirements found at 40 CFR § 262.20, and RCRA packaging and labeling requirements found at 40 CFR § 262.30 are deemed to be relevant and appropriate requirements and will be used for off-site disposal of wastes and other contaminated material generated during this removal action. Because on-site storage of repackaged hazardous wastes is not expected to exceed ninety (90) days, specific storage requirements found at 40 CFR Part 265 are neither applicable nor relevant and appropriate. *See* 40 CFR § 262.34).

d. To-be-considered (TBCs) - In addition to ARARs, other advisories, criteria, or guidance that may be useful in developing the remedy were, as appropriate, identified and considered.

5. Project Schedule

The proposed actions for this time critical removal action are expected to be completed in six months.

B. Estimated Costs

Extramural Costs

Removal Contractors.....	$ 224,013
START III Contractors.....	$ 50,000
Subtotal, Extramural Costs	$ 274,013
Extramural Costs Contingency (20%)	$ 54,802

TOTAL, EXTRAMURAL COSTS..... $328,815

VI. EXPECTED CHANGE IN THE SITUATION SHOULD NO ACTION BE TAKEN OR ACTION BE DELAYED

Should the actions described in this Action Memorandum be delayed or not taken, the elevated gamma radiation dose and associated excess cancer risk will continue to pose a significant threat to the resident located on the Site.

VII. OUTSTANDING POLICY ISSUES

There are no outstanding policy issues associated with this removal action.

VIII. ENFORCEMENT

The EPA Region 6 has initiated the enforcement process on this Site. (See Enforcement Confidential Attachment #1, for additional details). The total cost to EPA for this removal action, consisting of the excavation and disposal of the contaminated soil/debris is **$540,304.**

(Direct Cost) + (Other Direct) + (42.63% of Total Direct {Indirect Cost}) = Estimated EPA Cost for a Removal Action

$328,815 + $50,000 + (42.63% x $274,013) = **$540,304**

Direct costs include direct extramural costs and direct intramural costs. Indirect costs are calculated based on an estimated indirect cost rate expressed as a percentage of site-specific direct costs, consistent with the full cost accounting methodology effective October 2, 2002. These estimates do not include pre-judgment interest, do not take into account other enforcement costs, including Department of Justice costs, and may be adjusted during the course of a removal action.

IX. RECOMMENDATION

This decision document represents the selected removal action for the Hogan Mine Area Site, near the Village of San Mateo, McKinley County, New Mexico, and is developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601 et seq., and is not inconsistent with the National Contingency Plan (NCP), 40 CFR Part 300. This decision is based on the administrative record for the Site.

Conditions at the Site meet the NCP Section 300.415 (b) (2), 40 CFR § 300.415 (b)(2) criteria for a time-critical removal action. We recommend your approval of the proposed time-critical removal action request. The total estimated EPA cost for the removal is $540,304. Of this, an estimated $328,815 comes from regional funds.

APPROVED: Pamela Phillips Acting DATE: 9/26/11

Samuel Coleman, P.E., Director
Superfund Division

MEMORANDUM

SEP 26 2011

SUBJECT: Request for a Time-Critical Removal Action, at the Hogan Mine Area Site, near San Mateo Village, McKinley County, New Mexico

FROM: Warren Zehner, On-Scene Coordinator
Removal Team (6SF-PR)

Jon Rinehart, On-Scene Coordinator
Removal Team (6SF-PR)

THRU: Ragan Broyles, Associate Director
Prevention and Response Branch (6SF-P)

TO: Samuel Coleman, P.E., Director
Superfund Director

I. PURPOSE

This memorandum requests approval for a time-critical removal action, pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. § 9601 et seq., at the Hogan Mine Area (HMA) Site (the "Site") in San Mateo, McKinley County, New Mexico. The proposed actions for this Site include the excavation, consolidation, and removal of radiologically contaminated soil/debris from a residential property.

As described in Section III of this memorandum, the factors described in Section 300.415 of the National Contingency Plan (NCP), 40 CFR § 300.415, have been considered, and, based on those factors, a determination has been made that a removal action at the Site is appropriate. This Removal Action is not expected to exceed the statutory twelve-month time limit, nor is it expected to exceed the statutory $2,000,000 cost ceiling.

II. SITE CONDITIONS AND BACKGROUND

CERCLIS ID: NMN000607182
Category of Removal: Time Critical
Site ID: A6BZ
Latitude: 35. 355716 N
Longitude: -107. 758851 W

Webster	Broyles/Petersen	Bradsher	Johnson	Travis	Peycke
6SF-PR	6SF-P	6SF-TE	6SF-TE	6RC-S	6RC-S
Verbal ODR for SW 9-22-11	JCP 9/29/11	9/12/11	LJ 9/12/11	PAT 09/16/11	MARS 09/29/11

ATTACHMENT 1

ENFORCEMENT ATTACHMENT TO THE ACTION MEMORANDUM FOR the "Hogan Mine Area Superfund Site" IS ENFORCEMENT SENSITIVE/FOIA EXEMPT

Note: **This document has been withheld as Enforcement Confidential and is located in Separate "CONFIDENTIALITY FILING" at U.S. EPA, Region 6**

Attachment 2

NMED Referral Letter

NEW MEXICO
ENVIRONMENT DEPARTMENT

Ground Water Quality Bureau

Harold Runnels Building
1190 St. Francis Drive, P.O. Box 5469
Santa Fe, NM 87505-5469
Phone (505) 827-2918 Fax (505) 827-2965
www.nmenv.state.nm.us

SUSANA MARTINEZ
Governor

JOHN A. SANCHEZ
Lieutenant Governor

DAVE MARTIN
Cabinet Secretary

BUTCH TONGATE
Acting Deputy Secretary

August 25, 2011

Ms. Susan Webster (6SF-PR)
Team Leader, Removal Site Team
U.S. EPA Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Re: Hogan Mine Area, McKinely County, New Mexico -Time Critical Removal Action EPA ID NMN000607182

Dear Ms. Webster:

NMED has been informed that EPA Region 6 staff have identified a residential structure near the Hogan Mine in McKinely County that exceeds established acceptable dose and cancer risk levels such that a removal action is warranted. This structure was identified as part of the Grants Mining District structural assessment.

Gamma radiation levels that exceed the EPA established dose rate of 15 mrem/year (above local background) and the associated increased cancer risk of 3×10^{-4} have been identified. The proposed removal action will excavate contaminated soil/debris which will be disposed of in a secure off-site facility. NMED concurs with EPA that a removal action is warranted to clean-up the identified structure and requests that EPA address the site through the Superfund removal program to protect human health and welfare, and the environment from any imminent threats posed by the site.

NMED appreciates the attention given to this site and the efforts of the Prevention and Response Branch. Please contact Ms. Dana Bahar of my staff at (505) 827-2908 should you have any questions or require additional information.

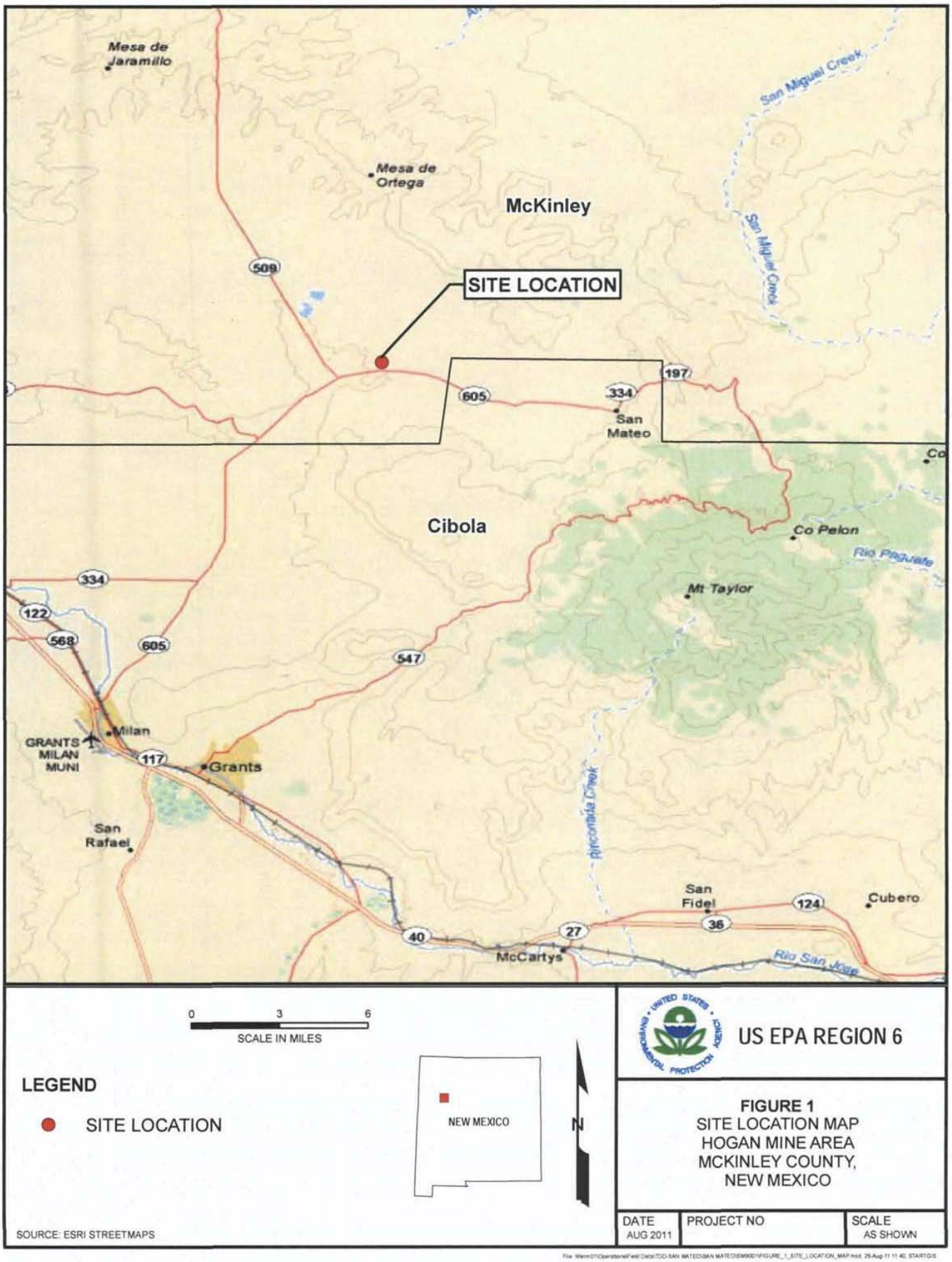
Sincerely,

Jerry Schoeppner
Acting Chief
Ground Water Quality Bureau

xc: John Rinehart, On-Scene Coordinator, EPA Region 6
Dana Bahar, Manager, Superfund Oversight Section
SOS Read File

Attachment 3

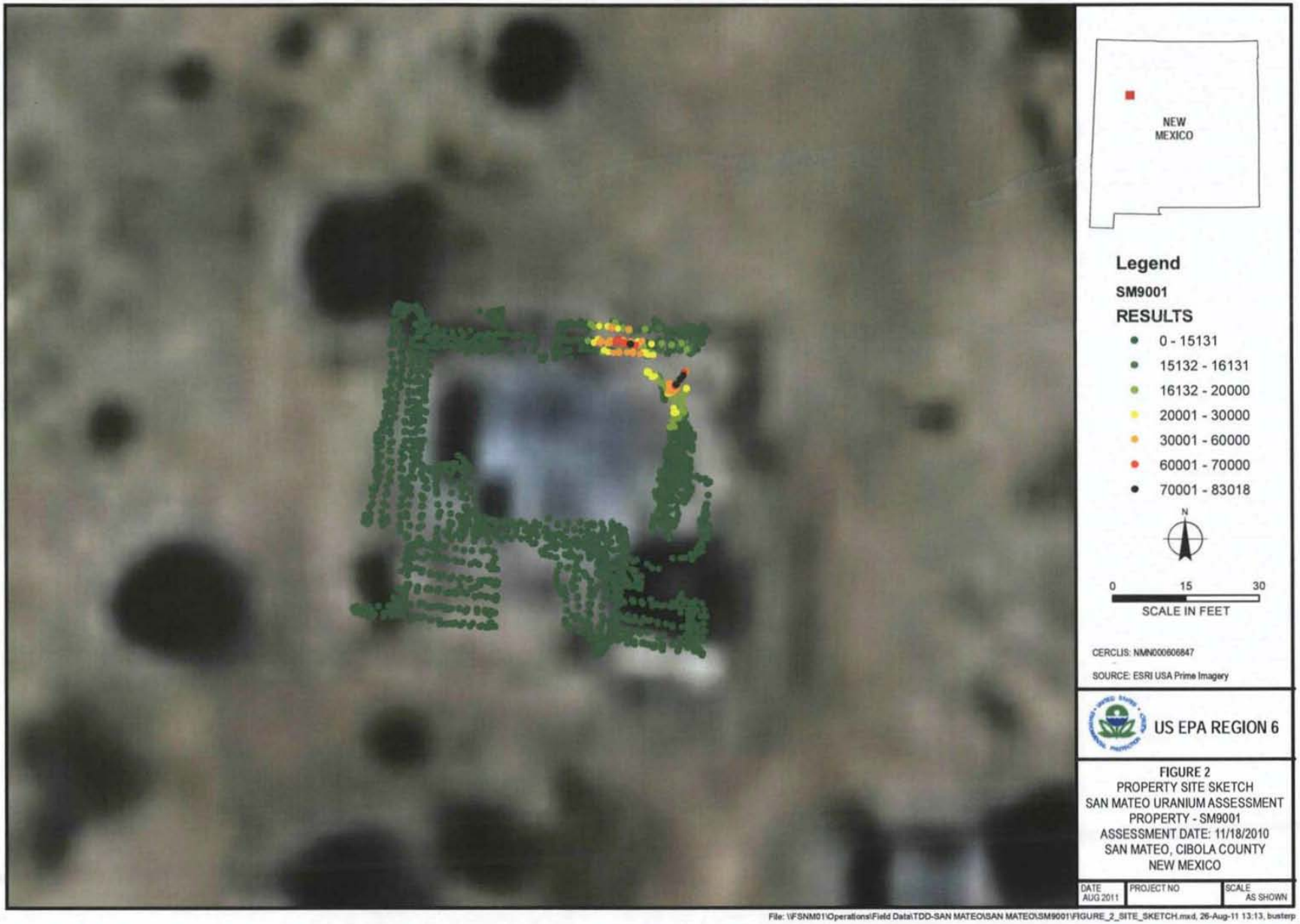
Site Location Map


Mesa de Jaramillo
Mesa de Ortega
McKinley
San Miguel Creek
SITE LOCATION
509
605
334
197
San Mateo
Cibola
Co Pelon
Rio Puguate
Mt Taylor
334
122
568
605
547
GRANTS MILAN MUNI
Milan
117
Grants
San Rafael
Rincontada Creek
San Fidel
124
Cubero
36
40
27
McCartys
Rio San Jose
0 3 6
SCALE IN MILES
LEGEND
SITE LOCATION
NEW MEXICO
N
SOURCE: ESRI STREETMAPS
US EPA REGION 6
FIGURE 1
SITE LOCATION MAP
HOGAN MINE AREA
MCKINLEY COUNTY,
NEW MEXICO
DATE
AUG 2011
PROJECT NO
SCALE
AS SHOWN

Attachment 4

Site Sketch

SM9001



File: \\FSNM01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM9001\FIGURE_2_SITE_SKETCH.mxd, 26-Aug-11 13:13, busterp

Attachment 5

Interim Status Report, San Mateo & Poison Communities
Structure Removal Assessment

Weston Solutions, Inc.
4324 S. Sherwood Forest Blvd., Ste. B100
Baton Rouge, LA 70816
225-297-5403 • Fax 225-293-8339
www.WestonSolutions.com

August 4, 2011

Mr. Warren Zehner
On-Scene Coordinator, Region 6
U.S. Environmental Protection Agency
10625 Fallstone Road
Houston, TX 77099

Re: **Interim Status Report for San Mateo and Poison Canyon Communities**
TDD: TO-0005-09-02-01
Work Order No.: 20406.012/016.005.0397.01

Mr. Zehner:

Please find attached an Interim Status Report for Phase 1 and Phase 2 Removal Assessment activities conducted at residential properties in the San Mateo and Poison Canyon communities in 2010-2011. The properties were assessed as part of the Grants Mineral Belt Radiological Structures Assessment project centered around Grants, New Mexico and were performed under the above-referenced TDD. The interim report is a segment of the Final Report under same TDD that will be forthcoming at a later date.

Sincerely,

Robert Sherman

Robert Sherman
EPA Region 6, START-3 Project Manager

INTERIM STATUS REPORT
SAN MATEO AND POISON CANYON REMOVAL ASSESSMENT
SSID: A6AH

August 3, 2011

Weston Work Order No.: 20406.012/016.005.0397.01

I. General Information

EPA Contract No.	EP-W-06-042
Task Order	0005
TDD No.	TO-0005-09-02-01
Project Location	Cibola County, near Grants, NM
Work Activity	Removal Assessment (RA)
EPA Work Assignment Manager	Warren Zehner/ Jon Rinehart
WESTON Site Manager	David Bordelon

II. Interim Status

The village of San Mateo (Latitude 35° 20' 00", Longitude 107° 39' 00") is located in Cibola County approximately 17 miles northeast of Milan, New Mexico on NM Highway 605. The settlement of Poison Canyon (Latitude 35° 20' 00", Longitude 107° 51' 30") is located in McKinley County approximately 10 miles north of Milan, New Mexico and west of NM Highway 605 (see Figure 1). Due to results of the EPA Airborne Spectral Photometric Environmental Collection Technology (ASPECT) survey flown in October 2009, which revealed elevated gamma readings from the Mt. Taylor uranium mine located near the village of San Mateo and elevated gamma readings from unnamed uranium mines near Poison Canyon, EPA conducted 41 Phase 1 outdoor assessments of residential properties in San Mateo, including two properties located approximately 5 miles west of the main village, and two Phase 1 outdoor assessments in Poison Canyon as part of the San Mateo Creek Basin Uranium project. One of the properties located 5 miles west of the main San Mateo village has been addressed in a separate Interim Status Report and EPA has initiated a removal action on the property. EPA obtained a signed Access Agreement from each property owner prior to commencement of work on the subject properties.

Phase 1 Outdoor Assessments

The Phase 1 Outdoor Assessments consisted of:

a) a walking, ground-level gamma scan (2-3 feet per second; 15 inches above ground surface) of residential soils utilizing a Model 44-10 2"x2" NaI probe attached to a Model 2210 count- meter, a laptop computer and a global positioning system (together referred to as the [Rapid Assessment Tool] RAT system) all mounted in a modified baby buggy,

b) the collection of 20 stationary, 1-minute gamma measurements uniformly spaced throughout the assessment area utilizing the RAT system,

c) the collection of grab, 'hot spot,' surface, soil samples for laboratory analysis of Radium-226 where gamma scan readings exceeded the screening level (the derived concentration guideline level [DCGL]) of 3,648 counts per minute (cpm) above background,

d) the collection of stationary, 1-minute gamma measurements at the 'hot spot' surface soil sample locations utilizing the RAT system,

e) the attainment of a residential data information sheet detailing residents' work relationship with local uranium mines and mills, structural elements of the residence and other buildings, and consumption of home-grown produce, and

f) the collection of two 10-point, composite, surface soil samples (from the 20 stationary, 1-minute gamma measurement locations) for laboratory analysis of elemental Uranium (non-radiological/ non-carcinogenic).

Only those parts of yards that were used by residents on a regular basis, up to a maximum 40,000 sq. ft. area, were assessed. EPA calculated a property-specific DCGL of 3,596 cpm for one property, SM0035, due to higher consumption of home-grown produce than the project default value; SM0039 also had higher home-grown produce consumption than the default value but exhibited Phase 1 assessments results that exceeded the default DCGL and thus did not warrant a property-specific DCGL.

Each assessed property was subjected subsequently to up to four statistical tests, in general accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidelines (EPA is not required to adhere strictly to MARSSIM), to determine if the property exceeded the DCGL (3,648 cpm or 2.5 pico Curies per gram (pCi/g) above background) and warranted a Phase 2 Indoor Assessment. Two background locations in San Mateo were chosen for comparison to individual property results. The background assessments included the collection of 20 stationary, 1-minute gamma measurements uniformly spaced throughout the assessment area utilizing the RAT system; and the collection of 20 five-minute, gamma measurements utilizing a Pressurized Ionization Chamber (PIC) and 20 grab, surface soil samples for laboratory analysis of Radium-226 at the same 20 locations. See Table 1 for a summary of all Phase 1 Assessment and statistical results, including background results and the corresponding properties to which they were compared. Graphic illustrations of walking gamma scan results (RAT Maps) for each property are presented in Appendix A.

