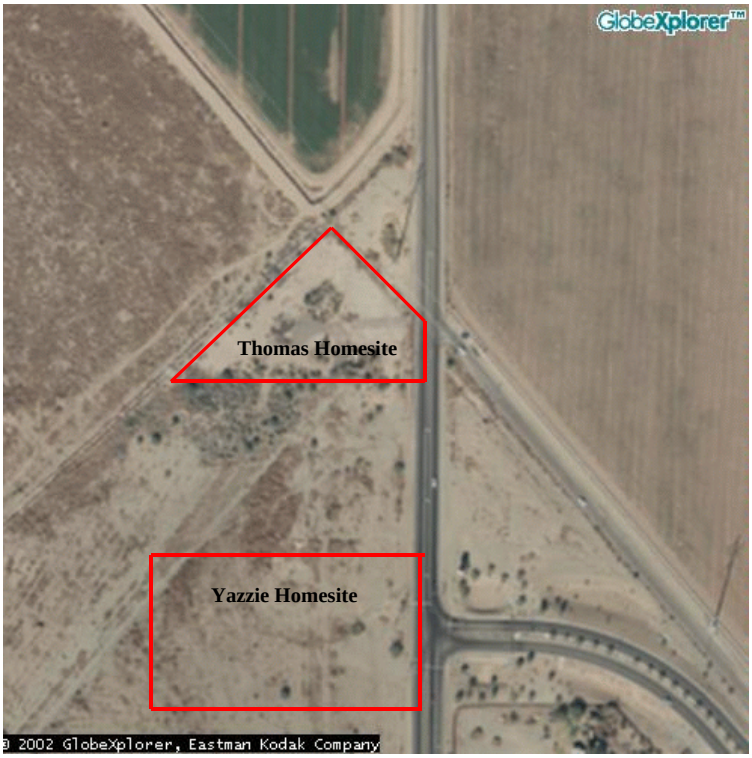
SUPERFUND TECHNICAL ASSESSMENT AND RESPONSE TEAM



Gila River Toxaphene Boundary Site Removal Final Report

Gila River Indian Community
Pinal County, Arizona

July 2005

Prepared For:

U.S. Environmental Protection Agency

Contract No: 68-W-01-012
TDD: 09-04-12-0014

Prepared By:

ecology and environment, inc.

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1 INTRODUCTION

The Gila River Indian Community (GRIC) Department of Environmental Quality (DEQ) requested assistance from the U.S. Environmental Protection Agency (EPA) Region 9 Emergency Response Section (ERS) with the assessment, removal and remediation of toxaphene-contaminated soil at the Gila River Toxaphene Boundary Site (Boundary Site). The ERS, under the authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and the Superfund Amendment and Reauthorization Act of 1986 (SARA), directed the Ecology and Environment, Inc. (E & E) Superfund Technical Assessment and Response Team (START) to conduct a removal assessment at the Boundary Site, located on the Gila River Indian Reservation in Arizona. The assessment, conducted under Technical Directive Documents (TDD) 09-02-05-0007 and 09-02-12-0019, determined the magnitude and extent of toxaphene contamination at the site and provided preliminary calculations of volumes of soil requiring removal or treatment. The results of the removal assessment are presented in the *Gila River Toxaphene Boundary Site - Removal Assessment Report,* February 2003.

Based on the removal assessment findings, the ERS directed that removal activities be conducted at the site. The START, EPA's Emergency Response Team (ERT) of Edison, New Jersey, and the Emergency Rapid Response Services (ERRS) contractor participated in the removal effort. The EPA tasked the START to provide technical assistance and oversight during a bioremediation pilot test and two bench scale studies, conducted from April 2003 to March 2004 under TDDs 09-02-12-0019 and 09-03-12-0021, and bioremediation removal activities, conducted from April 2004 to February 2005 under TDDs 09-04-02-0009 and 09-04-12-0014. This report describes field activities conducted by the START for the EPA, and the results of those activities.

2 SITE BACKGROUND

2.1 Site Location

The Boundary Site is located on the boundary of the GRIC along the west side of 51st Avenue near the intersection of 51st and Komatke Lane (Figure 2-1, Site Location Map). The site is approximately 2 ½ miles northeast of the Gila River and approximately ½ mile west of Phoenix South Mountain Park in Section 20, Township 1 South, Range 2 East of the Gila and Salt River Baseline and Meridian. The geographic coordinates of the site are 33E 19' 30" north latitude and 112E10' 06" west longitude.

2.2 Site Description

The Boundary Site assessment studied an approximately 13 acre area, that includes parts of Allotment Parcels 4569B, 4776B and 4776A, immediately west of 51st Avenue at the northern edge of the GRIC boundary, (Figure 2-2, Site Map). The assessment area encompassed two residential parcels, the Yazzie Homesite and the Thomas Homesite, and the area directly across the GRIC boundary northeast of and adjacent to the Thomas Homesite. An airstrip that extends southwest from the site terminates between the Yazzie and Thomas Homesites, and a shallow concrete drainage channel runs roughly parallel with the airstrip along the northwestern side of the site.

The Thomas Homesite is currently vacant with the exception of the ruins of a building in the central portion of the site and debris along the southern edge of the site. A soil cap on the Thomas Homesite, installed after an EPA removal in 1985, has experienced significant disturbance - an approximately 3,280 square feet (ft^2) portion of the cap was removed near a building pad, a 9 ft^2 pit exists adjacent to the building ruins, and various post holes and erosion riles are present in the cap. The Yazzie Homesite is vacant, although pipes, evidence of a septic system and former utility service, were observed by the START.

2.3 Site History

The site was used by crop dusters as a base of operations from 1959 until the early 1980s. Crop dusters used the airstrip that terminates between the Yazzie and Thomas Homesites and planes reportedly “blew-out” residual pesticides at the end of the airstrip. Aerial photographs documented what appeared to be a turnaround area for planes on the Thomas Homesite and

parking of planes on the Homesite's northern edge as well as adjacent to the northwest corner of the Yazzie Homesite. Additionally, work areas, buildings and storage areas for the crop dusters were located on a parcel northeast of the Thomas Homesite. An above ground storage tank, presumably for fuel, was documented in a 1972 aerial photograph but is no longer present.

2.4 Previous Investigations

In 1984, the EPA ERS conducted a CERCLA emergency removal action, excavating soil on the Thomas Homesite with toxaphene concentrations greater than 1,000 milligrams per kilogram (mg/kg). Soil that remained in place was treated *in-situ*, initially by adjusting the pH, and watering and turning the soil to enhance natural attenuation. Later, active bioremediation using soil amendments was conducted. The site was leveled, soil was neutralized and nutrients were added to it, a drip irrigation system was installed, and the site was covered with plastic sheeting to enhance anaerobic biodegradation processes. After this treatment, estimated to have reduced toxaphene levels by 45 percent, the site was capped with 200 cubic yards (yd^3) of soil. No plan for maintenance of the cap was instituted.

In 1996, URS Greiner, Inc. (URS), a contractor for the EPA States, Tribes and Site Assessment Office, conducted a CERCLA Site Inspection of the Boundary Site. Five soil samples were collected from the soil cap on the Thomas Homesite; toxaphene concentrations ranged from not-detected to 17 mg/kg. URS collected samples from 52 locations on the Yazzie Homesite and along the northeastern end of the airstrip. In the absence of complete information, these samples are all assumed to be surface soil samples. Results documented toxaphene levels ranging from 0.7 to 830 mg/kg. Toxaphene concentrations in 13 samples from this investigation exceeded the Arizona non-residential soil remediation level (NR-SRL) of 17 mg/kg; these samples and two additional samples exceeded the residential-SRL (R-SRL) of 4 mg/kg. In addition, 4,4'-dichlorodiphenyldichloroethane (DDD) was identified in one sample at 12 mg/kg, 4,4'-dichlorodiphenyldichloroethylene (DDE) was detected in 19 samples at concentrations ranging from 0.02 to 7.2 mg/kg, chlordane was detected in 19 samples at concentrations ranging from 0.027 to 12 mg/kg, endosulfan sulfate was detected in one sample at 0.045 mg/kg, and endrin aldehyde was detected in two samples at 0.079 and 0.14 mg/kg. Chlordane was documented in five samples at concentrations that exceeded the R-SRL; no other compounds exceeded any SRLs.

In January and February 2002, GRIC DEQ conducted additional sampling that, in general, confirmed the 1996 data. The thirteen Yazzie Homesite samples were collected from 0.5 to 1 foot below ground surface (bgs); samples from the cap at the Thomas Homesite samples were collected at either 0.5 to 1 foot bgs or 2 to 2.5 feet bgs. At one location on the Thomas Homesite, samples were collected at 0.5 to1 foot bgs, 2 to 2.5 feet bgs and 5 to 5.5 feet bgs; toxaphene was documented at 18, 130 and <0.2 mg/kg, respectively, in these intervals.

The START conducted a removal assessment from October 21 through October 25, 2002, to determine the magnitude and extent of toxaphene contamination at the site and the volume of soil requiring removal or treatment. A grid with 65 by 65-foot sections was established over the study area, encompassing approximately 14 acres. Soil cores were collected with a Geoprobe™ direct-push soil probe rig. Samples were collected from 131 boring locations at seven depth intervals: 0 to 0.5 feet bgs, 0.5 to 1 foot bgs, 1.5 to 2 feet bgs, 2.5 to 3 feet bgs, 3.5 to 4 feet bgs, 4.5 to 5 feet bgs, and 5.5 to 6 feet bgs. Samples were analyzed using RaPID Assay® cyclodienes immunoassay (IA) test kits through October 31, 2002 and selected samples were sent to the laboratory for confirmation analysis.

Toxaphene concentrations exceeding the Arizona NR-SRL of 17 mg/kg were documented over the majority of the investigation area in surficial soils (0 to 0.5 feet bgs) and at the 0.5 to 1 foot bgs interval with maximum concentrations of 295 and 220 mg/kg, respectively. Toxaphene concentrations in the 1.5 to 2 foot bgs interval samples exceeded action levels primarily in the northeast quadrant of the site with a few points that exceeded action levels in the southwest quadrant. The maximum toxaphene concentration found in this interval was 99 mg/kg. By the 3.5 to 4 foot bgs interval, the only areas of contamination exceeding action levels were documented along the eastern side of the investigation area, with a maximum concentration of 49 mg/kg. The areas of elevated toxaphene contamination to depth corresponded with the location of the crop dusting facility and are consistent with reports that planes "blew-out" residual pesticides in the area at the end of the airstrip.

Toxaphene was documented at concentrations ranging from 0.14 to 4.4 mg/kg in the three background samples collected southwest of the site. These results are consistent with reports from the GRIC DEQ that toxaphene concentrations in areas surrounding the site range from 2 to 5 mg/kg.

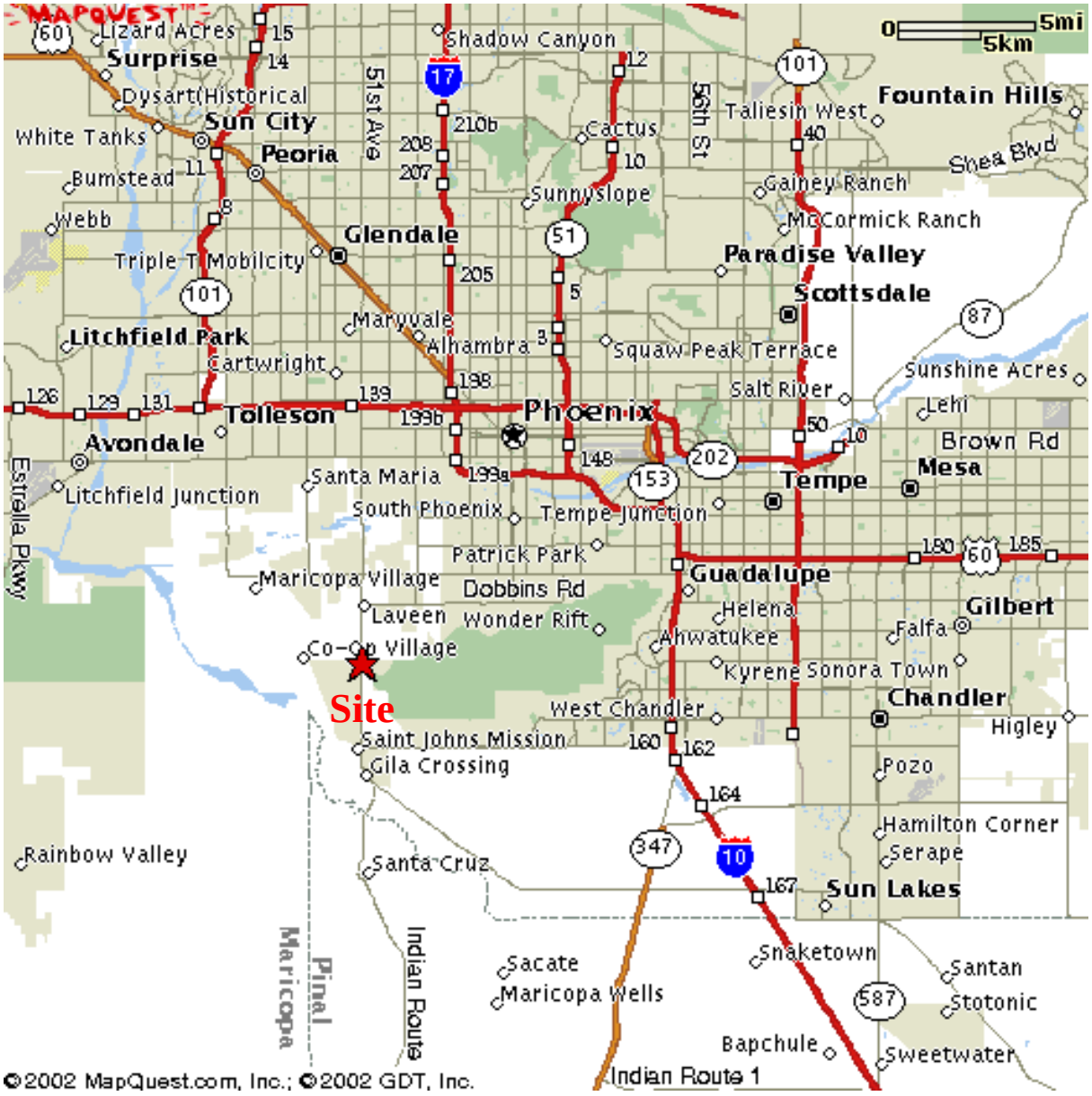
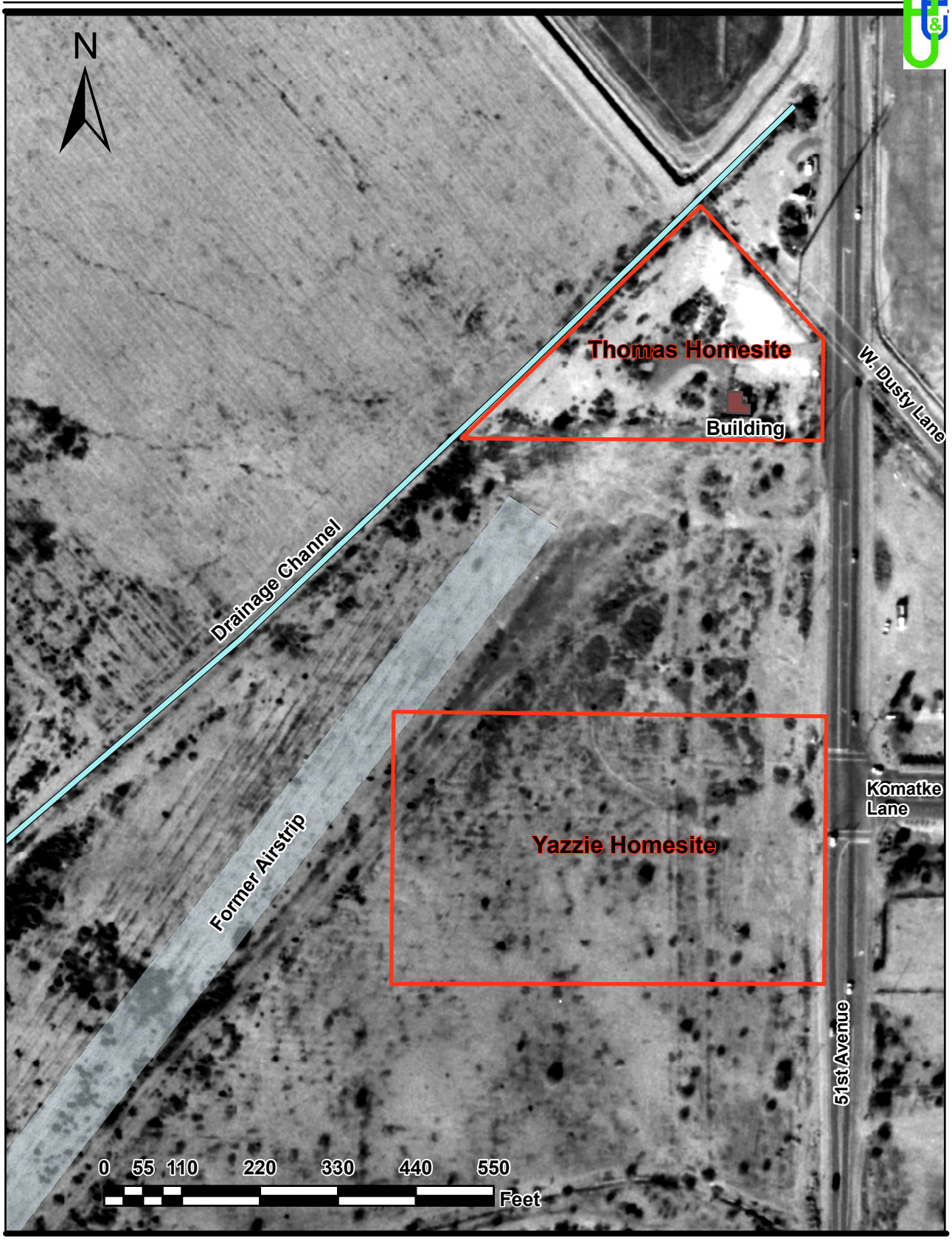


