PB95-964615
EPA/ROD/R10-95/125
January 1996

EPA Superfund Record of Decision:

Teledyne Wah Chang Albany Site, Surface & Subsurface O.U., Millersburg, OR 9/27/1995

RECORD OF DECISION

DECLARATION, DECISION SUMMARY, AND RESPONSIVENESS SUMMARY

FOR

FINAL REMEDIAL ACTION FOR SURFACE AND SUBSURFACE SOIL

OPERABLE UNIT

TELEDYNE WAH CHANG ALBANY SUPERFUND SITE

MILLERSBURG, OREGON

SITE NAME AND LOCATION

Teledyne Wah Chang Albany
Millersburg, Linn County, Oregon

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial actions for the surface and subsurface soils operable unit at the Teledyne Wah Chang Albany Site (Site or TWCA Site), in Millersburg, Linn County, Oregon, which were chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. §9601 et. seq., and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan, 40 C.F.R. Part 300, Published in 55 Fed. Reg. 8666, et. seq., on March 8, 1990 (NCP). This decision is based on the administrative record for the Site.

The State of Oregon concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response actions selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The remedial actions described below are the final CERCLA response actions planned for the surface and subsurface soil operable unit at the Site. Teledyne Wah Chang Albany is an active operating facility which primarily manufactures zirconium metal from zircon sands. The processing of the zircon sands generates sludge, waste water, residues and gases as by-products. The cleanup actions described in this ROD address the threats to public health posed by radionuclides and their decay products, polychlorinated biphenyls (PCBs), and other contaminants at the Site.

The selected remedy combines source remediation with institutional controls to reduce risks to human health and the environment posed by contaminants in surface and subsurface soil at the TWCA Site. The selected remedy consists of the following:

> Excavation of contaminated material exceeding the gamma radiation action level of 20 μrem/hour above background levels;
>
> Transportation of the excavated material to an appropriate off-site facility for disposal;
>
> For areas of the Site where modelling indicates that radon concentrations in future buildings could exceed 4 pCi/liter, institutional controls requiring that future buildings be constructed using radon resistant construction methods;

Requirement that information on areas of subsurface PCB and radionuclide contamination which do not pose a risk if they are not disturbed, be incorporated into the TWCA facilities maintenance plan, and be made available to future Site purchasers or regulatory agencies;

Because the determination that action is not required for certain areas of the Site is based on scenarios which do not allow unrestricted use, should excavation occur as part of future development of the TWCA Main Plant or the Soil Amendment Area, excavated material must be properly handled and disposed of in accordance with Federal and State laws; and

Institutional controls requiring that land use remain consistent with current industrial zoning.

Except as expressly stated in CERCLA, in the NCP, or in this ROD, this ROD is not designed to address TWCA's ongoing operations or to preclude the need for TWCA's ongoing operations to comply with other environmental laws or regulations. Regulation of TWCA's ongoing operations is covered under RCRA and under other State and Federal environmental laws. Except as otherwise stated in this ROD, determinations in this ROD are intended to apply to Site geographic areas rather than to ongoing plant operations.

The determinations made in this ROD regarding contamination of surface and subsurface soils apply to areas of the Site investigated during the RI/FS, and are based on information from the RI/FS. As TWCA is an active operating facility, some on-site conditions may have changed since the RI/FS. Material placed in CERCLA investigated areas subsequent to the RI/FS sampling may not necessarily be addressed by this ROD, but may be investigated and addressed under RCRA. Similarly, not all excavations on the Site are covered by this ROD.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable. Since treatment of the principal threats posed by the Site is not practicable at this time, it does not satisfy the statutory preference for treatment as a principal element.

Because this remedy will result in hazardous substances remaining on Site above health-based levels, a review will be conducted within five years after commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

9-27-95
Date

Regional Administrator
Environmental Protection Agency
Region 10

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1.0 INTRODUCTION

1.1 Site Name and Location

Teledyne Wah Chang Albany
Millersburg, Oregon

1.2 Lead and Support Agency

The U.S. Environmental Protection Agency (EPA) is the lead agency for this Superfund Site. The State of Oregon, through the Oregon Department of Environmental Quality (ODEQ), has reviewed and concurs with the response activities planned at the Site.

1.3 Administrative Record

This ROD is based on the Administrative Record (AR) for this Site and will become part of the AR file, in accordance with §300.825(a)(2) of the NCP. The AR is available for review at the EPA Regional Office, 1200 Sixth Avenue, Seattle, Washington, 98101, and at the Albany Public Library, in Albany Oregon. An index of the AR is included with this ROD.

2.0 SITE DESCRIPTION

2.1 Setting

The Teledyne Wah Chang Albany Site (Site or TWCA Site) is located in Millersburg, Oregon, an industrial-based community two miles north of downtown Albany (**Figure 2-1**). The Site is approximately 20 miles south of Salem, 65 miles south of Portland, 60 miles east of the Pacific Ocean, and adjacent to the Willamette River. Portions of the TWCA Site are within the river's 100-year and 500-year flood plains.

The TWCA plant is bounded on the east by Old Salem Road and Interstate 5 (I-5). The land east of the plant is used mainly for residential and commercial purposes. The land west of the Willamette River, which forms the western boundary of the plant, is used for agriculture. The land surrounding the Farm Ponds Area to the north of the Main Plant is also used for agricultural purposes.

The city of Albany had a population of approximately 29,000 in 1990; Millersburg had a population of about 700 people. The TWCA Site is located within an area that is zoned for heavy industry. Industrial facilities closest to the TWCA Site include: a particle board plant, a resin plant, a wood flour processing plant, and a closed plywood mill.