Ten properties in the village of San Mateo, one property west of the village of San Mateo (SM9001), and two properties in Poison Canyon (shaded in Table 1) exhibited Phase 1 Assessment results that **exceeded** the DCGL. The 13 properties had the following results:

- San Mateo and SM9001 gamma scan property averages ranged from 12,523 -13,528 cpm (595-1,600 cpm above background) for properties associated with a background of 11,928 cpm, and ranged from 11,484-14,588 cpm (0-2,104 cpm above background) for properties associated with a background of 12,484 cpm. The highest standard deviation across all 11 properties measured 9,533 cpm.

  Poison Canyon gamma scan property averages were 15,556 cpm (6,275 cpm above

background) at one property with a background of 9,281 cpm, and 16,627 cpm (8,509 cpm above background) at the second property with a background of 8,118 cpm. Standard deviations measured 11,521 cpm and 7,455 cpm, respectively.

- San Mateo and SM9001 stationary, 1-minute gamma measurement property averages ranged from 12,144-13,375cpm (0-1,447 cpm above background) for properties associated with a background of 11,928 cpm, and ranging from 8,347-13,823 cpm (0-1,339 cpm above background) for properties associated with a background of 12,484 cpm. The highest standard deviation across all properties measured 1,190 cpm.

  Poison Canyon stationary, 1-minute gamma measurement property averages were 13,047cpm (3,766 cpm above background) at one property with a background of 9,281 cpm, and 13,792cpm (5,674 cpm above background) at the second property with a background of 8,118 cpm. Standard deviations measured 3,290 cpm and 6,393 cpm, respectively.

- San Mateo and SM9001 'hot spot,' surface, soil sample laboratory results for Radium-226 ranged from 0.95-8.32 pCi/g (0.00-7.37 pCi/g above background) for properties associated with a background of 0.95 pCi/g, and ranged from 0.72-4.03 pCi/g (0.00-2.87 pCi/g above background) for properties associated with a background of 1.16 pCi/g.

  Associated stationary, 1-minute gamma measurements taken at 'hot spot' sample locations ranged from 12,142-51,266 cpm (214-39,338 cpm above background) for properties associated with a background of 11,928 cpm, and ranged from 12,620-148,827 cpm (136-136,343 cpm above background) for properties associated with a background of 12,484 cpm.

  Poison Canyon 'hot spot,' surface, soil sample laboratory results for Radium-226 ranged from 0.81-10.30 pCi/g (0.16-9.65 pCi/g above background) at one property with a background of 0.65 pCi/g, and ranged from 2.01-7.01 pCi/g (0.88-5.88 pCi/g above background) for properties associated with a background of 1.13 pCi/g.

  Associated stationary, 1-minute gamma measurements taken at 'hot spot,' sample locations ranged from 20,179-108,092 cpm (10,898-98,811 cpm above background) and from 12,284-27,593 cpm (4,166-19,475 cpm above background), respectively.

- MARSSIM Test 1 (the difference between the lowest background, stationary, 1-minute gamma measurement and the highest property gamma scan reading must be less than the DCGL for a property to PASS and negate a need for additional MARSSIM Tests 2-4):
  All 13 properties FAILED.

  MARSSIM Test 2 (the difference between the property gamma scan average and the background; and the property's 20 stationary, 1-minute gamma measurements average and the background must both be less than the DCGL for a property to PASS. Only a FAIL result negates a need for additional MARSSIM Tests 2-4):
  All 10 San Mateo properties and SM9001 PASSED. Both Poison Canyon properties FAILed.

MARSSIM Test 3 (Wilcoxon Rank Sum; a definition is supplied as Attachment B): *All 10 San Mateo properties and SM9001 PASSED. Non-applicable for Poison Canyon properties.*

MARSSIM Test 4 (Elevated Measurement Comparison/ Unity Rule; conducted only if concentrated, elevated 'hot spot(s)' are present on a property. The Unity ratio represents the fraction of the DCGL above background that a property's contamination exhibits, and must be less than 1.0 for a property to PASS. Note that in cases where the Unity ratio is greater than 1.0, this may not reflect all 'hot spot' contamination present on a property. Additional 'hot spot' areas were not included once the Unity ratio reached 1.0 or higher): *All 10 San Mateo properties and SM9001 FAILED Test 4.* Although property SM0170's ratio of 0.93 is less than 1.0, the property was deemed FAIL due to high gamma scan readings emanating from the residential structure itself. *Non-applicable for Poison Canyon properties.*

Thirty properties in San Mateo and zero properties in Poison Canyon (non-shaded in Table 1) exhibited Phase 1 Assessment results that **did not exceed** the DCGL. The 30 San Mateo properties had the following results:

- Gamma scan results ranged from 10,529-13,132 cpm (0-1,204 cpm above background) for properties associated with a background of 11,928 cpm, and ranged from 12,415-13,453 cpm (0-969 cpm above background) for properties associated with a background of 12,484 cpm. The highest standard deviation across all properties measured 1,266 cpm.

- Stationary, 1-minute gamma measurements ranged from 10,770-13,237 cpm (0-1,309 cpm above background) for properties associated with a background of 11,928 cpm, and ranged from 12,843-13,534 cpm (359-1,050 cpm above background) for properties associated with a background of 12,484 cpm. The highest standard deviation across all properties measured 1,009 cpm.

- 'Hot spot,' surface, soil sample laboratory results for Radium-226 ranged from 0.57-3.21 pCi/g (0.00-2.26 pCi/g above background) for properties associated with a background of 0.95 pCi/g, and ranged from 0.83-1.80 pCi/g (0.00-0.64 pCi/g above background) for properties associated with a background of 1.16 pCi/g. Three properties did not require collection of 'hot spot' soil samples, while samples were unable to be collected at one property due to the presence of rocky soil.

  Associated, stationary 1-minute gamma measurements taken at 'hot spot' sample locations ranged from 10,963-21,789 cpm (0-9,861 cpm above background) for properties associated with a background of 11,928 cpm, and ranged from 12,697-17,236 cpm (213-4,752 cpm above background) for properties associated with a background of 12,484 cpm.

- MARSSIM Test 1 (the difference between the lowest background, stationary, 1-minute gamma measurement and the highest property gamma scan reading must be less than the

DCGL for a property to PASS and negate a need for additional MARSSIM Tests 2-4):
4 of the 30 properties PASSED.

MARSSIM Test 2 (the difference between the property gamma scan average and the background; and the property's 20 stationary, 1-minute gamma measurements average and the background must both be less than the DCGL for property to PASS):
All 26 properties requiring the test PASSED.

MARSSIM Test 3 (Wilcoxon Rank Sum; a definition is supplied as Appendix B):
All 26 properties requiring the test PASSED.

MARSSIM Test 4 (Elevated Measurement Comparison/ Unity Rule; Test 4 was conducted only if concentrated, elevated 'hot spot(s)' were present on a property. The Unity ratio represents the fraction of the DCGL above background that a property's contamination exhibits):
16 properties did not require Test 4; the remaining 14 properties PASSED. The Unity Rule ratio on these 14 properties ranged from 0.05-0.83.

Four properties in San Mateo, SM0004, SM0006, SM0017 and SM0030, had two Phase 1 Assessments conducted, as EPA was unable to capture all satellite-dependent geographic coordinates during the initial walking gamma scan due to heavy tree foliage. In each case, the properties' initial assessment was subjected to the 4 MARSSIM statistical tests by assuming conservatively that any elevated measurements lacking coordinates were clustered together and constituted a 'hot spot'. Both assessments for property SM0017 passed MARSSIM Test 1, while both assessments for property SM0004 passed MARSSIM Tests 2-4. Initial assessments for both properties SM0006 and SM0030 failed MARSSIM Test 4; the second assessments for both properties passed MARSSIM Tests 2-4. Properties SM0006 and SM0030 received Phase 2 indoor assessments based on the initial Phase 1 assessment results.

All 43 properties in San Mateo and Poison Canyon exhibited elemental Uranium results significantly less than the EPA removal action-level of 230 mg/kg (parts per million (ppm)). Prior to September 2010, the composite surface samples were analyzed using a hand-held x-ray fluorescence (XRF) analyzer, with 10 percent of these sent for laboratory analysis. Subsequently, all samples were sent for laboratory analysis in lieu of XRF analysis. Laboratory results are listed in red in Table 1.

One property owner, SM0039, confirmed that material from local uranium mines and mills was used to construct their home; the property failed MARSSIM Test 4, thus exceeding the Phase 1 DCGL and triggering a Phase 2 assessment (see below)). EPA was unable to collect this data from 15 property owners.

Phase 2 Indoor Assessments

EPA conducted Phase 2 Indoor assessments on properties where Phase 1 assessment results exhibited residual gamma radioactivity in surface soils greater than the DCGL. Nine Phase 2 assessments in San Mateo and one Phase 2 assessment in Poison Canyon were conducted. One property, SM0001, had three separate houses on the property and were labeled House A, B and

C; each had an individual Phase 2 assessment conducted. Additionally, one property, SM0047, whose Phase 1 assessments did not require a Phase 2 assessment, had a partial Phase 2 indoor assessment (radon samples only) conducted at the request of the homeowner. Two homeowners in San Mateo and one in Poison Canyon, whose Phase 1 Assessment results exceeded the DCGL, declined an offer by the EPA to have a Phase 2 indoor assessment conducted.

The Phase 2 Indoor Assessments consisted of:

a) the collection of two short-term (6-day minimum; 7-day maximum) radon gas samples, utilizing activated charcoal adsorbent canisters, in two separate locations of each residence for laboratory analysis of Radon-222,

b) the collection of two long-term (91-day minimum; no maximum) radon gas samples, utilizing track etch detectors, at the two short-term detector locations of each residence where short-term Radon-222 results exceeded the EPA and Center for Disease Control (CDC) acceptable exposure level of 4 pico Curies per liter (pCi/l) for laboratory analysis of Radon-222,

c) the collection of 5-minute, stationary gamma measurements utilizing a PIC in the center of a minimum of the 2 most-often occupied rooms of a residence,

d) a walking, gamma scan of the floor and walls of each room in a residence utilizing a Model 44-10 2"x2" NaI probe attached to a Model 2210 count- meter,

e) the collection of wipe samples for 'alpha tray counter' analysis at locations where gamma scan readings exceeded a residence-specific screening level (quick, 'whole-house' scan average plus 1,900 cpm), and

f) the collection of additional 5-minute stationary gamma measurements utilizing a PIC in the center of each room where wipe sample(s) were collected.

Each assessed property then had an annual *indoor gamma dose above background* calculated (conservatively using the highest room average as the entire residential average) assuming default values of 12 hours per day and 365 days per year spent indoors. The annual indoor gamma dose was converted from milli-Roentgens per year (mR/yr) to milli-Roentgens equivalent-in-man per year (mrem/yr) [1.5 R = 1 rem, determined by MicroShield Analysis provided as Appendix C] to determine if the indoor assessment results exceeded the EPA action-level Total Effective Dose Equivalent (TEDE) above background of 15 mrem/yr. The same background locations in San Mateo village that were utilized for Phase 1 assessment results were used for comparison to the Phase 2 results. See Table 2 for a summary of all Phase 2 Assessment results.

Five properties in San Mateo, including all 3 houses within the SM0001 property, and one property in Poison Canyon exhibited short-term radon results from at least one of the two canisters placed in each home that **met or exceeded** 4.0 pCi/l. The 6 properties had the following results:

- Short-term radon concentrations ranged from 4.0 – 8.5 pCi/l.

The 5 properties in San Mateo that exhibited short-term radon results from both canisters that did **not exceed** 4.0 pCi/l had the following findings:

- Short-term radon concentrations ranged from 0.5 – 3.8 pCi/l.

Three of the San Mateo properties (shaded in Table 2), including all 3 houses within the SM0001 property, and zero Poison Canyon properties exhibited subsequent long-term radon results from at least one of the two detectors placed in each home that **met or exceeded** 4.0 pCi/l.

- Long-term San Mateo results ranged from 4.0 – 5.9 pCi/l.

The 2 properties in San Mateo and the Poison Canyon property that exhibited long-term radon results from both detectors that did **not exceed** 4.0 pCi/l had the following findings:

- Long-term radon concentrations ranged from 1.6 – 3.1 pCi/l.

Four properties in San Mateo (shaded in Table 2), including all three houses within the SM0001 property, and zero Poison Canyon properties exhibited an annual indoor TEDE above background that **met or exceeded** 15mrem/yr.

- Long-term radon results are still pending at one house in San Mateo.

- TEDEs ranged from 15.4 – 24.2 mrem/yr.

Five properties in San Mateo and the Poison Canyon property exhibited an annual indoor TEDE above background that did **not exceed** 15mrem/yr.

- TEDEs ranged from 0.0 – 14.5 mrem/yr.

Five properties in San Mateo, including only one house within the SM0001 property, and zero properties in Poison Canyon exhibited walking gamma scan results that **exceeded** the residence-specific screening level and required surface wipe samples to be obtained. The five properties had the following findings:

- Walking gamma scans of all floors and walls ranged from 9,800 – 25,000 cpm.

Five properties in San Mateo, including 2 houses within the San Mateo property, and the Poison Canyon property exhibited walking gamma scan results that did **not exceed** the residence-specific screening level and thus did not require surface wipe samples to be obtained. The five properties had the following findings:

- Walking gamma scans of all floors and walls ranged from 5,700 – 15,900 cpm.

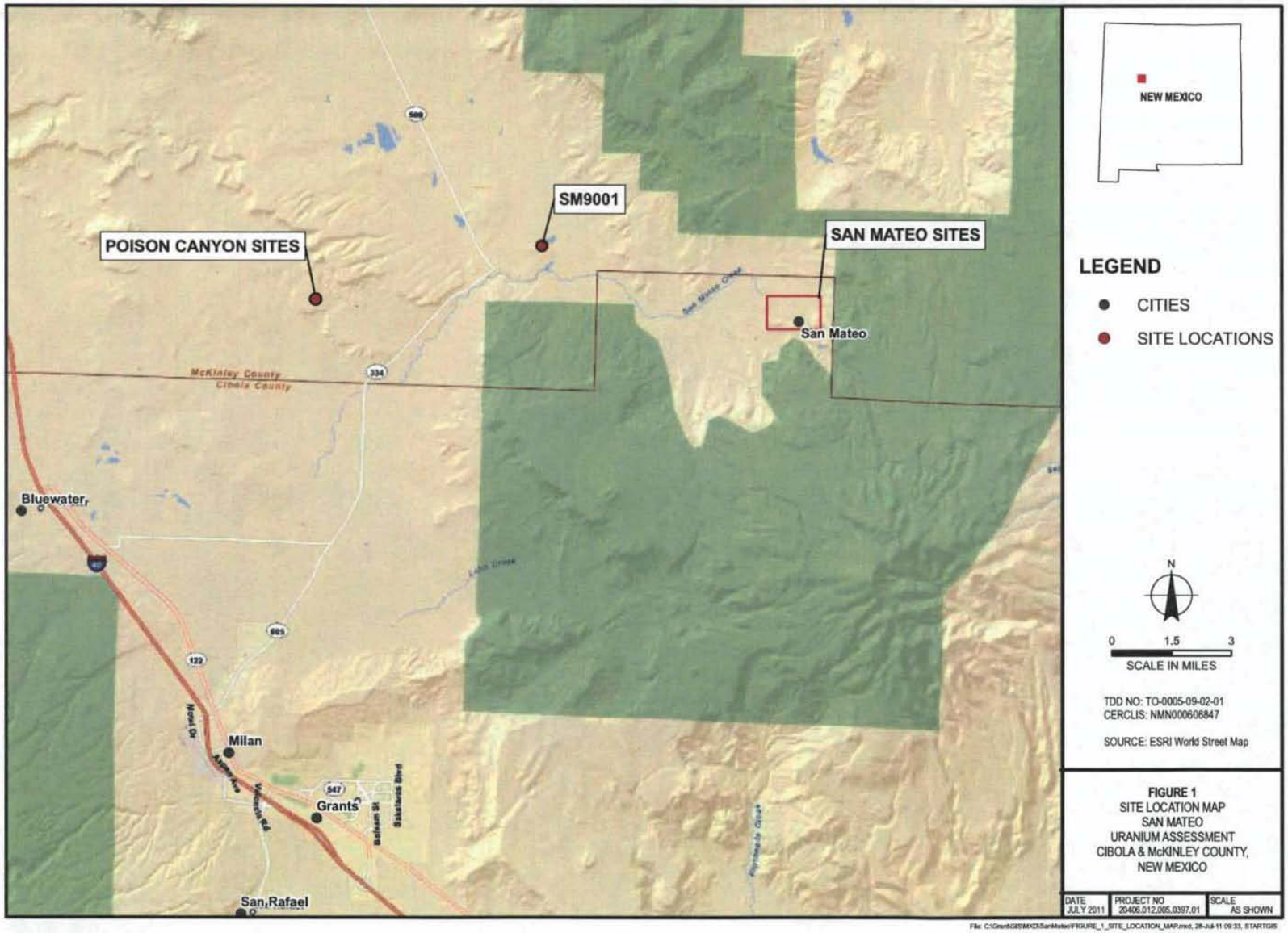
All properties in both San Mateo and Poison Canyon exhibited subsequent wipe sample results that did **not exceed** the EPA action-level of 20 disintegrations per minute (dpm).

Zero properties in San Mateo and Poison Canyon exhibited walking scan gamma results that exceeded a second EPA action-level of 3 times the corresponding background average.

Maps illustrating the locations of all assessed properties, color-coded to reflect exceedances of Phase 1, Phase 2 and long-term radon action-levels, are provided as Appendix D.