Figure 2-1 Site Location Map
Gila River Toxaphene Boundary Site Removal
Gila River Indian Community, Pinal County, Arizona



Ecology and Environment, Inc.
June 2005

TDD No.: 09-04-12-0014
Project No.: 0518.01RZ

Figure 2-2

Site Map

Gila River Toxaphene Boundary Site Removal

Gila River Indian Community, Pinal County, Arizona

3 PILOT TEST AND BENCH SCALE STUDIES

Based on the results of the removal assessment, the START estimated that 31,000 to 62,000 yd^3 of toxaphene-contaminated soil could require removal and/or treatment, depending on the action level selected. Given this volume of soil and known treatment methods, *ex situ* bioremediation of the contaminated soil in treatment cells was potentially cost-prohibitive. Pilot and bench scale testing was conducted between May 2003 and March 2004 to determine the effectiveness of several *in-situ* bioremediation methods intended to accelerate remediation time frames while reducing treatment costs. The amendments required to stimulate and nourish the anaerobes in this type of bioremediation treatment constitute a significant expense; therefore several different amendment combinations were studied to determine optimum proportions for timely and cost-effective treatment.

The pilot test and two bench scale studies were conducted under the supervision of Federal On-Scene Coordinators (OSC) Donn Zuroski and Harry Allen IV. Harry Allen III of EPA ERT; Ferrell Miller of Lockheed Martin, the EPA's Response Engineering and Analytical Contract (REAC); and START provided technical support for the pilot test and bench scale studies. Samples were collected in accordance with the *Data Quality Objectives Process Document for Soil Sampling, Gila River Toxaphene Boundary Site Bioremediation Pilot Test*, May 2003, and the *Emergency Response Quality Assurance Sampling Plan for Soil and Water Sampling*, May 2003 (Appendix A.) Toxaphene sample analysis and data validation were conducted by REAC laboratory personnel. The data presented in this report was made available to START by EPA ERT, and raw data is housed with the REAC contractor. The START was unable to verify data quality. Photographic documentation of test activities is included in Appendix B.

3.1 Pilot Test

The pilot test was conducted between May 2003 and January 2004. Three test plots measuring 4.5 feet long by 4.5 feet wide by 1 foot deep were constructed in May 2003. Plot A was unlined and the amendments were mixed *in situ* into the toxaphene contaminated soil in the cell. Plot B was lined with visqueen; amendments and toxaphene contaminated soil were mixed *ex situ* and then placed in the cell. Plot C was unlined, and amendments and toxaphene contaminated soil were mixed *ex situ* and the mixture was placed in the plot. In all plots, the amendment mixture consisted of 1 percent bloodmeal and 1 percent phosphate, with equal parts of monosodium and

disodium phosphate for pH control. The START conducted four sampling events on May 1, May 28, June 26 and August 7, 2003, to monitor toxaphene concentrations in the pilot test plots. With the exception of the May 28 sampling event, the plots were flooded with water following sample collection. The plots were covered with visqueen between sampling events.

The results of the sampling are presented in Table 3-1 and show little evidence of toxaphene degradation. Toxaphene removal rates ranged from 12 to 42 percent in Plot A and from 0 to 18 percent in Plots B and C. Soils must be saturated with water to allow the required anaerobic conditions to develop and the soil in the pilot test plots may have been too dry to promote toxaphene degradation.

Based on these results, the pilot test was modified in October 2003 to attempt to improve toxaphene degradation rates. Approximately 20 pounds of blood meal and 10 pounds each of mono- and di-basic phosphate were added to Plot A, as well as soil (innoculum) obtained from the Gila River Indian Community Toxaphene Site (Gila 1 Site) (TDDs 09-00-12-0033 and 09-02-01-0011.) Previous bioremediation of toxaphene at the Gila 1 Site was successful and anaerobes with the potential to degrade toxaphene are known to exist in site soils. Importing anaerobes from the Gila 1 Site could supplement existing microbial populations at the Boundary Site or help to establish a new community of anaerobes. A simple irrigation system consisting of a soaker hose connected to a 500 gallon tank was set up on the surface of Plot A and a berm was constructed around the perimeter of the plot to contain water. Plot A was then sampled, flooded, covered, and sealed.

No changes were made to Plot B; it was sampled, flooded, covered, and sealed as in previous sampling events. Plot C exhibited very little evidence of microbial activity and was abandoned. Additional bloodmeal and phosphate were added to the contents of Plot C and this mixture was placed in two plastic bags to create the contents of Plot D. One bag (bag D1) contained approximately 50 pounds of soil from Plot C and additional bloodmeal and phosphate. The other bag (bag D2) contained approximately 37.5 pounds of soil from Plot C, additional bloodmeal and phosphate, and approximately 12.5 pounds of soil of innoculum from the Gila 1 Site. The bags were double-bagged, sampled, filled with water, sealed, and placed in the visqueen-lined Plot D. Plot D was then filled with water, covered with visqueen, and sealed.

The START conducted three sampling events of the modified pilot test plots on October 2 and November 12, 2003, and January 21 and 22, 2004. Samples were collected from Plot D in accordance with the *Emergency Response Quality Assurance Sampling Plan for Soil and Water Sampling*, May 2003, with the following exception:

- Two grab samples were collected from different locations in each bag, rather than the collection of five samples from each plot.

Sample results of the October 2003 through January 2004 modified pilot test plot sampling are presented in Table 3-1. Plots A and B yielded similar results as compared to previous sampling events, with an average toxaphene degradation of 33 percent and 5 percent, respectively, through January 21-22, 2004. Samples collected from Plot D on January 21, 2004 reported an average toxaphene degradation of 49 percent.

3.2 Bench Scale Studies

Two bench scale studies were conducted by EPA ERT and REAC to determine optimal nutrient combinations for cost-effective bioremediation. On October 2, 2003, five jars (Recipe 1 through 5, see Table 3-2) containing soil, water, and different combinations of bloodmeal, phosphate, and starch were sealed and buried at the site. These jars were uncovered by the START on November 12, 2003, and shipped to the REAC laboratory for toxaphene analysis. The results of this bench scale study are presented in Table 3-2. This study found that bloodmeal accelerated degradation of toxaphene, and that the addition of starch further enhanced degradation activity. Moisture and tight encapsulation enabled the reaction. The addition of starch appears to establish anaerobic conditions quickly and inexpensively, requiring the use of less bloodmeal.

A second bench scale reactor study was conducted by EPA ERT and REAC between January 22 and March 10, 2004. Six five-gallon buckets (Reactor 1 through 6) were filled with soil from plots B and C, water, and different nutrient combinations (bloodmeal, phosphate, and starch, see Table 3-3.) The START conducted two sampling events on January 22, 2004 and March 10, 2004 at the request of OSC Allen. Samples were collected in accordance with the *Emergency Response Quality Assurance Sampling Plan for Soil and Water Sampling*, May 2003, with the following exceptions:

- On January 22, 2004, two grab samples per bucket were collected using a dedicated plastic sampling scoop, rather than the collection of five samples from each plot.
- On March 10, 2004, two grab samples per bucket were collected using a polyvinylchloride (PVC) sampling thief, rather than the collection of five samples from each plot using a dedicated plastic sampling scoop.

The average results of the two sampling events are presented in Table 3-3. This study served to confirm toxaphene degradation activity and was used to select nutrient distribution to be used in the treatment cells.

Table 3-1 (Page 1 of 4)
Pilot Test Sampling Results
Gila River Toxaphene Boundary Site
Pinal County, Arizona

	Toxaphene Concentration (mg/kg)[1]						
Sample	Day = 0 5/1/03	Day = 28 5/28/03	Day = 57 6/26/03	Day = 99 8/7/03	Day = 155 (Day = 0 [2]) 10/2/03	Day = 196 (Day = 41 [2]) 11/12/03	Day = 266 & 267 (Day = 111 & 112 [2]) 1/21 &1/22/04
Plot A							
A1	1900	1400	1600	1400	1500	790	600
A2	1500	1100	1200	930	1700	870	930
A3	1100	770	920	970	1400	1100	1800
A4	1400	1000	1200	320	1400	720	1100
A5	2200	1600	2100	1000	1300	1200	730
A6	--	--	1000 [3]	1000 [4]	1300 [5]	640 [6]	640 [7]
Average	1620	1174	1337	937	1433	887	967
Percent Removal	--	28	18	42	12	38 [8]	33 [8]

Table 3-1 (Page 2 of 4)
Pilot Test Sampling Results
Gila River Toxaphene Boundary Site
Pinal County, Arizona

	Toxaphene Concentration (mg/kg)[1]						
Sample	Day = 0 5/1/03	Day = 28 5/28/03	Day = 57 6/26/03	Day = 99 8/7/03	Day = 155 (Day = 0 [2]) 10/2/03	Day = 196 (Day = 41 [2]) 11/12/03	Day = 266 & 267 (Day = 111 & 112 [2]) 1/21 &1/22/04
Plot B							
B1	2800	2400	6200	4100	5400	3300	3500
B2	3600	2600	6200	7400	4000	4800	3400
B3	4100	3700	2700	3700	2900	3500	3200
B4	4900	2900	4200	4600	5200	3600	--
B5	2300	3300	4700	5700	4500	3800	--
B6	--	2500 [9]	3600 [10]	4300 [11]	--	5500 [12]	--
Average	3540	2900	4600	4967	4400	4083	3367
Percent Removal	--	18	--	--	--	--	5 [13]

Table 3-1 (Page 3 of 4)
Pilot Test Sampling Results
Gila River Toxaphene Boundary Site
Pinal County, Arizona

	Toxaphene Concentration (mg/kg)[1]						
Sample	Day = 0 5/1/03	Day = 28 5/28/03	Day = 57 6/26/03	Day = 99 8/7/03	Day = 155 (Day = 0 [2]) 10/2/03	Day = 196 (Day = 41 [2]) 11/12/03	Day = 266 & 267 (Day = 111 & 112 [2]) 1/21 &1/22/04
Plot C							
C1	2600	2400	2800	2700	--	--	--
C2	2600	2000	2900	1900	--	--	--
C3	3600	2000	3300	3100	--	--	--
C4	2700	1800	2300	4700	--	--	--
C5	2500	2300	2800	2300	--	--	--
C6	--	3300 [14]	--	--	--	--	--
Average	2800	2300	2820	2940	--	--	--
Percent Removal	--	18	--	--	--	--	–

Table 3-1 (Page 4 of 4)
Pilot Test Sampling Results
Gila River Toxaphene Boundary Site
Pinal County, Arizona

	Toxaphene Concentration (mg/kg)[1]						
Sample	Day = 0 5/1/03	Day = 28 5/28/03	Day = 57 6/26/03	Day = 99 8/7/03	Day = 155 (Day = 0 [2]) 10/2/03	Day = 196 (Day = 41 [2]) 11/12/03	Day = 266 & 267 (Day = 111 & 112 [2]) 1/21 &1/22/04
Plot D							
D1-1	--	--	--	--	2900	1100	1600
D1-2	--	--	--	--	2600	1000	1300
D1-3	--	--	--	--	2800 [15]	--	1500 [16]
D2-1	--	--	--	--	2800	1200	1500
D2-2	--	--	--	--	2500	2100	1100
Average	--	--	--	--	2720	1350	1400
Percent Removal	--	--	--	--	--	50 [8]	49 [8]

Notes:
[1] mg/kg - milligrams per kilogram
[2] Time after pilot test modification
[3] Duplicate of sample A2
[4] Duplicate of sample A3
[5] Duplicate of sample A3
[6] Duplicate of sample A1
[7] Duplicate of sample A1
[8] Relative to Day = 155
[9] Duplicate of sample B1
[10] Duplicate of sample B5
[11] Duplicate of sample B1
[12] Duplicate of sample B2
[13] Relative to Day = 0
[14] Duplicate of sample C3
[15] Duplicate of sample D1-2
[16] Duplicate of sample D1-2

Table 3-2 Bench Scale Study #1 Sampling Results Gila River Toxaphene Boundary Site Pinal County, Arizona				
	Toxaphene Concentration (mg/kg)[1]			
Sample	Day = 0 (Average Concentration) 10/2/03	Day = 41 11/12/03	Percent Removal	Recipe
Recipe 1	895	570	36	1 percent BM, 1 percent PO_4 1:1
Recipe 2	895	1200	--	0.5 percent BM, 1 percent PO_4 1:1
Recipe 3	895	240	73	1 percent BM, 0.4 percent starch, 1 percent PO_4 1:8.7
Recipe 4	895	310	65	0.5 percent BM, 0.4 percent starch, 1 percent PO_4 1:8.7
Recipe 5	895	260	71	0.25 percent BM, 0.4 percent starch, 1 percent PO_4 1:8.7

Notes:
[1] mg/kg - milligrams per kilogram
BM = Blood meal
PO_4 = Phosphate (Monobasic:Dibasic)

Table 3-3 Bench Scale Study #2 Sampling Results Gila River Toxaphene Boundary Site Pinal County, Arizona				
	Toxaphene Concentration (mg/kg)[1]			
Sample	Day = 0 (Average Concentration) 1/22/04	Day = 48 (Average Concentration) 3/10/04	Percent Removal	Recipe
Reactor 1	3100	3500	--	1 percent BM, 0.4 percent starch, 1 percent PO_4 1:8.7
Reactor 2	3400	2933	14	0.5 percent BM, 0.4 percent starch, 1 percent PO_4 1:8.7
Reactor 3	4000	3450	14	0.25 percent BM, 0.4 percent starch, 1 percent PO_4 1:8.7
Reactor 4	3933	2933	25	1 percent BM, 0.4 percent starch, 0.5 percent PO_4 1:8.7
Reactor 5	3450	3450	--	0.5 percent BM, 0.4 percent starch, 0.5 percent PO_4 1:8.7
Reactor 6	4100	3650	11	0.25 percent BM, 0.4 percent starch, 0.5 percent PO_4 1:8.7

Notes:
[1] mg/kg - milligrams per kilogram
BM = Blood meal
PO_4 = Phosphate (Monobasic:Dibasic)

4 REMOVAL ACTIVITIES

4.1 Removal and Excavation

Removal activities at the Boundary Site were conducted under the authority of OSC Allen from April 14, 2004 to May 19, 2004. The EPA ERT and the START provided technical support during removal activities. Soil excavation and bioremediation treatment cell construction activities were conducted by the EPA ERRS contractor, Environmental Quality Management (EQM) and EQM's subcontractor Southwest Hazard Control of Tempe, Arizona. START activities consisted of re-establishing the assessment sampling grid using a global positioning system to delineate excavation boundaries, excavation oversight, and collecting soil samples from the bioremediation treatment cells. Photographic documentation of START activities is included in Appendix B.

