WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

INTERIM ACTION REPORT
WEST SIDE HIGH SCHOOL
WENATCHEE, WASHINGTON

October 30, 2006

Prepared by Washington State Department of Ecology
Toxics Cleanup Program
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1.0 INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

The purpose of this report is to detail cleanup activities conducted at West Side High School (Site) during the summer of 2006.

1.2 AREA WIDE INTRODUCTION

Area-wide soil contamination is defined as contamination with concentrations above state cleanup levels that is dispersed over a large geographic area. The soil contamination in this case is a result of central Washington's orchard industry. Much of the region consists of current or former orchard land, where long-term pesticide application has taken its toll. Lead-arsenate, a pesticide commonly used between 1905 and 1947 to control the coddling moth, has been identified as the primary source of increased lead and arsenic concentrations.

Due to their chemical structure, lead and arsenic tend to bond with soil particles and often remain at or near ground surface level for decades, creating an exposure pathway through inhalation and/or ingestion.

Although lead and arsenic are naturally occurring elements, elevated concentrations have been proven to have a negative impact on human health. Young children are generally more susceptible than adults, which is why Ecology has focused remediation efforts on schools.

Because of the expansive nature of area-wide contamination, traditional methods of remediation are not feasible. Therefore, the Area-Wide Soil Contamination Task Force was established in 2002 to identify and pursue effective statewide strategies. Recommendations from the Task Force included soil testing, qualitative evaluations, and protective measures at child-use areas.

In the central Washington region, Okanogan, Chelan, Douglas, and Yakima counties were targeted based on the large volume of apple and pear production during the first half of the 20th century. Aerial photography from 1927 and 1947 that showed a high number of school properties located on former orchard land in the Wenatchee area. Therefore, Ecology's Central Regional Office (CRO) began initial sampling and analysis during the spring of 2002.

Sampling results from the Wenatchee area showed several schools with lead and arsenic concentrations exceeding state cleanup standards. Based on these results, soil testing was implemented in the four priority counties. Over 100 public schools were tested for lead and arsenic during the summer of 2005. Of the schools sampled, Ecology's CRO identified 35 schools with soil contamination exceeding state cleanup standards.

The 35 schools were then prioritized for remedial activities. Remedial activities started during the summer of 2006. Four Wenatchee area schools, including West Side High School, were chosen for initial activities due to close proximity between properties and summer break schedule. North Omak Elementary, Brewster High School, Manson Elementary, and Naches

Intermediate were chosen for remediation following completion of soil excavation and mixing activities in Wenatchee. Yakima area schools are currently scheduled for remediation in 2007.

2.0 SITE DESCRIPTION

West Side High School is located at 1521 9th Street in the City of Wenatchee in Chelan County, Washington. More specifically, the site is located at 47º43'25"N and -120º3'83" (GPS Coordinates) in the SE ¼ of the NW ¼ of Section 4, Township 22 North, Range 20 East. The site is approximately 1¾ mile west of the State Highway 285 as it extents north-south through downtown Wenatchee and 3 miles south of State Highway 97. See the vicinity map in Appendix A.

Situated on the eastern boundary of the Wenatchee Mountains, this location is approximately 780 feet above sea level within the Wenatchee Valley. Mission Ridge is located approximately 7 miles west of the site and the Columbia River is located about 1 ¼ mile east of the site. Relief is between 0% and 5% across the site. Ecology well log records suggest depth to groundwater is about 36 feet below ground surface. Groundwater will generally flow east toward the Columbia River.

According to the United States Department of Agriculture (USDA) Soil Survey of Chelan Area Washington, local soils are described as Burch loam. Burch soils were generally formed in valley fill and are primarily derived from sandstone. Burch soils are generally well-drained and composed of medium-textured and moderately coarse material. Burch loam is commonly found on flat terraces and orchard cultivation is common.

The Soil Survey describes the following soil horizons:

- At 0-8 inches below ground surface (bgs) soil consists of a grayish-brown loam. Soil is has a weak, fine-medium grained granular structure and is considered slightly hard, friable, slightly sticky and slightly plastic. Well impregnated with fine roots with few fine tubular pores. Soil has a neutral pH.
- At 8-17 inches bgs, soil is brown loam with a weak, medium, prismatic structure. Soil is slightly hard, friable, slightly sticky and slightly plastic. Well impregnated with fine roots and fine tubular pores. Neutral pH.
- Between 17 and 26 inches bgs soil is brown loam with a weak, medium, prismatic structure. Soil is hard, friable, slightly sticky and slightly plastic. Well impregnated with fine roots and very fine tubular pores. Neutral pH.
- At 26-36 inches bgs soil becomes yellowish-brown loam that is slightly hard and has homogeneous texture. Soil is very friable and non-sticky and non-plastic. Soil is well impregnated with fine roots and fine tubular pores. Neutral pH.
- At 33-60 inches bgs soil is yellowish-brown loam that is slightly hard and has homogeneous texture. Soil is very friable, slightly sticky and slightly plastic. Fine roots are uncommon. Many fine tubular pores. Neutral pH.

During excavation and deep mixing activities, soil appeared generally as described above.

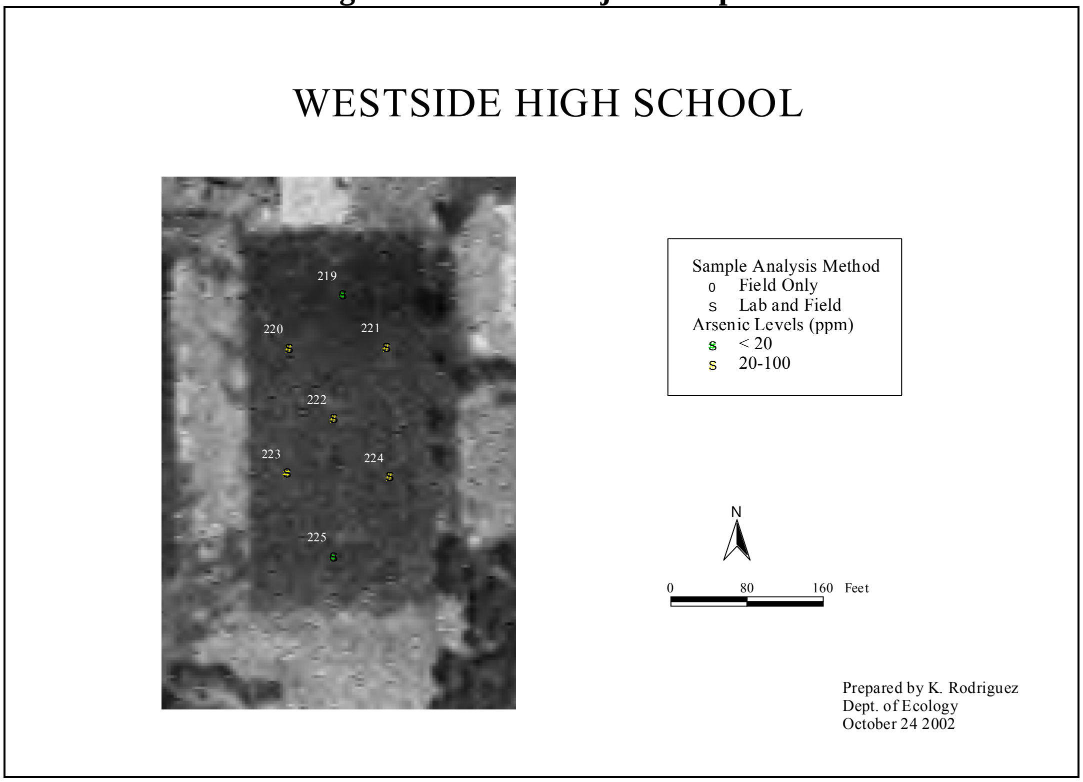
3.0 SITE HISTORY

According to the Wenatchee School District, West Side High School was occupied by orchards prior to 1949. In 1949, Wenatchee Valley College (WVC) began accumulating ownership of this and other surrounding properties as necessary to expand its campus. WVC developed the property for student housing and retained ownership until 1986, when the Wenatchee School District purchased the property for re-development as the West Side High School campus. The purchase included a renovated dorm building, now used as classroom space, and the adjacent recreation field.