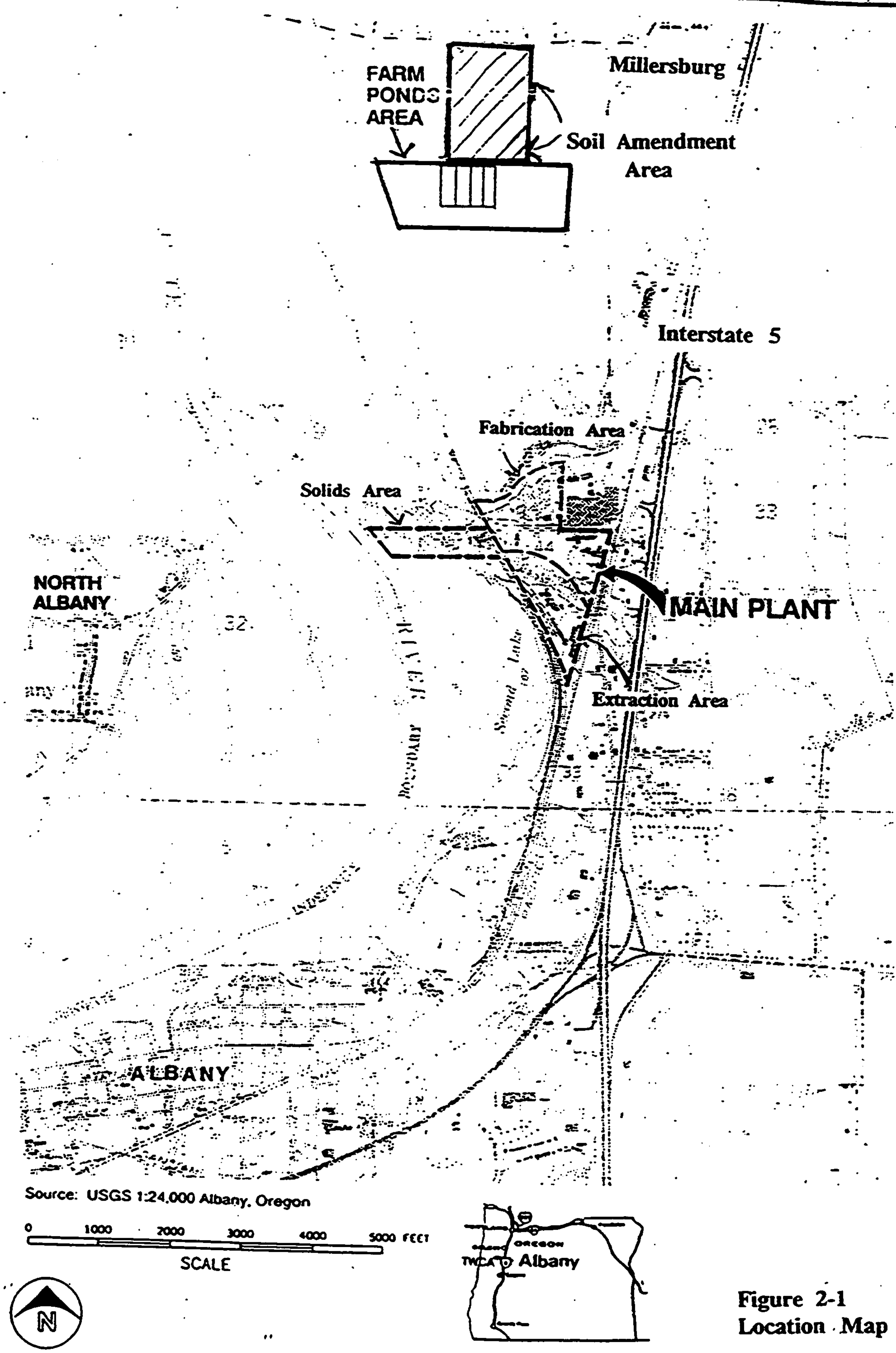


Figure 2-1
Location Map

2.2 Topography

TWCA is located within the broad and relatively flat Willamette Valley which was formed by the Willamette River as it meandered back and forth between the Coast Range mountains to the west and the Cascade Mountains to the east. The ground surface in the vicinity of TWCA slopes westward towards the river with a gradient of approximately 11 feet per mile.

2.3 Land Use

The TWCA Superfund Site covers the 110 acre Main Plant and the 115 acre Farm Ponds Area located 3/4 mile north of the Main Plant (**Figure 2-1**). The Main Plant is organized into the following areas; the Extraction Area (south of Truax Creek), the Fabrication Area (north of Truax Creek), and a Solids Storage Area west of the Burlington Northern Railroad. The Farm Ponds Area contains the plant's wastewater treatment ponds, four 2-1/2 acre solids storage ponds, and the 50 acre Soil Amendment Area. The Soil Amendment Area has been primarily used in the past for agriculture.

3.0 SITE BACKGROUND

3.1 Site History

Teledyne Wah Chang operations at the TWCA Site began in 1956 when, under contract with the U.S. Atomic Energy Commission, Wah Chang Corporation reopened the U.S. Bureau of Mines Zirconium Metal Sponge Pilot Plant. Construction of new facilities, at the location of the existing plant, began in 1957. These facilities were established primarily for the production of zirconium and hafnium sponge; however, tantalum and niobium pilot facilities were also included. Melting and fabrication operations were added in 1959. TWCA was established in 1967 after Teledyne Industries, Inc., purchased the Wah Chang Corporation of New York. In 1971, the plant became a separate corporation, Teledyne Wah Chang Albany.

Beginning in 1957, waste materials from TWCA's processes were placed in unlined ponds on the facility. Examples of unlined ponds used for disposal of waste sludges and other materials in the past include the V-2 Pond, Schmidt Lake, and the Lower River Solids Pond (LRSP) (**Figure 3-1**). From 1972 until 1978 chlorinator residues from TWCA's sand chlorinator process were placed in a separate pile north of Schmidt Lake. This practice was discontinued in 1978, when the contents of the pile were removed and transported off Site to a permitted low level radioactive waste disposal facility (**Figure 3-1**).

Solid residues generated during the development and operation of nonferrous metals manufacturing processes at the plant site were placed in a resource and recovery pile. The major material placed in the pile was magnesium chloride. From 1983 through 1988 TWCA recovered material from this pile to produce magnesium oxide for use in its ongoing processes (**Figure 3-1**).

The V-2 Pond was used for temporary storage and pretreatment of primarily hydrous metal precipitate and unreacted lime solids. The use of this pond was discontinued in 1979. The V-2 Pond was emptied in 1989. Confirmatory soil sampling of the pond was conducted in late 1991 and early 1992.

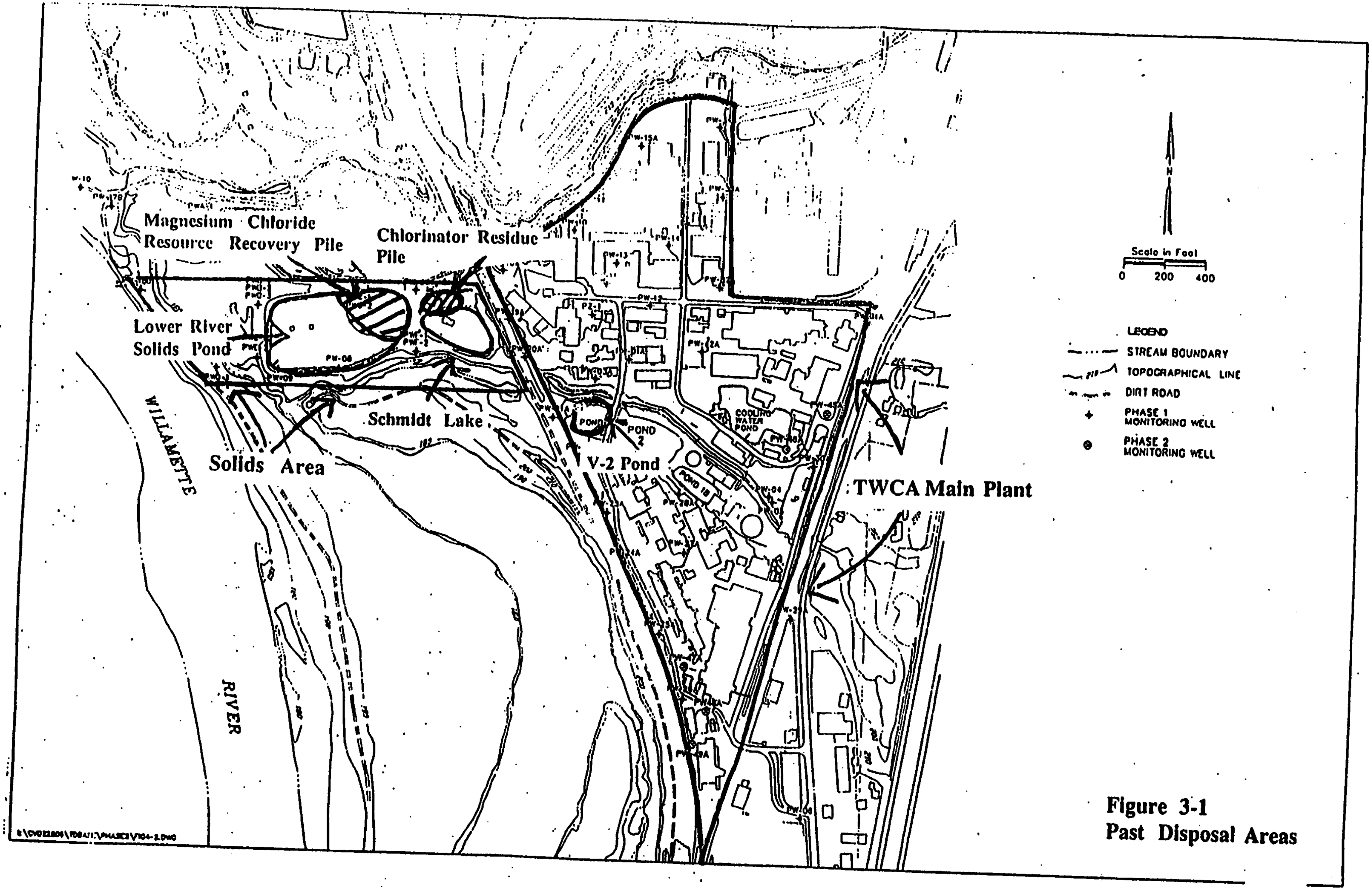


Figure 3-1
Past Disposal Areas

The V-2 Pond is currently filled with gravel and soil (Figure 3-1).