The START delineated excavation boundaries and depths based on toxaphene concentrations obtained during the removal assessment. Each sample location with a toxaphene concentration greater than 17 mg/kg was designated as the center of a 65-foot by 65-foot square, and the entire square was marked for excavation. Additional excavation areas were identified by OSC Allen based on isopleth contours generated with *Surfer*® (Golden Software, Inc., 2002) software. Toxaphene concentrations exceeding 17 mg/kg were reported at depths of up to four feet bgs; however the majority of the soils requiring excavation were within the 0-0.5 feet bgs interval. In cases where subsurface toxaphene concentrations exceeded the action level, all soil within that particular 65-foot by 65-foot square was excavated to the depth from which the contaminated sample was collected, regardless of shallow toxaphene concentrations. Approximately 6,000 yd^3 of soil were excavated from the site for treatment. The excavation boundaries and treatment cell locations are presented in Figure 4-1. Excavation depths are presented in Figure 4-2.

Contaminated soil was stockpiled pending excavation and construction of the treatment cells, which were located southwest of the investigation area. Soil generated during the excavation of the treatment cells was used to backfill excavations in the remainder of the site. Because of the extensive delineation of toxaphene contamination conducted during the preliminary site assessment, OSC Allen did not require the collection of confirmation samples after excavation.

During excavation activities, OSC Allen directed the START to collect a sample of the mud from the walls of the building ruins on the Thomas Homesite. GRIC representatives were

concerned about potential toxaphene contamination of this mud, due to a reported Gila River Indian custom in which the mud was ingested by family members after construction of the structure. This sample contained a toxaphene concentration of 4 mg/kg, which is below the Arizona NR-SRL of 17 mg/kg and equal to the Arizona R-SRL of 4 mg/kg.

4.2 Bioremediation Treatment Cell Construction

Based on the results of the pilot test and on experience with similar toxaphene-contaminated sites, *ex-situ* bioremediation was selected as the treatment technology to meet site cleanup goals. Six treatment cells measuring 142 feet long by 22 feet wide by 9 feet deep were filled with a mixture of contaminated soil, water, and nutrients to promote the anaerobic biodegradation of toxaphene. The nutrient distribution included 0.50 percent (by weight) blood meal, 0.50 percent (by weight) phosphates (9 parts disodium phosphate to 1 part monosodium phosphate), and 0.40 percent (by weight) starch, so that 1.4 percent of the solid mixture (by weight) consisted of amendments.

The treatment cells were designed to maximize the potential for anaerobic bacteria to degrade toxaphene. The excavated cells were lined with visqueen in order to prevent water loss and promote anaerobic conditions. Cell contents were homogenized during several phases of the cell construction process to distribute toxaphene contamination and nutrients as evenly as possible. The stockpiled soil was run through a 3-inch sieve to remove rocks and debris. Nutrients were then added to the contaminated soil and mixed in a bin. The nutrient and soil mixture was further homogenized in a pugmill, slightly moistened, and moved to the treatment cells. Water was continuously added to the treatment cells as they were filled with the amended soil mixture. The cells were then sealed with visqueen. Three sampling ports with gas release valves were installed around the perimeter of each cell (see Figure 4-3).

4.3 Treatment Cell Sampling

To monitor bioremediation treatment progress, the START conducted three sampling events in May, September, and November 2004. The *Data Quality Objectives Process Document for Soil Sampling, Gila River Toxaphene Boundary Site Removal Bioremediation Treatment Cells*, May 2004 is presented in Appendix A. Samples were collected in accordance with the *Emergency Response Quality Assurance Sampling Plan for Soil and Water Sampling*, May 2004 (Appendix A) with the following exception:

- Samples collected on May 12, 2004, from Cell 3 were taken before the installation of sampling ports. These samples were collected at the locations of the future sampling ports using 5 feet of PVC pipe instead of 15 feet.

Samples were shipped to the REAC laboratory in Edison, New Jersey for analysis by REAC method Standard Operating Procedure Number 1802, which is similar to EPA Method 8081A. Toxaphene sample analysis and data validation were conducted by REAC laboratory personnel. The data presented in this report was made available to START by EPA ERT, and raw data is housed with the REAC contractor. The START is unable to verify data quality.

4.3.1 Discussion of Data

The START collected three sets of samples for each of the treatment cells; initial samples (time = 0 days) were collected as the cells were completed in May 2004, the second sampling event took place on September 27 and the third sampling event on November 30, 2004. The results of the sampling events are presented in Tables 4-1, 4-2, and 4-3. The progress of toxaphene degradation in each cell are presented is graphed in Figure 4-4 and presented in Table 4-4.

4.3.1.1 Cell 1

The average concentration of toxaphene in Cell 1 decreased 71 percent over the 203 days from May 11, 2004, and the third sampling event. The range of toxaphene concentration documented in the third sampling event was 13 to 18 mg/kg. The average toxaphene concentration was 15 mg/kg, below the site action level of 17 mg/kg. The standard deviation (SD) and the percent coefficient of variance (%CV) of the data from the third sampling event were 2.5 and 16.4, respectively. Although not specified in the sampling plan, in general the START data quality objective for %CV is less than or equal to 25.

The greatest drop in toxaphene concentration occurred between the initial and second sampling events. One item of note in the data from the second sampling event is the significant difference in toxaphene concentrations in the duplicate sample pair, 19 mg/kg versus 43 mg/kg - a relative percent difference (RPD) of 77.4. High RPD values can be indicative of sampling or analysis error, however, in this case the RPD is more likely due to heterogeneous distribution of toxaphene in the sample due to the chemical's characteristics. Toxaphene adsorbs strongly to soil particles and is practically insoluble in water. Duplicate samples taken from Cell 1 in the initial sampling events had a RPD of 1.9.

4.3.1.2 Cell 2

The average concentration of toxaphene in Cell 2 decreased 76 percent over the 203 days from May 11, 2004, and the third sampling event. The range of toxaphene concentration documented in the third sampling event was 8 to 12 mg/kg. The average toxaphene concentration was 10 mg/kg, below the site action level of 17 mg/kg. The SD was 2.1 and the %CV was 21.5 for the third data set.

As with Cell 1, the greatest drop in toxaphene concentration occurred between the initial and second sampling events. A comparison of data from the second and third sampling events documents no significant decrease in the toxaphene concentration between the two sampling events. The average concentration of toxaphene in the second data set, the third data set and the two data sets combined was 13, 10 and 11.3 mg/kg, respectively.

4.3.1.3 Cell 3

Cell 3 had the highest initial average concentration of toxaphene and had the highest percent decrease over the treatment period. The average concentration of toxaphene in Cell 3 decreased 82 percent over the 202 days from May 12, 2004, and the third sampling event. The range of toxaphene concentration documented in the third sampling event was 9 to 36 mg/kg. The average toxaphene concentration was 20 mg/kg, above the site action level of 17 mg/kg. The SD was 14.4 and the %CV was 73.0 for the third data set.

As with the previously discussed cells, the greatest decrease in toxaphene concentration occurred between the initial and second sampling events. Although the average concentration of toxaphene in the data from the third sampling event slightly exceeded the site action level, the average concentration of toxaphene for the second data set was 13 mg/kg and the average for the two data sets was 16 mg/kg, both below the site action level. As previously discussed, the variability in the sample data likely reflects the heterogeneous distribution of toxaphene caused by the chemical's characteristics.

4.3.1.4 Cell 4

The average concentration of toxaphene in Cell 4 decreased 69 percent over the 187 days from May 27, 2004, and the third sampling event. The range of toxaphene concentration documented in the third sampling event was 8 to 10 mg/kg. The average toxaphene concentration was 9 mg/kg, below the site action level of 17 mg/kg. The SD was 1.0 and the %CV was 11.1 for the third data set. Duplicate samples collected from Cell 4 during the initial and second sampling

event had RPDs of 17.5 and 16.7, respectively.

Again, the greatest drop in toxaphene concentration occurred between the initial and second sampling events. A comparison of data from the second and third sampling events documents no significant decrease in the average toxaphene concentration between the two sampling events. The average concentration of toxaphene in the second data set, the third data set and the two data sets combined was 11, 9 and 10 mg/kg, respectively.

4.3.1.5 Cell 5

The decrease in the average concentration of toxaphene in Cell 5 was 66 percent over the 187 days from May 27, 2004, and the third sampling event. The range of toxaphene concentration documented in the third sampling event was 7 to 17 mg/kg. The average toxaphene concentration was 10 mg/kg, below the site action level of 17 mg/kg. The SD was 4.9 and the %CV was 49.8 for the third data set.

As in the cells previously discussed, the greatest drop in toxaphene concentration occurred between the initial and second sampling events and there was no decrease in the average toxaphene concentration between the two sampling events.

4.3.1.6 Cell 6

The average concentration of toxaphene in Cell 6 decreased 78 percent over the 187 days from May 27, 2004, and the third sampling event. The range of toxaphene concentration documented in the third sampling event was 5 to 6 mg/kg. The average toxaphene concentration was 6 mg/kg, below the site action level of 17 mg/kg. The SD was 0.6 and the %CV was 10.9 for the third data set.

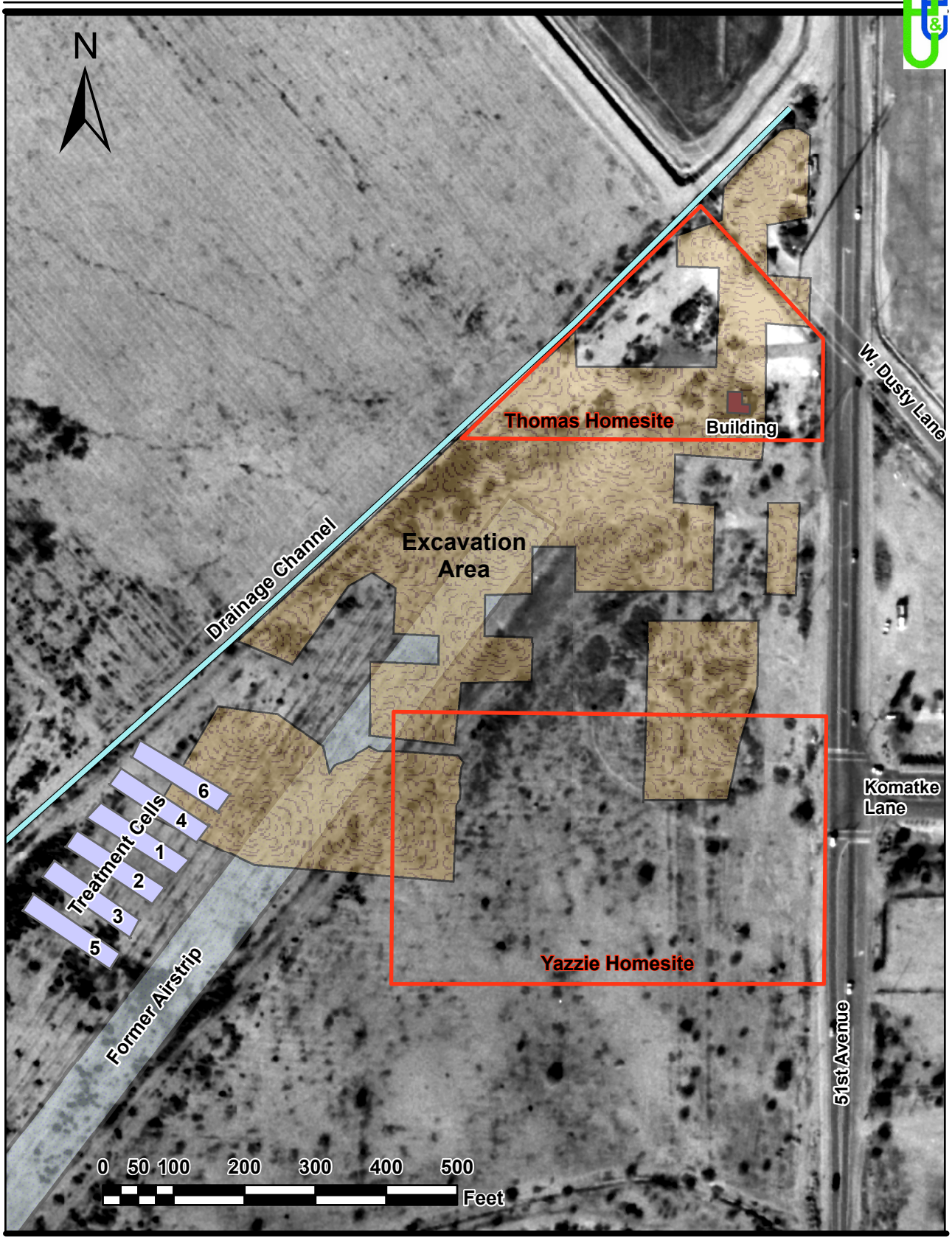
The average toxaphene concentration decreased 52 percent between the initial and second sampling event and 54 percent between the second and third events. The average concentration of toxaphene in the second data set, the third data set and the two data sets combined was 11, 6 and 8 mg/kg, respectively.

4.4 Treatment Cell Decommissioning

Based on analysis of the sample data, OSC Allen decided to decommission the treatment cells after the November 30, 2004, sampling event. The EPA ERRS contractor EQM dismantled the treatment cells from January 31 to February 3, 2005. The visqueen cover and sampling ports were removed and the bottom liner was punctured in three places to allow for permeation of the cell contents to the subsurface. The treatment cells were then backfilled with site soils and regraded.

During the decommissioning of the treatment cells, the START conducted additional sampling at the request of OSC Allen. On January 31 and February 1, 2005, three samples were collected from each treatment cell at locations opposite the former sampling ports; sampling locations for the final event were a mirror image of the previous locations (see Figure 4-3). Samples were collected in accordance with the *Addendum to the Emergency Response Quality Assurance Sampling Plan (ER QASP) for Soil and Water Sampling - Gila River Toxaphene Boundary Site*, Dated May 4, 2004. (Appendix A)

Data from this sampling event documented slightly higher average concentrations of toxaphene in the cells than the averages calculated from the sampling conducted prior to cell decommissioning (Table 4-5). However, when data from this sampling event was combined with the data from the second and third sampling events and analyzed, only Cells 1 and 3 had toxaphene concentrations that exceeded the site action level. The average for Cell 1 calculated from the three data sets was 23.6 mg/kg and that for Cell 3 was 18.6 mg/kg.