FIGURE 1

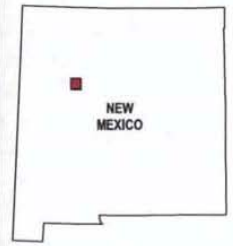
SITE LOCATION MAP


POISON CANYON SITES
SM9001
SAN MATEO SITES
San Mateo
San Mateo Creek
McKinley County
Cibola County
334
508
Bluewater
605
122
Milan
Grants
547
San Rafael
Prairie Dog Creek
NEW MEXICO
LEGEND
CITIES
SITE LOCATIONS
N
0
1.5
3
SCALE IN MILES
TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847
SOURCE: ESRI World Street Map
FIGURE 1
SITE LOCATION MAP
SAN MATEO
URANIUM ASSESSMENT
CIBOLA & McKINLEY COUNTY,
NEW MEXICO
DATE
JULY 2011
PROJECT NO
20406.012.005.0397.01
SCALE
AS SHOWN

APPPENDIX A

RAT Maps

SM0001



Legend

N

SM0001

Results

- 0 - 14574
- 14575 - 15575
- 15576 - 15999
- 16000 - 16999
- 17000 - 19999
- 20000 - 28711

0 25 50

SCALE IN FEET

TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847

SOURCE: ESRI USA Prime Imagery

US EPA REGION 6
START- 3

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0001
ASSESSMENT DATE: 05/12/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
SEPT 2010	20406.012.005.0397.01	AS SHOWN

File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0001\SM0001_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 03-Sep-10 15:14, STARTGIS

SM0002

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SM0003

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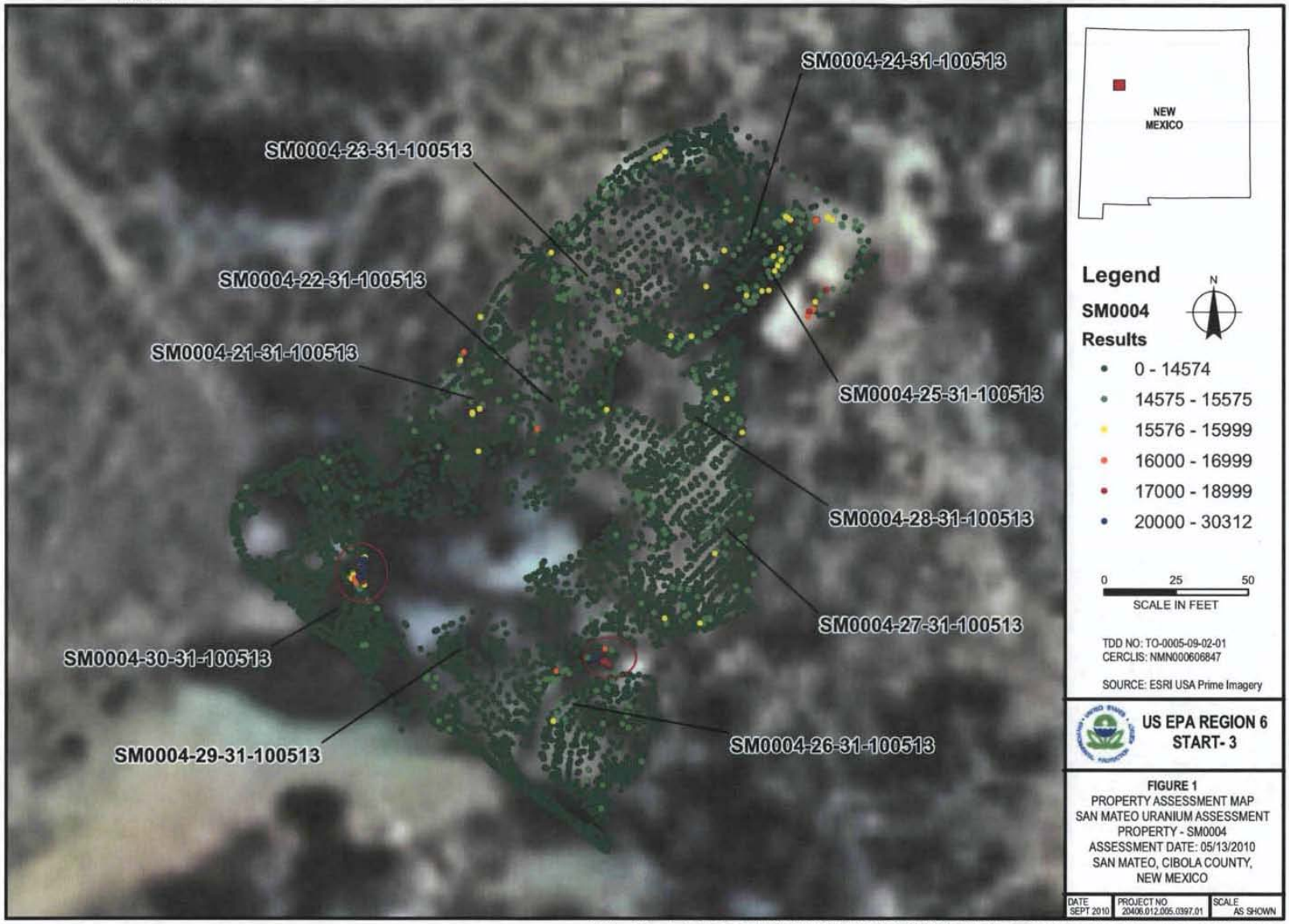
SM0004



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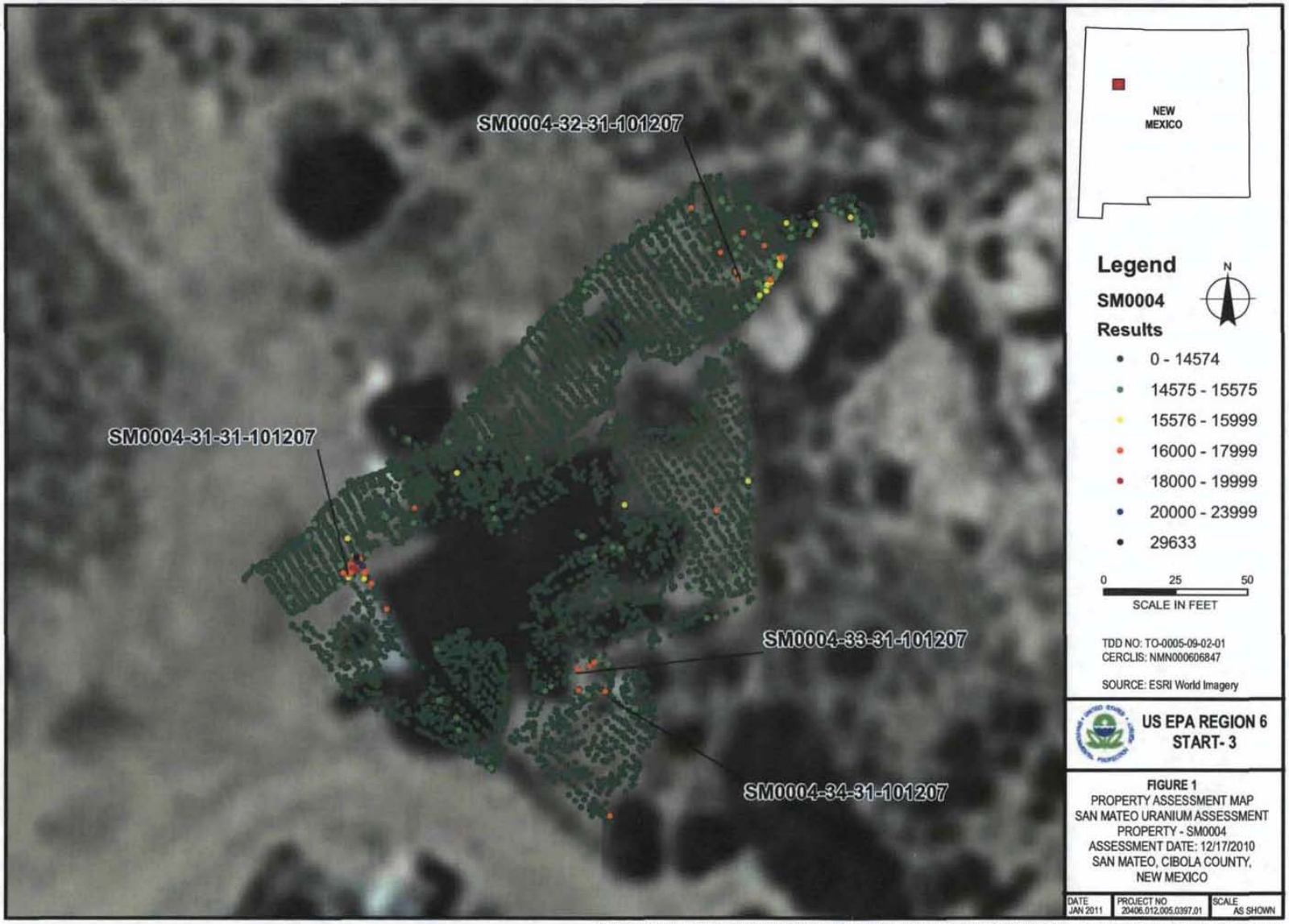
SM0004



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SM0006

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SM0006

Legend

SM0006

Results

- 0 - 14574
- 14575 - 15575

N

0 25 50

SCALE IN FEET

TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847

SOURCE: ESRI World Imagery

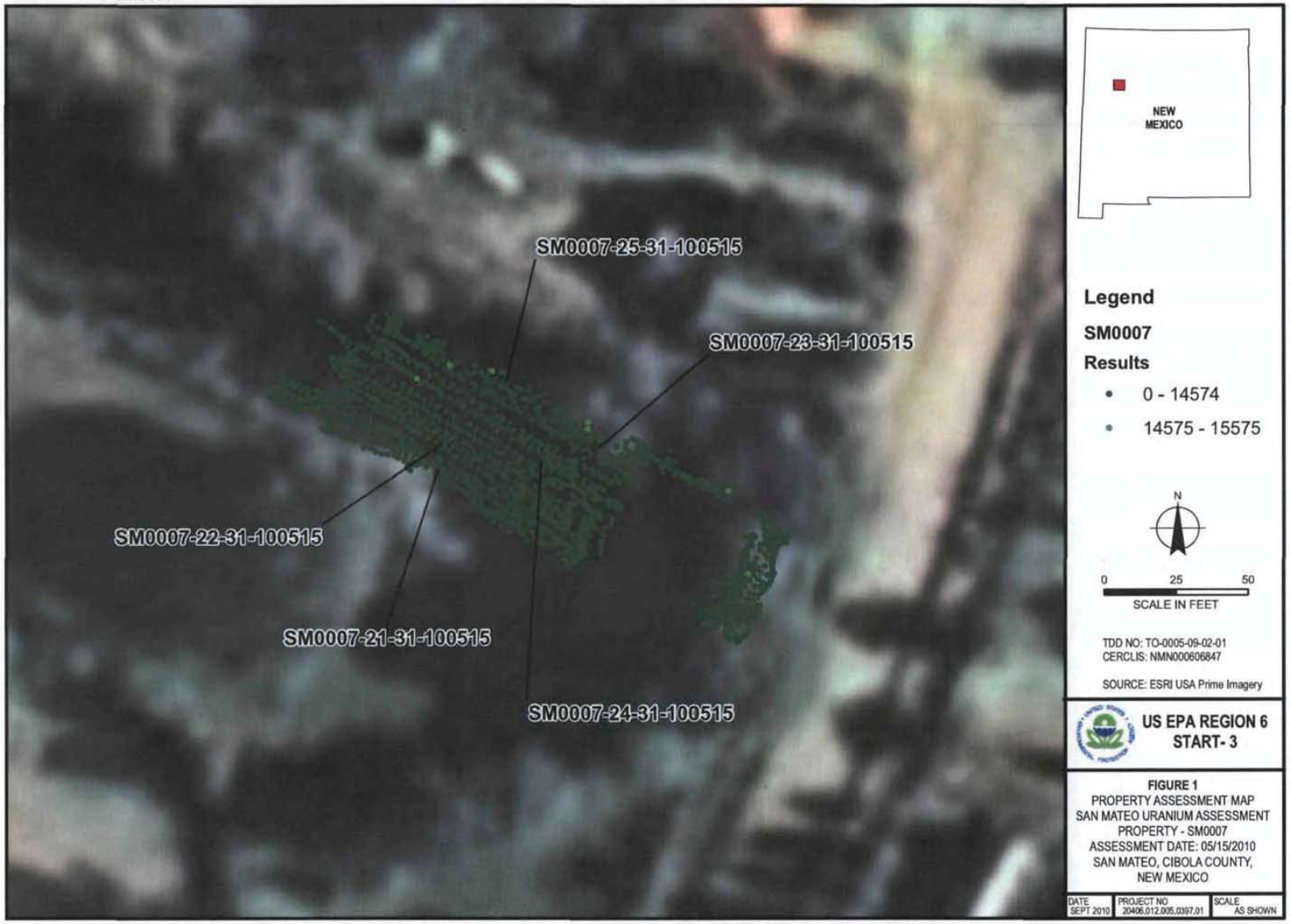
US EPA REGION 6
START- 3

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO
URANIUM ASSESSMENT
PROPERTY - SM0006
ASSESSMENT DATE: 11/19/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
DEC 2010	20406.012.005.0397.01	AS SHOWN

File: \\lanm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0006\SM0006_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP_02.mxd, 07-Dec-10 15:00, STARTGIS

SM0007



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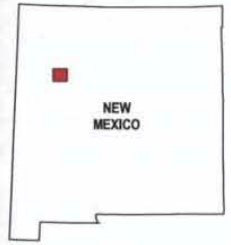
SM0008



Legend

SM0008

Results

- 0 - 14574
- 14575 - 15575
- 15576 - 15999

N

0 25 50

SCALE IN FEET

TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847

SOURCE: ESRI USA Prime Imagery

US EPA REGION 6
START- 3

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0008
ASSESSMENT DATE: 05/17/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
SEPT 2010	20406.012.005.0397.01	AS SHOWN

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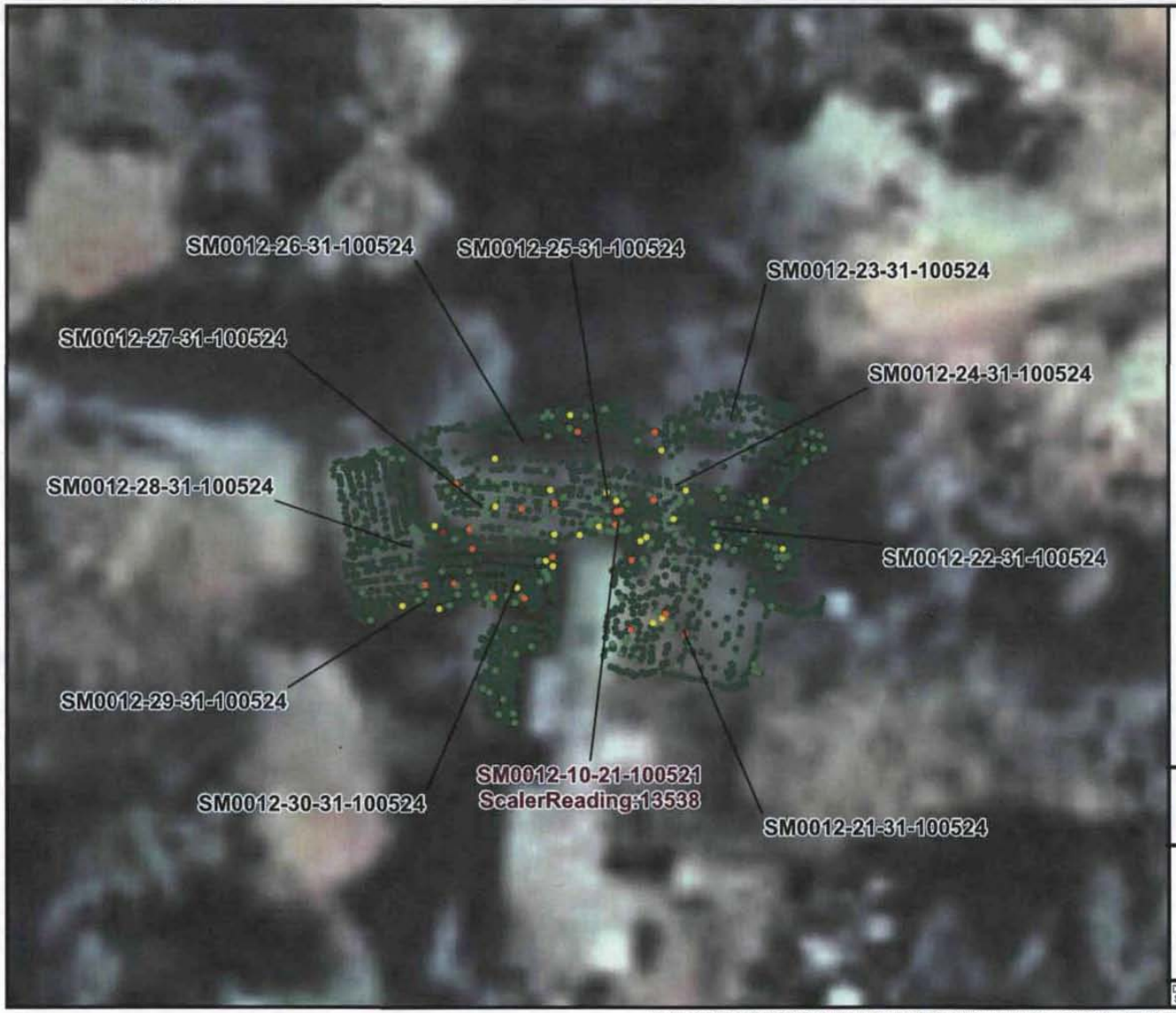
SM0009

File: \\snm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0009\SM0009_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 16-Sep-10 10:22, STARTGIS

SM0012



Legend

SM0012

Results

- 0 - 14574
- 14575 - 15575
- 15576 - 15999
- 16000 - 16999
- 17186

N

0 25 50

SCALE IN FEET

TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847

SOURCE: ESRI USA Prime Imagery

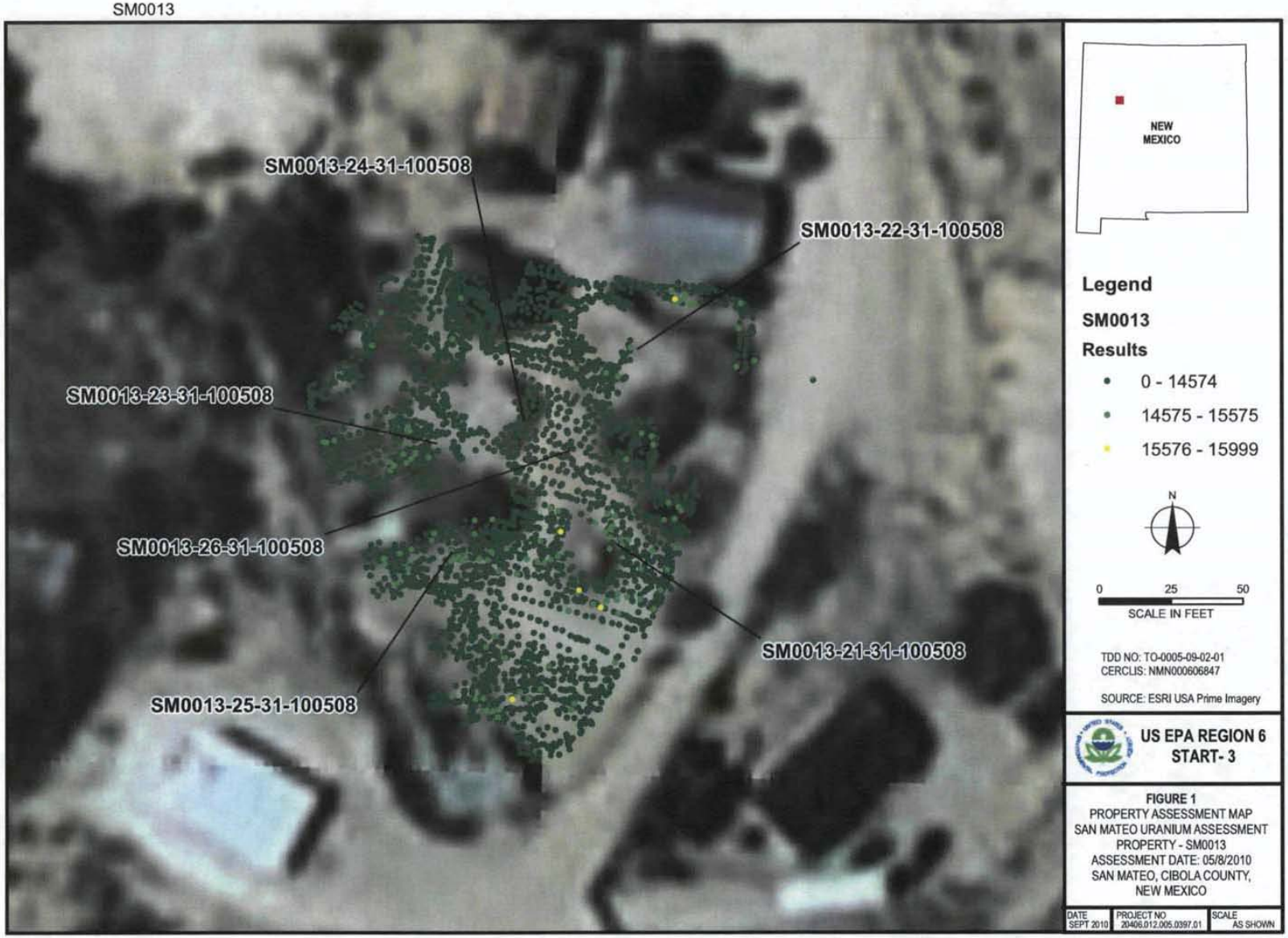
US EPA REGION 6
START- 3

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0012
ASSESSMENT DATE: 05/24/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
SEPT 2010	20406.012.005.0397.01	AS SHOWN