The unlined sludge ponds have attracted the attention of regulatory agencies (U.S. Environmental Protection Agency (EPA) and Oregon Department of Environmental Quality (ODEQ)) and the public for many years, particularly because of the presence of radioactive materials, which was first confirmed by the Oregon State Health Division in 1977. Waste sludges (lime solids) generated prior to 1979 were contained in the LRSP, Schmidt Lake, Arrowhead Lake, and the V2 Pond. Much of the public concern has focused on the LRSP and Schmidt Lake because of their proximity to the Willamette River.

Under an Oregon Department of Environmental Quality permit, some of the solids generated prior to 1976 were used as a beneficial soil amendment on land in the Farm Ponds Area (the Soil Amendment Area). In 1978 TWCA changed its production process which reduced the amount of radioactive materials in the lime solids. Lime solids generated after 1979 are now contained in 4 ponds located in the Farm Ponds Area.

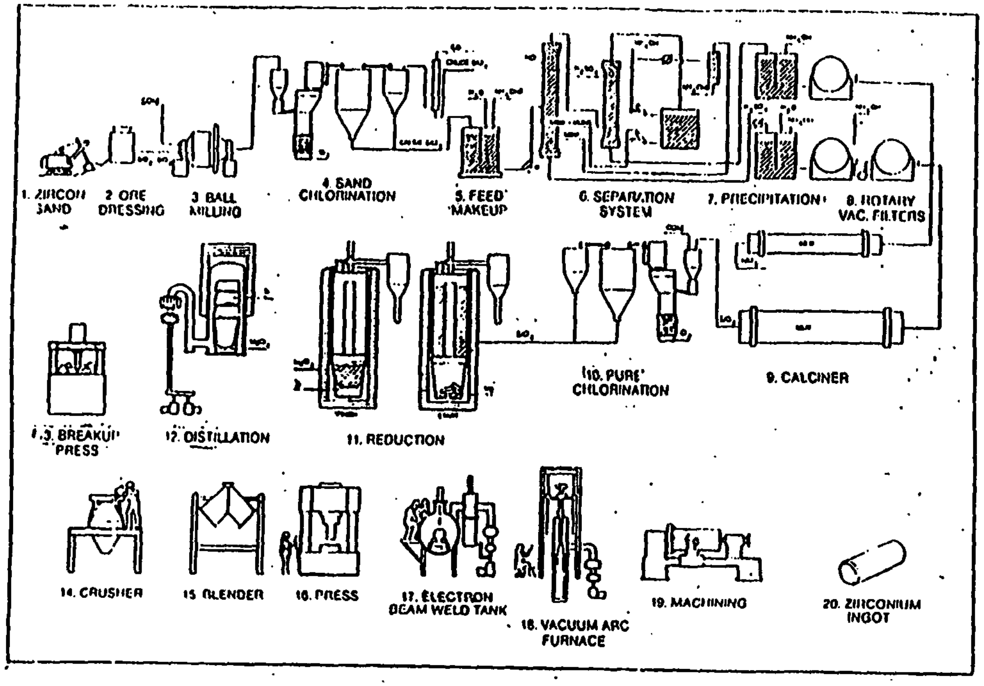
Concerns that the unlined sludge ponds were located in the Willamette River floodplain, and that hazardous materials from the sludge ponds would migrate to soil, surface water, and groundwater, led to the TWCA facility being proposed for inclusion on the National Priorities List (NPL) in December of 1982. The TWCA Site was placed on the NPL in October 1983.

3.2 Plant Processes

TWCA is an active, operating, producer of zirconium metal. Zircon sand, the principal ore, is generally imported from Australia. A schematic diagram showing TWCA's process for producing zirconium and hafnium is shown in **Figure 3-2**. Zircon sand (zirconium orthosilicate) is concentrated by gravity, electrostatic, and magnetic methods to remove all but a small amount of impurities before being shipped to the TWCA facility. Zircon sands typically contain small amounts of radioactive elements such as uranium and thorium which are concentrated during the TWCA production process. In addition, the zircon sands will contain 1 to 5 percent hafnium which becomes a co-product with zirconium.

The zircon concentrate is combined with petroleum coke, and mixed in a ball mill before feeding to a chlorination reactor where at high temperatures the zirconium orthosilicate is converted to zirconium-hafnium tetrachloride and silicon tetrachloride. The hafnium and zirconium are separated by mixing the zirconium-hafnium tetrachloride with methyl isobutyl ketone (MIBK), containing ammonium thiocyanate. This portion of the process separates the hafnium into an organic phase and the zirconium into an aqueous phase. Hafnium is removed from the organic phase by stripping with sulfuric acid, and then it is formed into a solid by precipitation with ammonium hydroxide. The precipitate is filtered and heated to form hafnium oxide. Zirconium is removed from the aqueous phase by precipitation with sulfuric acid. The zirconium precipitate is also filtered and heated to form zirconium oxide. MIBK and ammonium thiocyanate are purified and recycled.

The zirconium and hafnium oxides follow similar paths to metal production. Zirconium oxide is mixed with petroleum coke and fed to a chlorination reactor to form zirconium tetrachloride. Elemental magnesium is then reacted with the zirconium tetrachloride to form a sponge-like material consisting of magnesium chloride and zirconium. The magnesium chloride is physically removed from the zirconium sponge and sold as a byproduct. The zirconium sponge is consolidated into ingots



1. Zircon Sand ($ZrSiO_4$)
Zirconium is fairly common in the earth's crust, being more plentiful than some of the more familiar metals such as nickel and copper. Zircon (zirconium orthosilicate), the principal and most abundant zirconium bearing mineral, is widely distributed throughout the world. Australia is currently the major supplier of this important mineral.

2. Ore Dressing
Zircon is recovered as a coproduct with rutile and ilmenite. Flotation, electrostatic, and magnetic processes are employed to separate these minerals.

3. Ball Milling
Zircon sand and stoichiometric quantities of carbon in the form of coke are mixed and ground together in a ball mill to provide an intimate mixture within a specified particle size range.

4. Sand Chlorination
The zircon sand/coke mixture is reacted with chlorine (Cl_2) at about 1200° C to produce zirconium tetrachloride ($ZrCl_4$) and silicon tetrachloride ($SiCl_4$) according to the following chemical reaction:

$$ZrSiO_4 + 4C + 4Cl_2 \longrightarrow ZrCl_4 + SiCl_4 + 4CO$$

Zirconium tetrachloride and silicon tetrachloride are subsequently separated by partial condensation of the chlorinator off-gas. Silicon tetrachloride is treated as a byproduct of the process.

5. Feed Makeup
Zirconium tetrachloride containing approximately two percent hafnium tetrachloride, a major impurity and a sister element of zirconium, is dissolved in water. The feed solution is adjusted to a specific concentration and filtered to remove suspended solids (fine sand and carbon). This solution is then transferred to the separation system.

6. Separation System
The separation system is composed of a series of extraction, stripping, and scrubbing columns which separate, via liquid-liquid extraction, the elements zirconium and hafnium. Although these sister elements are very similar chemically, they differ markedly in their nuclear properties. Zirconium acts like a window to thermal neutrons while hafnium absorbs large quantities of neutrons. Consequently, there is a need for their separation.

7. & 8. Precipitation and Rotary Vacuum Filters
Solutions containing hafnium and zirconium are collected in their own storage tanks and handled separately. The aqueous zirconium solution is precipitated with sulfuric acid to form a hydrous zirconium sulfate. This slurry is filtered on a rotary filter; the filter cake is repulped with aqua ammonia to form hydrous zirconia and is filtered again to remove sulfate ions.

Hafnium precipitation is effected by the addition of ammonia to an aqueous solution of hafnium sulfate.