West Side High School was identified as a candidate for area-wide cleanup in 2002 as part of a pilot project being completed by Ecology's Central Regional Office (CRO). The project focused on devising appropriate sampling and analytical methods for historic orchard land currently being used as a public school or childcare facility. West Side was selected to participate in the study based on analysis of aerial photos from 1947 that indicated the school property was formerly occupied by an orchard. Soil analysis results showed lead and arsenic contamination in excess of MTCA Method A cleanup levels.

The following figure illustrates analytical results from the 2002 pilot project. Five of seven samples collected at West Side High School contained lead and arsenic concentrations exceeding Ecology MTCA Method A cleanup levels. Samples were analyzed by portable x-ray fluorescence (XRF) unit and laboratory verified by inductively coupled plasma (ICP). For an explanation of XRF technology, its impact to Area-Wide cleanup efforts, and comparison of XRF accuracy to the standard ICP laboratory method, see Appendix B.

Figure 3-1: Pilot Project Samples



Although results from pilot project sampling identified the need for soil remediation, work was delayed until area-wide cleanup efforts began in 2006. At that time, further soil sampling was conducted to better delineate soil contamination across the property. Analysis of 17 samples collected randomly across the property identified 13 samples that exceeded Method A cleanup levels for arsenic. Two samples were in excess of Method A cleanup levels for lead.

4.0 SITE CONTACT INFORMATION

This project was contracted through an interagency agreement between Ecology and the Wenatchee School District (WSD). All contracts were operated by the WSD and invoices were submitted to Ecology for reimbursement. Contractual and planning phases of the project were reviewed by the WSD prior to beginning field operations. Bryan Vischer provided final approval on all field work completed by contractors. Ecology maintained contact with Wenatchee School District staff throughout the remedial process to maintain a positive working relationship and exchange information as needed.

CBA Environmental was contracted for deep soil mixing and served as the General Contractor for all school sites in the WSD. George Williams was the onsite representative for CBA Environmental and was responsible for managing deep mixing operations and other general contractor activities. Smith Excavation completed all soil moving activities and Mountain View Landscaping completed all irrigation and landscaping work. WSD Maintenance & Operations staff were often onsite to provide information and suggestions as needed.

The following table contains contact information for individuals responsible for various roles in the completion of remedial activities.

Table 4-1: Contacts

Name	Organization	Position	Phone Number
Les Vandervort	Wenatchee School District	Chief Financial Officer	(509) 663-8161
Bryan Vischer	Wenatchee School District	Maintenance & Operations Director	(509) 663-0555
Pam Peer	Wenatchee School District	Maintenance & Operations Secretary	(509) 663-0555
George Williams	CBA Environmental	Deep Mixing Contractor/GC	(570) 682-8742
Greg Smith	Smith Excavation	Excavation and Hauling	(509) 782-0446
Mike Stubblefield	Mountain View Landscaping	Landscaping & Irrigation	(509) 663-3168
Chet Harum	West Side High School	Principal	(509) 663-7947

5.0

6.0 REMEDIAL PROCESS

5.1 RISK

The most common exposure pathways for lead and arsenic in soil include inhalation, ingestion, and dermal absorption. It is important to note that ingestion is not considered as an exposure pathway in the site hazard assessment ranking method. For the purpose of this cleanup, ingestion was determined to be the primary exposure pathway, particularly in the case of young children. Metals in dust or soil can be ingested accidentally by hand-to-mouth activity. Pica behavior in young children, that is, eating of non-food items, will increase this exposure. Ingestion or inhalations of wind-blown soil or dust are additional pathways of exposure to lead and arsenic. Children are considered a sensitive population because they tend to ingest more soil and dust than adults and because they tend to absorb more of the lead they ingest. Metals are not readily absorbed through the skin, so dermal absorption of metals is not a significant concern at the concentrations found at schools in the area-wide cleanup program.

Evidence of groundwater contamination or the threat of groundwater contamination has not been found relative to area wide lead and arsenic contamination. Extensive soil profile sampling in Central Washington has demonstrated that lead and arsenic contamination does not extend below 30 inches bgs in undisturbed situations. Concentrations of arsenic above 50 parts per million (ppm) and concentrations of lead above 250 ppm were not found below 12 inches bgs. These results may vary in climates with more precipitation, but in this region, the findings were very consistent. Due to the depth of groundwater found in the vicinity of the school, combined with the distribution of the contamination, the risk of lead and arsenic contamination in groundwater is minimal.

5.2 REMEDIAL PROCESS

5.2.1 SAFETY AND HEALTH

Throughout the construction process, the site was restricted from public access by a 6-foot high chain link fence. The contractor was required to provide a site specific Health & Safety Plan (HSP) for the site construction activities. All personnel working at the site were responsible for reading and understanding the HSP.

5.2.2 DUST CONTROL PLAN

The contactor was required to control dust and to prepare a dust control plan. Dust control measures at a minimum included a water truck.

5.2.3 REMEDIAL ACTIVITIES

The West Side High School sports field was picked as the first site to conduct a full scale deep mixing remedial action for the summer of 2006. Based on existing sampling data, West Side appeared to be an ideal candidate for the deep mixing technology. Lead and arsenic were found at relatively low concentrations, which allowed for the entire site to be blended without the excavation and removal of hot spots. The entire site was open and square which allows the deep mixer to run in long straight rows and maximize efficiency. These factors made West Side a good location to fine tune our remedial process and work through unexpected challenges that might arise. In addition, this sports field is used for football and soccer practice. The nature of football and soccer tend to disturb turf more than typical playground activities. This increases the risk of soil ingestion, which is the primary risk factor for lead and arsenic contamination in soil.

The deep mixing technology was supplied by CBA Environmental Inc. (CBA) from Hegins, Pennsylvania. The deep mixer is a piece of heavy equipment manufactured by Vermeer Manufacturing and modified by CBA for the purpose of deep soil mixing. The machine is track mounted and weighs between 50 and 120 tons depending on model. A large rotating drum mounted on the front of the machine is lowered to a maximum depth of 4.5 feet bgs where it rotates and mixes the soil. It travels at average speeds between 4 and 8 feet per minute and typically covers between ⅓ and ½ acre per day. Studies conducted by Ecology and CBA have shown a mixing efficiency between 70% and 95% depending on soil types. After the deep mixer has made a mixing pass, a windrow of overburden is deposited next to the mixed soil. This overburden is created as a result of the decompaction caused by deep mixing.