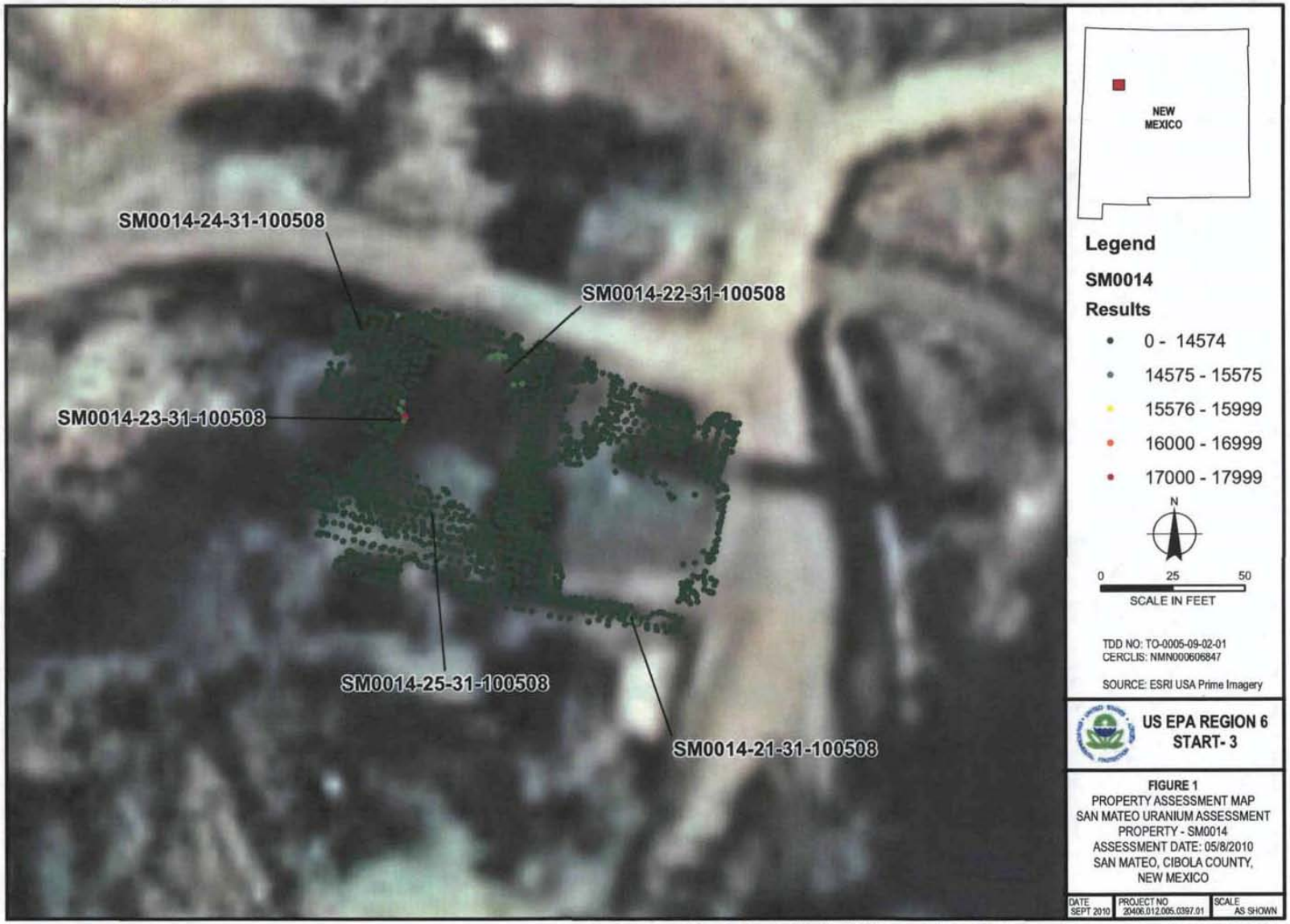
File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0012\SM0012_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 08-Sep-10 10:31, STARTGIS

SM0013



File: \\tsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0013\SM0013_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 15-Nov-10 12:34, STARTGIS

SM0014



File: \\lsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0014\SM0014_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 08-Sep-10 15:54, STARTGIS

SM0017

File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0017\SM0017_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 07-Dec-10 15:32, STARTGIS

SM0017

Legend

SM0017

Results

- 0 - 12592

N

0 30 60

SCALE IN FEET

TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847

SOURCE: ESRI World Imagery

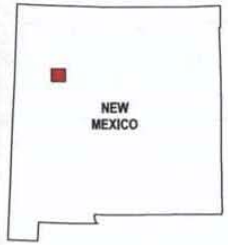
US EPA REGION 6
START- 3

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO
URANIUM ASSESSMENT
PROPERTY - SM0017
ASSESSMENT DATE: 11/13/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
DEC 2010	20406.012.005.0397.01	AS SHOWN

File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0017\SM0017_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP_02.mxd, 07-Dec-10 15:39, STARTGIS

SM0018



Legend

SM0018

Results

- 0 - 14574
- 14575 - 15575
- 15576 - 15999
- 16000 - 16999
- 17000 - 17145

N

0 25 50

SCALE IN FEET

TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847

SOURCE: ESRI USA Prime Imagery

US EPA REGION 6
START- 3

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0018
ASSESSMENT DATE: 05/11/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
SEPT 2010	20406.012.005.0397.01	AS SHOWN

File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0018\SM0018_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 09-Sep-10 09:30, STARTGIS

SM0019

Legend

SM0019

Results

- 0 - 14574
- 14575 - 15575

TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847

SOURCE: ESRI USA Prime Imagery

US EPA REGION 6
START- 3

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0019
ASSESSMENT DATE: 05/27/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
SEPT 2010	20406.012.005.0397.01	AS SHOWN

File: \\anm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0019\SM0019_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 09-Sep-10 10:54, STARTGIS

SM0022

Legend

SM0022

Results

- 0 - 14574
- 14575 - 15575

N

0 25 50

SCALE IN FEET

TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847

SOURCE: ESRI USA Prime Imagery

US EPA REGION 6
START- 3

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0022
ASSESSMENT DATE: 05/10/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

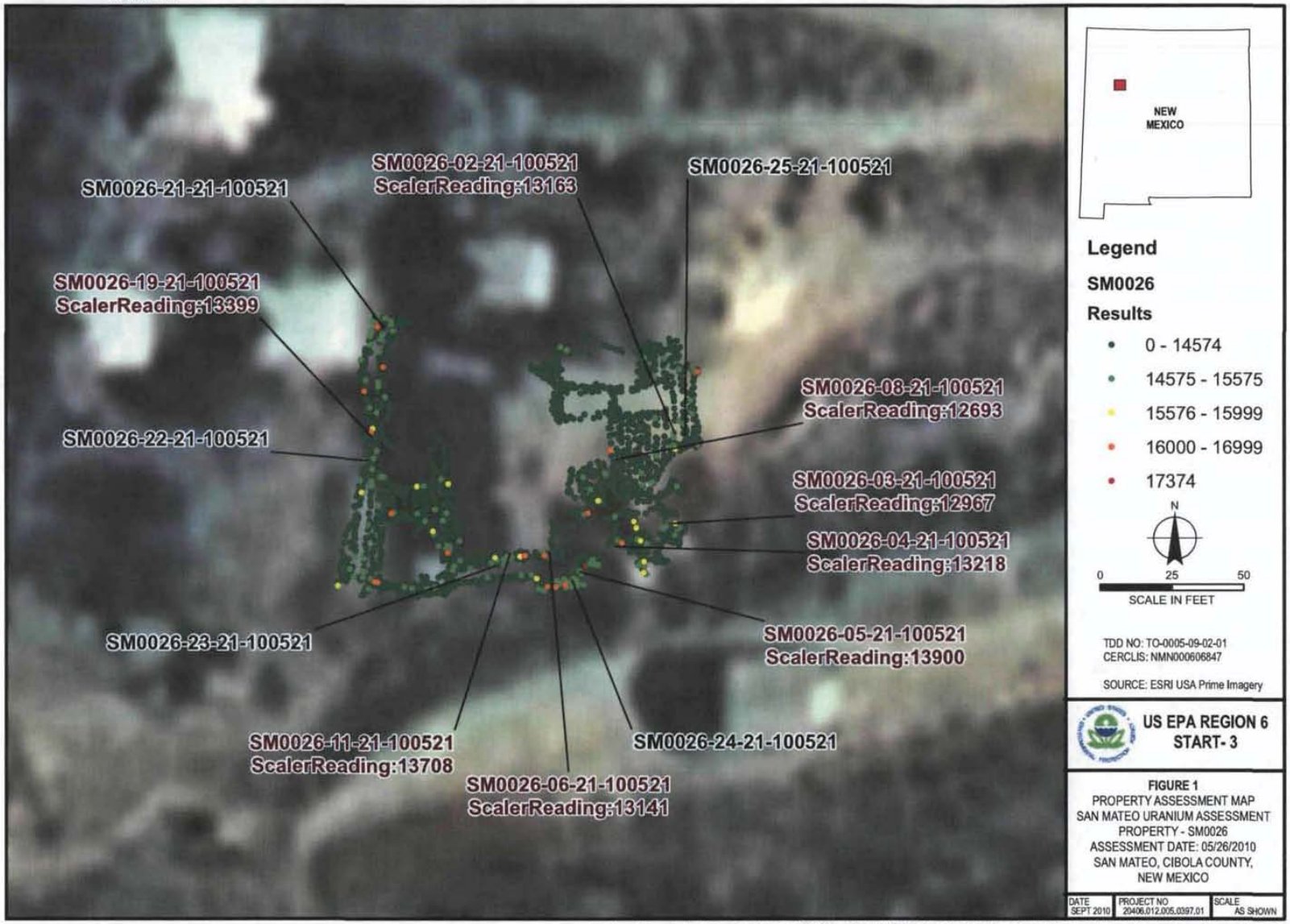
DATE	PROJECT NO	SCALE
SEPT 2010	20406.012.005.0397.01	AS SHOWN

File: \\snm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0022\SM0022_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 09-Sep-10 12:26, STARTGIS

SM0023

File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0023\SM0023_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 09-Sep-10 14:04, STARTGIS

SM0026



File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0026\SM0026_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 09-Sep-10 14:42, STARTGIS

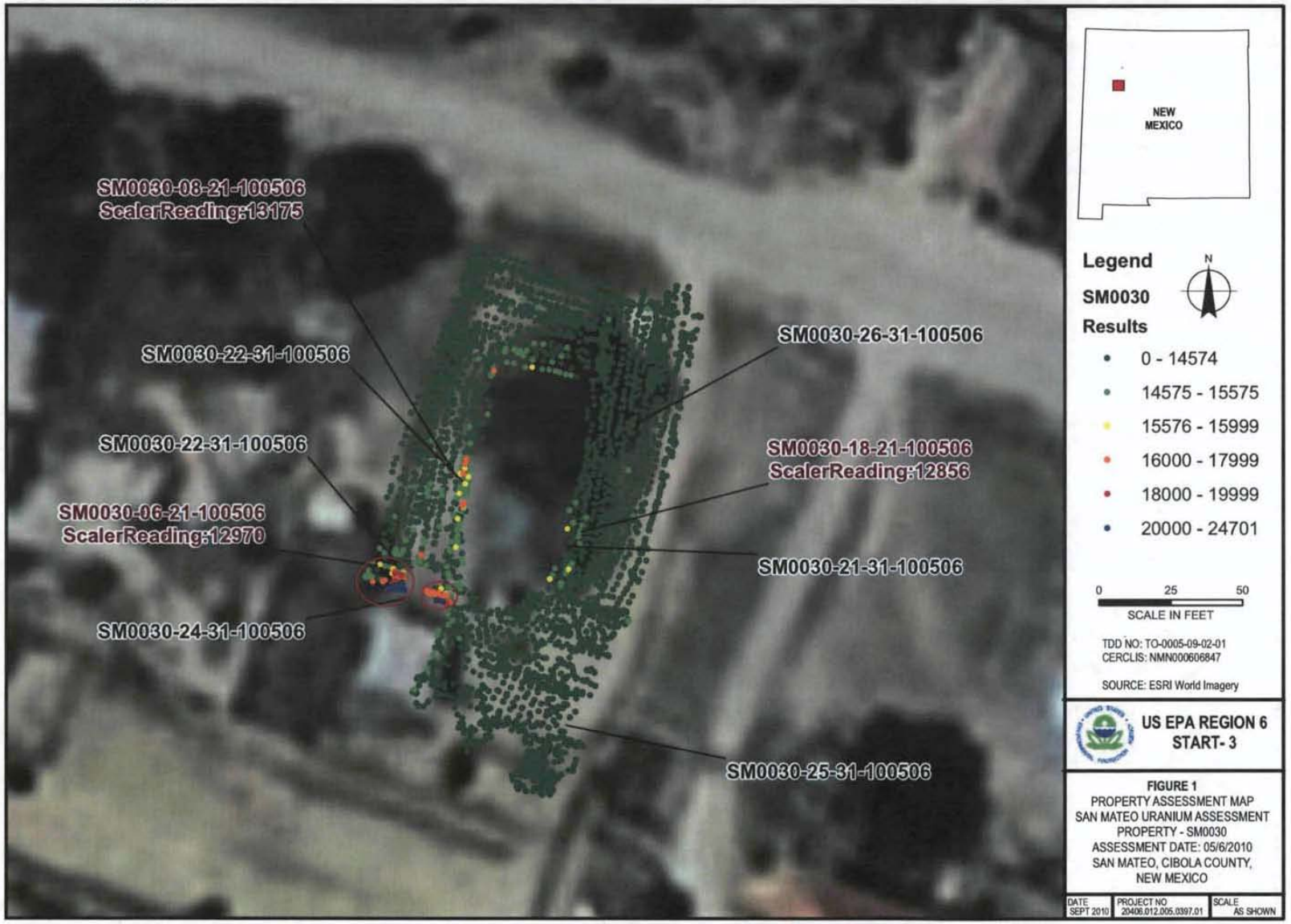
SM0027

File: \\anm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0027\SM0027_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 15-Dec-10 13:07, STARTGIS

SM0028

File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0028\SM0028_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 15-Dec-10 14:36, STARTGIS

SM0030



File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0030\SM0030_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 30-Oct-10 12:40, STARTGIS

SM0030

File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0030\SM0030_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 02-Feb-11 14:15, STARTGIS

SM0035

File: \\anm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0035\SM0035_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 10-Sep-10 12:44, STARTGIS

SM0039

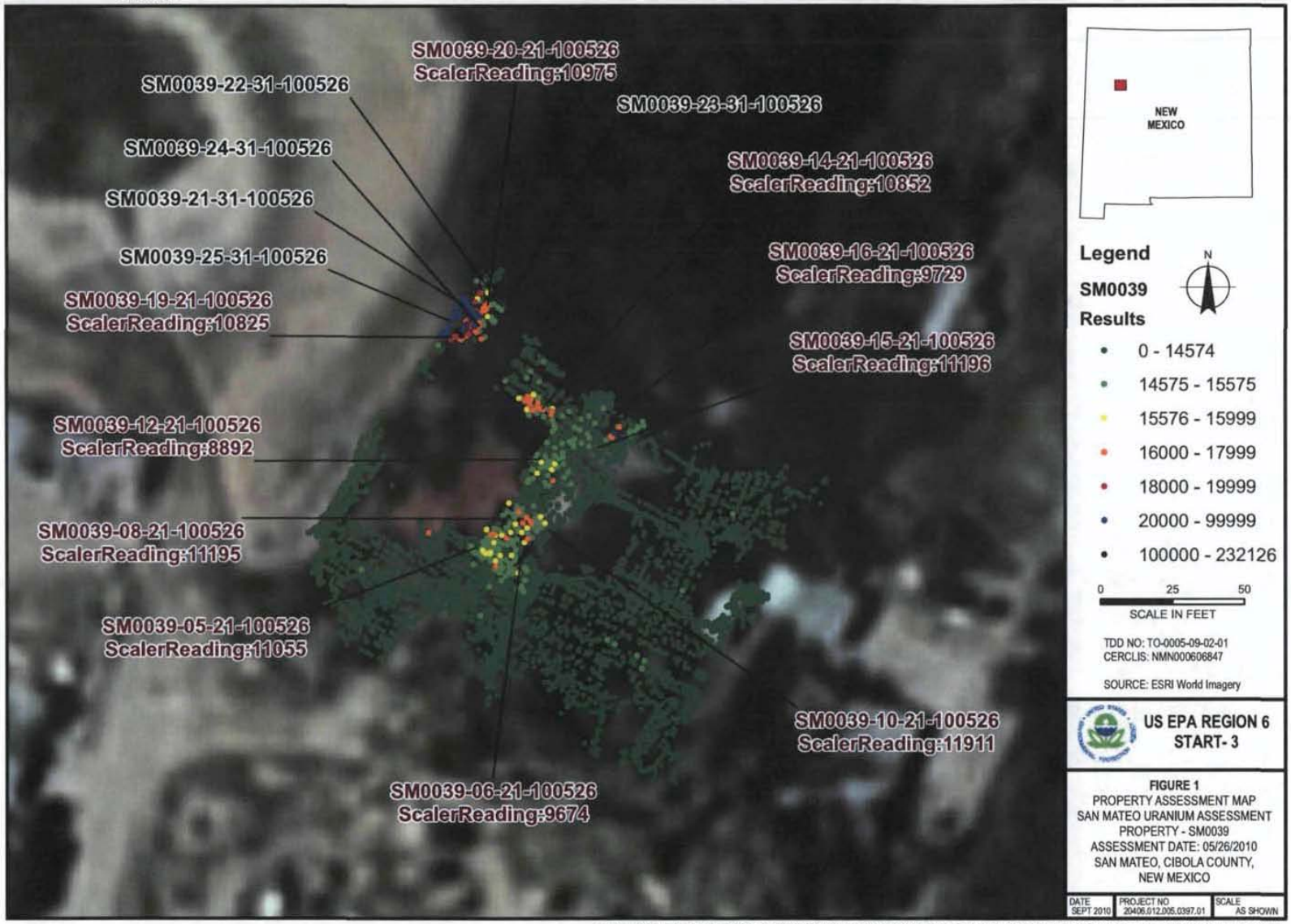
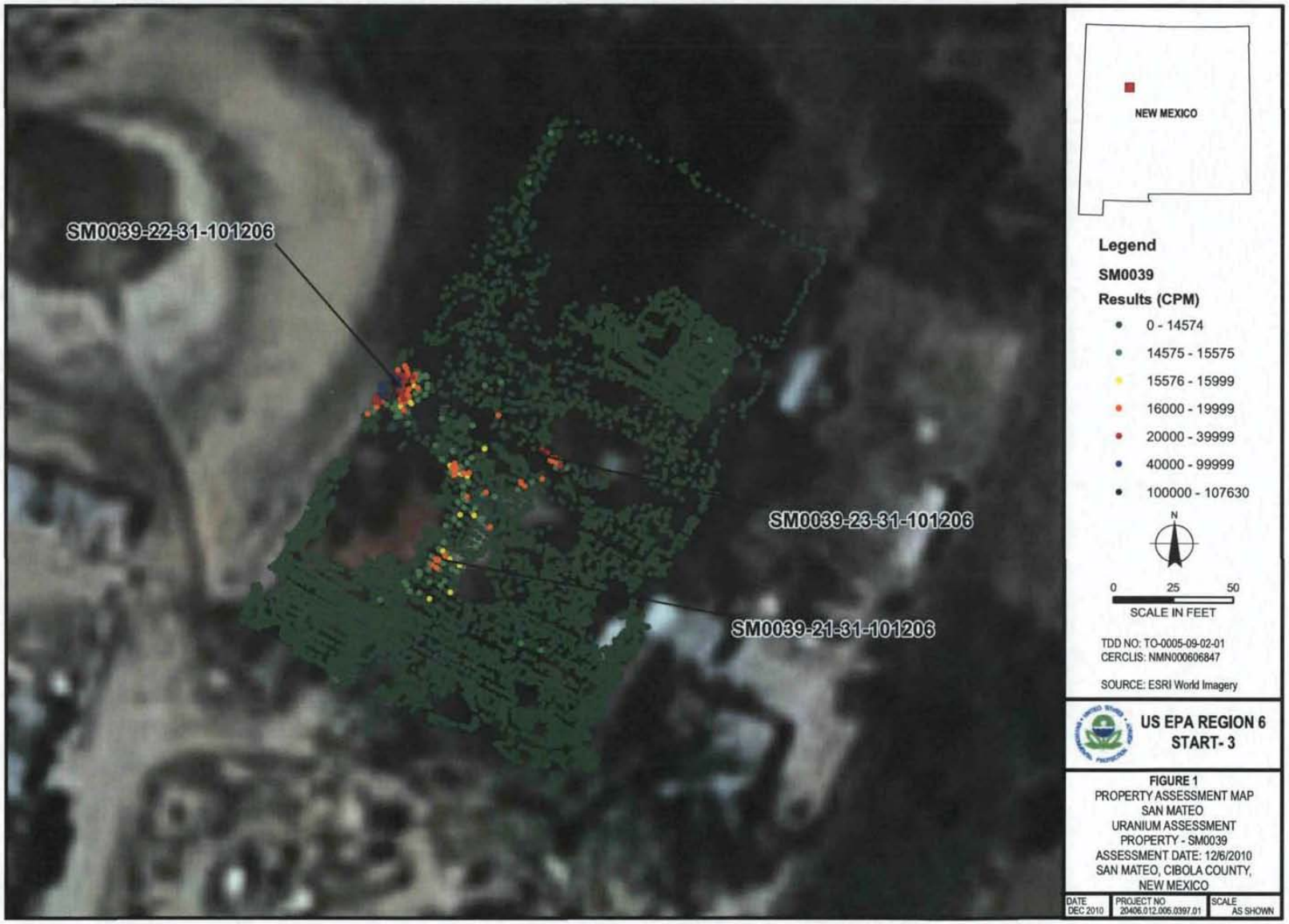


FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0039
ASSESSMENT DATE: 05/26/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
SEPT 2010	20406.012.005.0397.01	AS SHOWN