9. Calciner
Hydrous zirconia from the last wash filter is pumped to a gas-fired rotary kiln which operates at a temperature of approximately 1000°C (1832°F). The calcined product, zirconium oxide (ZrO_2), is collected in containers at the discharge end of the calciner.

Hafnium is also processed through a calciner to obtain hafnium oxide (HfO_2).

10. Pure Chlorination
Zirconium oxide and stoichiometric quantities of carbon (coke) are intimately blended and reacted with chlorine according to the following chemical reaction

$$ZrO_2 + 2C + 2Cl_2 \longrightarrow ZrCl_4 + 2CO$$

Several impurities including aluminum, iron and titanium are reduced during this chlorination operation.

11. Reduction
Zirconium tetrachloride is reacted with metallic magnesium in a classic Kroll reduction according to the following chemical reaction:

$$ZrCl_4 + 2Mg \longrightarrow Zr + 2MgCl_2$$

Magnesium chloride ($MgCl_2$) is formed as a byproduct.

12. Distillation
The magnesium chloride byproduct is physically removed from the Kroll reduction reaction products. The remaining zirconium regulus is loaded into a distillation furnace. Here the surplus magnesium is distilled from the zirconium metal, leaving a porous sponge-like material.

13. Breakup Press
The zirconium sponge regulus is broken into smaller pieces which are suitable as feed to the crushing operation. Hand grading of sponge product is performed during this operation to upgrade quality.

14. Crusher
Sponge is crushed from approximately four inch material down to minus three-quarter inch. Fines are rejected at this point.

15. Blender
Individual runs of zirconium sponge are blended together to meet production specification requirements.

16. Press
Zirconium sponge and alloying elements are mixed together and pressed into a 14" diameter x 5" thick compact.

17. Electron Beam Weld Tank
Sponge compacts and scrap billets are electron beam welded to form arc melt electrodes.

18. Vacuum Arc Furnace
Welded electrodes are melted into ingots (23" dia. x 13,000#) by the consumable arc melting process. Doubling melting ensures homogeneity.

19. Machining
Cast ingots are machined to remove surface porosity and melting anomalies.

20. Zirconium Ingot
Final machined ingots are then fabricated into wrought product by forging, hot rolling, cold rolling or extrusion.

Figure 3-2
Zirconium Manufacturing Process

by first crushing, blending and pressing the sponge into briquettes. The briquettes are then welded together with an electron beam to form an electrode which is melted and cast into homogenized ingots in a vacuum arc furnace. The cast zirconium ingots are then fabricated into numerous shapes and forms such as forgings, plate, sheet, foil, tubing, rod, and wire. The fabrication process can involve caustic cleaning, degreasing, and/or pickling.

3.3 Radioactive Materials Handling

In March 1978, a Naturally Occurring Radioactive Materials (NORM) license was granted to TWCA to transfer, receive, possess and use zircon sands and industrial byproducts containing licensable concentrations of radioactive material. TWCA currently disposes of its radioactive waste material at the U.S. Ecology Low Level Radioactive Waste Site located on the Hanford Reservation in Washington and operates under the provisions set forth in the 1978 NORM license.

3.4 Past Remedial and Removal Activities

3.4.1 Sludge Ponds Operable Unit

The LRSP and Schmidt Lake lie adjacent to each other in the western portion of the TWCA Site, next to the east bank of the Willamette River, between Murder Creek to the north and Truax Creek to the south (**Figure 3-1**).

In the summer of 1988, in order to expedite cleanup, EPA and TWCA identified the sludges in the LRSP and Schmidt Lake as a separate operable unit from the rest of the Site for the following reasons:

a) the sludges in the unlined ponds were a likely source of groundwater contamination;
b) the LRSP and Schmidt Lake are located in the Willamette River flood plain;
c) the sludges in the ponds contained low levels of radioactive materials, and had been the focus of community concerns about the Site; and
d) TWCA, in response to the community concerns wished to clean up the ponds without waiting for the full Site RI/FS to be completed.

A Record of Decision (ROD) for an Interim Response Action at the Sludge Ponds Unit was signed by EPA on December 28, 1989. The Operable Unit ROD presented the selected remedial action for the sludge ponds unit.

The major components of the selected remedy consisted of:

- Excavation and removal of the sludges from the ponds.

- Partial solidification of the sludge with a solidification agent such as Portland cement.

- Construction of a monocell at an off-site permitted solid waste facility.

- Transportation of the solidified sludge to the off-site facility and disposal in the monocell.

- Long-term operation and maintenance (O&M) of the off-site monocell.

On February 14, 1991, EPA issued a Unilateral Order (Order) to TWCA for design and implementation of the selected remedy for the operable unit. In June of 1991, construction of the off-site monocell at the Finley Buttes Landfill in Boardman, Oregon was completed. Excavation and removal of the sludges began in July of 1991 and was completed in November 1991. Approximately 100,000 cubic yards of solids (including cement) were transported to the monocell at Finley Buttes. Cover construction and grass seeding of the monocell was completed in April 1992. On June 30, 1993, EPA issued a Certification of Completion for the Sludge Ponds Operable Unit Remedial Action to TWCA.

3.4.2 Supplementary Removal Action at Schmidt Lake

In 1991, EPA received information provided by a former TWCA employee that radioactive materials had been buried in Schmidt Lake in the 1970's. These radioactive materials were buried in drums which were allegedly located below the sludges that had been the subject of the operable unit remedial action. Based on this information, EPA requested that TWCA conduct additional geophysical investigations in this area. In 1992, pursuant to the additional work provision of the RI/FS Consent Order with EPA, TWCA conducted an electromagnetic survey in this area. The electromagnetic survey identified potential additional source materials in and around Schmidt Lake. These source materials included several corroded metal drums containing sands with elevated amounts of thorium and uranium, and an underground storage tank containing liquid petroleum product.

In December 1992, as part of an action referred to as the Schmidt Lake Excavation Project (SLEP), 2,016 cubic yards of materials containing zircon sands with elevated levels of thorium and uranium were removed from Schmidt Lake and transported by TWCA to the U.S. Ecology low-level radioactive waste site in Washington for disposal.

3.4.3 Soil Removal in Fabrication Area

In December 1991, during the installation of a soil boring adjacent to the Emergency Services Building in the Fabrication Area of the Main Plant (Boring B91-5) (**Figure 3-3**), a floating nonaqueous oil layer containing 8 percent PCBs was detected. Groundwater in the vicinity of this boring contained up to 22,500 parts per billion (ppb) PCBs. Additional sampling identified an area of soil, approximately 30 feet by 30 feet, as a probable source/receptor for the PCB-contaminated oil.

In order to prevent further degradation of water quality resulting from the oil layer, in November 1992 TWCA initiated a removal action in the area. After approval by EPA, TWCA excavated approximately 230 cubic yards of PCB-contaminated soil and disposed the soil at an off-site permitted landfill. The source of the oil layer was not identified.