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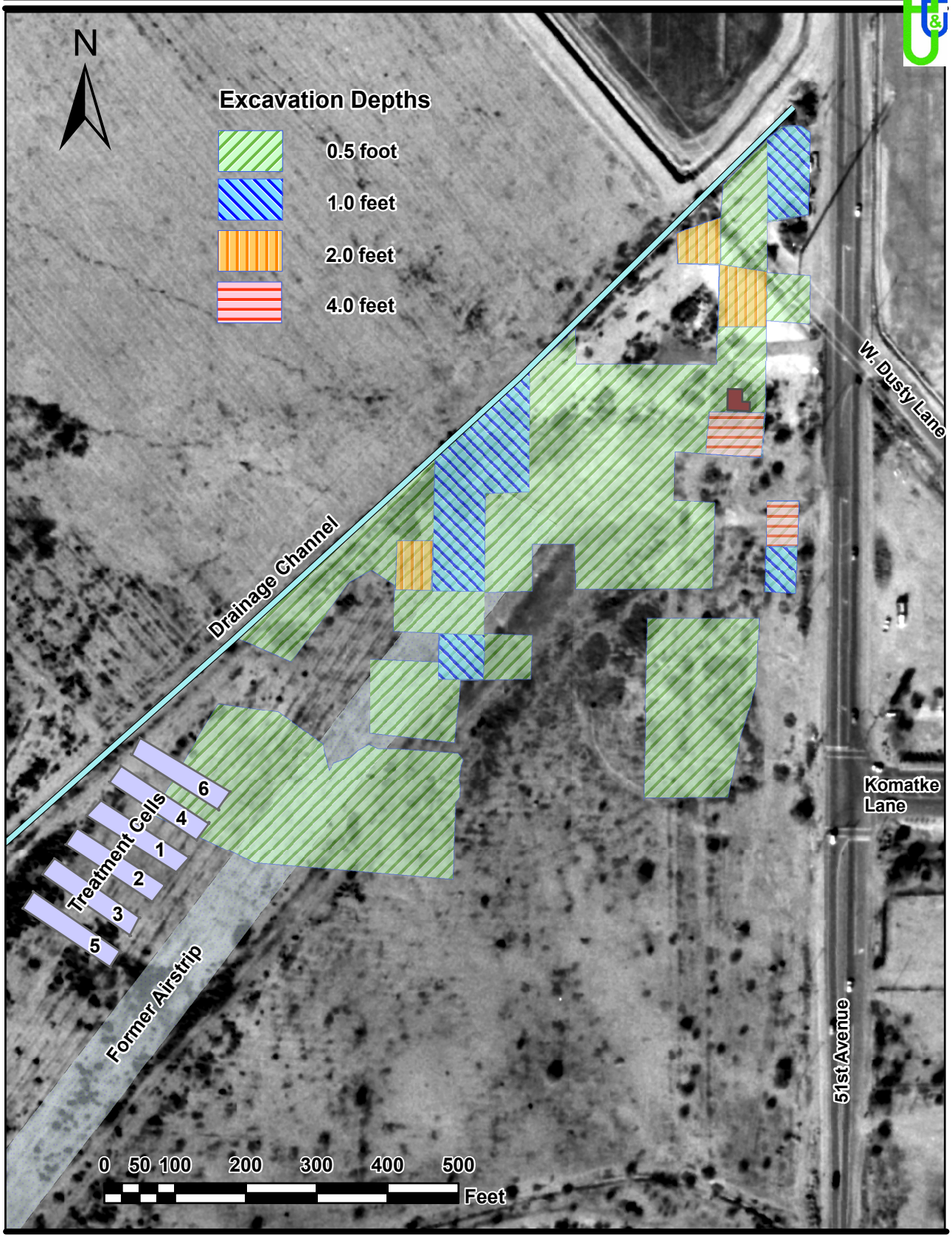
Project No.: 0518.01RZ

Figure 4-1

Excavation Boundaries

Gila River Toxaphene Boundary Site Removal

Gila River Indian Community, Pinal County, Arizona



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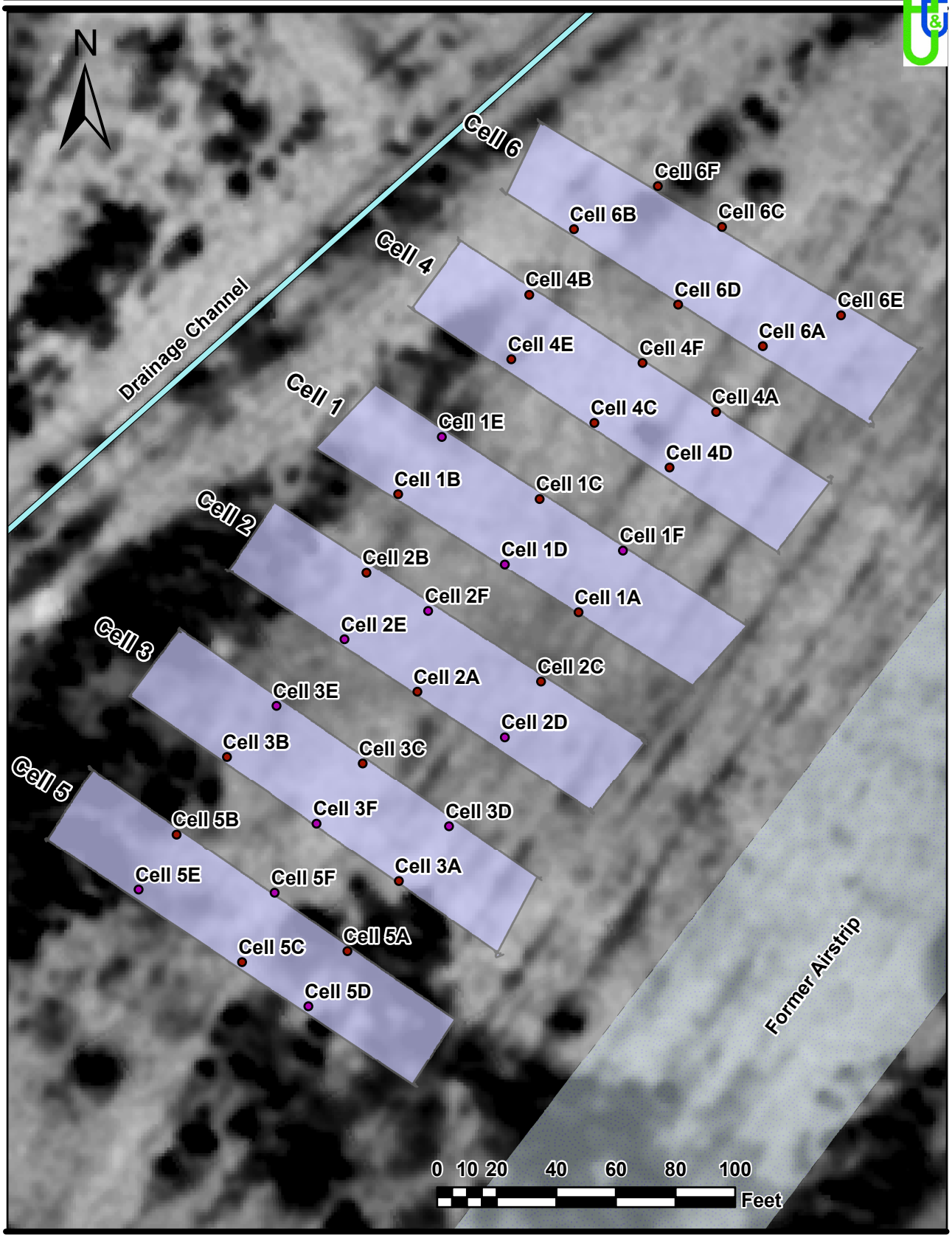
Project No.: 0518.01RZ

Figure 4-2

Excavation Depths

Gila River Toxaphene Boundary Site Removal

Gila River Indian Community, Pinal County, Arizona



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Project No.: 0518.01RZ

Figure 4-3

Treatment Cell Sampling Locations

Gila River Toxaphene Boundary Site Removal

Gila River Indian Community, Pinal County, Arizona

Figure 4-4
Toxaphene Concentration Trends in Treatment Cells

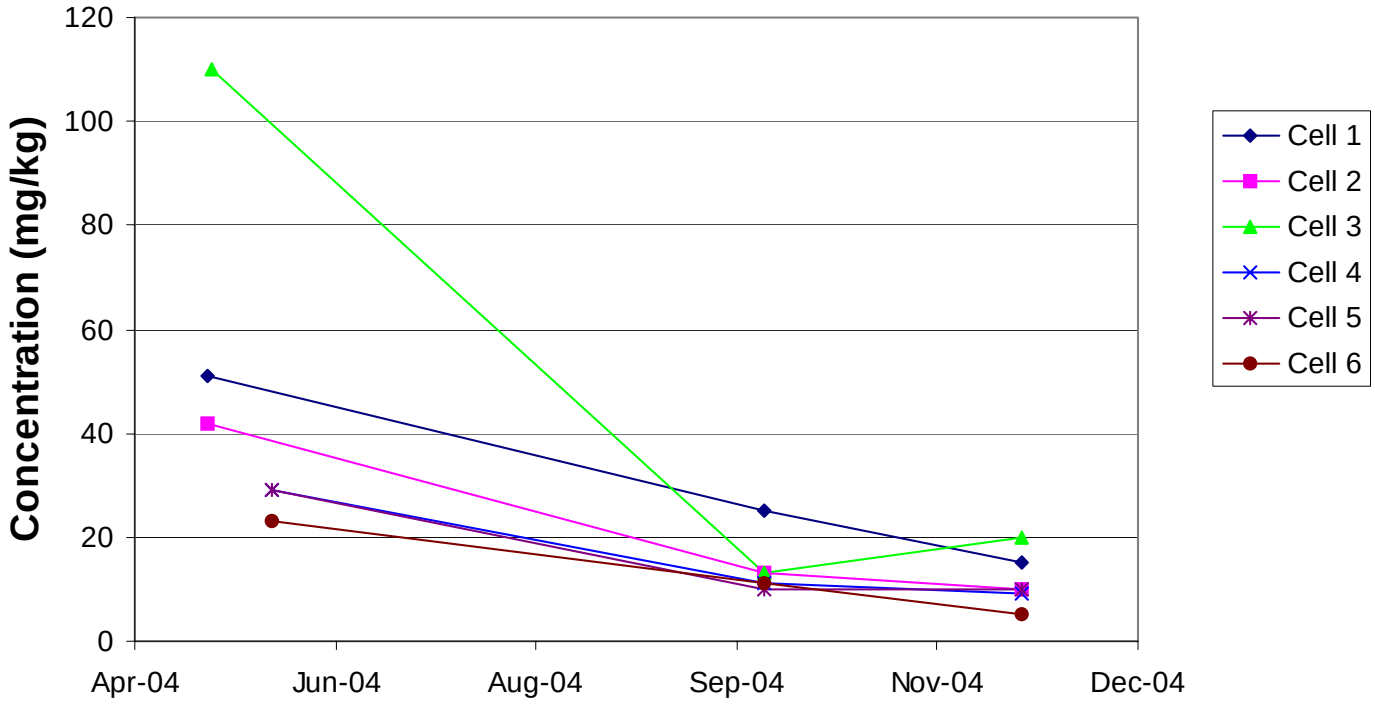


Table 4-1 Treatment Cell Toxaphene Concentrations - May 2004 Gila River Toxaphene Boundary Site Pinal County, Arizona					
Cell #	Sample ID	Sampling Date	Age (Days)	Toxaphene Concentration (mg/kg) [1]	Statistics
1	CELL1A-0	5/11/04	0	53	Average = 51 Standard Deviation = 2.7 CV [2] = 5.3
	CELL1B-0	5/11/04		47	
	CELL1C-0	5/11/04		52	
	CELL1D-0 [3]	5/11/04		52	
2	CELL2A-0	5/11/04	0	29	Average = 42 Standard Deviation = 12.6 CV = 29.7
	CELL2B-0	5/11/04		44	
	CELL2C-0	5/11/04		54	
3	CELL3A-0	5/12/04	0	100	Average = 110 Standard Deviation = 10.0 CV = 9.1
	CELL3B-0	5/12/04		120	
	CELL3C-0	5/12/04		110	
4	CELL4A-0	5/27/04	0	31	Average = 29 Standard Deviation = 4.6 CV = 15.9
	CELL4B-0	5/27/04		24	
	CELL4C-0	5/27/04		34	
	CELL4D-0 [4]	5/27/04		26	
5	CELL5A-0	5/27/04	0	24	Average = 29 Standard Deviation = 5.0 CV = 17.6
	CELL5B-0	5/27/04		34	
	CELL5C-0	5/27/04		28	
6	CELL6A-0	5/27/04	0	30	Average = 23 Standard Deviation = 7.6 CV = 32.7
	CELL6B-0	5/27/04		25	
	CELL6C-0	5/27/04		15	

Notes:
[1] mg/kg - milligrams per kilogram
[2] CV - Coefficient of variance (percent)
[3] Duplicate of sample CELL1A-0
[4] Duplicate of sample CELL4A-0

Table 4-2 Treatment Cell Toxaphene Concentrations - September 2004 Gila River Toxaphene Boundary Site Pinal County, Arizona					
Cell #	Sample ID	Sampling Date	Age (Days)	Toxaphene Concentration (mg/kg) [1]	Statistics
1	CELL1A-SEP	9/27/04	139	19	Average = 25 Standard Deviation = 12.2 CV [2] = 49.2
	CELL1B-SEP	9/27/04		18	
	CELL1C-SEP	9/27/04		19	
	CELL1D-SEP [3]	9/27/04		43	
2	CELL2A-SEP	9/27/04	139	11	Average = 13 Standard Deviation = 1.7 CV = 13.3
	CELL2B-SEP	9/27/04		14	
	CELL2C-SEP	9/27/04		14	
3	CELL3A-SEP	9/27/04	138	14	Average = 13 Standard Deviation = 1.0 CV = 7.7
	CELL3B-SEP	9/27/04		13	
	CELL3C-SEP	9/27/04		12	
4	CELL4A-SEP	9/27/04	123	11	Average = 11 Standard Deviation = 1.3 CV = 11.2
	CELL4B-SEP	9/27/04		10	
	CELL4C-SEP	9/27/04		11	
	CELL4D-SEP [4]	9/27/04		13	
5	CELL5A-SEP	9/27/04	123	11	Average = 10 Standard Deviation = 1.0 CV = 10.0
	CELL5B-SEP	9/27/04		10	
	CELL5C-SEP	9/27/04		9	
6	CELL6A-SEP	9/27/04	123	10	Average = 11 Standard Deviation = 3.2 CV = 28.4
	CELL6B-SEP	9/27/04		9	
	CELL6C-SEP	9/27/04		15	

Notes:
[1] mg/kg - milligrams per kilogram
[2] CV - Coefficient of variance (percent)
[3] Duplicate of sample CELL1A-SEP
[4] Duplicate of sample CELL4A-SEP

Table 4-3 Treatment Cell Toxaphene Concentrations - November 2004 Gila River Toxaphene Boundary Site Pinal County, Arizona					
Cell #	Sample ID	Sampling Date	Age (Days)	Toxaphene Concentration (mg/kg) [1]	Statistics
1	CELL1A-NOV	11/30/04	203	18	Average = 15
	CELL1B-NOV	11/30/04		13	Standard Deviation = 2.5
	CELL1C-NOV	11/30/04		15	CV [2] = 16.4
2	CELL2A-NOV	11/30/04	203	8	Average = 10
	CELL2B-NOV	11/30/04		12	Standard Deviation = 2.1
	CELL2C-NOV	11/30/04		9	CV = 21.5
3	CELL3A-NOV	11/30/04	202	9	Average = 20
	CELL3B-NOV	11/30/04		36	Standard Deviation = 14.4
	CELL3C-NOV	11/30/04		14	CV = 73.0
4	CELL4A-NOV	11/30/04	187	8	Average = 9
	CELL4B-NOV	11/30/04		10	Standard Deviation = 1.0
	CELL4C-NOV	11/30/04		9	CV = 11.1
5	CELL5A-NOV	11/30/04	187	7	Average = 10
	CELL5B-NOV	11/30/04		17	Standard Deviation = 4.9
	CELL5C-NOV	11/30/04		8	CV = 49.8
	CELL5D-NOV [3]	11/30/04		7	
6	CELL6A-NOV	11/30/04	187	6	Average = 6
	CELL6B-NOV	11/30/04		6	Standard Deviation = 0.6
	CELL6C-NOV	11/30/04		5	CV = 10.9
	CELL6D-NOV [4]	11/30/04		5	

Notes:
[1] mg/kg - milligrams per kilogram
[2] CV - Coefficient of variance (percent)
[3] Duplicate of sample CELL5A-NOV
[4] Duplicate of sample CELL6A-NOV

Table 4-4
Toxaphene Degradation in Treatment Cells
Gila River Toxaphene Boundary Site
Pinal County, Arizona

Cell #	Age (Days)	Average Toxaphene Concentration (mg/kg) [1]	Age (Days)	Average Toxaphene Concentration (mg/kg)	Percent Removal	Age (Days)	Average Toxaphene Concentration (mg/kg)	Percent Removal
1	0	51	139	25	51	203	15	71
2	0	42	139	13	69	203	10	76
3	0	110	138	13	88	202	20	82
4	0	29	123	11	62	187	9	69
5	0	29	123	10	66	187	10	66
6	0	23	123	11	52	187	5	78

Notes:
[1] mg/kg - milligrams per kilogram

Table 4-5 Treatment Cell Toxaphene Concentrations - January/February 2005 Gila River Toxaphene Boundary Site Pinal County, Arizona					
Cell #	Sample ID	Sampling Date	Age (Days)	Toxaphene Concentration (mg/kg) [1]	Statistics
1	CELL1D-JAN	2/1/05	266	30	Average = 29 Standard Deviation = 2.6 CV [2] = 9.1
	CELL1E-JAN	2/1/05		29	
	CELL1F-JAN	2/1/05		25	
	CELL1G-JAN [3]	2/1/05		31	
2	CELL2D-JAN	2/1/05	266	21	Average = 19 Standard Deviation = 2.9 CV = 14.9
	CELL2E-JAN	2/1/05		16	
	CELL2F-JAN	2/1/05		21	
3	CELL3D-JAN	2/1/05	265	18	Average = 23 Standard Deviation = 5.0 CV = 22.2
	CELL3E-JAN	2/1/05		28	
	CELL3F-JAN	2/1/05		22	
4	CELL4D-JAN	1/31/05	249	12	Average = 16 Standard Deviation = 4.5 CV = 27.6
	CELL4E-JAN	1/31/05		21	
	CELL4F-JAN	1/31/05		16	
5	CELL5D-JAN	2/1/05	250	11	Average = 11 Standard Deviation = 0.6 CV = 5.1
	CELL5E-JAN	2/1/05		12	
	CELL5F-JAN	2/1/05		11	
6	CELL6D-JAN	1/31/05	249	11	Average = 19 Standard Deviation = 15.4 CV = 81.0
	CELL6E-JAN	1/31/05		10	
	CELL6F-JAN	1/31/05		42	
	CELL6G-JAN [4]	1/31/05		13	

Notes:
[1] mg/kg - milligrams per kilogram
[2] CV - Coefficient of variance (percent)
[3] Duplicate of sample CELL1E-JAN
[4] Duplicate of sample CELL6E-JAN

5 SUMMARY

The EPA tasked the START to provide technical assistance and oversight during bioremediation pilot test and bench scale studies and removal activities at the Gila River Toxaphene Boundary Site. The START conducted sampling events associated with the pilot test and bench scale studies to determine optimal bioremediation treatment methods between April 2003 and March 2004. Removal activities at the site were conducted between April 2004 and February 2005 and consisted of excavation and bioremediation of toxaphene-contaminated soils with concentrations greater than the site action level of 17 mg/kg.