Prior to beginning deep mixing, it was decided that deep soil profile samples should collected down to a depth of 36 inches bgs to confirm that no abnormalities existed in the vertical distribution of lead and arsenic. This additional sampling indicated that re-grading had occurred since lead and arsenic application had occurred. Lead and arsenic distribution did not follow the patterns found after normal pesticide application. The lower 1/3 of the field had consistent lead and arsenic concentrations above MTCA cleanup levels from the surface to depths up to 30 inches bgs. It appears that when the field was re-graded, the contaminated topsoil was cut from the west side and used as fill on the east side. This soil could not be successfully mixed without redistributing the contaminant load. It was determined that substantial amounts of soil needed to be moved from the east side of the field to the west side to recreate an even distribution of the contamination. After redistributing the contamination, soil mixing took place without incident.

Soil sampling was conducted continuously throughout the remedial process. Samples were collected directly from the deep mixing rows with a clean nitrile glove and placed in a new, clean, sealed plastic bag. Sample collection was varied between the overburden row and various depths in the mixing row itself. As the deep mixer completed each row, that row was sampled and analyzed to ensure the mixing was successful in reducing contaminant levels below MTCA standards. In the event that lead and arsenic levels were not reduced below MTCA cleanup standards, a row could be remixed with deeper soils to reduce concentrations further. No re-mixing was required at West Side.

Due to the rocky soils found at the site, between 3 and 5 inches of clean topsoil was brought in after deep mixing to create a safer, higher quality playing field. The topsoil was tested prior to import and was found to have no detectable lead concentrations and arsenic concentrations at typical background levels of less than 10 ppm.

5.3 SAMPLE RESULTS

Remedial activities at West Side High School were successful in reducing the majority of lead and arsenic concentrations below MTCA cleanup levels for unrestricted land use. There were several samples that exceeded MTCA cleanup levels for arsenic, though none were twice the cleanup level. Of the 154 samples collected after remediation, 11 exceeded MTCA cleanup levels. Statistical analysis indicates that less than 10% of samples exceed MTCA standards. According to MTCA cleanup guidelines, a site may be considered clean if no more than 10% of samples exceed MTCA cleanup levels and no samples are greater than twice MTCA cleanup levels. Based on these guidelines, no further action is required for the site.

Pre-remediation arsenic samples had an average concentration of 40 ppm and a maximum concentration of 85 ppm. Pre-remediation lead samples had an average concentration of 134 ppm and a maximum concentration of 702 ppm. Post-remediation arsenic samples had an average concentration of 17 ppm and maximum concentration of 33 ppm. Post-remediation lead samples had an average concentration of 75 ppm and a maximum concentration of 192 ppm. The tables below contain pre and post remediation sample data. Maps containing a general representation of this data are available in Appendix C.

Table 5-1: Pre-Remediation Samples

<u>MTCA Method A</u>
<u>Soil Cleanup Levels</u>

As- 20ppm

Pb- 250ppm

Date	As	Pb	Location	Sample ID
26-May-06	**23.17**	**312.09**	West Side	W-bank 1
26-May-06	**22.38**	**217.98**	West Side	W-bank 2
26-May-06	**31.97**	**48.2**	West Side	W-bank 2 6-9
26-May-06	**50.06**	**116.87**	West Side	W-bank 3 1-4
26-May-06	**31.2**	**18.76**	West Side	W-bank 3 6-9
26-May-06	**76.99**	**295.19**	West Side	W-t-1
26-May-06	**42.61**	**113.75**	West Side	W-t-2
26-May-06	**47.01**	**158.1**	West Side	W-t-3
26-May-06	**46.52**	**108.77**	West Side	W-t-4
26-May-06	**44.6**	**133.14**	West Side	W-t-4 12-16
26-May-06	**37.79**	**165.23**	West Side	W-t-5 2-6
26-May-06	**37.15**	**136.58**	West Side	W-5 15-18
26-May-06	**40.29**	**34.16**	West Side	W-6 20-22
26-May-06	**47.58**	**19**	West Side	W-6 28-32
26-May-06	**46.05**	**47.7**	West Side	W-t-6 20-24
26-May-06	**85.73**	**702.3**	West Side	W-t-6 12-15
26-May-06	**51.28**	**181.28**	West Side	W-t-6 0-3
26-May-06	**13.21**	**17.49**	West Side	W-t-7 32-34
26-May-06	**13.41**	**17.94**	West Side	W-t-7 20-24
26-May-06	**40.05**	**110.14**	West Side	W-t-7 15-18

Date	As	Pb	Location	Sample ID
26-May-06	**35.85**	**446.83**	West Side	W-t-7 4-8
26-May-06	**16.61**	**65.46**	West Side	W-t-8
26-May-06	**14.85**	**44.19**	West Side	W-
26-May-06	**13.33**	**18.47**	West Side	W-t-9 20-24
26-May-06	**13.63**	**18.63**	West Side	W-t-9 12-16
26-May-06	**44.66**	**127.24**	West Side	W-t-9 0-3
26-May-06	**15.52**	**48.53**	West Side	W-t-9
30-May-06	**61.42**	**180.1**	West Side	W-t-10 3-6
30-May-06	**57.94**	**301.59**	West Side	W-t-10 12-16
30-May-06	**79.73**	**394.38**	West Side	W-t-10 18-22
30-May-06	**29.54**	**36.85**	West Side	W-t-11 15-18
1-Jun-06	**31.78**	**103.37**	West Side	W-t preschool 1
1-Jun-06	**80.39**	**399.2**	West Side	W-t preschool 2
1-Jun-06	**56.42**	**257.68**	West Side	W-t preschool 3
1-Jun-06	**17.73**	**139.45**	West Side	W-t preschool 4
30-May-06	**34.88**	**17.3**	West Side	W-t-11 unmixed 24"
30-May-06	**49.98**	**233.75**	West Side	W-t-11 unmixed 1
30-May-06	**31.19**	**111.27**	West Side	W-t-12 unmixed 30"
30-May-06	**35.31**	**120.5**	West Side	W-t-13 unmixed 24"
30-May-06	**36.19**	**31.97**	West Side	W-t-13 unmixed 24"
30-May-06	**43.85**	**104.31**	West Side	W-t-14 unmixed 1
30-May-06	**12.94**	**17.92**	West Side	W-t-14 unmixed 2
30-May-06	**37.15**	**98.44**	West Side	W-t-14 unmixed 3
30-May-06	**39.43**	**152.92**	West Side	W-t-14 unmixed 4
30-May-06	**37.97**	**52.4**	West Side	W-t-14 unmixed 5
30-May-06	**50.05**	**170.71**	West Side	W-t-14 unmixed 6
30-May-06	**34.24**	**58.96**	West Side	W-t-15 unmixed 1
30-May-06	**37.09**	**103.35**	West Side	W-t-15 unmixed 1
30-May-06	**46.56**	**152.5**	West Side	W-t-15 unmixed 2
30-May-06	**21.63**	**17.74**	West Side	W-t-15 unmixed 3
30-May-06	**12.84**	**17.71**	West Side	W-t-15 unmixed 4
30-May-06	**51.55**	**100.03**	West Side	W-t-15 unmixed 5
31-May-06	**39.03**	**154.69**	West Side	W-t-16 unmixed 1
31-May-06	**37.4**	**135.59**	West Side	W-t-16 unmixed 2
31-May-06	**45.8**	**166.69**	West Side	W-t-16 unmixed 3
31-May-06	**52.89**	**153.07**	West Side	W-t-16 unmixed 4
31-May-06	**43.96**	**143.37**	West Side	W-t-16 unmixed 5
31-May-06	**38.09**	**126.86**	West Side	W-t-16 unmixed 6
31-May-06	**46.99**	**209.72**	West Side	W-t-16 unmixed 7
31-May-06	**40.7**	**173.56**	West Side	W-t-16 unmixed 8
31-May-06	**39.2**	**61.94**	West Side	W-t-17 unmixed 1
31-May-06	**40.96**	**56.72**	West Side	W-t-17 unmixed 2
31-May-06	**48.32**	**123.32**	West Side	W-t-17 unmixed 3
31-May-06	**41.24**	**160.04**	West Side	W-t-17 unmixed 4
31-May-06	**52.42**	**117.4**	West Side	W-t-17 unmixed 5