3.5 Operable Unit 2: Groundwater and Sediments

On June 10, 1994, EPA selected the Final Remedial Action for Groundwater and Sediments. This Operable Unit ROD presented the selected remedial action for surface water, groundwater and sediments at the Site. The major components of the selected remedy consisted of:

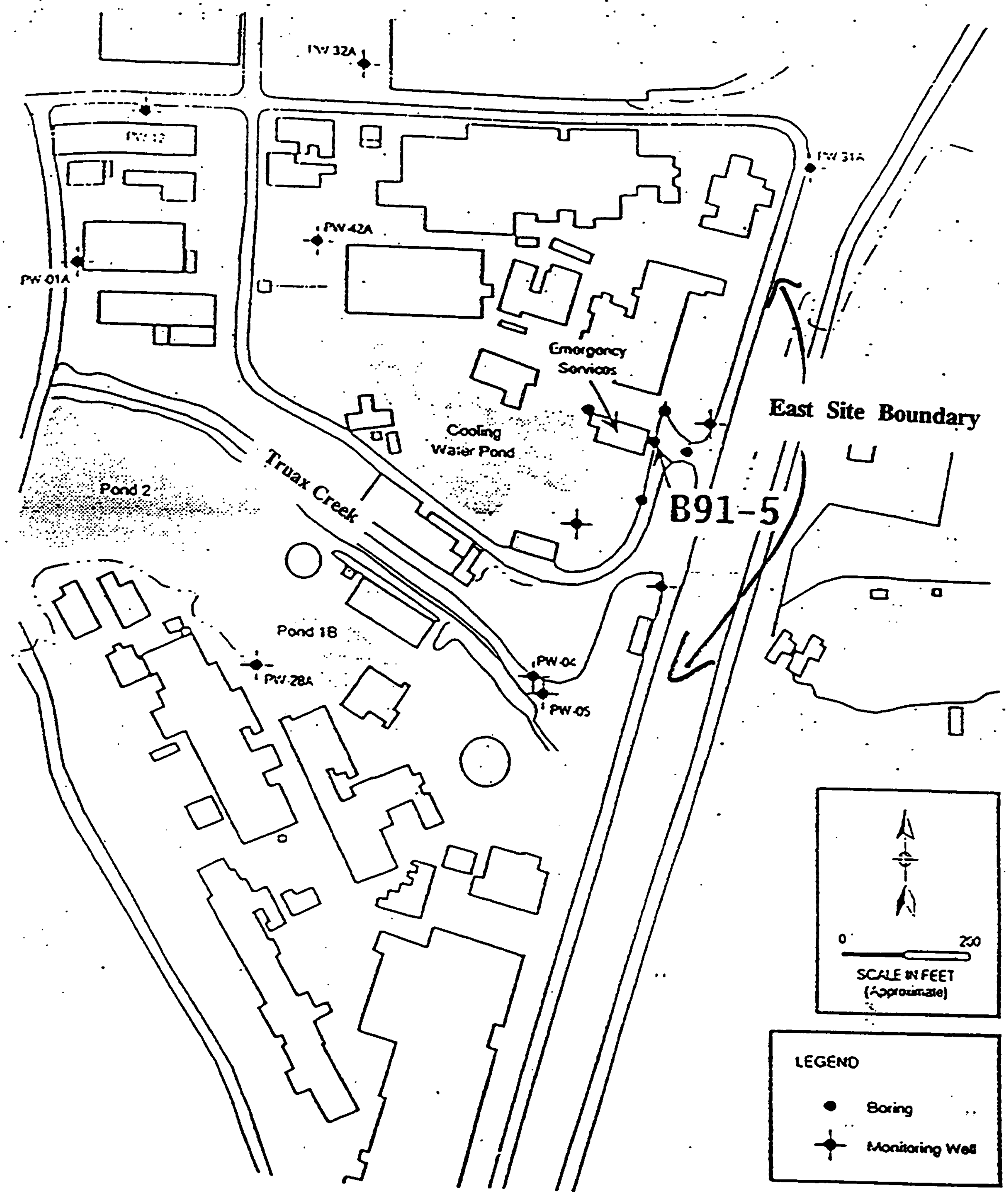


Figure 3-3
Location of Boring B-91-5

For Contaminated Groundwater:

- Remediation of groundwater via groundwater extraction in the Feed Makeup area and at areas on Site where contaminant concentrations exceed lifetime cancer risk levels of 10^{-4} and/or substantially exceed noncancer HI of 1 for worker exposure. Extraction shall continue until contaminant concentrations in groundwater throughout the Site are reduced to below SDWA MCLs, non-zero MCLGs, or cancer risk levels of 10^{-6} and noncancer risk HI < 1 for worker exposure, or until EPA in consultation with ODEQ determines that continued groundwater extraction would not be expected to result in additional cost effective reduction in contaminant concentrations at the Site. Contaminated groundwater in exceedance of SDWA MCLs, non-zero MCLs, or cancer risk levels of 10^{-6} and noncancer risk HI > 1 for residential use shall be prevented from migrating off the plant site, or beyond the current boundary of the groundwater contaminant plume at the Farm Ponds Area.

- Discharge of extracted groundwater to Teledyne Wah Chang Albany's wastewater treatment plant. Pretreatment of groundwater to comply with CWA requirements prior to discharge to the wastewater treatment plant.

- Treatment or removal of subsurface source material near the Feed Makeup Building on the main plant.

For Contaminated Sediments:

- Slope erosion protection consisting of a geotextile covered by riprap placed along the banks of Truax Creek to prevent contaminated fill material from entering the creek.

- Removal of approximately 3,600 cubic yards of contaminated sediments from the surface water bodies adjacent to, or flowing through the Site. Additional ecological characterization prior to removal to determine potential impacts of sediment removal to the local ecosystem and to provide mechanisms to mitigate those impacts.

Site-Wide Actions:

- Deed restrictions and institutional controls on land and groundwater use for both the main plant and Farm Ponds area. The objective of this component of the remedy is to ensure that the property and groundwater are used only for purposes appropriate to the cleanup levels achieved.

- Environmental evaluations of currently uncharacterized potential contaminant source areas, as needed to ensure achievement of groundwater RAOs. The objective of this component of the remedy is to ensure that contaminant source areas do not adversely impact the remedy.

- Long-term on-site and off-site groundwater, surface water, and sediment monitoring which shall include at a minimum the monitoring of on-site wells which are in exceedance of MCLs and non-zero MCLGs, cancer risk levels of 10^{-6}, and noncancer risk HI > 1 for residential exposure.

- Review of selected remedy at least once every five years to ensure protection of human health and the environment.

The groundwater ROD has not yet been implemented. The implementation of the groundwater ROD will be done concurrently with the Soils Operable Unit (the subject of this current ROD).

4.0 COMMUNITY RELATIONS

The Revised Draft RI/FS and the Proposed Plan for the Site were originally released to the public for comment on August 25, 1993. The Proposed Plan addressed remediation for contamination in groundwater and sediments, and in surface and subsurface soils. Based in part on supplemental RI/FS data received from Teledyne Wah Chang Albany on December 21, 1993, EPA determined that it would be more realistic to address remediation of the Site in two parts. On June 10, 1994, EPA issued a ROD for groundwater and sediments.

This ROD addresses contamination in surface and subsurface soil, as Operable Unit Three. The Proposed Plan was issued July 21, 1995. The public comment period lasted from August 1 to August 30, 1995. The RI/FS and supporting documentation were made available to the public in the information repositories maintained at the Superfund Records Center in Region 10's offices in Seattle, and the Albany Public Library. The notice of availability of the RI/FS documents was published in the Albany Democratic Herald on July 31, 1995.

The proposed plan offered the opportunity to hold a public meeting if sufficient interest was expressed by the public. Because little interest was expressed, a public meeting was not held.

Past EPA Region 10 community relations activities at the Site have included the following:

- December 1982 - TWCA Site proposed for inclusion on NPL: 60-day public comment period initiated.
- October 1983 - TWCA Site listed on NPL.
- February-May 1987 - Local citizens and officials interviewed in order to prepare a Community Relations Plan.
- November 1987 - Final Community Relations Plan issued.
- November 1987 - Information Repositories established at Albany Public Library, ODEQ (Portland), and EPA Region 10 (Seattle).
- November 1988 - RI/FS work plan for entire facility sent out for 30-day public comment period. Work plan was placed in Information Repositories and a Fact Sheet was published.
- February 1989 - Fact Sheet published announcing EPA's approval of the final work plan.
- June 1989 - Fact Sheet published announcing that TWCA had submitted a draft RI/FS report to EPA for the Sludge Ponds Operable Unit.
- August 16, 1989 - Interim Action (Operable Unit #1) Proposed Plan published.
- August 18 - October 16, 1989 - Public comment period for the Operable Unit #1 Proposed Plan.