The START sampled the bioremediation treatment cells in May, September, and November 2004 to monitor treatment progress. All cells exhibited a decrease in toxaphene concentrations between May 2004 and November 2004. Five out of six treatment cells contained average toxaphene concentrations below the site action level of 17 mg/kg on November 30, 2004. Based on the November 2004 sample data, OSC Allen determined bioremediation treatment at the Boundary Site was complete and the treatment cells were decommissioned in January and February 2005.

APPENDIX A
Quality Assurance Sampling Plans and Data Quality Objectives

Attachment I

EPA Emergency Response Section and Superfund Technical Assistant and Response Team (START)

Emergency Response Quality Assurance Sampling Plan for Soil and Water Sampling

Response Location: Gila River Toxaphene Boundary Site
Date: May 22, 2003
Prepared by: Sara Dwight
Reviewed By: Cindy McLeod
Approved By (OSC):

This emergency sampling plan is intended to be used in conjunction with the EPA's Emergency Response Section's Generic Data Quality Objectives for Emergency Responses and Time Critical Evaluations. This sampling plan has been designed to assist field responders in their preparation for collecting, analyzing, shipping, storing and handling samples collected during an emergency response. The use of this generic sampling plan will involve forethought and planning that should help direct the sampling and analytical work. It is meant to be used in the case of emergency responses or time-critical responses when sampling teams may not have the opportunity to write a more thorough sampling plan. Sampling teams should always reference standard quality procedures, standard operations procedures and standard methods for additional sampling and analytical guidance.

The development of this generic plan will improve the documentation, communication, planning, and overall quality associated with the sampling and analysis by:

1) encouraging field teams to consider their goals and objectives before the generation of environmental data,
2) creating a common written emergency plan format for field sampling teams
3) increasing communication between sampling personnel and decision makers, and
4) detailing expectations before samples are collected.

1.0 Introduction and Background. *What is the problem, what precipitated the response, which agencies and companies are on site, who has taken the lead for the response and for environmental clean-up actions? Describe the site and specify the geographic boundaries for the area of concern (AOC).*

The site is located at the boundary of the Gila River Indian Community (GRIC) along the west side of 51st street near the intersection of 51st and Komatke Lane. Crop dusters used the site as a base of operations from 1959 until the early 1980's and routinely "blew out" residual pesticides after landing on an airstrip formerly located on the site. Elevated levels of toxaphene were documented in shallow soils at the site, and with the surrounding area undergoing increased development, the GRIC was concerned that the site poses an exposure risk to human health and the environment.

After multiple phases of investigation and removal work on the site, the EPA constructed bioremediation pilot test study plots on the site in an effort to determine the effectiveness of a large-scale bioremediation remedial action at the site. EPA OSC Don Zuroski, Harry Allen of ERT, and REAC and START personnel oversaw the installation of three test plots on May 1, 2003. The plots each measured 4.5 feet x 4.5 feet x 1 foot. Two of the plots were unlined (with plastic) and one plot was lined. Amendments were added to soil from the three plots; one unlined and the lined plot had amendments mixed in ex-situ, and the other unlined plot had the amendments mixed in-situ to simulate the amendment application method if the entire site were to undergo bioremediation.

2.0 Objectives. *Brief statement on the general project objective. What is the overall goal or objective? Specific objectives are summarized in Table A.*

The sampling objective is to make a comparison between the T=0 samples collected when the plots were installed and the T=28 samples to determine whether the percent decrease in toxaphene concentrations in the test plots are similar. The overall objective of the pilot test is to determine if bioremediation is an effective means of remediating the entire site.

2.1 Data Use Objectives. (How will the data be used?)

Check Appropriate Box(es):
Data that are generated will be used:

1 X To be compared with a background or reference sample(s).

2 ☐ To be compared with an available detection or quantification level.

3 ☐ To assist in determining the presence or absence of a hazardous material or substance at levels above an available detection or quantification level.

4 ☐ To assist with determining the area of impact due to a hazardous material release. (i.e horizontal and lateral).

5 ☐ To be compared with site-specific action levels or risk-based action levels (e.g., EPA PRGs) to assist in determination if health threats exist.

6 ☐ As definitive confirmatory data for non-definitive (screening) data.

7 ☐ Other objectives: _____

_____

2.2 Sampling Objectives. (What are you proposing to do?)

1 ☐ Soil sampling to determine only the presence or absence of a hazardous substance over entire site.

2 ☐ Soil sampling to determine: ☐ contamination levels ☐ contaminated area(s) over entire site.

3 ☐ Areal soil sampling to determine the location of hot spots over entire site.

4 ☐ Areal soil sampling to determine the lateral extent of contamination
☐ of a source area ☐ over entire site.

5 ☐ Sub-surface soil sampling to determine the vertical extent of contamination
☐ of a source area ☐ over entire site.

6 ☐ Off-site soil sampling to: _____

7 ☐ On-site water sampling to only determine the presence or absence of a hazardous substance.

8 ☐ On-site water sampling to determine: ☐ contamination levels ☐ contaminated area(s)

9 ☐ Off-site water sampling to: _____

10 ☐ Perimeter water sampling to: _____

11 X Other objectives: Sampling of bioremediation test plots in order to determine rates of concentration decrease

2.3 Data Categories

In general, the quality of the data should be known and documented prior to use. The U.S. EPA has divided data into two categories: definitive methodology data (generally laboratory data using EPA methods), and non-definitive methodology data (also referred to as screening data) with conformation of 10% by definitive methodology. An additional category referred to as screening data is usable in emergency situations where definitive data is not available. Note that the data category is not an indicator of precision or accuracy! It is only a practical indicator of QA/QC documentation. Refer to the START QAPP for specific DQO parameters. Reported data can be verified (by a party other than the laboratory) as meeting quality control and data category requirements by following a verification or validation procedure.

Check appropriate box(es):

1 X Screening category data will be generated. **The data by itself may not be verifiable. Due to the time critical situation, the data must be reported and used for comparison.**

2a ☐ Screening data with 10 percent definitive category data will be generated. Data using non-definitive analytical methodologies will be used for comparison to action levels. The data by itself may not be verifiable. **Due to the time critical situation, the data must be reported and used for comparison prior to generation of definitive data.** Screening data will be evaluated and reported with definitive category data at a later time.

2b ☐ Screening data with 10 percent definitive category data will be generated. Data using non-definitive analytical methodologies will be used for comparison to action levels. The data by itself may not be verifiable. **Data will not be reported until it is evaluated against definitive category data.**

3a ☐ Definitive category data will be generated. The sampling must be done on an emergency basis. **Due to the time critical situation, the data must be reported and used for comparison without validation. A analytical data packages will be required. However, since the data is not intended to be used for decision making, validation of the data package will not be performed.** (Document generic DQO deviation in section 4.4)

3b ☐ Definitive category data will be will be generated. The sampling must be done on an emergency basis. **Due to the time critical situation, the data must be preliminarily reported and used for comparison without validation. The generated analytical documentation packages will be reviewed and validated. Qualified data will be reported.**

3c ☐ Definitive category data will be will be generated. **Full documentation will be required. Analytical Data Packages will be reviewed and validated prior to reporting.**

Table A
Data Objectives and Sample Collection

Sample Location Refer to Section 3.3.1	Data Use Objective(s) Refer to Section 2.1	Data Category Refer to Section 2.3	Analytical Method Refer to Section 3.1	Number of Samples & Matrix (soil or water)
Test Plot A	Compare to T=0 sample	Screening	Toxaphene, EPA Method 8081	5 soil samples
Test Plot B	Compare to T=0 sample	Screening	Toxaphene, EPA Method 8081	5 soil samples and 1 duplicate
Test Plot C	Compare to T=0 sample	Screening	Toxaphene, EPA Method 8081	5 soil samples and 1 duplicate

ERS/START:
Soil and Water Emergency QASP
2.4 Contaminants of Concern

Potential contaminants of concern (COC), proposed analytical method, proposed action limits and available reporting limit are summarized in Table B.

Table B			
Potential COC	**Proposed Analytical Method**	**Proposed Action Level**	**Available Reporting Limit**
Toxaphene	EPA Method 8081	Toxaphene concentration at T=0	1 ppm
Other Data Collection Activity (non-chemical) *(circle all that apply)*	GPS Visual Interviews Magnetometer Other Goephysical Modeling Photography File Search		

Add additional pages if necessary.

3.0 Approach and Sampling Methodologies
3.1 Sampling Approach

Indicate sampling approaches to be used (circle approaches).

(Judgmental) Random Grid Transect Search-Grid

If you indicated search-grid, specify contamination parameters (circle one for each parameter).

Grid Type: Square Triangle Rectangle

Size of Hot-spot to be detected:_____

Shape of Hot-spot: Circle Elliptical Elongated-Elliptical

Required Grid Spacing :_____

Acceptable probability of missing Hot-spot: 5 % 10 % 20% 40%

3.2 Field Sampling and Field Analysis Equipment

Field Analysis Equipment. Specify the field analytical procedures to be used. Check the appropriate boxes.

Instruments and Test Kits:

- ☐ X-ray Fluorescence (XRF) Device [for metals]
- ☐ Hanby Oil Analysis Kit [for oils]
- ☐ Immunoassay Test Kits [pesticides, oils, chlorinated substances]
- ☐ Chlor-n-soil/chlor-n-oil test kits[PCBs, chlorinated substances]
- ☐ pH Meter
- ☐ Enzytech field test kits [for pesticides]
- ☐ Pensky-Martins flash point test
- ☐ Radiation Meter (such as Victoreen)
  for ~, β _____ , γ _____
- ☐ Other field equipment or test kits, as listed below:

_____

_____

Field equipment requirements are summarized in Table C.

Table C
Field Sampling Equipment and Decontamination

Analyses and Matrix	Sampling Equipment	Dedicated or Reusable	Decontamination Solution	Resource/ Contractor
Toxaphene in soil	8-ounce jars, plastic sampling spoons	Dedicated	N/A	N/A

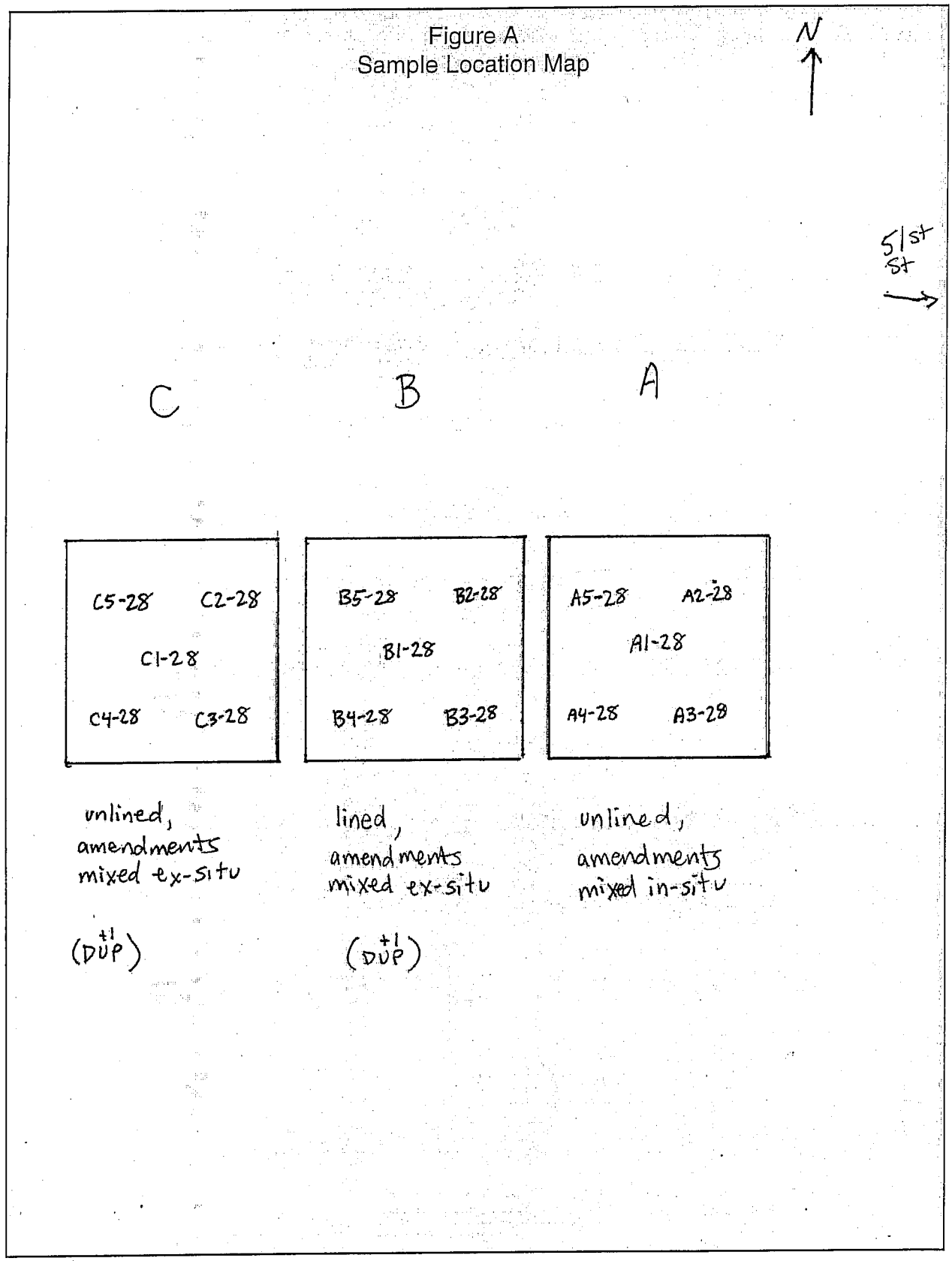
3.3 Field Methods and Procedures

3.3.1 Sample Location. Describe the rationale for the sample locations chosen.

Samples will be collected from the center and halfway between the center and each corner from each pit in order to sample soil that has been thoroughly mixed with nutrients. Sampling too close to the edge of each pit could result in sampling native soil without amendments added. The top 4 inches of soil will not be sampled so as to sample relatively undisturbed soil which is more likely to be undergoing anaerobic degredation.

Sketch a map of the sampling area in Figure A. Use a scale that is meaningful for the sampling work covered under this plan. Sketch out where the samples will be collected. Attach a local map to this plan if it is available.

Figure A
Sample Location Map



3.3.2 Sample Labeling and Documentation

Sample Jar Labels

Sample labs will clearly identify the particular sample, and should include the following:

1. Site name and number.
2. Time and date samples were taken.
3. Sample preservation.
4. Analysis requested.
5. Sample location.

Sample labels will be securely affixed to the sample container.

Chain of Custody Record

A Chain of Custody record will be maintained from the time the sample is taken to its final deposition. Every transfer of custody must be noted and signed for, and a copy of this record kept by each individual who has signed. When samples (or groups of samples) are not under direct control of the individual responsible for them, they must be stored in a locked container sealed with a Custody Seal.