Date	As	Pb	Location	Sample ID
31-May-06	**47.61**	**132.45**	West Side	W-t-18 unmixed 1
31-May-06	**41.06**	**84.85**	West Side	W-t-18 unmixed 2
31-May-06	**39.62**	**160.28**	West Side	W-t-18 unmixed 3
31-May-06	**51.04**	**147.24**	West Side	W-t-18 unmixed 4
31-May-06	**39.52**	**112.71**	West Side	W-t-18 unmixed 5
31-May-06	**28.03**	**18.13**	West Side	W-t-19 unmixed 1
31-May-06	**65.5**	**140.98**	West Side	W-t-19 unmixed 2
31-May-06	**40.45**	**85.93**	West Side	W-t-19 unmixed 3
Average	**40.15**	**133.75**		
Maximum	**85.73**	**702.3**		

Table 5-2: Post-Remediation Samples

Date	As	Pb	Location	Sample ID
30-May-06	**22.13**	**81.40**	West Side	W-t-11 mixed 1
30-May-06	**17.11**	**69.87**	West Side	W-t-11 mixed 2
30-May-06	**16.55**	**52.72**	West Side	W-t-11 mixed 3
30-May-06	**18.45**	**110.14**	West Side	W-t-11 mixed 4
30-May-06	**18.61**	**188.80**	West Side	W-t-11 mixed 5
30-May-06	**14.89**	**132.21**	West Side	W-t-11 mixed 6
30-May-06	**32.19**	**71.99**	West Side	W-t-11 mixed 7
30-May-06	**16.88**	**60.41**	West Side	W-t-11 Mixed 8
30-May-06	**13.83**	**77.03**	West Side	W-t-11 mixed 9
30-May-06	**15.47**	**66.14**	West Side	W-t-11 mixed 11
30-May-06	**18.40**	**108.43**	West Side	W-t-12 mixed 1
30-May-06	**16.48**	**184.36**	West Side	W-t-12 mixed 2
30-May-06	**14.56**	**33.89**	West Side	W-t-12 mixed 3
30-May-06	**15.21**	**47.68**	West Side	W-t-12 mixed 4
30-May-06	**20.62**	**37.47**	West Side	W-t-12 mixed 5
30-May-06	**17.67**	**111.63**	West Side	W-t-12 mixed 6
30-May-06	**25.11**	**116.62**	West Side	W-t-12 mixed 7
30-May-06	**19.43**	**67.68**	West Side	W-t-12 mixed 8
30-May-06	**14.89**	**21.45**	West Side	W-t-12 mixed 9
30-May-06	**18.84**	**82.75**	West Side	W-t-12 mixed 11
30-May-06	**17.29**	**58.56**	West Side	W-t-12 mixed 12
30-May-06	**14.19**	**116.92**	West Side	W-t-13 mixed 1
30-May-06	**16.73**	**44.11**	West Side	W-t-13 mixed 2
30-May-06	**18.21**	**44.50**	West Side	W-t-13 mixed 3
30-May-06	**19.68**	**34.79**	West Side	W-t-13 mixed 4
30-May-06	**18.82**	**39.30**	West Side	W-t-13 mixed 5
30-May-06	**29.10**	**18.11**	West Side	W-t-13 mixed 6
30-May-06	**19.15**	**35.28**	West Side	W-t-13 mixed 7

Date	As	Pb	Location	Sample ID
30-May-06	**14.82**	**30.08**	West Side	W-t-13 mixed 8
30-May-06	**18.06**	**30.99**	West Side	W-t-13 mixed 9
30-May-06	**17.54**	**23.52**	West Side	W-t-13 mixed 10
30-May-06	**14.11**	**103.51**	West Side	W-t-13 mixed 11
30-May-06	**14.98**	**175.80**	West Side	W-t-14 mixed 1
30-May-06	**17.11**	**126.26**	West Side	W-t-14 mixed 2
30-May-06	**14.98**	**151.02**	West Side	W-t-14 mixed 3
30-May-06	**17.34**	**82.37**	West Side	W-t-14 mixed 4
30-May-06	**12.98**	**112.00**	West Side	W-t-14 mixed 5
30-May-06	**12.76**	**16.84**	West Side	W-t-14 mixed 6
30-May-06	**17.99**	**18.00**	West Side	W-t-14 mixed 7
30-May-06	**12.64**	**17.22**	West Side	W-t-14 mixed 8
30-May-06	**20.63**	**81.55**	West Side	W-t-14 mixed 9
30-May-06	**19.59**	**37.68**	West Side	W-t-14 mixed 10
30-May-06	**16.12**	**33.87**	West Side	W-t-14 mixed 11
30-May-06	**15.77**	**192.28**	West Side	W-t-14 mixed 12
30-May-06	**33.28**	**148.60**	West Side	W-t-14 mixed 13
30-May-06	**15.25**	**44.41**	West Side	W-t-15 mixed 1
30-May-06	**17.31**	**51.44**	West Side	W-t-15 mixed 2
30-May-06	**12.83**	**17.99**	West Side	W-t-15 mixed 3
30-May-06	**12.87**	**17.93**	West Side	W-t-15 mixed 4
30-May-06	**12.58**	**17.39**	West Side	W-t-15 mixed 5
30-May-06	**19.67**	**73.54**	West Side	W-t-15 mixed 6
30-May-06	**16.34**	**67.71**	West Side	W-t-15 mixed 7
30-May-06	**13.64**	**65.38**	West Side	W-t-15 mixed 8
30-May-06	**16.14**	**66.27**	West Side	W-t-15 mixed 9
30-May-06	**15.25**	**121.41**	West Side	W-t-15 mixed 10
30-May-06	**12.84**	**131.31**	West Side	W-t-15 mixed 11
31-May-06	**16.65**	**84.15**	West Side	W-t-16 mixed 1
31-May-06	**13.18**	**102.31**	West Side	W-t-16 mixed 2
31-May-06	**18.54**	**45.92**	West Side	W-t-16 mixed 3
31-May-06	**19.23**	**43.85**	West Side	W-t-16 mixed 4
31-May-06	**14.22**	**40.89**	West Side	W-t-16 mixed 5
31-May-06	**17.86**	**54.30**	West Side	W-t-16 mixed 6
31-May-06	**11.58**	**188.67**	West Side	W-t-16 mixed 7
31-May-06	**18.83**	**113.99**	West Side	W-t-16 mixed 8
31-May-06	**15.66**	**76.43**	West Side	W-t-16 mixed 9
31-May-06	**16.19**	**32.72**	West Side	W-t-16 mixed 10
31-May-06	**21.51**	**107.06**	West Side	W-t-17 mixed 1
31-May-06	**18.43**	**42.42**	West Side	W-t-17 mixed 2
31-May-06	**16.05**	**94.00**	West Side	W-t-17 mixed 3
31-May-06	**11.99**	**45.50**	West Side	W-t-17 mixed 4
31-May-06	**14.39**	**82.34**	West Side	W-t-17 mixed 5
31-May-06	**15.94**	**56.92**	West Side	W-t-17 mixed 6
31-May-06	**15.77**	**59.93**	West Side	W-t-17 mixed 7