- September 6, 1989 - Public meeting for the Operable Unit #1 Proposed Plan was held in Albany, Oregon.
- October 11, 1990 - Fact Sheet published announcing expansion of scope of RI to include identification of potential sources of contamination. Fact Sheet also announced beginning of negotiations with TWCA for Sludge Ponds Operable Unit remedial action.
- March 5, 1991 - Fact Sheet published announcing issuance of Unilateral Order by EPA to TWCA for cleanup of Sludge Ponds Operable Unit.
- July 1991 - Local citizens and officials updated and interviewed in order to prepare a Revised Community Relations Plan.
- October 1991 - Revised Community Relations Plan issued.
- February 19, 1992 - Fact Sheet published announcing issuance of Request for Information letter by EPA to TWCA regarding the threat of a release of hazardous substances in or around Schmidt Lake. Fact Sheet also updated continuing RI investigations.
- October 29, 1992 - Fact Sheet published announcing that TWCA had submitted a draft RI/FS report to EPA for the entire Site. Fact Sheet also updates public on discovery of decayed metal drums containing zircon sand within Schmidt Lake.
- April 1, 1993 - Fact Sheet published announcing removal of decayed metal drums and approximately 2,100 cubic yards of contaminated sands from Schmidt Lake.
- August 25, 1993 - Proposed Plan for entire Site Superfund cleanup published.
- August 27-October 27, 1993 - Public comment period for Proposed Plan.
- September 14, 1993 - Public meeting to take comments and answer questions regarding the Proposed Plan held in Albany, Oregon.
- October 15, 1993 - EPA meets with TWCA to discuss TWCA's objections to Proposed Plan.
- October 22, 1993 - Fact Sheet published updating public on public comment period and Proposed Plan.
- June 10, 1994 - Fact Sheet announcing the signing of the ROD and detailing major elements of the cleanup plan.
- July 21, 1995 - Proposed Plan for Surface and Subsurface Soil Operable Unit published.
- July 21, 1995 - Fact Sheet summarizing the Proposed Plan for Final Remedial Action for Surface and Subsurface Soils and inviting comments during the public comment period.

5.0 SCOPE AND ROLE OF RESPONSE ACTION WITHIN SITE STRATEGY

As with many Superfund sites, the problems at the TWCA Site are complex. TWCA is an active facility with ongoing operations. As a result, EPA organized the Superfund work into three operable units (OUs). These are:

- OU One: The sludges in the LRSP and Schmidt Lake.
- OU Two: Contamination in the groundwater and sediments.
- OU Three: Contamination in surface and subsurface soils.

EPA selected the remedy for OU One, sludges in the LRSP and Schmidt Lake, in a ROD signed on December 28, 1989. The selected remedy for OU One has resulted in removal and off-site disposal of contaminated sludges from the LRSP and Schmidt Lake. This remedial action was completed in June 1993.

EPA selected the remedy for OU Two, addressing the contamination in groundwater and sediment at the Site, on June 10, 1994. The remedial actions described in the ROD are designed to deal with contaminated groundwater and sediment, as well as the sources of the groundwater and sediment contamination at the facility. The implementation of the OU Two ROD has been postponed until the completion of this current ROD for OU Three.

The third OU, the subject of this ROD, addresses the contamination in surface and subsurface soils at the TWCA Site. Surface and subsurface soils on the TWCA Site are contaminated with PCBs and radionuclides as well as other contaminants. The decay products of the radionuclides, gamma radiation and radon, are also present on the Site.

The remedial actions presented in this ROD will address the presently known threats to human health and the environment posed by contaminated surface and subsurface soil.

TWCA is an operating facility. The facility is currently being inspected under the requirements of EPA's Resource Conservation and Recovery Act (RCRA). EPA and the Oregon Department of Environmental Quality (ODEQ) are working together and with TWCA to coordinate the activities of the CERCLA and RCRA programs in their regulation of TWCA. The coordination between the two programs at the facility has led to the following determinations:

> Except as expressly stated in CERCLA, in the NCP, or in this ROD, this ROD is not designed to address TWCA's ongoing operations or to preclude the need for TWCA's ongoing operations to comply with other environmental laws or regulations. Regulation of TWCA's ongoing operations is covered under RCRA and under other State and Federal environmental laws. Except as otherwise stated in this ROD, determinations in this ROD are intended to apply to Site geographic areas rather than to ongoing plant operations.
>
> The determinations made in this ROD regarding contamination of surface and subsurface soils apply to areas of the Site investigated during the RI/FS, and are based on information from the RI/FS. As TWCA is an active operating facility, some on-site conditions may have

changed since the RI/FS. Material placed in CERCLA investigated areas subsequent to the RI/FS sampling may not necessarily be addressed by this ROD, but may be investigated and addressed under RCRA. Similarly, not all excavations on the Site are covered by this ROD.

Areas of surface and subsurface soil contamination not addressed during the RI/FS and therefore not addressed in this ROD, but which are later found to be sources or potential sources of groundwater contamination are addressed in the Record of Decision for Final Remedial Action of Groundwater and Sediments Operable Unit, Teledyne Wah Chang Albany Superfund Site, June 10, 1994. Areas of the Site or contamination at the Site, not addressed by either the groundwater ROD or this ROD, are subject to investigation and corrective action under RCRA. For conditions or contamination at the Site previously unknown that are later discovered, such conditions or contamination may be addressed under either RCRA or CERCLA. In addition, under the NORM license administered by the Oregon Department of Health, TWCA will be required to remediate remaining radioactive material when the plant closes.

6.0 SITE CHARACTERISTICS

The TWCA RI was conducted in two phases. Phase I was designed to determine whether contamination existed in groundwater along the perimeter of the facility. As part of this investigation, soil borings, surface water and sediments were also sampled. Phase II was designed to locate and investigate potential sources of contamination at the facility. In recognition of TWCA's concerns, the EPA CERCLA program agreed that the scope of the RI/FS could be designed so as not to interfere with ongoing operations at the facility. Concerns regarding the potential adverse impact of the RI/FS on TWCA's ability to remain in operation, were also a factor in EPA's agreement at the time of scoping of the RI/FS, that TWCA could forego sampling of areas beneath certain active ponds, waste piles, pavements, and existing buildings and structures at the facility. During the preparation of the groundwater ROD, it was recognized that, should there be contaminated areas beneath unsampled areas, these areas could potentially serve as additional contaminant sources that could continue to undermine the effectiveness of the remedial action. Because of the potential for these contaminant sources to adversely impact the effectiveness of the remedy, determination of the nature and extent of possible contamination in these unsampled areas must necessarily take place at some point in the future. Integration of such sampling into the normal ongoing operations at the TWCA facility has been incorporated into the Record of Decision for Final Remedial Action of Groundwater and Sediments Operable Unit, Teledyne Wah Chang Albany Superfund Site, June 10, 1994.

6.1 Geology and Soils

The geology beneath the TWCA Site is typified by a stratigraphic column common to much of Oregon's central Willamette Valley. The column consists of five stratigraphic units which in order of youngest to oldest are: recent alluvium, Willamette Silt, Linn Gravel, Blue Clay (present in stratigraphic lows of the Spencer Formation), and Spencer Formation. A geologic cross section showing these units beneath the Solids Area is shown in **Figure 6-1**. Engineered fill is also present in many locations within the Main Plant area. The stratigraphic column at the Farm Ponds Area consists of Willamette Silt (brown silt and basal gray clay), Linn Gravel, and Blue Clay.

6.2 Extent of Soil Contamination

For purposes of the RI, the TWCA Site was divided into five areas, termed "remedial sectors". The remedial sectors, which are shown in **Figure 6-2**, include: 1) the Farm Ponds Area, 2) the Extraction Area, 3) the Fabrication Area, 4) the Solids Area, and 5) the Surface Water Remedial Sector. The subject of this ROD is the surface and subsurface soil contamination of 1) the Farm Ponds Area (north of the TWCA Main Plant), and on the TWCA Main Plant 2) the Extraction Area, 3) the Fabrication Area, and 4) the Solids Area.