The Chain of Custody record should include (at minimum) the following:

1. Sample identification number.
2. Sample information.
3. Sample location.
4. Sample date.
5. Names(s) and signature(s) of sampler(s).
6. Signature(s) of any individual(s) with control over samples.

Custody Seals

Custody Seals demonstrate that a sample container has not been tampered with, or opened. The individual in possession of the sample(s) will sign and date the seal, affixing it in such a manner that the container cannot be opened without breaking the seal. The name of this individual, along with a description of the samples' packaging, will be noted in the field book.

All sample documents will be completed legibly, in ink. Any corrections or revisions will be made by lining through the incorrect entry and by initialing the error. These include the soil and water sampling logbook, the chain-of-custody forms, this field QASP and any other forms.

Field Logbook

The field logbook is essentially a descriptive notebook detailing site activities and observations so that an accurate account of field procedures can be reconstructed in the writer's absence. All entries will be dated and signed by the individuals making the entries, and will include the following:

1. Site name and project number.
2. Names of sampling personnel.
3. Dates and times of all entries (military time preferred).
4. Descriptions of all site activities, especially sampling start and ending times. Include site entry and exit times.
5. Noteworthy events and discussions.
6. Weather conditions.
7. Site observations.
8. Identification and description of samples and locations.
9. Subcontractor information and names of on-site personnel.
10. Date and time of sample collections, along with chain of custody information.
11. Record of photographs.
12. Site sketches.
13. Meteorological data: Wind speed, wind direction, relative humidity.
14. Times: Exact times of various activities and occurrences related to sampling.
15. Changes from standard procedures or methods: The rational should also be given with the change.

3.3.3 Sample Containers and Preservatives

Containers and preservatives are summarized in Table D.

Table D Containers and Preservatives			
Analyses and Matrix	**Container Type (per sample)**	**Preservation Method**	**Holding Time**
Toxaphene in Soil	8-ounce jars	ice	14-day

3.4 Schedule of Sampling Activities

Sampling activities are summarized in Table E.

Table E Proposed Schedule of Work For Soil/Water Sampling Activities		
Activity	Start Date	End Date
Test plot sampling	May 28, 2003	May 28, 2003

3.5 Analytical Methods and Procedures

The analytical methods to be used are presented in Table A. General field QC considerations and requirements are presented in Table F.

Table F
Quality Control Samples and Data Quality Indicator Goals

QC Sample	Number/Frequency	Data Quality Indicator Goals & Evaluation Criteria	Comments/Exceptions *Site specific remarks:*
FIELD SPECIFIED QA/QC			
Background or reference sample N/A	At least one sample should be collected from an area believed to be unaffected by source contamination.	Source samples should be at least 3 times background.	Surface soil: up-slope. Surface water: upstream. Ground water: up-gradient. :
Field Blanks N/A	1 per SDG[1], per matrix, per method	Source samples should be at least 3 times the blank.	Water only. :
Travel Blanks N/A	1 per SDG, per matrix, per method	Source samples should be at least 3 times the blank.	Volatile analytes, water only. :
Equipment Blanks N/A	1 per SDG, per matrix, per method	Source samples should be at least 3 times the blank.	Only when the use of decontaminated non-dedicated equipment is involved. :
Field Duplicates or Replicates	1 per SDG, per matrix, per method 2 duplicates; samples and their duplicates will be homogenized and then split into 2 samples	50 to 200 RPD[2]	As needed by sampling objectives. The procedure for collecting duplicate samples can greatly effect the reproducibility. :2
Performance Standards N/A	1 per project, per matrix, per method	75 -125 %R[3]	If available. :
SELECTED LABORATORY QA/AC			
Method Blank	1 per SDG, per matrix, per method	Stds and samples should be at least 3 times the blank.	Mandatory.
Matrix Spike	1 per SDG, per matrix, per method on field designated sample.	75 -125 %R	Designate sample on COC.
Matrix Spike Duplicate or Replicate	1 per SDG, per matrix, per method on field designated sample.	≤50 RPD for organics; ≤20 RPD for metals	Designate sample on COC.
Reference Standards	1 per SDG, per matrix, per method	75 -125 %R	If available.
Internal Standards	All samples	50 -200 %R	All GC/MS and some GC analyses only.
Laboratory Control Standards	1 per SDG, per matrix, per method	75 - 125 %R	Per method for organic analyses.

[1] SDG = Sample Delivery Group (Maximum 20 samples)
[2] RPD = Relative Percent Difference
[3] %R = Percent Recovery

3.6 Project Laboratories

Laboratories used for this project are summarized in Table G.

Table G Laboratories	
Lab Name/ Location	Methods
Lockheed Martin REAC, New Jersey	Toxaphene by EPA Method 8081

4.0 Project Organization and Responsibilities

4.1 Project personnel and responsibilities are summarized in Table H.

Table H Sample Team(s) Personnel	
Personnel (Agency)	Responsibility
Sara Dwight (START)	Sampler

4.2 Modification or additions to the generic DQO output statements for this project are summarized in Table I. Also indicate which DQO step corresponds to the addition or modification.

Table I	
Additions or Modifications to the Generic DQO Output Statements	**DQO Step**

Add additional pages if necessary.

United States Environmental Protection Agency, Region 9
Emergency Response Section
Data Quality Objectives Process Document
for
Soil Sampling
Gila River Toxaphene Boundary Site
Bioremediation Pilot Test

BACKGROUND

Requirements

The generic data quality objectives (DQOs) presented in this document are based on typical technical and project directives encountered by the United States Environmental Protection Agency, (EPA) Region 9, Emergency Response Section (ERS) and the Ecology and Environment, Inc., Superfund Technical Assessment and Response Team (START) in emergency responses that involve releases to soil. The ERS and START planning process for an emergency response involving soil contamination is reflected in this DQO document. This document, coupled with site-specific output statements, as documented in an emergency response sampling plan (see Attachment I), is intended to meet the EPA's DQO process requirements as stated in the ERS quality management plan (QMP) and START's quality assurance project plan (QAPP). The following requirements and preconditions must be fulfilled to effectively implement these DQOs:

- The emergency responders must be familiar with all types of soil sampling procedures and possess sufficient emergency response experience and training to make emergency sampling design decisions.
- The emergency responders must be sufficiently prepared and organized for emergency response situations in order to implement the planning, mobilization, and communications necessary to support expeditious sampling, analyses, and decision making.
- The emergency responders must be familiar with the START QAPP and/or the ERS QMP.
- The emergency responders must be familiar with the EPA's DQO process and the information and objectives indicted in this generic DQO document. The emergency responders must document any additional DQO information and DQO modifications.
- Before any sample collection, the emergency responders must determine site-specific assessment parameters as indicated in the emergency response sampling plan (see Attachment I).
- All DQO-related information not specified in this DQO document or the emergency response sampling plan must be recorded in other project documentation (e.g., sampling plans, logbooks, action memos, or pollution reports).

STEP 1.
THE PROBLEM

Background for an Emergency Response Soil Sampling Project

The EPA ERS was notified that a release to soil that may pose a significant imminent threat to human health and/or the environment has been identified. The location of the contaminated soil is within the EPA, Region 9. Because of the nature of the perceived threat, the investigation must proceed immediately. There may be no available data regarding the types of contaminants, or the specific location, extent, or magnitude of soil contamination.

Planning Team

Primary Decision Maker:	D. Zuroski (OSC)
Plan Development:	C. McLeod and S. Dwight (START) and OSC Zuroski
Plan Approval:	D. Zuroski
On-Scene Assistance:	N/A
Supplemental Remote or On-Scene Support:	C. McLeod & S. Dwight (START), REAC analytical service provider, H. Allen (EPA Emergency Response Team (ERT))

The names and affiliations of the actual planning team will be documented in the field logbook or in the emergency response sampling plan.

Conceptual Site Model

- A description of the site and a list of the potential contaminants of concern (COCs) are provided in the site's emergency response sampling plan (see Attachment I).
- The medium of concern is soil. This medium will include surface soil, subsurface soil, and sediments either in place or in piles.

Exposure Scenario

- Toxaphene concentrations on site have evaluated by the EPA, Region 9, and have been determined to pose an imminent threat to human health and/or the environment.
- Concerns include migration of contaminants from soil to other media and direct exposure of human and/or environmental receptors to soil contaminants.

Resources

This is an emergency response under the technical direction of the EPA ERS. Labor resources for the sampling effort include:

- START personnel with a pilot test sampling budget.

Analytical service resources include the following:

- The REAC laboratory will perform sample analyses.

Resource Constraints

N/A

STEP 2.
THE DECISION

Principal Study Questions

Primary Questions:

1) Did the concentrations of toxaphene in the test plots decrease compared to the T=0 sample concentrations?

2) Did the concentrations of toxaphene in the unlined plots exhibit a similar percentage decrease as the concentrations of toxaphene in the control plot (lined plot)?

Actions that Could Result from the Resolution of Study Questions

1) The EPA would continue with the pilot test study without any changes.
2) The EPA would make changes to the amendment formulas in the plots.

Decision Statements (Directives)

- COC is toxaphene; action level is toxaphene concentration at T=0.

STEP 3.
DECISION INPUTS

Specific Data Required

- Toxaphene concentrations in samples collected at T=28 days after the installation of the test plots.

Sources for Study Information

- Pilot test plot sampling event.

Information Needed to Establish Action Level

- Toxaphene concentrations in samples collected by START at T=0 days.

Confirm that Measurement Methods Exist to Provide Data

- The REAC laboratory has developed analytical methods for measuring toxaphene.
- Analytical methods for this project are specified in the site's emergency response sampling plan (see Attachment I).

STEP 4.
STUDY BOUNDARIES

Specify Characteristics that Define the Population Being Studied

- The approximate COC concentrations in soil in each test plot.

Geographic Boundary of Investigation

- The geographic boundary for this sampling event is the boundary of the test pits.

Temporal Boundary of Investigation

- The data generated from the May 28, 2003 sampling event represents concentrations only on that day, as bioremediation is an active process.

Other Constraints on Data Collection

- Severe weather

STEP 5.
DECISION RULE

Statistical Parameter

The Decision Unit for this sampling event is each individual sampling point.

Action Levels

The action levels are specified in the emergency response sampling plan (see Attachment I). The action level is the concentration of toxaphene in the T=0 days samples.

Decision Rules

- If toxaphene concentrations in soil samples collected from the unlined pits have decreased (comparatively to the lined pits) then no ERT action will be required.

- If there is a significant difference in the percent decrease of toxaphene concentrations in the lined and unlined test plots, possible ERT action will be required.

- If a significant decrease in toxaphene concentrations from the samples taken at T=0 days to T=28 days is not observed, possible ERT action will be required.

STEP 6.
LIMITS ON DECISION ERRORS

Range of the Parameters of Interest

The COC concentrations may range from nondetect to 1,000 ppm.

The Null Hypothesis or Baseline Condition

Toxaphene concentrations in samples collected from the three pits at T=28 have decreased relative to samples collected at T=0.

The toxaphene concentrations in samples collected from the unlined test plots have experienced similar percent decreases as those collected from the lined test plot.

Alternative Hypothesis

Toxaphene concentrations in samples collected from the three pits at T=28 have not decreased relative to samples collected at T=0.

The toxaphene concentrations in samples collected from the unlined test plots have experienced smaller percent decreases as those collected from the lined test plot.

Decision Errors

DECISION ERRORS Soil Emergency Response		
Decision Error	Deciding that the sample concentration exceeds the action level when it does not.	Deciding that the sample concentration does not exceed the action level when it does.
True Nature of Decision Error	The sample concentration does not exceed the action level.	The sample concentration does exceed the action level.
The Consequence of Error	Areas of soil represented by the sample will undergo additional investigation or may be immediately excavated or treated. Each situation would cost the EPA, Region 9, additional resources of time, money, and manpower.	1) The community could be directly exposed to COCs in areas of contaminated soil. Exposure would be an imminent threat to human health and the environment. 2) The COCs in areas of contaminated soil could migrate from the soil to a drinking or agricultural water source. Exposure would be an imminent threat to human health. 3) The COCs in soil could migrate from soil to air. Exposure would be an imminent threat to human health and the environment. 4) The COCs in areas of contaminated soil could migrate from soil to sensitive environments. Exposure would be an imminent threat to the environment.
Which Decision Error Has More Severe Consequences near the Action Level?	**LESS SEVERE**	**MORE SEVERE** because the contaminated soil may pose risks to human health and/or the environment.
Error Type Based on Consequences	**False Negative Decision** A decision that the soil contaminant concentrations are greater than the action level when they actually are not.	**False Positive Decision** A decision that the soil contaminant concentrations are less than the action level when they actually are greater.

Definitions
False Negative Decision = A false negative decision error occurs when the null hypothesis is not rejected when it is false.
False Positive Decision = A false positive decision error occurs when the null hypothesis is rejected when it is true.
See the EPA document titled, *Guidance for the Data Quality Objective Process*, Chapter 6, (EPA QA/G-4) for additional guidance regarding decision error.

Decision Error Limits Goals

Decision Error Limits Goals for Emergency Responses		
True Concentration of Sample (% of Action Level)	**Typical Decision Error Probability Goals (Based on Professional Judgment)**	**Type of Decision Error**
0–75	Less than 5%	False negative
75–99	Gray area[1]	False negative
100–120	10%–50%[2]	False positive
120-150	5%–10%[2]	False positive
150–200	Less than 5%	False positive
>200	Very small	False positive
The goals in this table are based on professional judgment as relevant to a typical emergency response for soil contamination. Specific project goals may vary with the situation.		
[1] *Gray area* is where relatively large decision errors are acceptable. [2] Note that large decision errors are expected when the true contaminant concentrations are 100% to 150% of the action level.		

STEP 7.
DESIGN FOR OBTAINING DATA

All sampling, analytical, and QA activities will proceed under the START QAPP and documents referenced therein. All site-specific planning and activities will be documented either in an emergency response sampling plan or within a bound field logbook. A record of sampling activities must also be documented in a bound field logbook.

START has developed an emergency response quality assurance sampling plan (ER-QASP) for soil and water sampling. This ER-QASP will be used for all emergency response situations that require soil sampling and analysis. When possible, this sampling plan will be completed before the sample collection. In all cases, it will be completed within 30 days of the emergency response sampling event. The ER-QASP comprises four sections: "Background," "Objectives," "Sampling and Analysis Methodology," and "Project Organization and Responsibilities." The ER-QASP, the START QAPP, and the DQOs are intended to meet the EPA, Region 9, planning requirements for emergency response situations.

Before sample collection, the emergency responders should review sampling procedures and relevant QA/quality control (QC) requirements for selected analytical methods.

General Design

The May 28, 2003 sampling event is designed as directed by H. Allen of the ERT. 5 samples per test pit will be collected as follows: 1 sample will be collected from the center of each pit and 1 sample will be collected from half-way between the center and each corner of the pit. Approximately the first 4 inches of soil will be moved aside and an 8-ounce jar will be filled with underlying soil using a dedicated plastic scoop. Two duplicated samples will also be collected. The duplicate samples will be homogenized prior to being split into two samples.

The sampling plan for this project is also specified in the site's emergency response sampling plan (see Attachment I).

Attachment I

EPA Emergency Response Section and Superfund Technical Assistant and Response Team (START)

Emergency Response Quality Assurance Sampling Plan for Soil and Water Sampling

Response Location: Gila River Toxaphene Boundary Site
Date: May 6, 2004
Prepared by: Sara Dwight
Reviewed By: Cindy McLeod
Approved By (OSC):

This emergency sampling plan is intended to be used in conjunction with the EPA's Emergency Response Section's Generic Data Quality Objectives for Emergency Responses and Time Critical Evaluations. This sampling plan has been designed to assist field responders in their preparation for collecting, analyzing, shipping, storing and handling samples collected during an emergency response. The use of this generic sampling plan will involve forethought and planning that should help direct the sampling and analytical work. It is meant to be used in the case of emergency responses or time-critical responses when sampling teams may not have the opportunity to write a more thorough sampling plan. Sampling teams should always reference standard quality procedures, standard operations procedures and standard methods for additional sampling and analytical guidance.

The development of this generic plan will improve the documentation, communication, planning, and overall quality associated with the sampling and analysis by:

1) encouraging field teams to consider their goals and objectives before the generation of environmental data,
2) creating a common written emergency plan format for field sampling teams
3) increasing communication between sampling personnel and decision makers, and
4) detailing expectations before samples are collected.