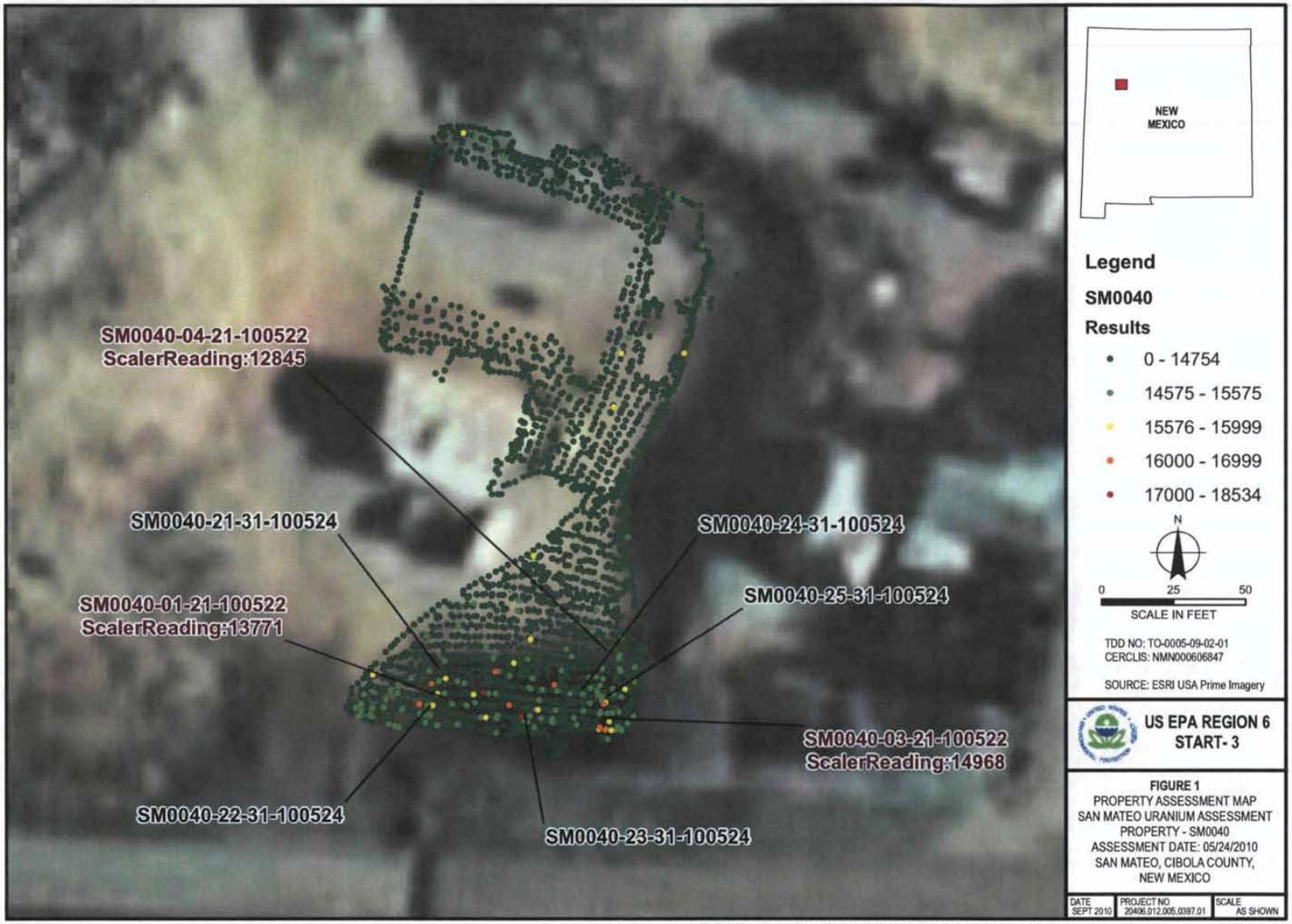
File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0039\SM0039_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 30-Oct-10 13:26, STARTGIS

SM0039



File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0039\SM0039_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP_02.mxd, 06-Dec-10 18:56, STARTGIS

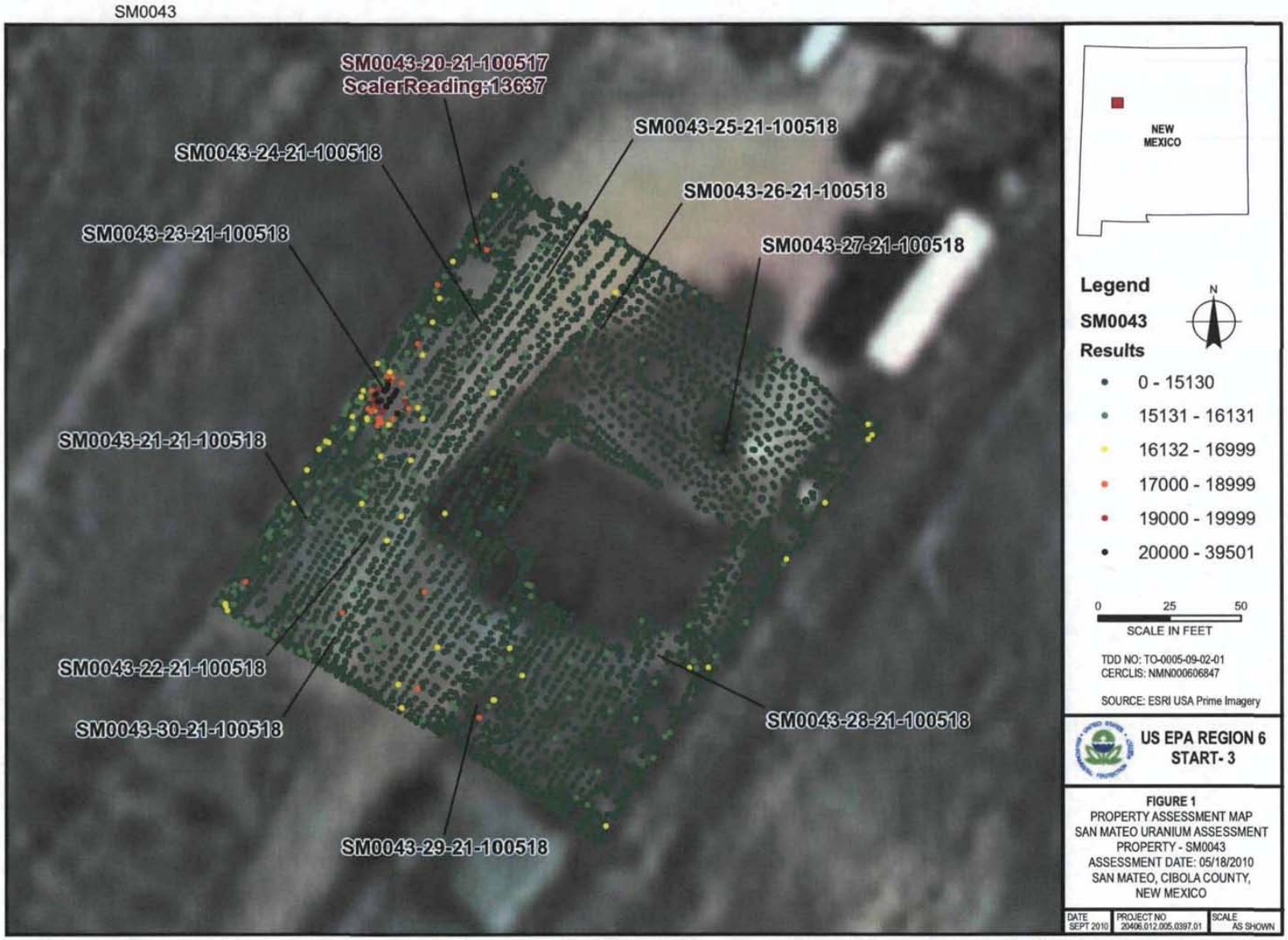
SM0040



File: \\srvm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0040\SM0040_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 11-Sep-10 10:13, STARTGIS

SM0042

File: \\fanm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0042\SM0042_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 11-Sep-10 11:57, STARTGIS


SM0043
SM0043-20-21-100517
ScalerReading:13637
SM0043-25-21-100518
SM0043-24-21-100518
SM0043-26-21-100518
SM0043-23-21-100518
SM0043-27-21-100518
SM0043-21-21-100518
SM0043-22-21-100518
SM0043-30-21-100518
SM0043-28-21-100518
SM0043-29-21-100518
NEW MEXICO
Legend
SM0043
Results
0 - 15130
15131 - 16131
16132 - 16999
17000 - 18999
19000 - 19999
20000 - 39501
N
0 25 50
SCALE IN FEET
TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847
SOURCE: ESRI USA Prime Imagery
US EPA REGION 6
START- 3
FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0043
ASSESSMENT DATE: 05/18/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO
DATE SEPT 2010
PROJECT NO 20406.012.005.0397.01
SCALE AS SHOWN
File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0043\SM0043_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 13-Sep-10 14:23, STARTGIS

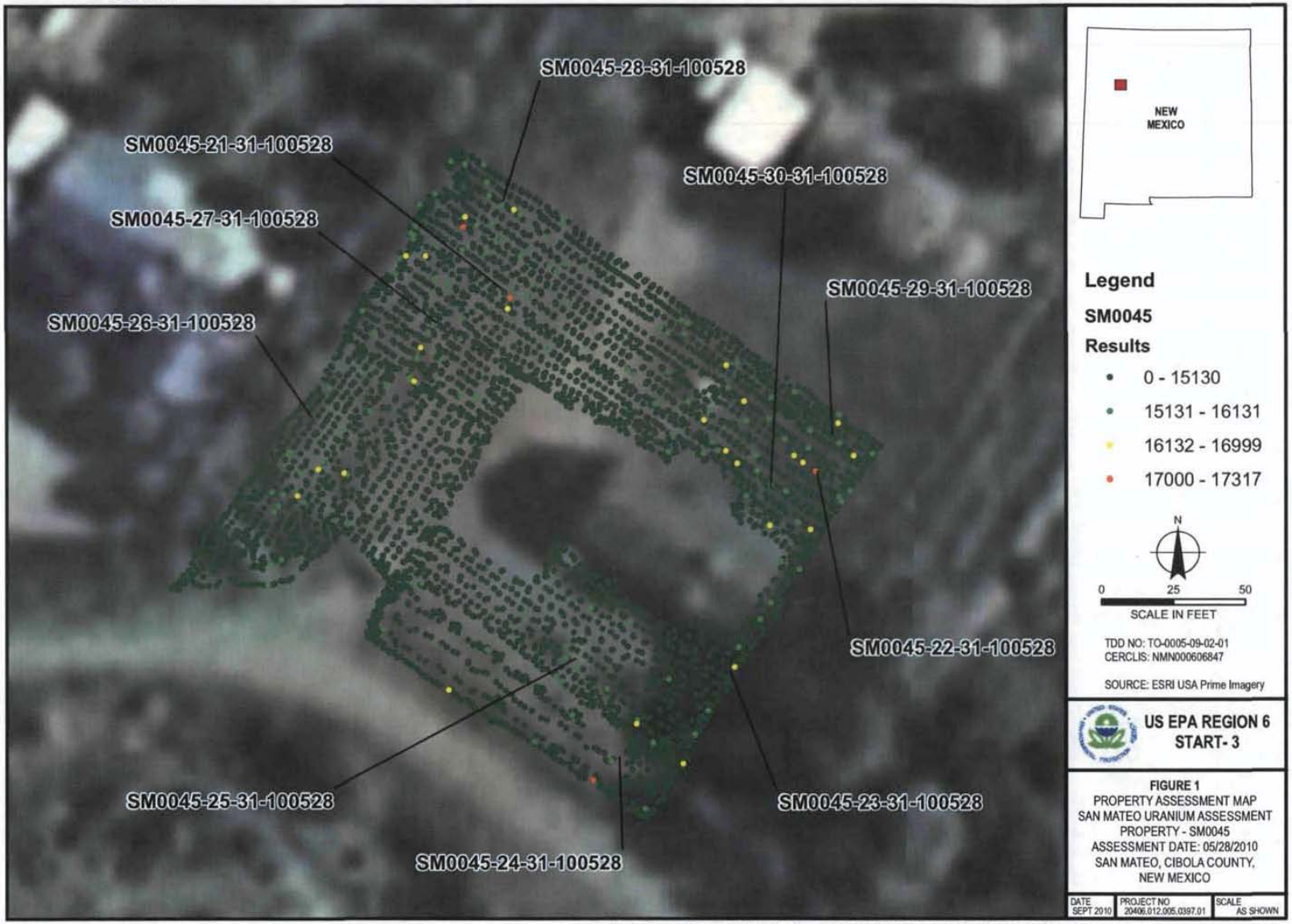
SM0044

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0044
ASSESSMENT DATE: 05/26/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
SEPT 2010	20406.012.005.0397.01	AS SHOWN

File: \\lavm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0044\SM0044_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 13-Sep-10 16:43, STARTGIS

SM0045



File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0045\SM0045_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 14-Sep-10 16:16, STARTGIS

SM0047

Legend

SM0047

Results

- 0 - 15130
- 15131 - 16131
- 16132 - 16999
- 17000 - 17818

N

0 25 50

SCALE IN FEET

TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847

SOURCE: ESRI USA Prime Imagery

US EPA REGION 6
START- 3

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0047
ASSESSMENT DATE: 05/19/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

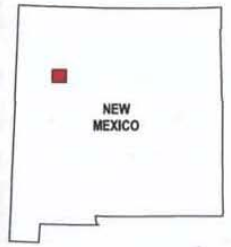
DATE	PROJECT NO	SCALE
SEPT 2010	20406.012.005.0397.01	AS SHOWN

File: \\fanm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0047\SM0047_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 13-Sep-10 18:04, STARTGIS

SM0050

File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0050\SM0050_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 15-Sep-10 10:00, STARTGIS

SM0052



Legend

SM0052

Results

- 0 - 14574
- 14575 - 15575

0 25 50

SCALE IN FEET

TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847

SOURCE: ESRI USA Prime Imagery

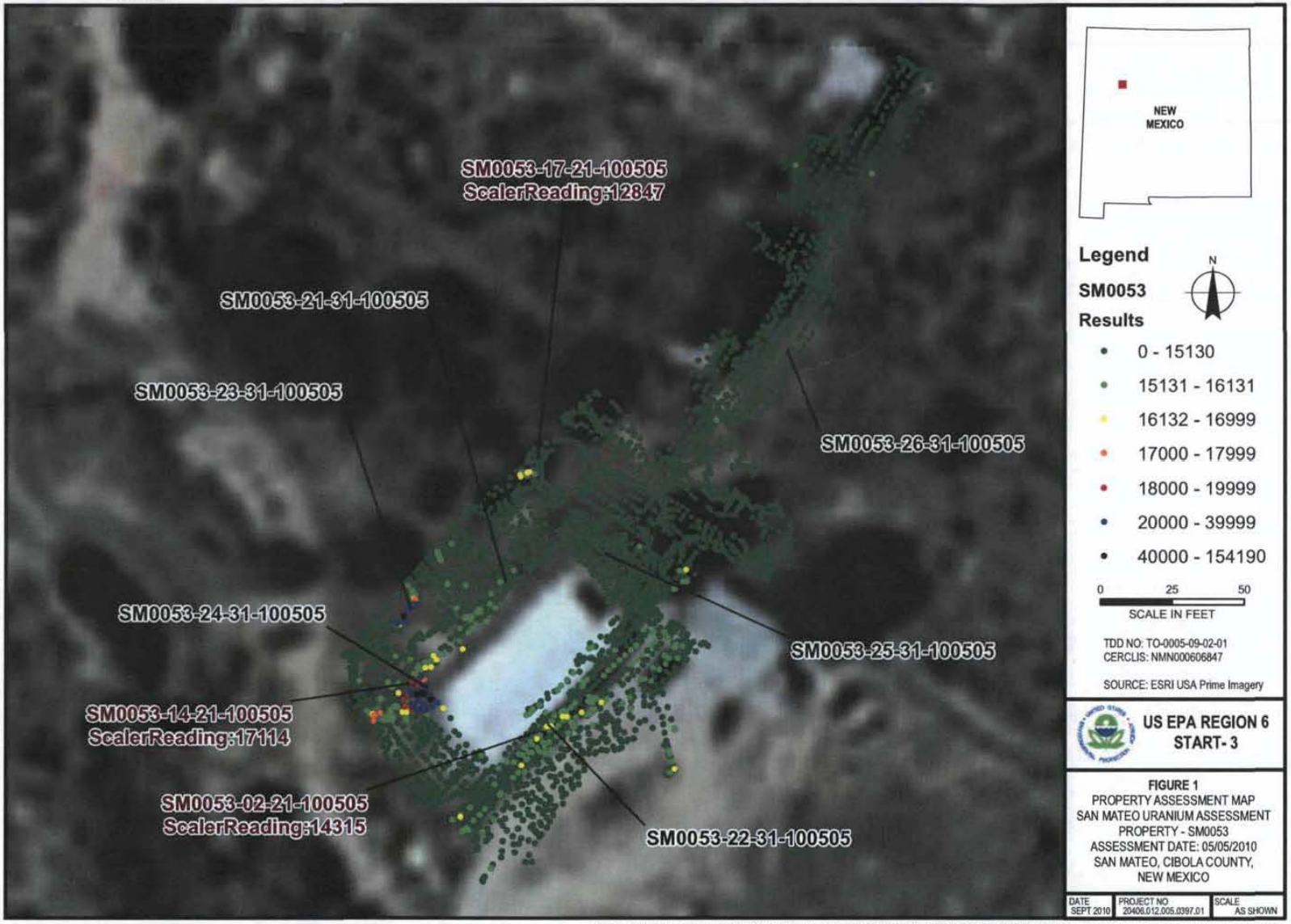
US EPA REGION 6
START- 3

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0052
ASSESSMENT DATE: 05/04/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
SEPT 2010	20406.012.005.0397.01	AS SHOWN

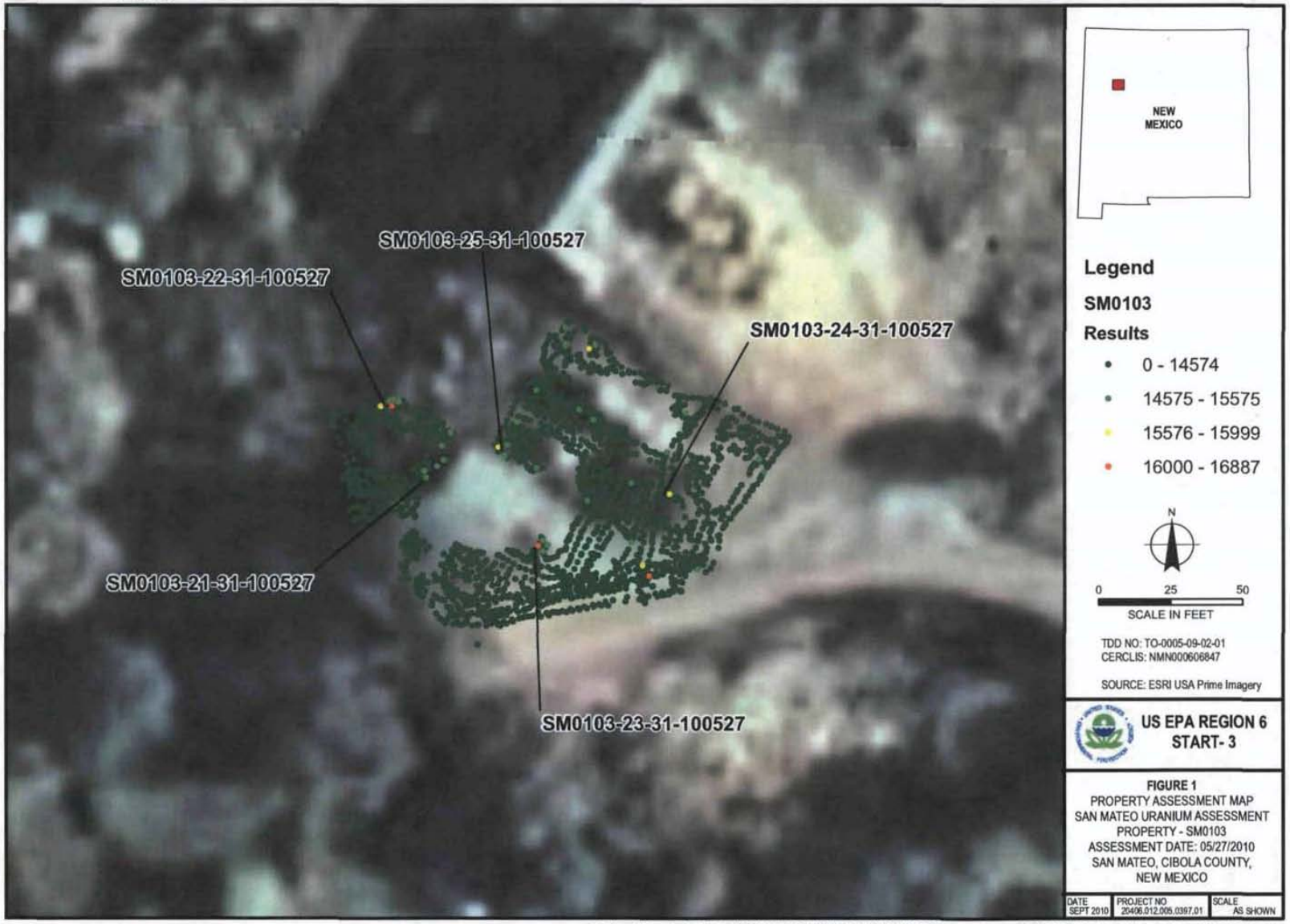
File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0052\SM0052_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 15-Sep-10 11:08, STARTGIS