Date	As	Pb	Location	Sample ID
31-May-06	**17.66**	**146.48**	West Side	W-t-17 mixed
31-May-06	**18.68**	**38.37**	West Side	W-t-17 mixed 9
31-May-06	**15.90**	**38.52**	West Side	W-t-18 mixed 1
31-May-06	**15.35**	**81.94**	West Side	W-t-18 mixed 2
31-May-06	**19.44**	**99.25**	West Side	W-t-18 mixed 3
31-May-06	**13.34**	**112.54**	West Side	W-t-18 mixed 4
31-May-06	**12.87**	**53.58**	West Side	W-t-18 mixed 5
31-May-06	**17.24**	**41.29**	West Side	W-t-18 mixed 6
31-May-06	**13.27**	**32.55**	West Side	W-t-18 mixed 7
31-May-06	**18.44**	**38.59**	West Side	W-t-18 mixed 8
31-May-06	**16.44**	**104.79**	West Side	W-t-18 mixed 9
31-May-06	**19.31**	**118.99**	West Side	W-t-18 mixed 10
31-May-06	**12.83**	**118.70**	West Side	W-t-18 mixed 11
31-May-06	**16.77**	**88.23**	West Side	W-t-19 mixed 1
31-May-06	**14.32**	**56.87**	West Side	W-t-19 mixed 2
31-May-06	**17.93**	**65.74**	West Side	W-t-19 mixed 3
31-May-06	**19.22**	**118.58**	West Side	W-t-19 mixed 4
31-May-06	**14.24**	**106.33**	West Side	W-t-19 mixed 5
31-May-06	**18.22**	**81.98**	West Side	W-t-19 mixed 6
31-May-06	**16.49**	**137.10**	West Side	W-t-19 mixed 7
31-May-06	**15.70**	**103.92**	West Side	W-t-19 mixed 8
31-May-06	**18.30**	**126.12**	West Side	W-t-19 mixed 9
31-May-06	**18.24**	**132.62**	West Side	W-t-19 mixed 10
31-May-06	**19.47**	**122.82**	West Side	W-t-19 mixed 11
31-May-06	**12.67**	**89.25**	West Side	W-t-19 mixed 12
31-May-06	**15.43**	**107.91**	West Side	W-t-19 mixed 13
31-May-06	**15.92**	**41.39**	West Side	W-t-20 mixed 1
31-May-06	**24.23**	**78.26**	West Side	W-t-20 mixed 2
31-May-06	**16.84**	**73.69**	West Side	W-t-20 mixed 3
31-May-06	**17.74**	**82.40**	West Side	W-t-20 mixed 4
31-May-06	**19.65**	**46.71**	West Side	W-t-20 mixed 5
31-May-06	**13.88**	**95.46**	West Side	W-t-20 mixed 6
31-May-06	**15.78**	**58.31**	West Side	W-t-20 mixed 7
31-May-06	**16.30**	**62.71**	West Side	W-t-20 mixed 8
31-May-06	**15.25**	**63.91**	West Side	W-t-20 mixed 9
31-May-06	**12.72**	**91.57**	West Side	W-t-20 mixed 10
1-Jun-06	**17.17**	**76.94**	West Side	W-t-21 mixed 1
1-Jun-06	**18.93**	**45.83**	West Side	W-t-21 mixed 2
1-Jun-06	**20.54**	**63.88**	West Side	W-t-21 mixed 3
1-Jun-06	**17.02**	**53.19**	West Side	W-t-21 mixed 4
1-Jun-06	**13.14**	**48.73**	West Side	W-t-21 mixed 5
1-Jun-06	**16.04**	**36.16**	West Side	W-t-21 mixed 6
1-Jun-06	**18.69**	**90.58**	West Side	W-t-21 mixed 7
1-Jun-06	**12.77**	**69.15**	West Side	W-t-21 mixed 8
1-Jun-06	**12.98**	**75.89**	West Side	W-t-21 mixed 9

Date	As	Pb	Location	Sample ID
1-Jun-06	**12.65**	**81.28**	West Side	W-t-21 mixed 10
1-Jun-06	**18.61**	**124.89**	West Side	W-t-21 mixed 11
1-Jun-06	**12.39**	**53.64**	West Side	W-t-21 mixed 12
1-Jun-06	**13.58**	**72.65**	West Side	W-t 22 mixed 1
1-Jun-06	**19.74**	**37.75**	West Side	W-t 22 mixed 2
1-Jun-06	**18.46**	**42.69**	West Side	W-t 22 mixed 3
1-Jun-06	**16.72**	**70.38**	West Side	W-t 22 mixed 4
1-Jun-06	**14.03**	**18.75**	West Side	W-t 22 mixed 5
1-Jun-06	**14.84**	**25.59**	West Side	W-t 22 mixed 6
1-Jun-06	**18.40**	**55.36**	West Side	W-t-22 mixed 7
1-Jun-06	**16.59**	**78.36**	West Side	W-t 22 mixed 8
1-Jun-06	**17.70**	**41.52**	West Side	W-t 22 mixed 9
1-Jun-06	**14.06**	**66.44**	West Side	W-t 22 mixed 10
1-Jun-06	**14.45**	**68.59**	West Side	W-t 22 mixed 11
1-Jun-06	**18.76**	**67.94**	West Side	W-t 22 mixed 12
1-Jun-06	**15.35**	**45.66**	West Side	W-t 23 mixed 1
1-Jun-06	**11.51**	**92.96**	West Side	W-t 23 mixed 2
1-Jun-06	**19.44**	**55.26**	West Side	W-t 23 mixed 3
1-Jun-06	**17.31**	**63.85**	West Side	W-t 23 mixed 4
1-Jun-06	**15.33**	**42.35**	West Side	W-t 23 mixed 5
1-Jun-06	**20.80**	**82.47**	West Side	W-t 23 mixed 6
1-Jun-06	**18.07**	**58.22**	West Side	W-t 23 mixed 7
1-Jun-06	**13.04**	**82.32**	West Side	W-t 23 mixed 8
1-Jun-06	**15.27**	**106.56**	West Side	W-t 23 mixed 9
1-Jun-06	**16.41**	**106.96**	West Side	W-t 23 mixed 10
1-Jun-06	**12.65**	**38.51**	West Side	W-t 23 mixed 11
1-Jun-06	**15.54**	**70.64**	West Side	W-t-24 mixed 1
1-Jun-06	**16.96**	**91.18**	West Side	W-t-24 mixed 2
1-Jun-06	**16.87**	**98.14**	West Side	W-t-24 mixed 3
1-Jun-06	**16.89**	**53.60**	West Side	W-t-24 mixed 4
1-Jun-06	**16.55**	**73.02**	West Side	W-t-24 mixed 5
1-Jun-06	**15.43**	**73.54**	West Side	W-t-24 mixed 6
1-Jun-06	**18.11**	**104.78**	West Side	W-t-24 mixed 7
1-Jun-06	**19.54**	**70.21**	West Side	W-t-24 mixed 8
1-Jun-06	**14.56**	**67.08**	West Side	W-t-24 mixed 9
1-Jun-06	**15.66**	**89.22**	West Side	W-t-24 mixed 10
Average	**16.74**	**74.88**		
Maximum	**33.28**	**192.28**		

5.4 CONFIRMATIONAL SAMPLING

Though samples were analyzed by XRF continuously during the remedial process, it was decided that several samples should also be collected for certified lab analysis. Certified lab analysis served two purposes: it provided additional third party data to validate remedial activities, and it provided additional data to correlate the relationship between XRF and wet chemistry.