1.0 Introduction and Background. *What is the problem, what precipitated the response, which agencies and companies are on site, who has taken the lead for the response and for environmental clean-up actions? Describe the site and specify the geographic boundaries for the area of concern (AOC).*

The site is located at the boundary of the Gila River Indian Community (GRIC) along the west side of 51st street near the intersection of 51st and Komatke Lane. Crop dusters used the site as a base of operations from 1959 until the early 1980's and routinely "blew out" residual pesticides after landing on an airstrip formerly located on the site. Elevated levels of toxaphene were documented in shallow soils at the site, and with the surrounding area undergoing increased development, the GRIC was concerned that the site poses an exposure risk to human health and the environment.

After multiple phases of investigation and removal work on the site and a bioremediation pilot test study, the EPA constructed full-scale bioremediation treatment cells at the site in an effort to reduce toxaphene concentrations to below the site action level of 17 mg/kg. EPA OSC Harry Allen IV, Harry Allen III of ERT, and START personnel oversaw the installation of the treatment cells in April-May 2004. The treatment cells each measure 142 feet x 22 feet x 9 feet. The cells were lined with plastic and amendments (bloodmeal, sodium phosphate, and starch) were added to soil. The soil/amendments mixture was placed in the cells and the cells were then filled with water and sealed. Excavation of contaminated soil and construction of cells is not complete at this time; therefore the exact number of treatment cells hass not yet determined.

2.0 Objectives. *Brief statement on the general project objective. What is the overall goal or objective? Specific objectives are summarized in Table A.*

The sampling objective is to make a comparison between the T=0 samples collected when the treatment cells were installed and the T=6 months samples to determine the percent decrease in toxaphene concentrations. The overall objective of the bioremediation treatment cells is to reduce toxaphene concentrations at the site to below the action level of 17 mg/kg.

ERS/START:
Soil and Water Emergency QASP

2.1 Data Use Objectives. (How will the data be used?)

Check Appropriate Box(es):
Data that are generated will be used:

1 X To be compared with a background or reference sample(s).

2 ☐ To be compared with an available detection or quantification level.

3 ☐ To assist in determining the presence or absence of a hazardous material or substance at levels above an available detection or quantification level.

4 ☐ To assist with determining the area of impact due to a hazardous material release. (i.e horizontal and lateral).

5 X To be compared with site-specific action levels or risk-based action levels (e.g., EPA PRGs) to assist in determination if health threats exist.

6 ☐ As definitive confirmatory data for non-definitive (screening) data.

7 ☐ Other objectives: _____

_____

2.2 Sampling Objectives. (What are you proposing to do?)

1 ☐ Soil sampling to determine only the presence or absence of a hazardous substance over entire site.

2 ☐ Soil sampling to determine: ☐ contamination levels ☐ contaminated area(s) over entire site.

3 ☐ Areal soil sampling to determine the location of hot spots over entire site.

4 ☐ Areal soil sampling to determine the lateral extent of contamination
☐ of a source area ☐ over entire site.

5 ☐ Sub-surface soil sampling to determine the vertical extent of contamination
☐ of a source area ☐ over entire site.

6 ☐ Off-site soil sampling to: _____

7 ☐ On-site water sampling to only determine the presence or absence of a hazardous substance.

8 ☐ On-site water sampling to determine: ☐ contamination levels ☐ contaminated area(s)

9 ☐ Off-site water sampling to: _____

10 ☐ Perimeter water sampling to: _____

11 X Other objectives: Sampling of bioremediation treatment cells in order to determine rates of concentration decrease

2.3 Data Categories

In general, the quality of the data should be known and documented prior to use. The U.S. EPA has divided data into two categories: definitive methodology data (generally laboratory data using EPA methods), and non-definitive methodology data (also referred to as screening data) with conformation of 10% by definitive methodology. An additional category referred to as screening data is usable in emergency situations where definitive data is not available. Note that the data category is not an indicator of precision or accuracy! It is only a practical indicator of QA/QC documentation. Refer to the START QAPP for specific DQO parameters. Reported data can be verified (by a party other than the laboratory) as meeting quality control and data category requirements by following a verification or validation procedure.

Check appropriate box(es):

1 X Screening category data will be generated. **The data by itself may not be verifiable. Due to the time critical situation, the data must be reported and used for comparison.**

2a ☐ Screening data with 10 percent definitive category data will be generated. Data using non-definitive analytical methodologies will be used for comparison to action levels. The data by itself may not be verifiable. **Due to the time critical situation, the data must be reported and used for comparison prior to generation of definitive data.** Screening data will be evaluated and reported with definitive category data at a later time.

2b ☐ Screening data with 10 percent definitive category data will be generated. Data using non-definitive analytical methodologies will be used for comparison to action levels. The data by itself may not be verifiable. **Data will not be reported until it is evaluated against definitive category data.**

3a ☐ Definitive category data will be generated. The sampling must be done on an emergency basis. **Due to the time critical situation, the data must be reported and used for comparison without validation. A analytical data packages will be required. However, since the data is not intended to be used for decision making, validation of the data package will not be performed.** (Document generic DQO deviation in section 4.4)

3b ☐ Definitive category data will be will be generated. The sampling must be done on an emergency basis. **Due to the time critical situation, the data must be preliminarily reported and used for comparison without validation. The generated analytical documentation packages will be reviewed and validated. Qualified data will be reported.**

3c ☐ Definitive category data will be will be generated. **Full documentation will be required. Analytical Data Packages will be reviewed and validated prior to reporting.**

Table A
Data Objectives and Sample Collection

Sample Location Refer to Section 3.3.1	Data Use Objective(s) Refer to Section 2.1	Data Category Refer to Section 2.3	Analytical Method Refer to Section 3.1	Number of Samples & Matrix (soil or water)
Treatment Cells	T=0 sample taken for reference; Compare T=6 months sample to T=0 sample	Screening	Toxaphene, EPA Method 8081	TBD: 1 sample per sample port, estimated 3 samples per cell. Matrix = soil

2.4 Contaminants of Concern

Potential contaminants of concern (COC), proposed analytical method, proposed action limits and available reporting limit are summarized in Table B.

Table B

Potential COC	Proposed Analytical Method	Proposed Action Level	Available Reporting Limit
Toxaphene	EPA Method 8081	Toxaphene concentration of 17 mg/kg	1 ppm
Other Data Collection Activity (non-chemical) *(circle all that apply)*	GPS Visual Interviews Magnetometer Other Goephysical Modeling Photography File Search		

Add additional pages if necessary.

3.0 Approach and Sampling Methodologies

3.1 Sampling Approach

Indicate sampling approaches to be used (circle approaches).

Judgmental Random Grid Transect Search-Grid

If you indicated search-grid, specify contamination parameters (circle one for each parameter).

Grid Type: Square Triangle Rectangle

Size of Hot-spot to be detected:_____

Shape of Hot-spot: Circle Elliptical Elongated-Elliptical

Required Grid Spacing :_____

Acceptable probability of missing Hot-spot: 5 % 10 % 20% 40%

3.2 Field Sampling and Field Analysis Equipment

Field Analysis Equipment. Specify the field analytical procedures to be used. Check the appropriate boxes.

Instruments and Test Kits:

- ☐ X-ray Fluorescence (XRF) Device [for metals]
- ☐ Hanby Oil Analysis Kit [for oils]
- ☐ Immunoassay Test Kits [pesticides, oils, chlorinated substances]
- ☐ Chlor-n-soil/chlor-n-oil test kits[PCBs, chlorinated substances]
- ☐ pH Meter
- ☐ Enzytech field test kits [for pesticides]
- ☐ Pensky-Martins flash point test
- ☐ Radiation Meter (such as Victoreen)
  for ~, β _____ , γ _____
- ☐ Other field equipment or test kits, as listed below:

_____

_____

Field equipment requirements are summarized in Table C.

Table C
Field Sampling Equipment and Decontamination

Analyses and Matrix	Sampling Equipment	Dedicated or Reusable	Decontamination Solution	Resource/ Contractor
Toxaphene in soil	8-ounce jars, plastic sampling scoops, PVC sampling thieves	Dedicated	N/A	N/A

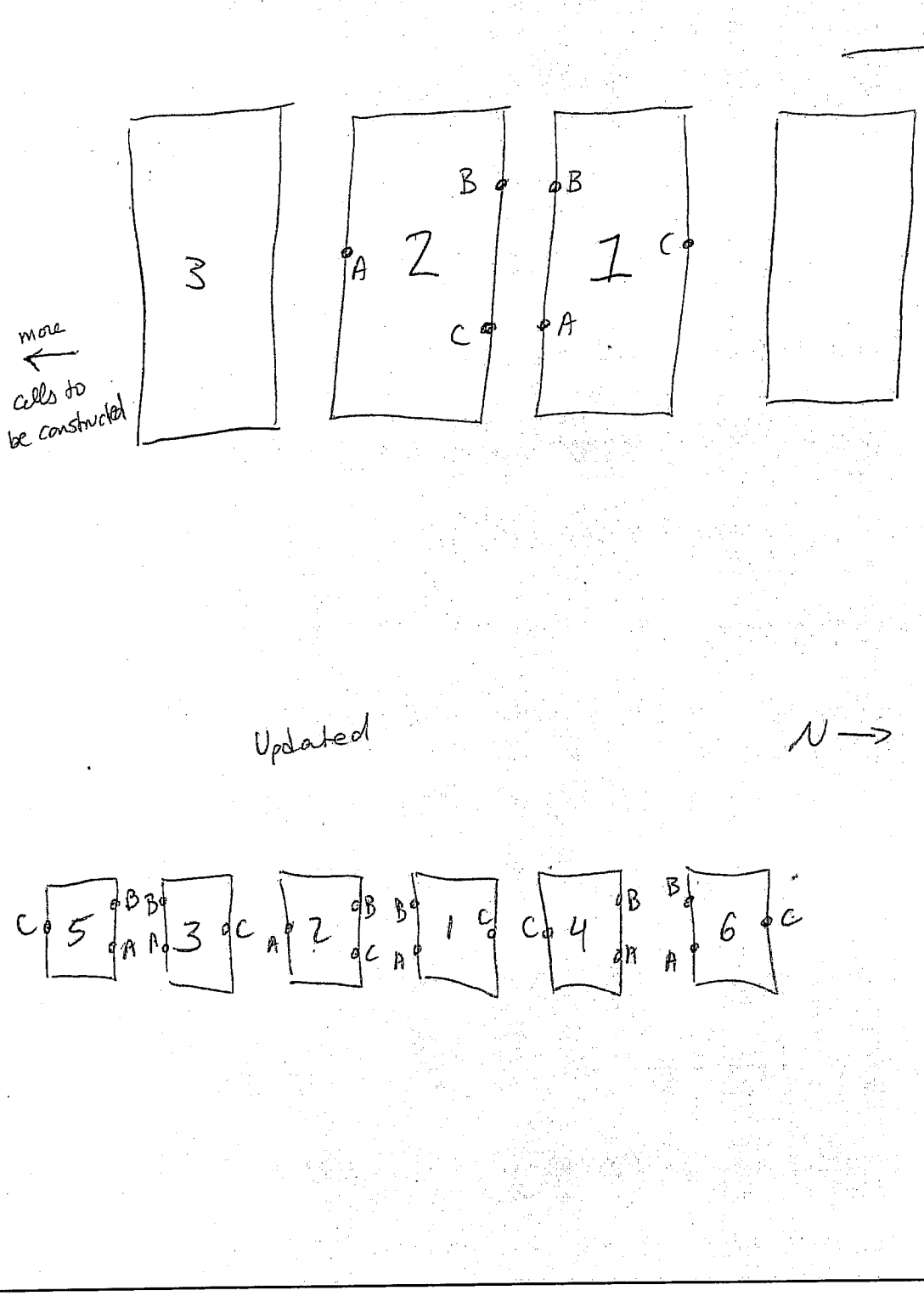
3.3 Field Methods and Procedures

3.3.1 Sample Location. Describe the rationale for the sample locations chosen.

Three sampling ports will be installed in each treatment cell. These sampling ports will be accessed using approximately ~~8~~ 15 -foot long 1.5" diameter PVC sampling thieves so as obtain a sample consisting of different depths to better characterize the concentrations in the treatment cell. One sample will be collected per sampling port for a total of three samples per cell. The number of cells is not yet determined. Contents will be homogenized in plastic bag and then placed in 8oz jar w/ plastic scoop. 6 cells will be sampled.

Sketch a map of the sampling area in Figure A. Use a scale that is meaningful for the sampling work covered under this plan. Sketch out where the samples will be collected. Attach a local map to this plan if it is available.

Figure A
Sample Location Map



3.3.2 Sample Labeling and Documentation

Sample Jar Labels

Sample labs will clearly identify the particular sample, and should include the following:

1. Site name and number.
2. Time and date samples were taken.
3. Sample preservation.
4. Analysis requested.
5. Sample location.

Sample labels will be securely affixed to the sample container.

Chain of Custody Record

A Chain of Custody record will be maintained from the time the sample is taken to its final deposition. Every transfer of custody must be noted and signed for, and a copy of this record kept by each individual who has signed. When samples (or groups of samples) are not under direct control of the individual responsible for them, they must be stored in a locked container sealed with a Custody Seal.

The Chain of Custody record should include (at minimum) the following:

1. Sample identification number.
2. Sample information.
3. Sample location.
4. Sample date.
5. Names(s) and signature(s) of sampler(s).
6. Signature(s) of any individual(s) with control over samples.

Custody Seals

Custody Seals demonstrate that a sample container has not been tampered with, or opened. The individual in possession of the sample(s) will sign and date the seal, affixing it in such a manner that the container cannot be opened without breaking the seal. The name of this individual, along with a description of the samples' packaging, will be noted in the field book.

All sample documents will be completed legibly, in ink. Any corrections or revisions will be made by lining through the incorrect entry and by initialing the error. These include the soil and water sampling logbook, the chain-of-custody forms, this field QASP and any other forms.

Field Logbook

The field logbook is essentially a descriptive notebook detailing site activities and observations so that an accurate account of field procedures can be reconstructed in the writer's absence. All entries will be dated and signed by the individuals making the entries, and will include the following:

1. Site name and project number.
2. Names of sampling personnel.
3. Dates and times of all entries (military time preferred).
4. Descriptions of all site activities, especially sampling start and ending times. Include site entry and exit times.
5. Noteworthy events and discussions.
6. Weather conditions.
7. Site observations.
8. Identification and description of samples and locations.
9. Subcontractor information and names of on-site personnel.
10. Date and time of sample collections, along with chain of custody information.
11. Record of photographs.
12. Site sketches.
13. Meteorological data: Wind speed, wind direction, relative humidity.
14. Times: Exact times of various activities and occurrences related to sampling.
15. Changes from standard procedures or methods: The rational should also be given with the change.

3.3.3 Sample Containers and Preservatives

Containers and preservatives are summarized in Table D.

Table D Containers and Preservatives			
Analyses and Matrix	**Container Type (per sample)**	**Preservation Method**	**Holding Time**
Toxaphene in Soil	8-ounce jars	ice	14-day

3.4 Schedule of Sampling Activities

Sampling activities are summarized in Table E.

Table E Proposed Schedule of Work For Soil/Water Sampling Activities		
Activity	Start Date	End Date
Test plot sampling	May 11, 2004	TBD

3.5 Analytical Methods and Procedures

The analytical methods to be used are presented in Table A. General field QC considerations and requirements are presented in Table F.

Table F
Quality Control Samples and Data Quality Indicator Goals

QC Sample	Number/Frequency	Data Quality Indicator Goals & Evaluation Criteria	Comments/Exceptions *Site specific remarks:*
FIELD SPECIFIED QA/QC			
Background or reference sample. N/A	At least one sample should be collected from an area believed to be unaffected by source contamination.	Source samples should be at least 3 times background.	Surface soil: up-slope. Surface water: upstream. Ground water: up-gradient. :
Field Blanks N/A	1 per SDG[1], per matrix, per method	Source samples should be at least 3 times the blank.	Water only. :
Travel Blanks N/A	1 per SDG, per matrix, per method	Source samples should be at least 3 times the blank.	Volatile analytes, water only. :
Equipment Blanks N/A	1 per SDG, per matrix, per method	Source samples should be at least 3 times the blank.	Only when the use of decontaminated non-dedicated equipment is involved. :
Field Duplicates or Replicates	1 per SDG, per matrix, per method 2 duplicates; samples and their duplicates will be homogenized and then split into 2 samples	50 to 200 RPD[2]	As needed by sampling objectives. The procedure for collecting duplicate samples can greatly effect the reproducibility. :2
Performance Standards N/A	1 per project, per matrix, per method	75 -125 %R[3]	If available. :
SELECTED LABORATORY QA/AC			
Method Blank	1 per SDG, per matrix, per method	Stds and samples should be at least 3 times the blank.	Mandatory.
Matrix Spike	1 per SDG, per matrix, per method on field designated sample.	75 -125 %R	Designate sample on COC.
Matrix Spike Duplicate or Replicate	1 per SDG, per matrix, per method on field designated sample.	≤50 RPD for organics; ≤20 RPD for metals	Designate sample on COC.
Reference Standards	1 per SDG, per matrix, per method	75 -125 %R	If available.
Internal Standards	All samples	50 -200 %R	All GC/MS and some GC analyses only.
Laboratory Control Standards	1 per SDG, per matrix, per method	75 - 125 %R	Per method for organic analyses.