SM0053



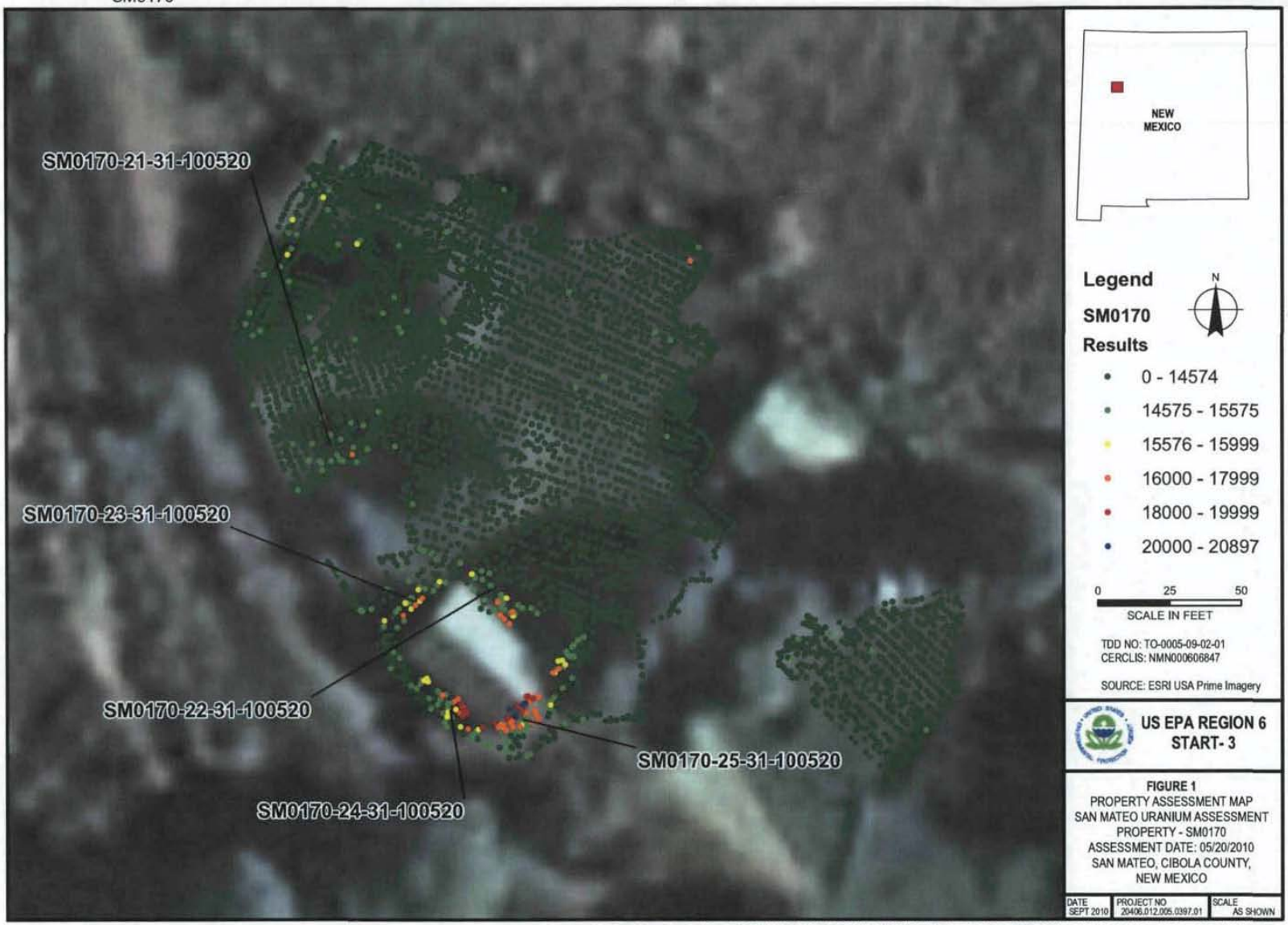
File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0053\SM0053_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 15-Nov-10 14:24, STARTGIS

SM0103

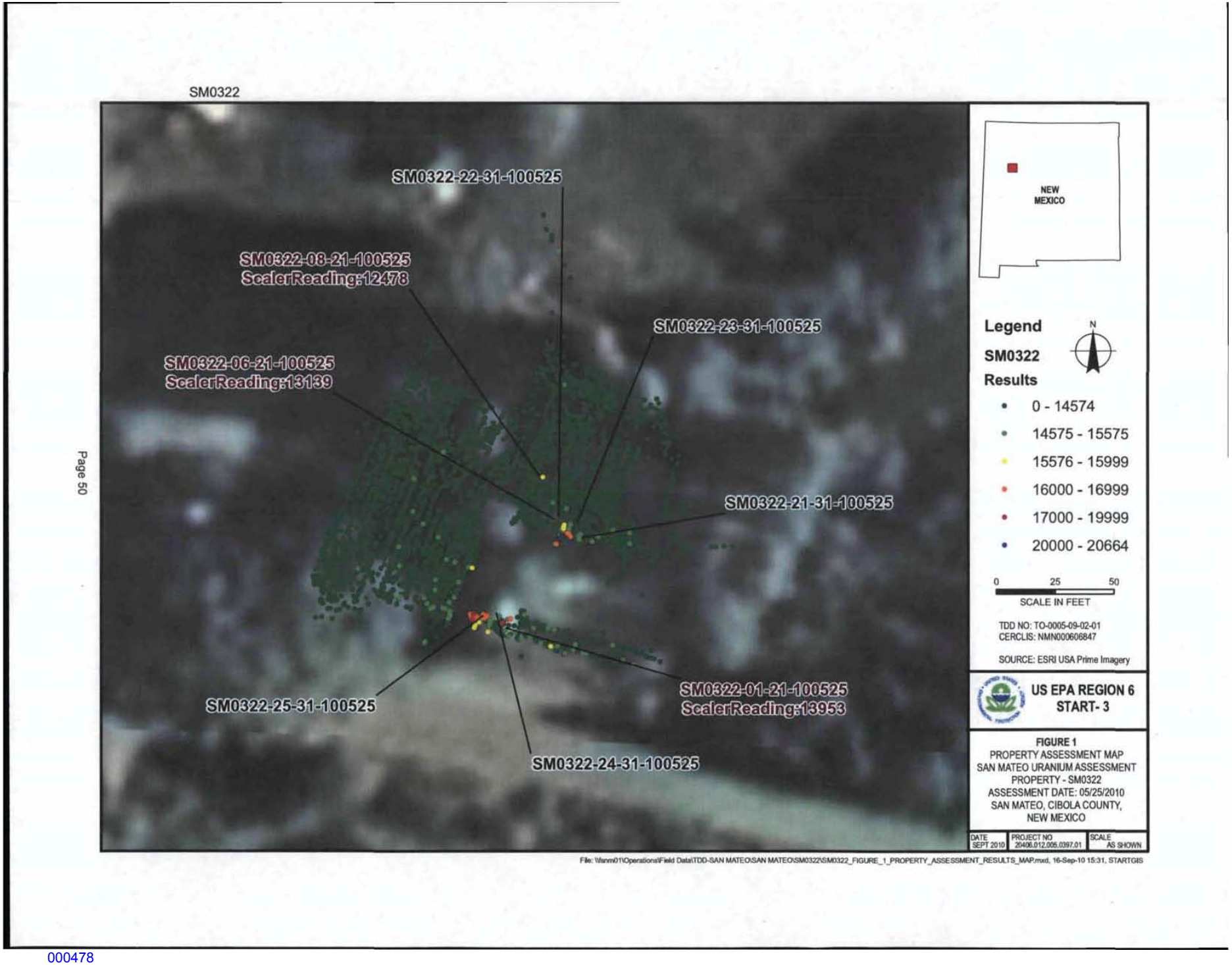


File: \\lanm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0103\SM0103_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 15-Sep-10 16:34, STARTGIS

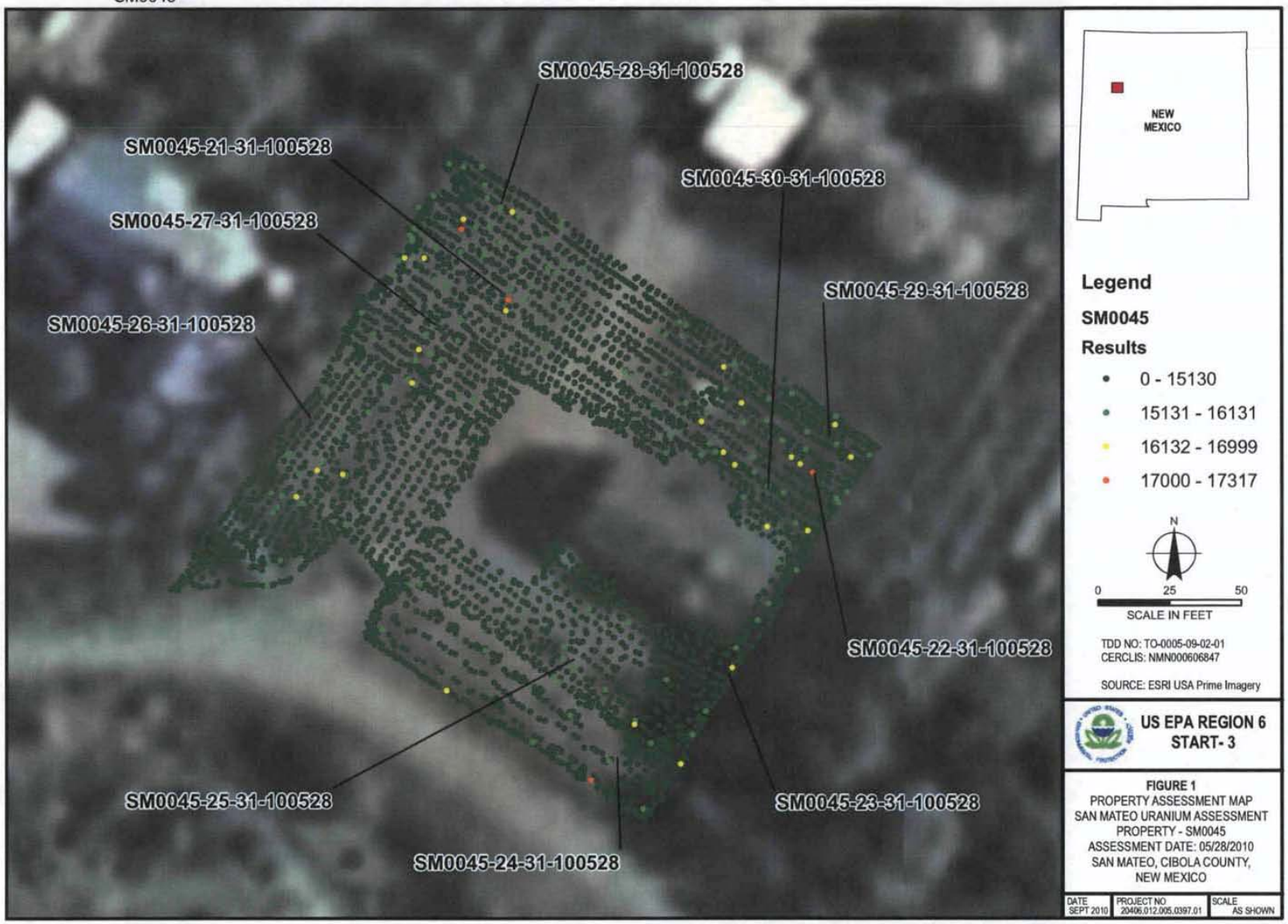
SM0170



File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0170\SM0170_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 16-Sep-10 14:27, STARTGIS

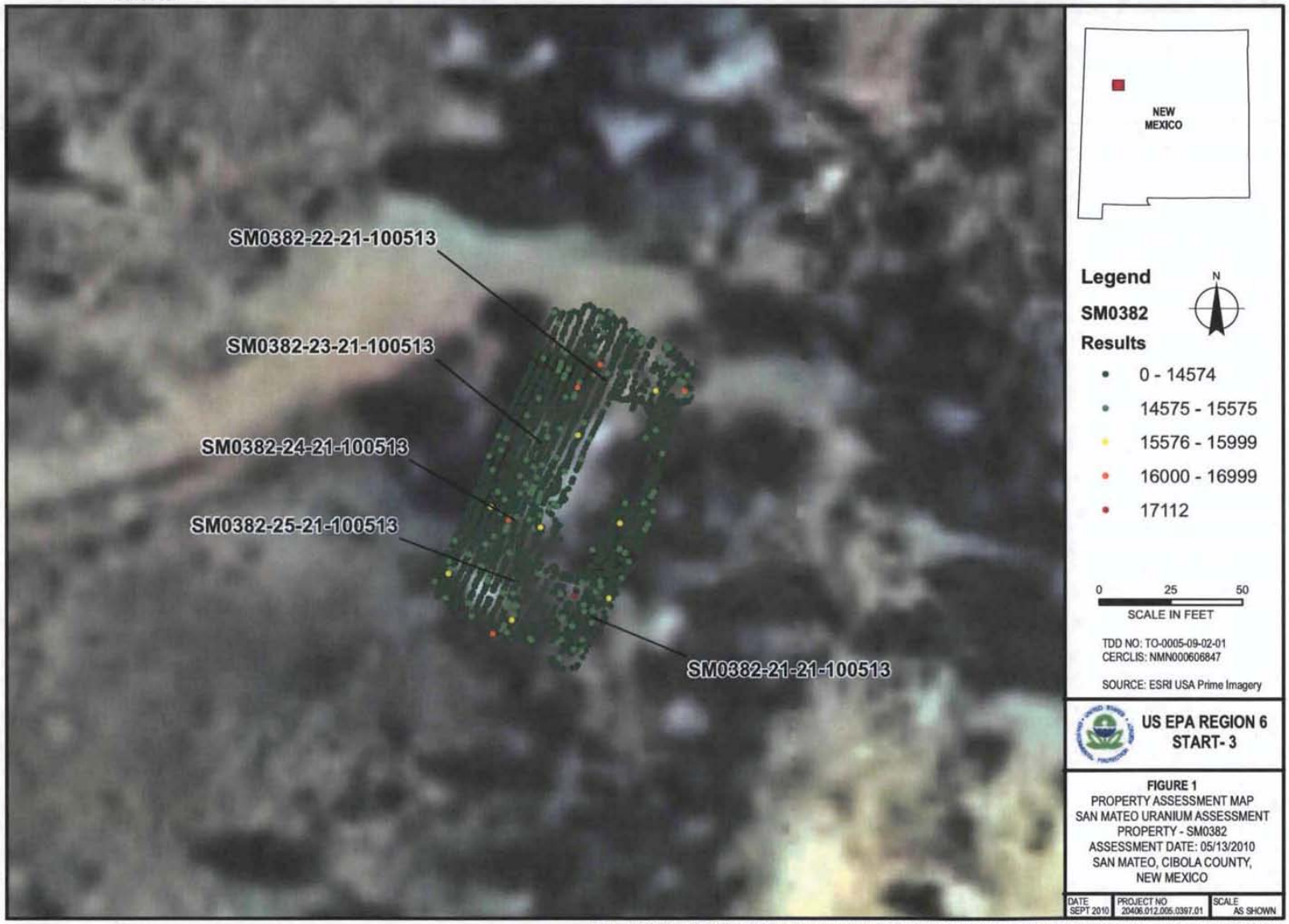

SM0322
SM0322-22-31-100525
SM0322-08-21-100525
ScalerReading:12478
SM0322-23-31-100525
SM0322-06-21-100525
ScalerReading:13139
SM0322-21-31-100525
SM0322-25-31-100525
SM0322-01-21-100525
ScalerReading:13953
SM0322-24-31-100525
NEW MEXICO
Legend
SM0322
Results
0 - 14574
14575 - 15575
15576 - 15999
16000 - 16999
17000 - 19999
20000 - 20664
N
0
25
50
SCALE IN FEET
TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847
SOURCE: ESRI USA Prime Imagery
US EPA REGION 6
START- 3
FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0322
ASSESSMENT DATE: 05/25/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO
DATE
SEPT 2010
PROJECT NO
20406.012.005.0397.01
SCALE
AS SHOWN
File: \\fanm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0322\SM0322_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 16-Sep-10 15:31, STARTGIS

SM0045



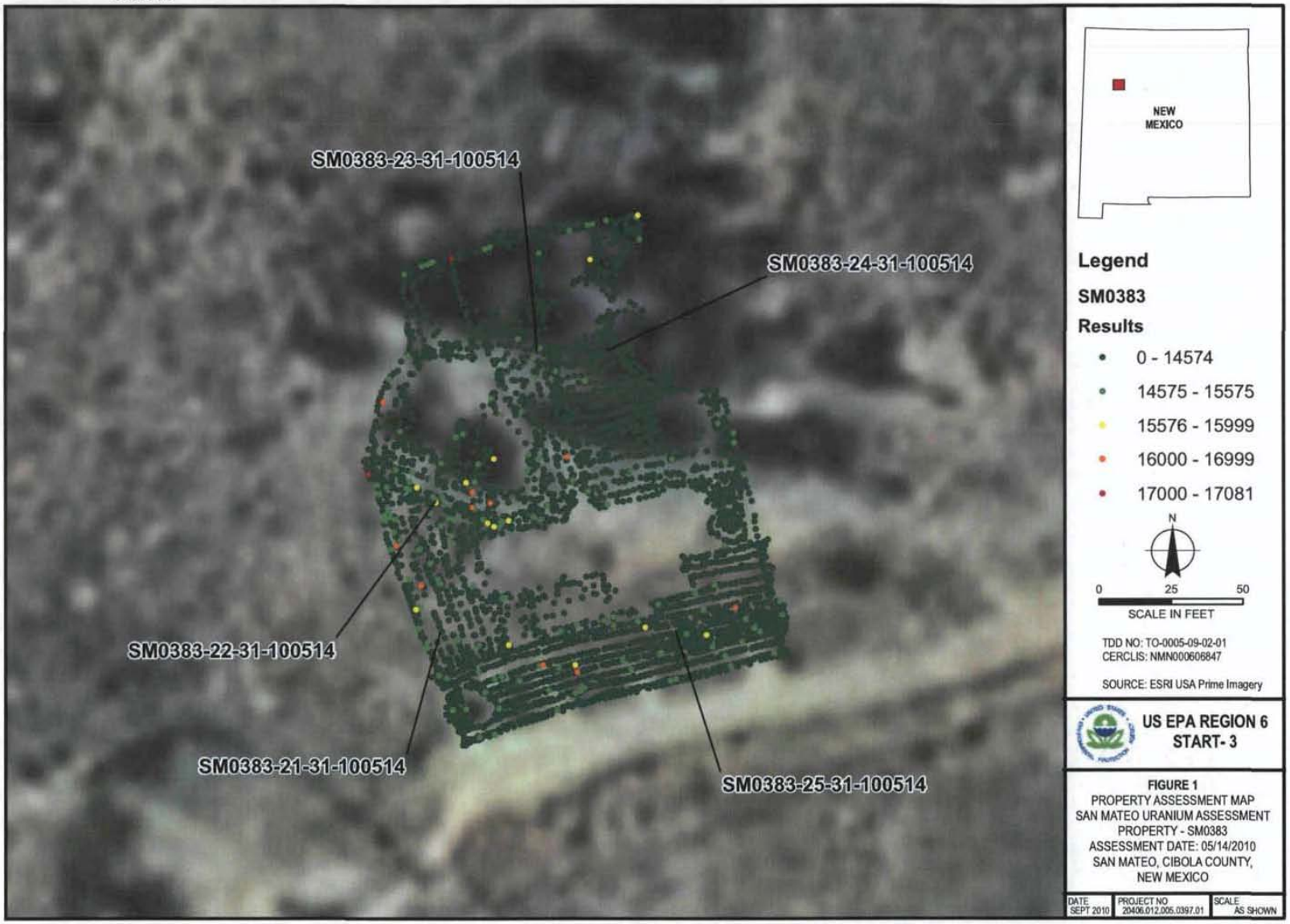
File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0045\SM0045_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 14-Sep-10 16:16, STARTGIS