Samples collected for laboratory analysis were collected after all remediation was complete in 2006. A clean soil probe was used to collect a sample from 1-8 inches bgs. This sample was thoroughly mixed in a clean stainless steel bowl to homogenize the sample. The sample was then split into two portions. One portion was placed in a new, clean, sealed plastic bag and analyzed with the XRF. The other portion was placed in a clean, laboratory supplied, glass jar for laboratory analysis. The samples collected for laboratory analysis were then sent under sealed chain-of-custody to CCI Analytical Laboratory in Everett, Washington for lead and arsenic analysis.

The analysis found a correlation coefficient (r2 value) between Innov-X XRF field measurements and Inductively-Coupled Plasma (ICP) laboratory analyses of 0.779 for arsenic and 0.893 for lead. It should be noted that many of the data points were actually method detection limits for samples in which lead or arsenic was not detected. When those non-detect data points are removed, the analysis found that the Innov-X XRF had a correlation coefficient (r2 value) between field and Inductively-Coupled Plasma (ICP) laboratory analyses of 0.838 for arsenic and 0.879 for lead. The samples specific to West Side High School are available in the table below.

Table 5-3: XRF-ICP Split Samples

Date	As Lab	As XRF	Pb Lab	Pb XRF	Sample ID	School
12-Sep-06	**ND**	**ND**	**ND**	**ND**	W-lab-1	West Side
12-Sep-06	**ND**	**ND**	**ND**	**ND**	W-lab-2	West Side
12-Sep-06	**ND**	**ND**	**ND**	**ND**	W-lab-3	West Side
12-Sep-06	**ND**	**ND**	**ND**	**ND**	W-lab-4	West Side
Average	2.15	7.97	2.15	10.36		
Max	2.30	8.64	2.30	10.98		

ND=Non-detect

7.0 PROJECT SUMMARY

Soil samples collected at West Side High School during sampling events in 2002 and 2006 indicated lead and arsenic contamination existed in surface soils at concentrations above MTCA cleanup levels. Deep mixing technology was used to blend the contaminated surface soil with deeper clean soils. As a result, lead and arsenic concentrations at the site were spread throughout a four foot soil profile and the majority of soil on site no longer contains concentrations above MTCA cleanup levels. Though some samples still slightly exceed MTCA cleanup levels, statistical analysis was used to show that fewer than 10% of samples exceeded MTCA cleanup levels and none were twice the MTCA cleanup level. MTCA cleanup guidelines require no further action at a site when these conditions are met. Following remediation, the site was restored to its original condition.