[1] SDG = Sample Delivery Group (Maximum 20 samples)
[2] RPD = Relative Percent Difference
[3] %R = Percent Recovery

3.6 Project Laboratories

Laboratories used for this project are summarized in Table G.

Table G Laboratories	
Lab Name/ Location	Methods
Lockheed Martin REAC, New Jersey	Toxaphene by EPA Method 8081

4.0 Project Organization and Responsibilities

4.1 Project personnel and responsibilities are summarized in Table H.

Table H Sample Team(s) Personnel	
Personnel (Agency)	Responsibility
Sara Dwight (START)	Sampler

4.2 Modification or additions to the generic DQO output statements for this project are summarized in Table I. Also indicate which DQO step corresponds to the addition or modification.

Table I	
Additions or Modifications to the Generic DQO Output Statements	**DQO Step**

Add additional pages if necessary.

Addendum to the Emergency Response Quality Assurance Sampling Plan (ER QASP) for Soil and Water Sampling - Gila River Toxaphene Boundary Site, Dated May 4, 2004

Purpose of Addendum

The purpose of this addendum is to address additional soil samples requested by the USEPA after the bioremediation treatment cells are decommissioned. The requested sampling is to be conducted at the Gila River Toxaphene Boundary Site the week of January 31, 2005.

Planned Sampling Activities

Post-treatment sampling of the six treatment cells at the Gila River Toxaphene Boundary Site.

Objective of Sampling

The objective of sampling is to determine and document toxaphene concentrations in the treatment cells after they are decommissioned to reinforce the findings that the soil has been cleaned up to below the site action level. Previous treatment cell samples were collected from sampling ports; during this event, samples will be collected from different locations within the treatment cells to allow for a comparison of toxaphene concentrations across the cells, as well as provide end-of-treatment reference data.

Action Level

The action level, 17 milligrams per kilogram (mg/kg), for this sampling event is the same as that for previous treatment cell sampling events at the site.

Sampling Design

Three sampling ports were installed in each treatment cell at the site for periodic monitoring of bioremediation progress. Samples collected from the treatment cells prior to this sampling event were from obtained from these set locations. For this sampling event, the USEPA has requested that a sample be collected directly opposite from each sampling port; that is, the sample locations for this event will be a mirror image of the previous locations.

Methods and Procedures

To remain consistent with previous treatment cell sampling events, samples will be collected in the manner described in the ER QASP, with two exceptions: sampling ports will not be installed at the new sample locations, and the length of PVC sampling pipe used will be shortened to 10 feet as the additional 5 feet was used to compensate for the height of the sampling ports. The sampling procedure is as follows: Samples will be collected using 10 feet of 1.5-inch diameter PVC piping ("sampling thief"). The sampling thief will be inserted into the soil in the treatment cell at approximately the same angle as the sampling ports and the same amount of material will be collected as was obtained in previous sampling events. The contents of the sampling thief will be homogenized in a plastic bag and then placed in an 8-ounce glass jar with a disposable plastic scoop.

Analytical Methods

Definitive analysis of soil samples will be by EPA method 8081. Samples will be shipped to Lockheed

Martin, USEPA's REAC contractor, in Edison, New Jersey for toxaphene analysis.

Sample Numbering

Sample numbering will be consistent with the numbering system used for previous sampling events: the first three letters of the sampling month, followed by the cell number and a letter designation of the sample location. In this case, the letters D, E, and F will be used to represent the sample location within the cells, and their location relative to the sampling ports will be documented in the site logbook.

QA/QC

All QA/QC procedures as described in the START ER QASP will apply to this sampling event.

United States Environmental Protection Agency, Region 9
Emergency Response Section
Data Quality Objectives Process Document
for
Soil Sampling
Gila River Toxaphene Boundary Site Removal
Bioremediation Treatment Cells

BACKGROUND

Requirements

The generic data quality objectives (DQOs) presented in this document are based on typical technical and project directives encountered by the United States Environmental Protection Agency, (EPA) Region 9, Emergency Response Section (ERS) and the Ecology and Environment, Inc., Superfund Technical Assessment and Response Team (START) in emergency responses that involve releases to soil. The ERS and START planning process for an emergency response involving soil contamination is reflected in this DQO document. This document, coupled with site-specific output statements, as documented in an emergency response sampling plan (see Attachment I), is intended to meet the EPA's DQO process requirements as stated in the ERS quality management plan (QMP) and START's quality assurance project plan (QAPP). The following requirements and preconditions must be fulfilled to effectively implement these DQOs:

- The emergency responders must be familiar with all types of soil sampling procedures and possess sufficient emergency response experience and training to make emergency sampling design decisions.
- The emergency responders must be sufficiently prepared and organized for emergency response situations in order to implement the planning, mobilization, and communications necessary to support expeditious sampling, analyses, and decision making.
- The emergency responders must be familiar with the START QAPP and/or the ERS QMP.
- The emergency responders must be familiar with the EPA's DQO process and the information and objectives indicted in this generic DQO document. The emergency responders must document any additional DQO information and DQO modifications.
- Before any sample collection, the emergency responders must determine site-specific assessment parameters as indicated in the emergency response sampling plan (see Attachment I).
- All DQO-related information not specified in this DQO document or the emergency response sampling plan must be recorded in other project documentation (e.g., sampling plans, logbooks, action memos, or pollution reports).

STEP 1.
THE PROBLEM

Background for an Emergency Response Soil Sampling Project

The EPA ERS was notified that a release to soil that may pose a significant imminent threat to human health and/or the environment has been identified. The location of the contaminated soil is within the EPA, Region 9. Because of the nature of the perceived threat, the investigation must proceed immediately. There may be no available data regarding the types of contaminants, or the specific location, extent, or magnitude of soil contamination.

Planning Team

Primary Decision Maker:	H. Allen (OSC)
Plan Development:	C. McLeod and S. Dwight (START) and OSC Allen
Plan Approval:	OSC Allen
On-Scene Assistance:	N/A
Supplemental Remote or On-Scene Support:	C. McLeod & S. Dwight (START), REAC analytical service provider, H. Allen (EPA Emergency Response Team (ERT))

The names and affiliations of the actual planning team will be documented in the field logbook or in the emergency response sampling plan.

Conceptual Site Model

- A description of the site and a list of the potential contaminants of concern (COCs) are provided in the site's emergency response sampling plan (see Attachment I).
- The medium of concern is soil. This medium will include surface soil, subsurface soil, and sediments either in place or in piles.

Exposure Scenario

- Toxaphene concentrations on site have evaluated by the EPA, Region 9, and have been determined to pose an imminent threat to human health and/or the environment.
- Concerns include migration of contaminants from soil to other media and direct exposure of human and/or environmental receptors to soil contaminants.

Resources

This is an emergency response under the technical direction of the EPA ERS. Labor resources for the sampling effort include:

- START personnel with a removal/treatment cell sampling budget.

Analytical service resources include the following:

- The REAC laboratory will perform sample analyses.

Resource Constraints

N/A

STEP 2.
THE DECISION

Principal Study Questions

Primary Questions:

1) Did the concentrations of toxaphene in the treatment cells decrease compared to the T=0 sample concentrations?

2) Did the concentrations of toxaphene in the treatment cells decrease to levels below 17 mg/kg?

Actions that Could Result from the Resolution of Study Questions

1) The EPA would continue with the bioremediation treatment cell effort without any changes.
2) The EPA would continue with the bioremediation treatment cell effort after making changes.
3) The EPA would consider the site to have met cleanup standards and decommission the cells.

Decision Statements (Directives)

- COC is toxaphene; action level for evaluating percent decrease is toxaphene concentration at T=0.
- COC is toxaphene; action level for evaluating the need to continue treatment is 17 mg/kg.

STEP 3.
DECISION INPUTS

Specific Data Required

- Toxaphene concentrations in samples collected at T=0 days and T=6 months after the installation of the treatment cells.

Sources for Study Information

- Treatment cell sampling events.

Information Needed to Establish Action Level

- Toxaphene concentrations in samples collected by START at T=0 days.

Confirm that Measurement Methods Exist to Provide Data

- The REAC laboratory has developed analytical methods for measuring toxaphene.
- Analytical methods for this project are specified in the site's emergency response sampling plan (see Attachment I).

STEP 4.
STUDY BOUNDARIES

Specify Characteristics that Define the Population Being Studied

- The approximate COC concentrations in soil in each treatment cell.

Geographic Boundary of Investigation

- The geographic boundary for this sampling event is the boundary of the treatment cells.

Temporal Boundary of Investigation

- The data generated from a specific sampling event represents concentrations only on that day, as bioremediation is an active process.

Other Constraints on Data Collection

- Severe weather

STEP 5.
DECISION RULE

Statistical Parameter

The Decision Unit for this sampling event is each individual sampling point.

Action Levels

The action levels are specified in the emergency response sampling plan (see Attachment I). The action level is the concentration of toxaphene in the T=0 days samples.

Decision Rules

- If toxaphene concentrations in soil samples collected from the treatment cells at T=6months have decreased (compared to the T=0 samples) then no ERT action will be required.
- If a significant decrease in toxaphene concentrations from the samples taken at T=0 days to T=6 months is not observed, possible ERT action will be required.
- If toxaphene concentrations in soil samples collected from the treatment cells at T=6months are below 17 mg/kg, possible ERT action will be required.

STEP 6.
LIMITS ON DECISION ERRORS

Range of the Parameters of Interest

The COC concentrations may range from nondetect to 1,000 ppm.

The Null Hypothesis or Baseline Condition

Toxaphene concentrations in samples collected from the treatment cells at T=6 months have decreased relative to samples collected at T=0.

Alternative Hypothesis

Toxaphene concentrations in samples collected from the treatment cells at T=6 months have not decreased relative to samples collected at T=0.

Decision Errors

DECISION ERRORS Soil Emergency Response		
Decision Error	Deciding that the sample concentration exceeds the action level when it does not.	Deciding that the sample concentration does not exceed the action level when it does.
True Nature of Decision Error	The sample concentration does not exceed the action level.	The sample concentration does exceed the action level.
The Consequence of Error	Areas of soil represented by the sample will undergo additional investigation or may be immediately excavated or treated. Each situation would cost the EPA, Region 9, additional resources of time, money, and manpower.	1) The community could be directly exposed to COCs in areas of contaminated soil. Exposure would be an imminent threat to human health and the environment. 2) The COCs in areas of contaminated soil could migrate from the soil to a drinking or agricultural water source. Exposure would be an imminent threat to human health. 3) The COCs in soil could migrate from soil to air. Exposure would be an imminent threat to human health and the environment. 4) The COCs in areas of contaminated soil could migrate from soil to sensitive environments. Exposure would be an imminent threat to the environment.
Which Decision Error Has More Severe Consequences near the Action Level?	**LESS SEVERE**	**MORE SEVERE** because the contaminated soil may pose risks to human health and/or the environment.
Error Type Based on Consequences	**False Negative Decision** A decision that the soil contaminant concentrations are greater than the action level when they actually are not.	**False Positive Decision** A decision that the soil contaminant concentrations are less than the action level when they actually are greater.

Definitions
False Negative Decision = A false negative decision error occurs when the null hypothesis is not rejected when it is false.
False Positive Decision = A false positive decision error occurs when the null hypothesis is rejected when it is true.
See the EPA document titled, *Guidance for the Data Quality Objective Process*, Chapter 6, (EPA QA/G-4) for additional guidance regarding decision error.

Decision Error Limits Goals

Decision Error Limits Goals for Emergency Responses		
True Concentration of Sample (% of Action Level)	**Typical Decision Error Probability Goals (Based on Professional Judgment)**	**Type of Decision Error**
0–75	Less than 5%	False negative
75–99	Gray area[1]	False negative
100–120	10%–50%[2]	False positive
120-150	5%–10%[2]	False positive
150–200	Less than 5%	False positive
>200	Very small	False positive
The goals in this table are based on professional judgment as relevant to a typical emergency response for soil contamination. Specific project goals may vary with the situation.		
[1] *Gray area* is where relatively large decision errors are acceptable. [2] Note that large decision errors are expected when the true contaminant concentrations are 100% to 150% of the action level.		

STEP 7.
DESIGN FOR OBTAINING DATA

All sampling, analytical, and QA activities will proceed under the START QAPP and documents referenced therein. All site-specific planning and activities will be documented either in an emergency response sampling plan or within a bound field logbook. A record of sampling activities must also be documented in a bound field logbook.

START has developed an emergency response quality assurance sampling plan (ER-QASP) for soil and water sampling. This ER-QASP will be used for all emergency response situations that require soil sampling and analysis. When possible, this sampling plan will be completed before the sample collection. In all cases, it will be completed within 30 days of the emergency response sampling event. The ER-QASP comprises four sections: "Background," "Objectives," "Sampling and Analysis Methodology," and "Project Organization and Responsibilities." The ER-QASP, the START QAPP, and the DQOs are intended to meet the EPA, Region 9, planning requirements for emergency response situations.

Before sample collection, the emergency responders should review sampling procedures and relevant QA/quality control (QC) requirements for selected analytical methods.

General Design

The T=0 and T=6 month sampling events are designed as directed by H. Allen of the ERT. Three samples per treatment cell (one sample per sampling port) will be collected as follows: a dedicated sampling thief will be inserted into each sampling port and a column of soil will be withdrawn. The soil will be placed in a ziploc bag for homogenization and then transferred to an 8-oz. glass sampling jar using a dedicated plastic scoop. Duplicate samples will be collected at a rate of one duplicate sample for every 10 samples. Duplicate samples will be homogenized prior to being split into two samples.

The sampling plan for this project is also specified in the site's emergency response sampling plan (see Attachment I).

APPENDIX B
Photodocumentation

ECOLOGY AND ENVIRONMENT, INC.
Superfund Technical Assessment and Response Team
Gila River Toxaphene Boundary Site Removal
Gila River Indian Community, Pinal County, Arizona

Project No.: 0518.01RZ TDD No.: 09-04-12-0014
Photographer: S. Dwight Date: 8/7/03 & 11/12/03

Photo 1: Original pilot test plots A, B, and C.

Photo 2: OSC Allen and START Johnson seal the edges of pilot test plots A, B, and D.

ECOLOGY AND ENVIRONMENT, INC.
Superfund Technical Assessment and Response Team
Gila River Toxaphene Boundary Site Removal
Gila River Indian Community, Pinal County, Arizona

Project No.: 0518.01RZ TDD No.: 09-04-12-0014
Photographer: S. Dwight Date: 4/19/04

Photo 3: Stockpile of toxaphene-contaminated soil awaiting treatment.

Photo 4: Four-foot deep excavation area on the Thomas Homesite.

ECOLOGY AND ENVIRONMENT, INC.
Superfund Technical Assessment and Response Team
Gila River Toxaphene Boundary Site Removal
Gila River Indian Community, Pinal County, Arizona

Project No.: 0518.01RZ TDD No.: 09-04-12-0014
Photographer: S. Dwight Date: 4/23/04 & 5/11/04

Photo 5: Treatment cell construction: pugmill and sieve in operation.

Photo 6: Addition of soil, nutrients, and water to treatment cell.

ECOLOGY AND ENVIRONMENT, INC.
Superfund Technical Assessment and Response Team
Gila River Toxaphene Boundary Site Removal
Gila River Indian Community, Pinal County, Arizona

Project No.: 0518.01RZ TDD No.: 09-04-12-0014
Photographer: S. Dwight Date: 9/27/04 & 5/27/04

Photo 7: Completed treatment cells with sampling ports, looking north.

Photo 8: START Baker sampling treatment cells.