SM0382



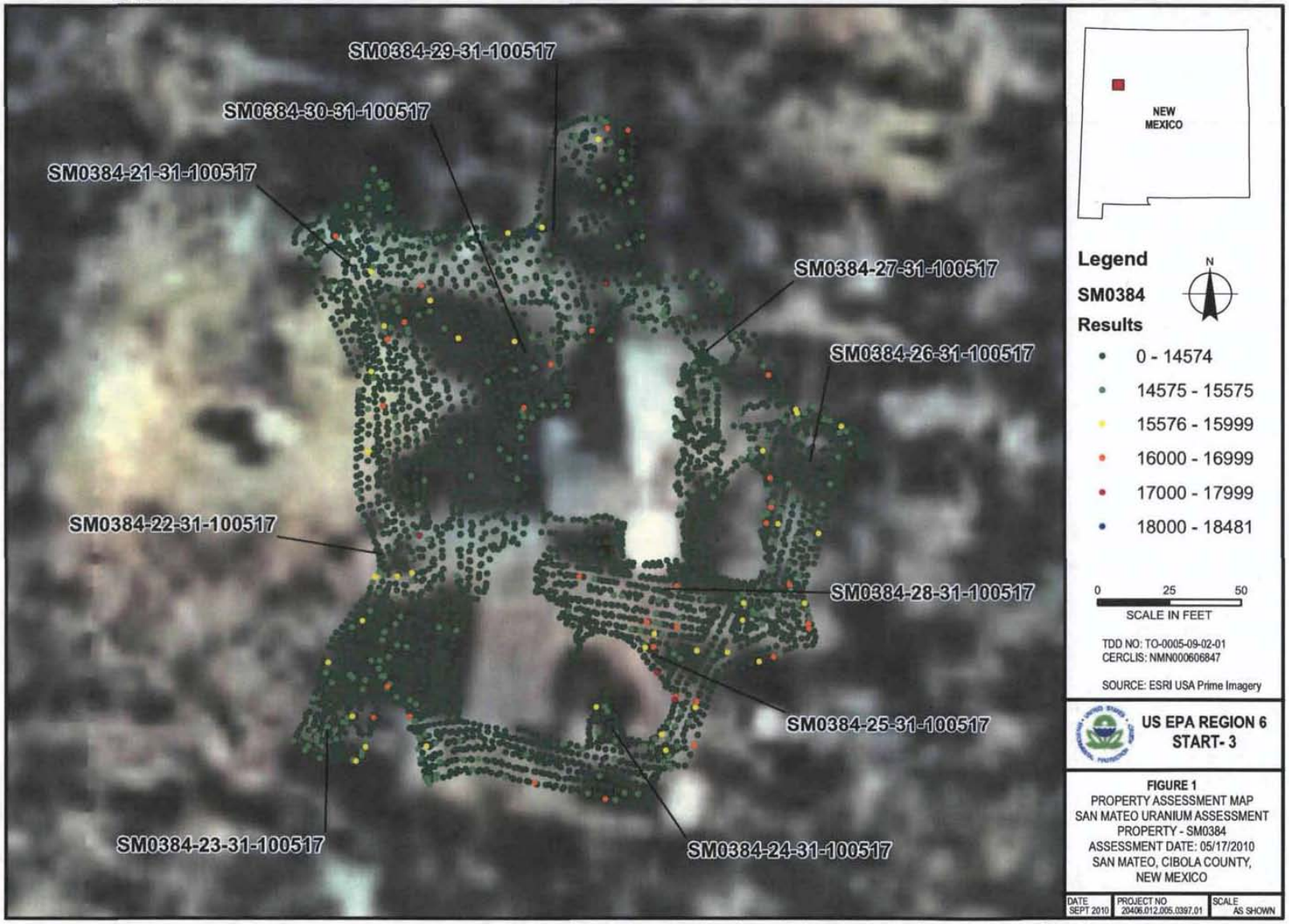
File: \\snm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0382\SM0382_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 17-Sep-10 09:12, STARTGIS

SM0383



File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0383\SM0383_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 17-Sep-10 10:17, STARTGIS

SM0384



File: \\snm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0384\SM0384_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 17-Sep-10 12:40, STARTGIS

SM0385

NEW MEXICO

Legend

SM0385

Results

- 0 - 14574
- 14575 - 15575
- 15576 - 15999
- 16000 - 16665

N

0 25 50

SCALE IN FEET

TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847

SOURCE: ESRI World Imagery

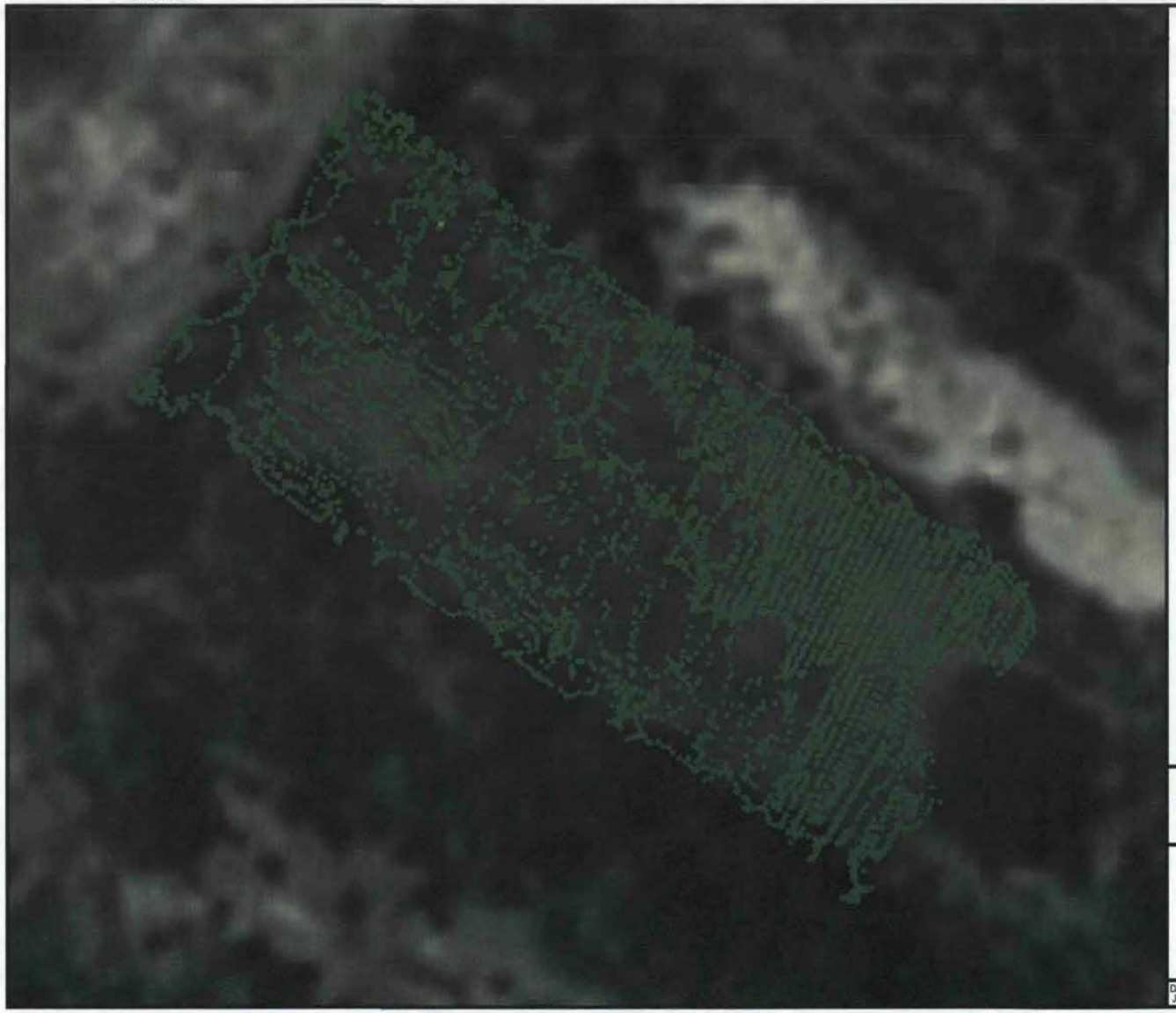
US EPA REGION 6
START- 3

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0385
ASSESSMENT DATE: 11/17/2010
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
JAN 2011	20406.012.005.0397.01	AS SHOWN

File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0385\SM0385_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 28-Jan-11 15:53, STARTGIS

SM0385B



Legend

SM0385B

Results

- 0 - 14574
- 14642

N

0 25 50

SCALE IN FEET

TDD NO: TO-0005-09-02-01
CERCLIS: NMN000606847

SOURCE: ESRI World Imagery

US EPA REGION 6
START- 3

FIGURE 1
PROPERTY ASSESSMENT MAP
SAN MATEO URANIUM ASSESSMENT
PROPERTY - SM0385B
ASSESSMENT DATE: 6/21/2011
SAN MATEO, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
JUN 2011	20406.012.005.0397.01	AS SHOWN

File: \\wnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0385B\SM0385B_FIGURE_1.mxd, 21-Jun-11 15:29, STARTGIS

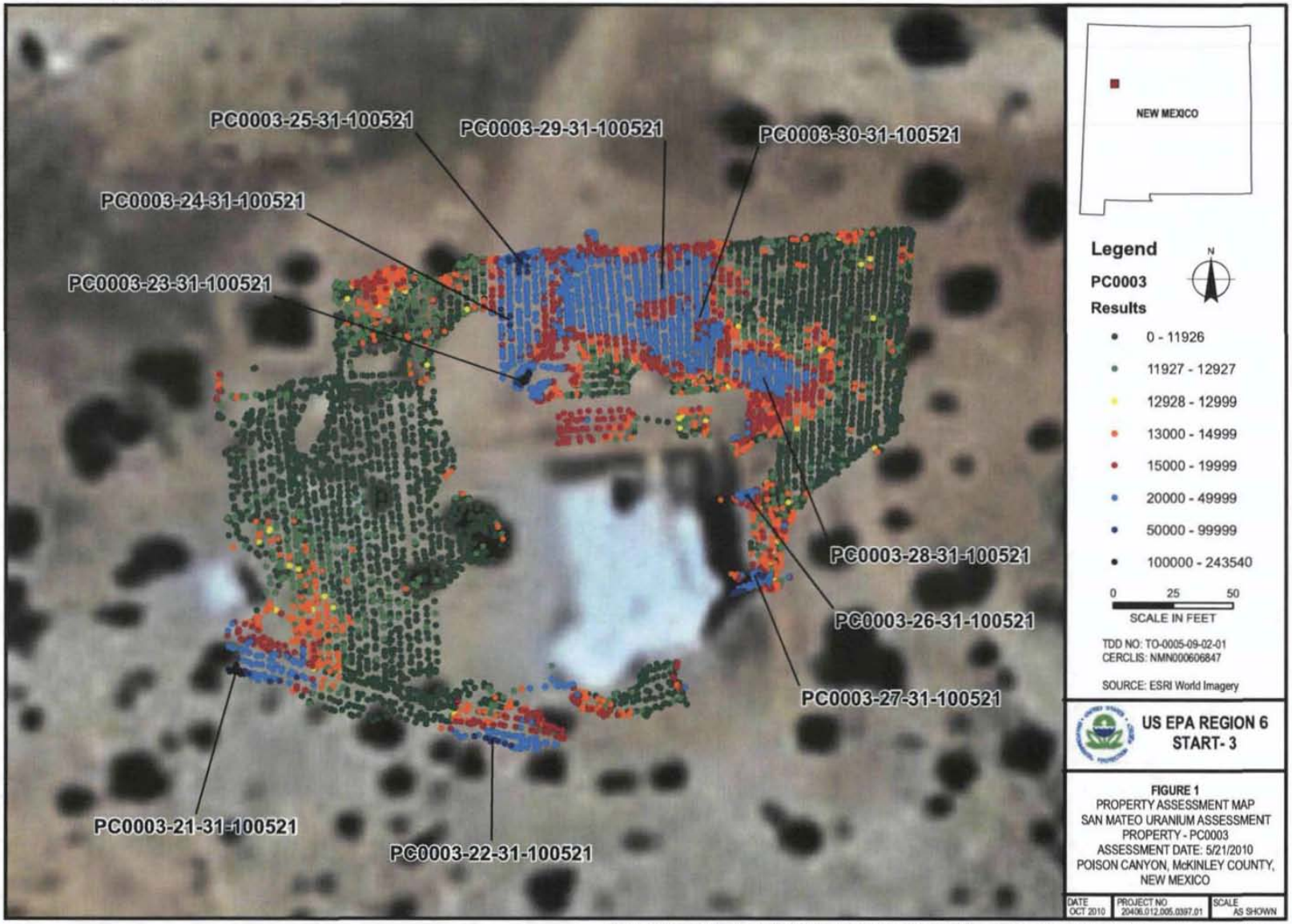
SM0940

File: \\lsnm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM0940\SM0940_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 17-Sep-10 14:20, STARTGIS

SM9001

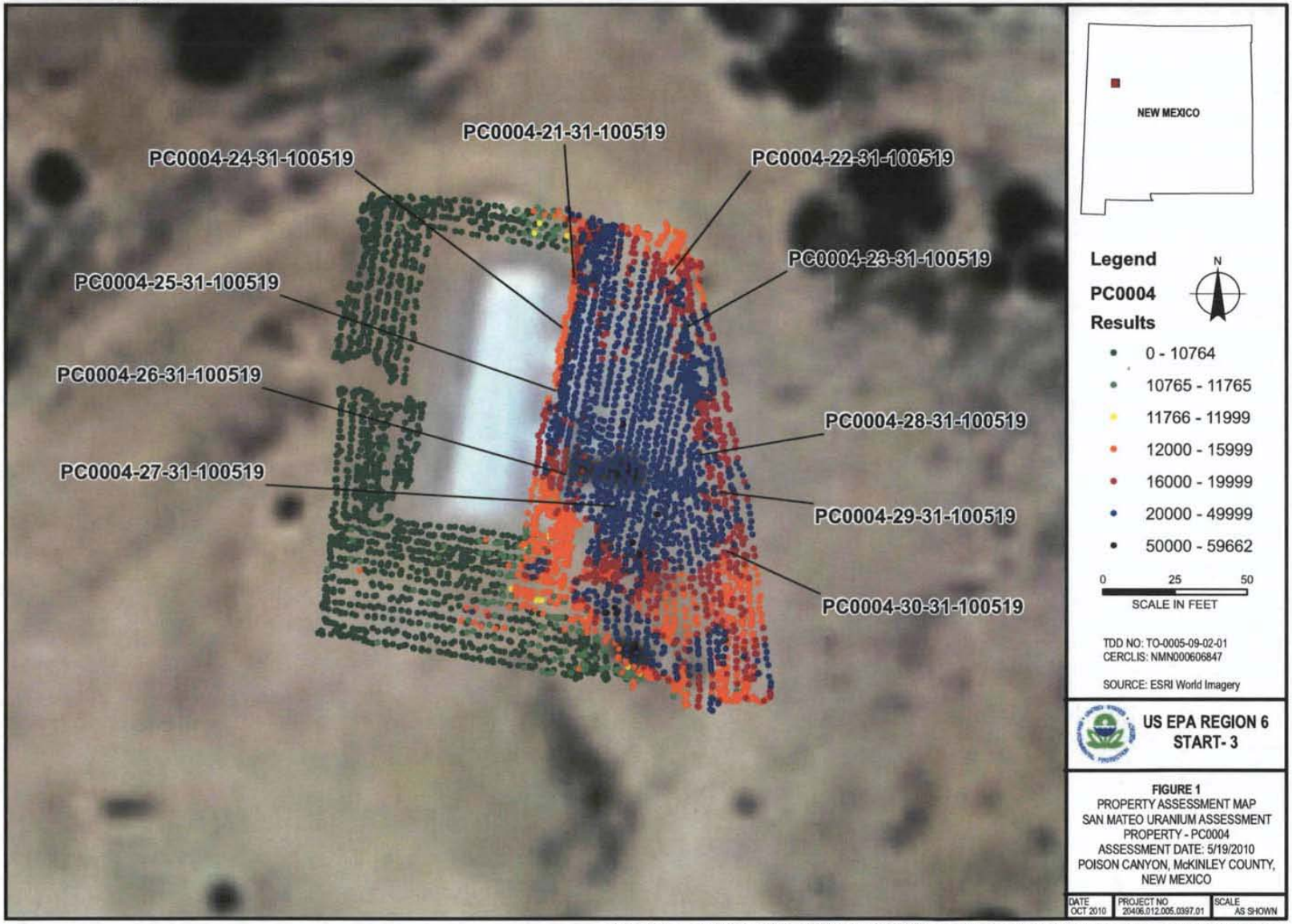
File: \\snm01\Operations\Field Data\TDD-SAN MATEO\SAN MATEO\SM9001\SM9001_FIGURE_1_PROPERTY_ASSESSMENT_MAP.mxd, 21-Jan-11 14:30, STARTGIS

PC0003



File: \\srvm01\Operations\Field Data\TDD-SAN MATEO\POISON CANYON\PC0003\PC0003_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS.mxd, 29-Oct-10 17:46, STARTGIS

PC0004



File: \\fsnm01\Operations\Field Data\TDD-SAN MATEO\POISON CANYON\PC0004\PC0004_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS.mxd, 30-Oct-10 08:54, STARTGIS

APPENDIX B

MARSSIM TEST 3
WILCOXON RANK SUM TEST

From MARSSIM Manual, Section 8.4.1

Two-Sample Statistical Test

The comparison of measurements from the reference area and survey unit is made using the Wilcoxon Rank Sum (WRS) test (also called the Mann-Whitney test). The WRS test should be conducted for each survey unit. In addition, the EMC is performed against each measurement to ensure that it does not exceed a specified investigation level. If any measurement in the remediated survey unit exceeds the specified investigation level, then additional investigation is recommended, at least locally, regardless of the outcome of the WRS test.

The WRS test is most effective when residual radioactivity is uniformly present throughout a survey unit. The test is designed to detect whether or not this activity exceeds the $DCGL_W$. The advantage of the nonparametric WRS test is that it does not assume that the data are normally or log-normally distributed. The WRS test also allows for "less than" measurements to be present in the reference area and the survey units. As a general rule, the WRS test can be used with up to 40 percent "less than" measurements in either the reference area or the survey unit. However, the use of "less than" values in data reporting is not recommended as discussed in Section 2.3.5. When possible, report the actual result of a measurement together with its uncertainty.

The hypothesis tested by the WRS test is

> Null Hypothesis H_0: The median concentration in the survey unit exceeds that in the reference area by more than the $DCGL_W$
>
> versus
>
> Alternative Hypothesis H_a: The median concentration in the survey unit exceeds that in the reference area by less than the $DCGL_W$

The null hypothesis is assumed to be true unless the statistical test indicates that it should be rejected in favor of the alternative. One assumes that any difference between the reference area and survey unit concentration distributions is due to a shift in the survey unit concentrations to higher values (*i.e.*, due to the presence of residual radioactivity in addition to background). Note that some or all of the survey unit measurements may be larger than some reference area measurements, while still meeting the release criterion. Indeed, some survey unit measurements may exceed some reference area measurements by more than the $DCGL_W$. The result of the hypothesis test determines whether or not the survey unit as a whole is deemed to meet the release criterion. The EMC is used to screen individual measurements.

Two assumptions underlying this test are: 1) samples from the reference area and survey unit are independent, identically distributed random samples, and 2) each measurement is independent of every other measurement, regardless of the set of samples from which it came.

8.4.2 Applying the Wilcoxon Rank Sum Test

The WRS test is applied as outlined in the following six steps....

1. Obtain the adjusted reference area measurements, Z_i, by adding the $DCGL_W$ to each reference area measurement, X_i. $Z_i = X_i + DCGL_W$
2. The m adjusted reference sample measurements, Z_i, from the reference area and the n sample measurements, Y_i, from the survey unit are pooled and ranked in order of increasing size from 1 to N, where $N = m+n$.
3. If several measurements are tied (*i.e.*, have the same value), they are all assigned the average rank of that group of tied measurements.
4. If there are t "less than" values, they are all given the average of the ranks from 1 to t. Therefore, they are all assigned the rank t(t+1)/(2t) = (t+1)/2, which is the average of the first t integers. If there is more than one detection limit, all observations below the largest detection limit should be treated as "less than" values.[3]
5. Sum the ranks of the adjusted measurements from the reference area, W_r. Note that since the sum of the first N integers is $N(N+1)/2$, one can equivalently sum the ranks of the measurements from the survey unit, W_s, and compute $W_r = N(N+1)/2 - W_s$.
6. Compare W_r with the critical value given in Table I.4 for the appropriate values of n, m, and α. If W_r is greater than the tabulated value, reject the hypothesis that the survey unit exceeds the release criterion.