8.0 APPENDICES

Appendix A: Figures

Figure A-1: Vicinity Map

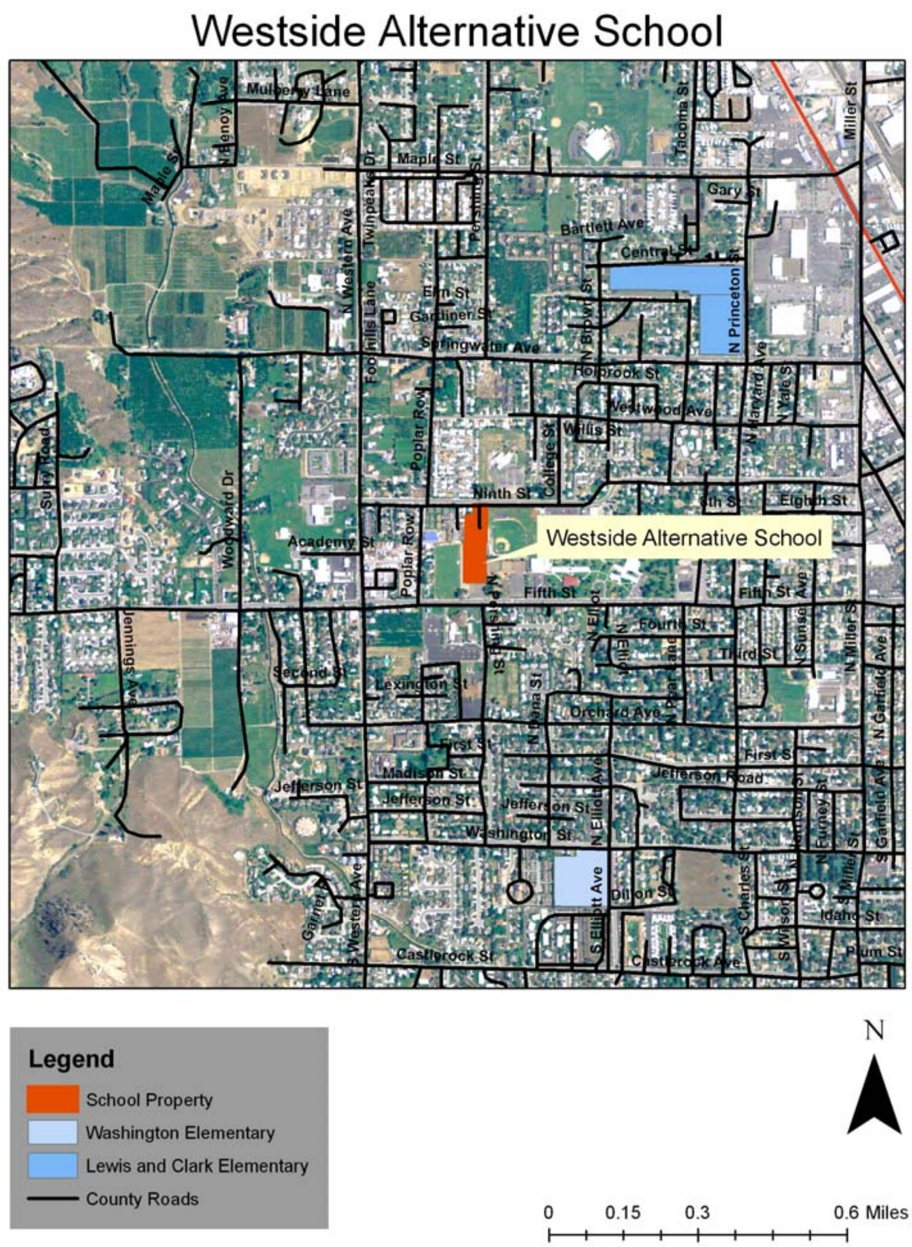


Figure A-2: Pre-Remediation Samples

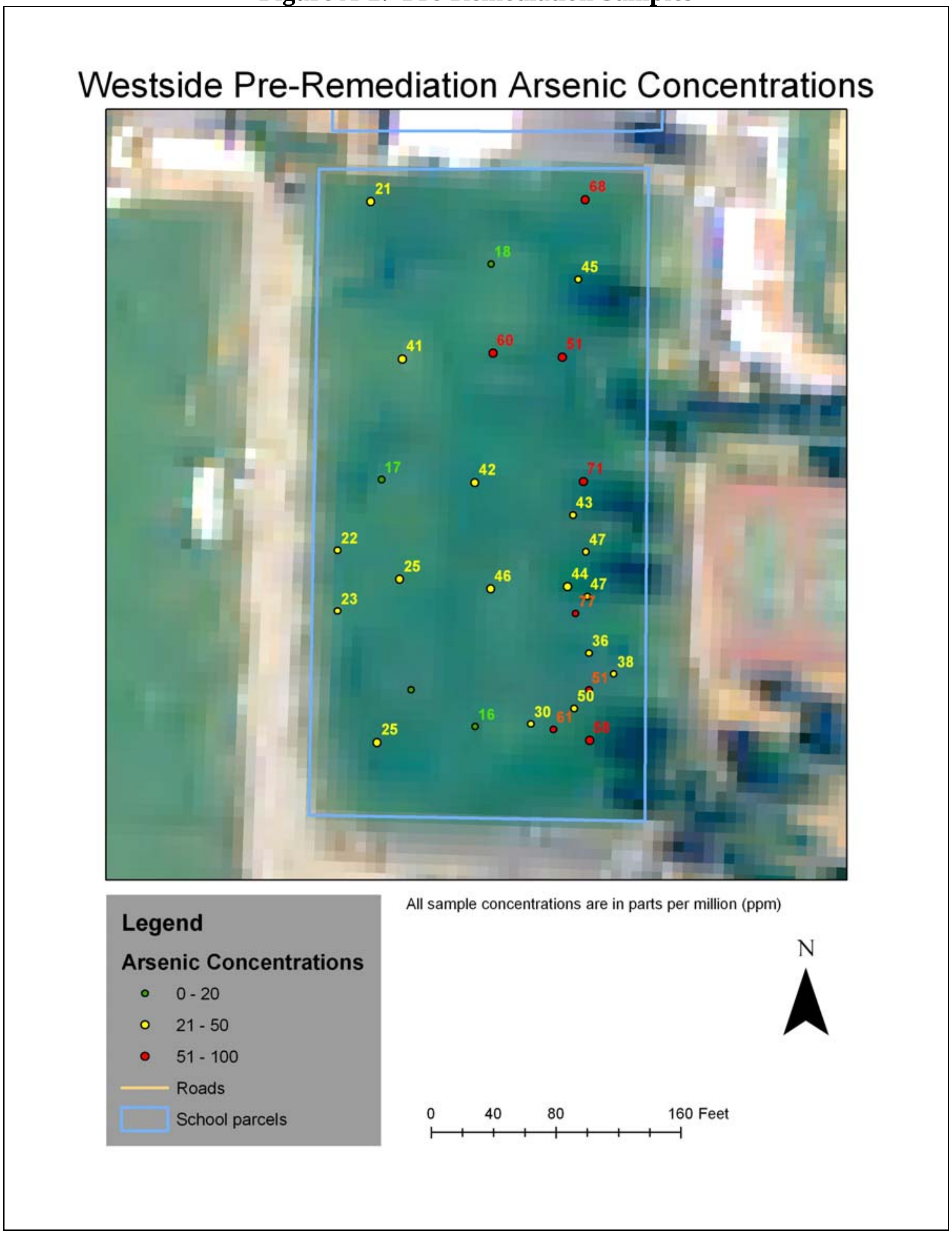


Figure A-3: Post-Remediation Samples

Appendix B: XRF USE

The summer 2006 area-wide contamination clean-up projects involved the collection and analysis of a vast number of soil samples. Concentrations of lead and arsenic in these soil samples provided information as to whether or not an area was contaminated, and this information was used to determine how the remedial activities would proceed. Therefore project staff needed a way to quickly and reliably evaluate soil arsenic and lead concentrations. This was achieved through the use of two portable X-Ray Fluorescence (XRF) Analyzers manufactured by Innov-x Systems.

The instruments use x-ray technology to excite elemental electrons in a soil sample and cause these elements to emit characteristic x-rays. The intensity of these elemental x-rays is then measured to determine the amount of a particular element present in the sample. The entire analysis is performed in approximately one minute and the data is stored in a removable Hewlett-Packard (HP) iPAQ personal data assistant which can transmit the information to a laptop.

The use of portable XRF units for the determination of soil elemental concentrations has been described by EPA Method 6200 and has been found to provide, "a rapid field screening procedure" for site characterization [US EPA]. Results from the study conducted by Ecology in 2002 (as shown in the graphs below) found that a portable Niton XRF had a correlation coefficient (r2 value) between field and Inductively-Coupled Plasma (ICP) laboratory analyses of 0.8057 for lead and 0.933 for arsenic. In addition, a verification study conducted by the EPA Superfund Innovative Technology Evaluation (SITE) Monitoring and Measurement Technology (MMT) Program provides additional support for the use of this technology. The investigation compared an Innov-x XRF model, similar to the one used by Ecology, with reference laboratory data and showed a correlation coefficient of 0.8762 for arsenic and 0.91 for lead [US EPA]. All of this data shows that an XRF can be an effective tool for characterizing large contamination sites.

Figure B-1: 2002 Arsenic Comparison

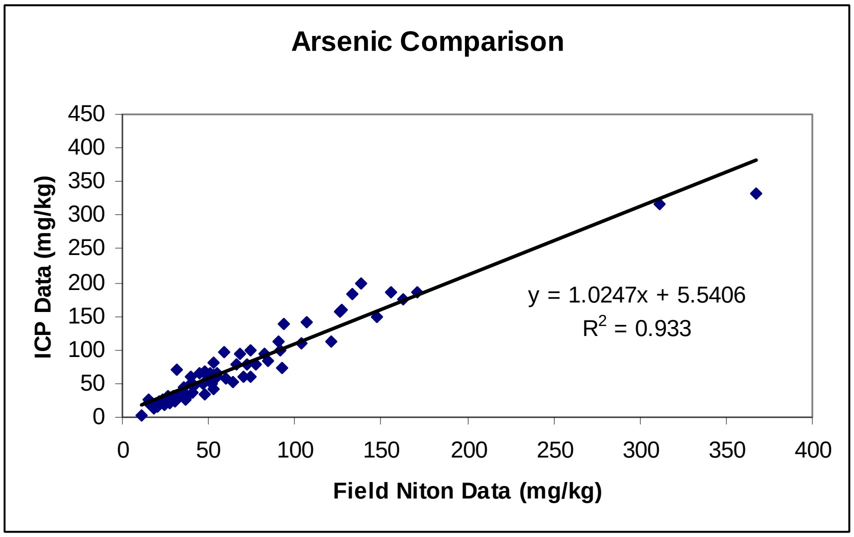
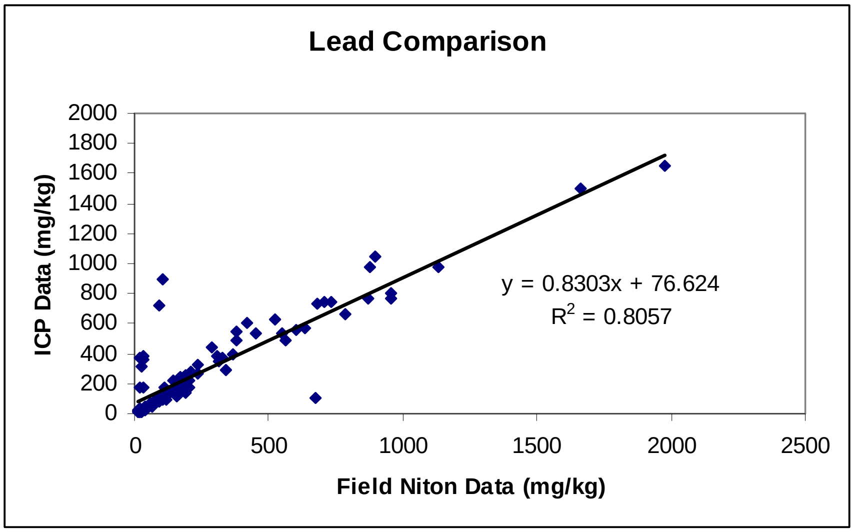


Figure B-2: 2002 Lead Comparison



During the summer 2006 projects, soil samples were collected and analyzed with the XRF instruments from a variety of locations. These locations included: undisturbed portions of the school playfields, sections of the playfields where initial soil excavations had occurred, and areas that had been processed by the deep mixer. As timely decision making was often required to keep the projects on schedule, the ability to assess the effectiveness of remediation activities with on-site soil analysis was invaluable to the overall success of the project. The XRF could determine concentrations of lead and arsenic in minutes. Sending samples for laboratory analysis at standard rates takes 2-3 weeks and would have drastically reduced the efficiency of remedial activities. Real-time results from these field analyses enabled project staff to make decisions such as whether the removal of additional soil was necessary or whether the barrel of the deep mixer should be raised to mix less soil or lowered to mix more.

Following the completion of the remediation projects conducted in 2006, additional samples were collected for comparison between XRF and Lab ICP methods. A total of 95 additional samples were collected and analyzed by both methods. These samples were analyzed by XRF prior to packaging in clean sealed jar. The analysis (as shown in the graphs below) found that the Innov-X XRF had a correlation coefficient (r2 value) between field and Inductively-Coupled Plasma (ICP) laboratory analyses of 0.779 for arsenic and 0.893 for lead. It should be noted that many of the data points were actually detection limits of both analysis methods for samples where lead or arsenic was not detected. When those non-detect data points are removed, the analysis found that the Innov-X XRF had a correlation coefficient (r2 value) between field and Inductively-Coupled Plasma (ICP) laboratory analyses of 0.838 for arsenic and 0.879 for lead.

Figure B-3: 2006 Arsenic Comparison

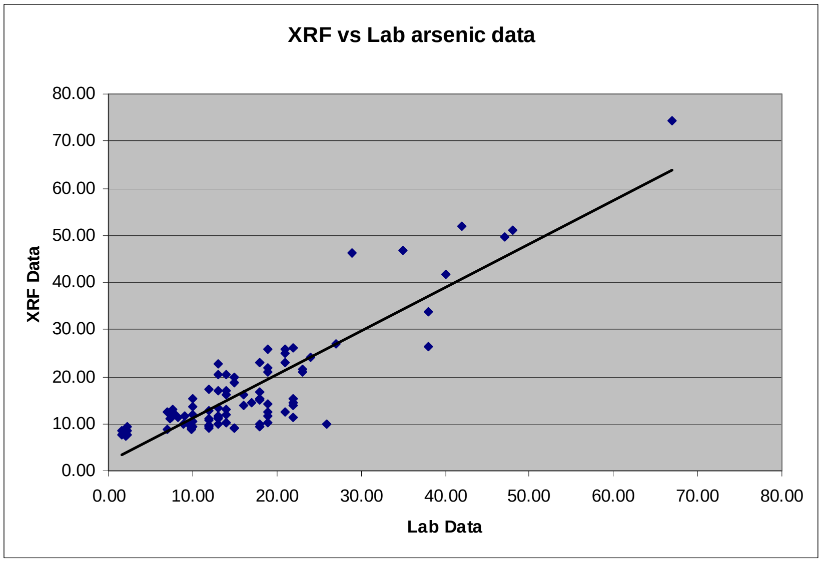
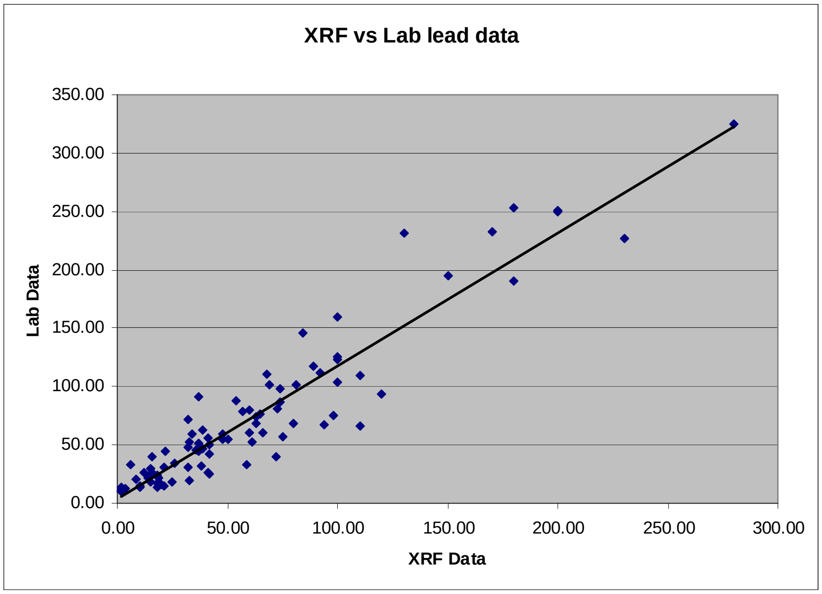


Figure B-4: 2006 Lead Comparison



Project staff followed all safety protocols for use of the XRF instruments including completion of mandatory information and safety trainings before sampling analysis began. In order to reduce health risks associated with radiation exposure, the instruments were operated while in a docking station and careful attention was paid to eliminate direct x-ray exposure. Actual amounts of radiation exposure as regulated by OSHA were monitored with the use of dosimeters which were carried by all sampling personnel.

Finally, in addition to the time saving benefits of the XRF instruments, their use proved to be a cost effective option for sample analysis. Due to the area (total acreage) covered during the school remediation projects, a large number of samples were required to characterize site progress. Use of the instruments resulted in a significant reduction in the number of soil samples sent off for laboratory analysis at a cost of $62-$66 per sample. Therefore, instead of project money being spent on one time analyses, it was invested in a second XRF instrument which enabled remediation work to occur simultaneously in several locations. Not only has the instrument paid for itself over the course of a single summer, but it will now be available for use in many future projects.

Appendix C: COSTS

Remediation costs for West Side High School were higher than anticipated for two primary reasons:

- Previous grading at the site had disturbed the distribution of lead and arsenic, forcing soil to be moved before deep mixing could take place.
- Areas of large rock were encountered during the deep mixing process.

West Side High School Remediation Costs

Mobilization	
Rock Picker	$ 1,636.00
Final Grading	$13,298.00
Deep Mixing Costs	
Deep Mixing	$34,800.00
Excavation Costs	
Shallow Excavation	$ 1,050.00
Landscaping	
New Soil	$19,747.00
Soil Amendments	$ 8,547.00
Raking, Prep, and Hydro-seed	$18,295.00
Irrigation	
New Irrigation System	$25,795.00
Miscellaneous	
Fencing	$ 1,625.00
Total	$124,793
Acres remediated	2.05
Cost per acre	$60,874.30
Square feet remediated	89298
Cost per square foot	$1.40

Appendix D: PHOTO LOG

Photo D-1: Deep mixer in action at West Side

Photo D-2: Pre-School play area post-remediation

Photo D-3: West Side after remediation, grading and hydroseeding

Photo D-4: West Side after germination

Appendix E: BIBLIOGRAPHY

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