[3] If more than 40 percent of the data from either the reference area or survey unit are "less than," the WRS test *cannot* be used. Such a large proportion of non-detects suggest that the DQO process be re-visited for this survey to determine if the survey unit was properly classified or the appropriate measurement method was used. As stated previously, the use of "less than" values in data reporting is not recommended. Wherever possible, the actual result of a measurement, together with its uncertainty, should be reported.

APPENDIX C

MICROSHIELD ANALYSIS

(Roentgen (R) to Roentgen-Equivalent-in-Man (rem) Conversion)

Print

MicroShield v6.02 (6.02-00039)
AQ_Safety,_Inc.

	:1
File	:U-238soilSlab.ms6
Date	: May 25, 2011
Time	: 11:26:33 AM
tion	: 00:00:00

File Ref	:
Date	:
By	:
Checked	:

Case Title: U+chainSlab
Description: U-238 + chain slab
Geometry: 16 - Infinite Slab

Source Dimensions:

Thickness	15.0 cm	(5.9 in)

Dose Points

A	X	Y	Z
# 1	115 cm	0 cm	0 cm
	3 ft 9.3 in	0.0 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	Infinite	ANS soil 2011	1.5
Air Gap		Air	0.00122

Source Input : Grouping Method - Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Included
Library : Grove

Nuclide	_Ci/cm_	Bq/cm_
Bi-210	1.4990e-006	5.5464e-002
Bi-214	1.4993e-006	5.5476e-002
Pa-234	2.3993e-009	8.8772e-005
Pa-234m	1.4995e-006	5.5483e-002
Pb-210	1.4990e-006	5.5464e-002
Pb-214	1.4993e-006	5.5476e-002
Po-210	1.4990e-006	5.5464e-002
Po-214	1.4990e-006	5.5464e-002
Po-218	1.4996e-006	5.5487e-002
Ra-226	1.4996e-006	5.5487e-002
Rn-222	1.4996e-006	5.5487e-002
Th-230	1.4996e-006	5.5487e-002
Th-234	1.4995e-006	5.5483e-002
U-234	1.4996e-006	5.5486e-002

U-238 1.4995e-006 5.5483e-002

Buildup : The material reference is - Source
Integration Parameters

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm_/sec No Buildup	Fluence Rate MeV/cm_/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	4.281e-02	2.034e-05	2.102e-05	1.745e-06	1.803e-06
0.04	1.087e-07	2.822e-09	4.722e-09	1.248e-11	2.088e-11
0.05	2.925e-03	1.432e-04	3.334e-04	3.815e-07	8.882e-07
0.06	2.379e-03	1.794e-04	4.971e-04	3.563e-07	9.873e-07
0.08	1.287e-02	1.689e-03	6.226e-03	2.672e-06	9.853e-06
0.1	3.503e-03	6.578e-04	2.943e-03	1.006e-06	4.503e-06
0.15	6.623e-05	2.220e-05	1.137e-04	3.655e-08	1.872e-07
0.2	5.995e-03	2.976e-03	1.474e-02	5.252e-06	2.602e-05
0.3	1.145e-02	9.877e-03	4.263e-02	1.874e-05	8.087e-05
0.4	2.123e-02	2.721e-02	1.057e-01	5.302e-05	2.059e-04
0.5	9.991e-04	1.746e-03	6.028e-03	3.427e-06	1.183e-05
0.6	2.678e-02	6.037e-02	1.901e-01	1.178e-04	3.710e-04
0.8	5.427e-03	1.834e-02	4.905e-02	3.488e-05	9.329e-05
1.0	1.796e-02	8.322e-02	1.987e-01	1.534e-04	3.662e-04
1.5	1.057e-02	8.715e-02	1.696e-01	1.466e-04	2.853e-04
2.0	1.485e-02	1.833e-01	3.162e-01	2.835e-04	4.889e-04
Totals	**1.798e-01**	**4.769e-01**	**1.103e+00**	**8.228e-04**	**1.948e-03**

MicroShield v6.02 (6.02-00039)
AQ_Safety,_Inc.
Conversion of calculated exposure in air to dose
FILE: C:\Program Files\MicroShield\Examples\casefiles\U-238soilSlab.ms6
Case Title: U+chainSlab
This case was run on Wednesday, May 25, 2011 at 11:26:33 AM
Dose Point # 1 - (115,0,0) cm

Results (Summed over energies)	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm2/sec	5.109e-001	1.464e+000
Photon Energy Fluence Rate	MeV/cm2/sec	4.769e-001	1.103e+000
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	8.228e-004	1.948e-003
Absorbed Dose Rate in Air	mGy/hr	7.183e-006	1.700e-005
"	mrad/hr	7.183e-004	1.700e-003
Deep Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	8.333e-006	2.001e-005
o Opposed	"	7.014e-006	1.647e-005
o Rotational	"	7.013e-006	1.646e-005
o Isotropic	"	6.274e-006	1.471e-005
Shallow Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	8.781e-006	2.105e-005
o Opposed	"	8.416e-006	2.008e-005
o Rotational	"	8.415e-006	2.008e-005
o Isotropic	"	6.621e-006	1.556e-005
Effective Dose Equivalent Rate	(ICRP 51 - 1987)		
o Anterior/Posterior Geometry	mSv/hr	7.442e-006	1.779e-005
o Posterior/Anterior	"	6.777e-006	1.601e-005
o Lateral	"	5.335e-006	1.237e-005
o Rotational	"	6.099e-006	1.436e-005
o Isotropic	"	5.363e-006	1.252e-005

Print

MicroShield v6.02 (6.02-00039)
AQ_Safety,_Inc.

	:1
File	:Ra-226SoilSlab.ms6
Date	: May 25, 2011
Time	: 11:20:52 AM
tion	: 00:00:00

File Ref	:
Date	:
By	:
Checked	:

Case Title: Ra-226SoilSlab
Description: Ra226 infinite soil 15 cm slab
Geometry: 16 - Infinite Slab

Source Dimensions:

Thickness	15.0 cm	(5.9 in)

Dose Points

A	X	Y	Z
# 1	115 cm	0 cm	0 cm
	3 ft 9.3 in	0.0 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	Infinite	ANS soil 2011	1.5
Air Gap		Air	0.00122

Source Input : Grouping Method - Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Included
Library : Grove

Nuclide	_Ci/cm_	Bq/cm_
Bi-210	1.5206e-006	5.6261e-002
Bi-214	1.4997e-006	5.5489e-002
Pb-210	1.5205e-006	5.6260e-002
Pb-214	1.4997e-006	5.5489e-002
Po-210	1.5209e-006	5.6274e-002
Po-214	1.4994e-006	5.5478e-002
Po-218	1.5000e-006	5.5500e-002
Ra-226	1.5000e-006	5.5500e-002
Rn-222	1.5000e-006	5.5500e-002

Buildup : The material reference is - Source
Integration Parameters

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm_/sec No Buildup	Fluence Rate MeV/cm_/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	2.191e-02	1.041e-05	1.076e-05	8.931e-07	9.230e-07
0.05	2.892e-03	1.416e-04	3.297e-04	3.772e-07	8.782e-07
0.08	1.279e-02	1.679e-03	6.190e-03	2.657e-06	9.795e-06
0.1	7.532e-05	1.414e-05	6.328e-05	2.164e-08	9.682e-08
0.2	5.977e-03	2.967e-03	1.470e-02	5.237e-06	2.594e-05
0.3	1.145e-02	9.874e-03	4.262e-02	1.873e-05	8.084e-05
0.4	2.123e-02	2.721e-02	1.057e-01	5.302e-05	2.059e-04
0.5	9.912e-04	1.732e-03	5.981e-03	3.400e-06	1.174e-05
0.6	2.675e-02	6.031e-02	1.899e-01	1.177e-04	3.706e-04
0.8	5.244e-03	1.772e-02	4.740e-02	3.370e-05	9.015e-05
1.0	1.737e-02	8.051e-02	1.922e-01	1.484e-04	3.543e-04
1.5	1.056e-02	8.707e-02	1.694e-01	1.465e-04	2.851e-04
2.0	1.485e-02	1.833e-01	3.162e-01	2.835e-04	4.890e-04
Totals	**1.521e-01**	**4.726e-01**	**1.091e+00**	**8.141e-04**	**1.925e-03**

MicroShield v6.02 (6.02-00039)
AQ_Safety,_Inc.
Conversion of calculated exposure in air to dose
FILE: Case1
Case Title: Ra-226SoilSlab
This case was run on Wednesday, May 25, 2011 at 11:20:52 AM
Dose Point # 1 - (115,0,0) cm

Results (Summed over energies)	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm2/sec	4.968e-001	1.416e+000
Photon Energy Fluence Rate	MeV/cm2/sec	4.726e-001	1.091e+000
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	8.141e-004	1.925e-003
Absorbed Dose Rate in Air	mGy/hr	7.107e-006	1.681e-005
"	mrad/hr	7.107e-004	1.681e-003
Deep Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	8.246e-006	1.976e-005
o Opposed	"	6.948e-006	1.629e-005
o Rotational	"	6.947e-006	1.628e-005
o Isotropic	"	6.215e-006	1.454e-005
Shallow Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	8.684e-006	2.079e-005
o Opposed	"	8.330e-006	1.985e-005
o Rotational	"	8.330e-006	1.985e-005
o Isotropic	"	6.555e-006	1.539e-005
Effective Dose Equivalent Rate	(ICRP 51 - 1987)		
o Anterior/Posterior Geometry	mSv/hr	7.367e-006	1.758e-005
o Posterior/Anterior	"	6.711e-006	1.583e-005
o Lateral	"	5.286e-006	1.224e-005
o Rotational	"	6.041e-006	1.420e-005
o Isotropic	"	5.313e-006	1.238e-005

Print

MicroShield v6.02 (6.02-00039)
AQ_Safety,_Inc.

	:1
File	:Ra-226SoilConcrete.ms6
Date	: May 25, 2011
Time	: 2:40:34 PM
tion	: 00:00:00

File Ref	:
Date	:
By	:
Checked	:

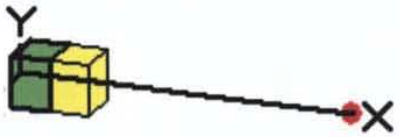
Case Title: Ra-226+found
Description: Ra-226 chain plus 15 cm foundation
Geometry: 16 - Infinite Slab

Source Dimensions:

Thickness	15.0 cm	(5.9 in)

Dose Points

A	X	Y	Z
# 1	130 cm	0 cm	0 cm
	4 ft 3.2 in	0.0 in	0.0 in



Shields

Shield N	Dimension	Material	Density
Source	Infinite	ANS soil 2011	1.5
Shield 1	15.0 cm	Concrete	2.1
Air Gap		Air	0.00122

Source Input : Grouping Method - Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Included
Library : Grove

Nuclide	_Ci/cm_	Bq/cm_
Bi-210	1.5206e-006	5.6261e-002
Bi-214	1.4997e-006	5.5489e-002
Pb-210	1.5205e-006	5.6260e-002
Pb-214	1.4997e-006	5.5489e-002
Po-210	1.5209e-006	5.6274e-002
Po-214	1.4994e-006	5.5478e-002
Po-218	1.5000e-006	5.5500e-002
Ra-226	1.5000e-006	5.5500e-002
Rn-222	1.5000e-006	5.5500e-002

Buildup : The material reference is - Shield 1
Integration Parameters

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm_/sec No Buildup	Fluence Rate MeV/cm_/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	2.191e-02	0.000e+00	0.000e+00	0.000e+00	0.000e+00
0.05	2.892e-03	1.168e-10	6.039e-10	3.112e-13	1.609e-12
0.08	1.279e-02	4.030e-07	5.306e-06	6.377e-10	8.396e-09
0.1	7.532e-05	9.805e-09	1.760e-07	1.500e-11	2.693e-10
0.2	5.977e-03	1.053e-05	2.366e-04	1.859e-08	4.177e-07
0.3	1.145e-02	6.703e-05	1.252e-03	1.272e-07	2.375e-06
0.4	2.123e-02	2.825e-04	4.237e-03	5.505e-07	8.256e-06
0.5	9.912e-04	2.464e-05	3.058e-04	4.836e-08	6.002e-07
0.6	2.675e-02	1.099e-03	1.153e-02	2.144e-06	2.251e-05
0.8	5.244e-03	4.689e-04	3.685e-03	8.919e-07	7.008e-06
1.0	1.737e-02	2.804e-03	1.775e-02	5.170e-06	3.272e-05
1.5	1.056e-02	4.801e-03	2.050e-02	8.078e-06	3.450e-05
2.0	1.485e-02	1.342e-02	4.597e-02	2.075e-05	7.108e-05
Totals	**1.521e-01**	**2.298e-02**	**1.055e-01**	**3.778e-05**	**1.795e-04**

MicroShield v6.02 (6.02-00039)
AQ_Safety,_Inc.
Conversion of calculated exposure in air to dose
FILE: C:\Program Files\MicroShield\Examples\casefiles\Ra-226SoilConcrete.ms6
Case Title: Ra-226+found
This case was run on Wednesday, May 25, 2011 at 2:40:34 PM
Dose Point # 1 - (130,0,0) cm

Results (Summed over energies)	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm2/sec	1.617e-002	9.486e-002
Photon Energy Fluence Rate	MeV/cm2/sec	2.298e-002	1.055e-001
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	3.778e-005	1.795e-004
Absorbed Dose Rate in Air	mGy/hr	3.299e-007	1.567e-006
"	mrad/hr	3.299e-005	1.567e-004
Deep Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	3.761e-007	1.805e-006
o Opposed	"	3.278e-007	1.540e-006
o Rotational	"	3.278e-007	1.540e-006
o Isotropic	"	2.943e-007	1.378e-006
Shallow Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	3.955e-007	1.901e-006
o Opposed	"	3.826e-007	1.831e-006
o Rotational	"	3.826e-007	1.831e-006
o Isotropic	"	3.083e-007	1.451e-006
Effective Dose Equivalent Rate	(ICRP 51 - 1987)		
o Anterior/Posterior Geometry	mSv/hr	3.383e-007	1.617e-006
o Posterior/Anterior	"	3.138e-007	1.482e-006
o Lateral	"	2.547e-007	1.179e-006
o Rotational	"	2.840e-007	1.337e-006
o Isotropic	"	2.533e-007	1.181e-006

Date: 5-25-2011

To: Nels Johnson

From: Rick Haaker

Subject Microsohield Calculations of Exposure rate and dose equivalent rate

---

On May 10 , 2009 I provided a technical memo entitled *Response Estimates for a 2"x2" NaI Detector to Ra-226 That is Distributed in Soil*. The last paragraph of that memo was a discussion of conversion factors between soil concentration, exposure rate, and effective dose equivalent rate for the U-238 decay chain. This memo elaborates on that final paragraph. In determining the conversion factors, the geometry assumed was an infinite slab of soil having a thickness of 15 cm and a density of 1.5. A simplified soil composition derived from ANSI/ANS 6.6.1-19971 was used in the Microshield® 6.02 modeling2, see Table 1.

Table 1 Simplified Soil Composition from ANSI/ANS 6.6.1.

Element	Weight Percent
Hydrogen	0.954
Oxygen	54.4
Aluminum	12.9
Silicon	31.8

Three cases were considered for the Microshield calculations:

- an infinite slab of soil 15 cm thick containing U-238 plus progeny through Po-210 in decay equilibrium, and
- an infinite slab of soil 15 cm thick containing Ra-226 plus progeny through Po-210 in decay equilibrium.
- an infinite slab of soil 15 cm thick containing Ra-226 plus progeny through Po-210 in decay equilibrium covered by a 15-cm thick concrete foundation.
-

A circular slab of uniformly contaminated soil that is 20 meters in diameter is approximately "infinite" with respect to the Microshield calculations. Microshield also will also model other, non-infinite geometries.

Each time a Microshield calculation was performed, the corresponding "Conversion of Calculated Exposure in Air to Dose" report was generated via the Microshield software package.

Results for a U-238 at 1 pCi/g Plus Progeny

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1 ANSI/ANS-6.6.1-1987, Calculation and Measurement of Direct and Scattered Gamma Radiation from LWR Nuclear Power Plants. American Nuclear Society, La Grange Park, Il, 1987.

2 Microshield 6.02, Grove Engineering, Framatone ANP, Rockville, MD, 2003.

Table 2 provides results for the U-238 decay chain

Table 2. Results for 1 pCi/g U-238 with decay chain in equilibrium

Exposure rate	1.948 μR/h
EDE rate in isotropic field	1.252 μREM/hr
Ratio	1.56 μR/μREM

Results for a Ra-226 at 1 pCi/g Plus Progeny

Table 3 provides results for the Ra-226 decay chain

Table 3. Results for 1 pCi/g Ra-226 with decay chain in equilibrium

Exposure rate	1.925 μR/h
EDE rate in isotropic field	1.238 μREM/hr
Ratio	1.55 μR/μREM

Results for a Ra-226 at 1 pCi/g Plus Progeny and 15 cm Foundation

Table 4 provides results for the Ra-226 decay chain assuming a 15 cm thick concrete foundation covers the entire site.

Table 4. Results for 1 pCi/g Ra-226 with decay chain in equilibrium plus concrete foundation.

Exposure rate	0.1795 μR/h
EDE rate in isotropic field	0.1181 μREM/hr
Ratio	1.52 μR/μREM

Use of estimates indoors

A house is a complicated object, it is constructed of materials that serve to shield the occupant to some degree from the terrestrial gamma radiation field. The degree of shielding that a structure provides an occupant will depend on the materials of construction, their thickness and radiation attenuating properties and other factors.

The RESRAD software package3 accounts for external radiation attenuation by a structure via an external radiation transmission factor, and the RESRAD default value of 0.7 was used for all RESRAD calculations we have performed; this is probably a reasonable value for frame houses. Another source, NCRP Report 94 suggests an external gamma transmission factor of 0.8.4

As a limiting case, a Microshield calculation was performed assuming a 15-cm thick concrete foundation covers the infinite slab of contaminated soil. The μR/μREM ratio decreased insignificantly to 1.52 μR/μREM; see Table 4. Thus it is concluded that any attenuation of external gamma radiation, which is caused by the structure will affect EDE and exposure to a similar degree.

In addition, the materials of construction will contain Ra-226, Ra-228, and K-40, and these will contribute to the external dose of an occupant to some degree. NCRP Report 94 reports that in Europe where masonry houses are prevalent, the structural materials increase indoor gamma radiation exposures by about 20% relative to terrestrial background.

Limitations of estimates

These estimates utilize Microshield 6.02, and so they inherit all of its limitations. Microshield quickly does simple radiation attenuation and build-up calculations, which otherwise would be tedious to do in a spreadsheet. It does not account for:

- surface roughness,
- bremstrahlung arising from beta emitters,
- more than one radiation source at a time,
- complicated radiation behaviors like backscatter or skyshine, or
- dose buildup in more than one model element at a time.

Equilibrium in the decay chain has been assumed, comparison of table 2 and table 3 shows that the amount of U-238 through U-234 in the chain is unimportant. Some radon (Rn-222) is usually lost from near surface soil and this may cause both the external EDE rate and exposure rates to be lower per pCi/g of Ra-226 than have been estimated.

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3 C. Yu et al. ,User's Manual for RESRAD Version 6, ANL/EAD-4, Argonne National Laboratory, Argonne, IL, 2001.

4 Exposure of the Population of the United States and Canada from Natural Background Radiation, NCRP Report 94, National Council on Radiation Protection and Measurements. Bethesda, MD, 1992.

APPENDIX D

GRAPHIC, SPATIAL REPRESENTATION OF PHASE 1 AND PHASE 2 RESULTS


SM0053
SM0050
SM0047
SM0042
SM0044
SM0043
SM0042
SM0092
SM0004
SM0363
SM0005
SM0124
SM0006
SM0007
SM0040
SM0039
SM0009
SM0008
SM0052
SM0035
SM0034
SM0030
SM0027
SM0026
SM0023
SM0022
SM0170
SM0364B
SM0385
SM0103
SM0017
SM0014
SM0013
SM0012
SM0019
San Mateo Property Status Map
Legend
Properties Failed Phase I
Properties Failed Phase I & II
Properties Failed Phase I, refused Phase II
Properties Passed Phase I
Properties Failed Long-Term Radon
N


PC0004
PC0003
Poison Canyon Property Status Map
Legend
Properties Failed Phase I
Properties Failed Phase I, refused Phase II
N