The remedial sectors were subdivided into areas based on current or past manufacturing activities conducted in each area. Finally, each area was divided into smaller subareas. Surface soil samples were taken from each subarea. The purpose for this approach was to find localized areas of soil contamination within the much larger area of the Site. Subsurface soil samples were taken from areas of potential source locations. **Figures 6-3a, b, and c** show the surface sample locations across the Site. Samples were taken in areas which would not impact ongoing TWCA operations.

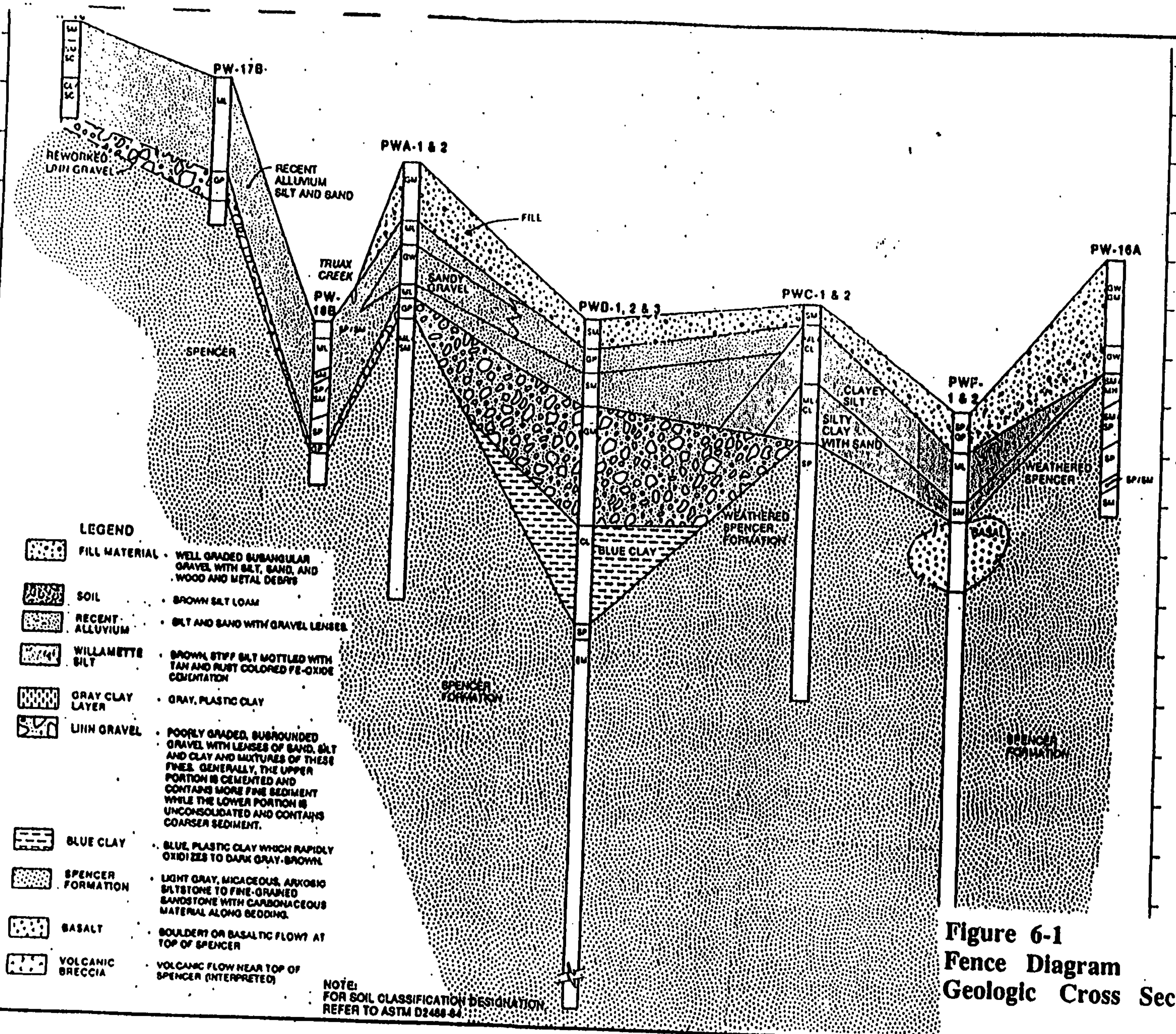


Figure 6-1
Fence Diagram
Geologic Cross Section of Solids Area

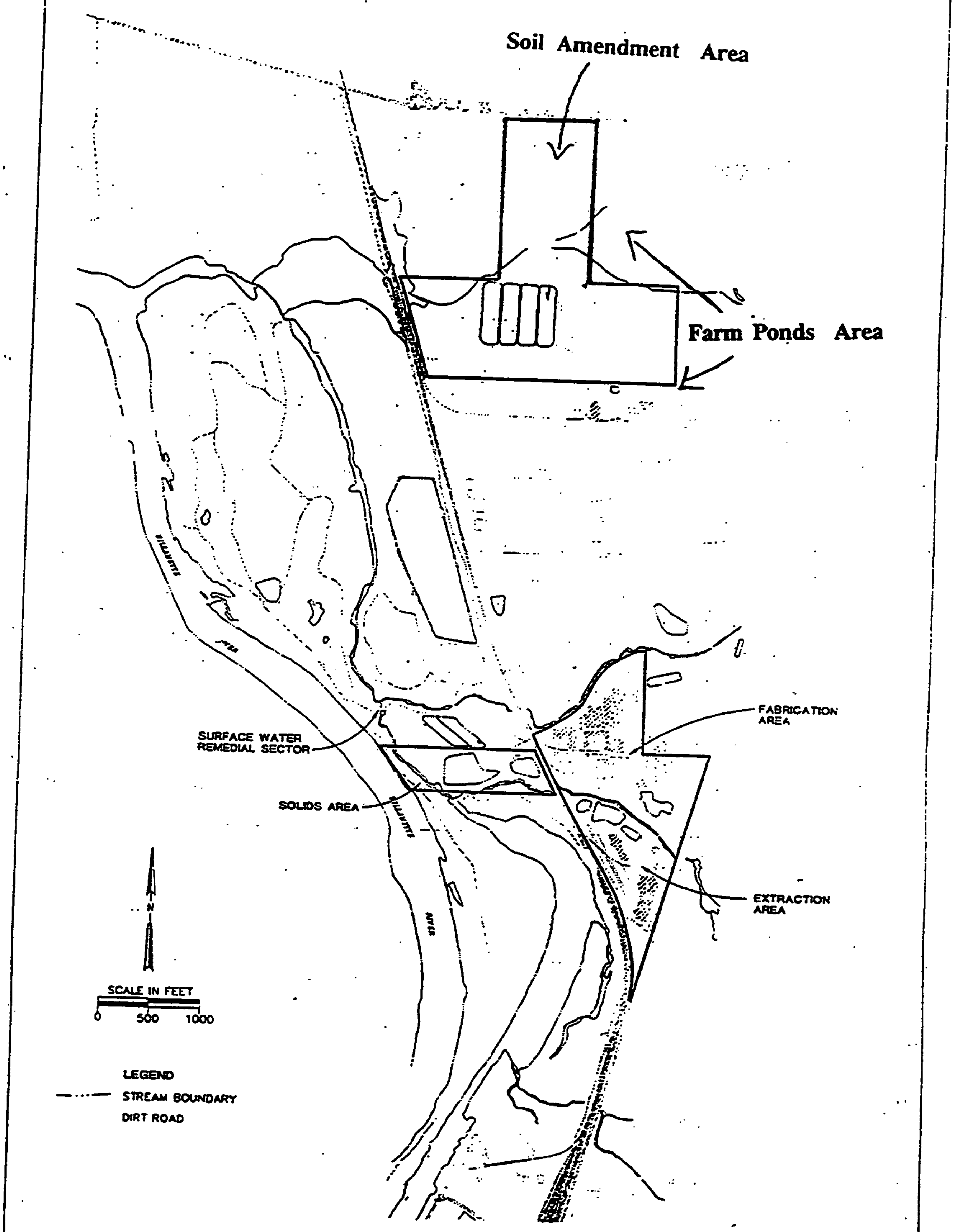


Figure 6-2
Remedial Sectors

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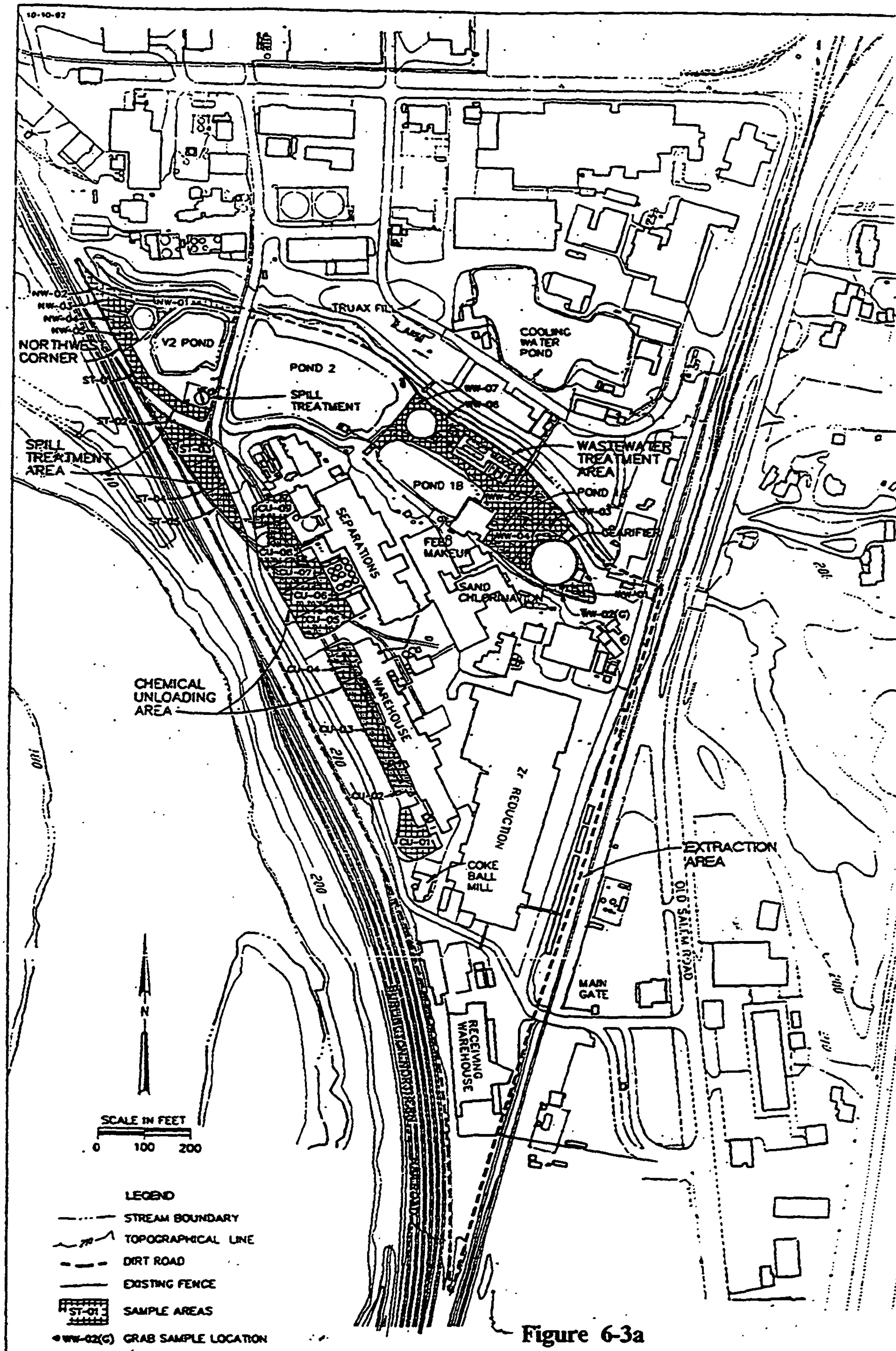

Figure 6-3a
Surface Soil Sampling Locations
Extraction Area

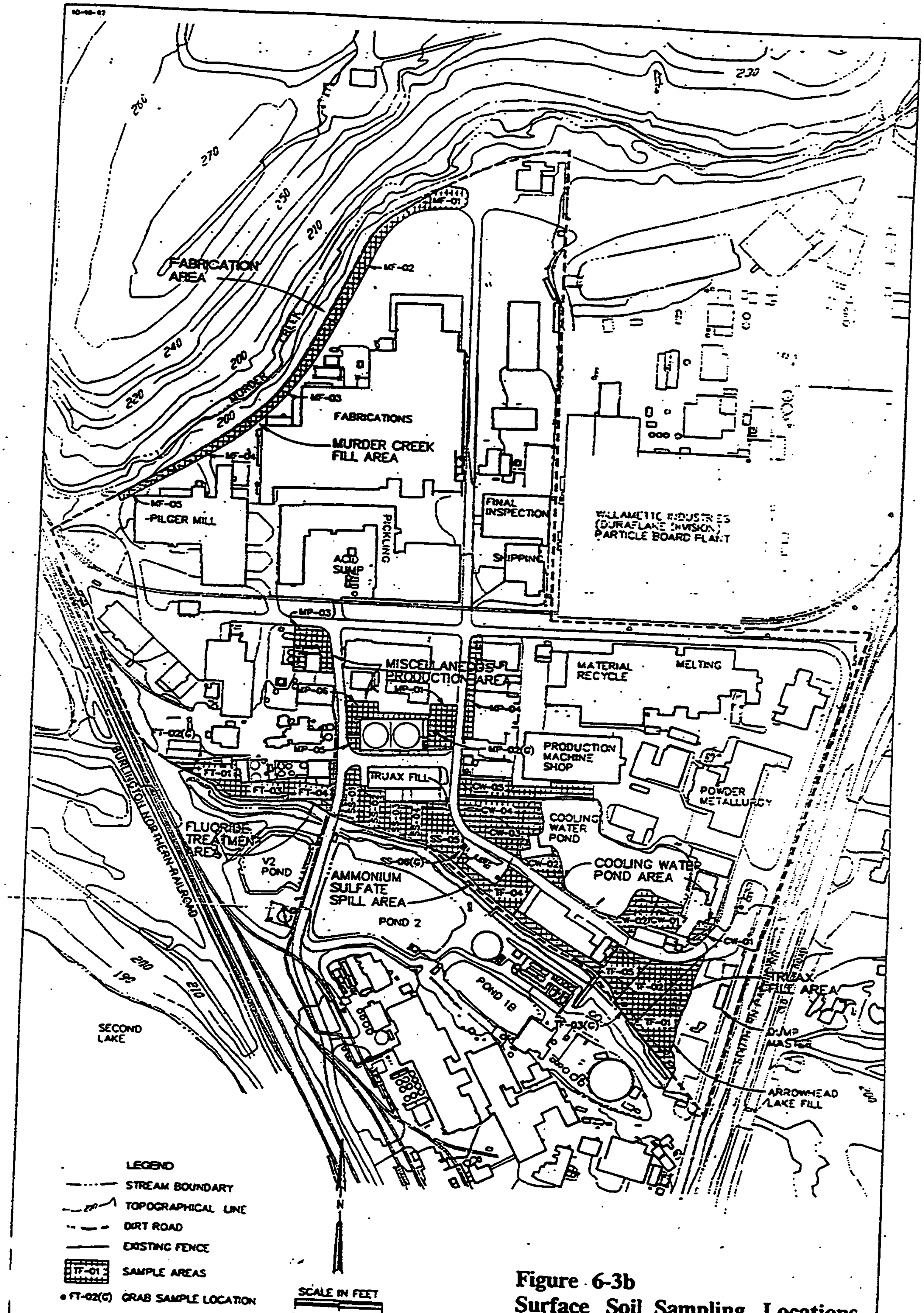

Figure 6-3b
Surface Soil Sampling Locations
Fabrication Area

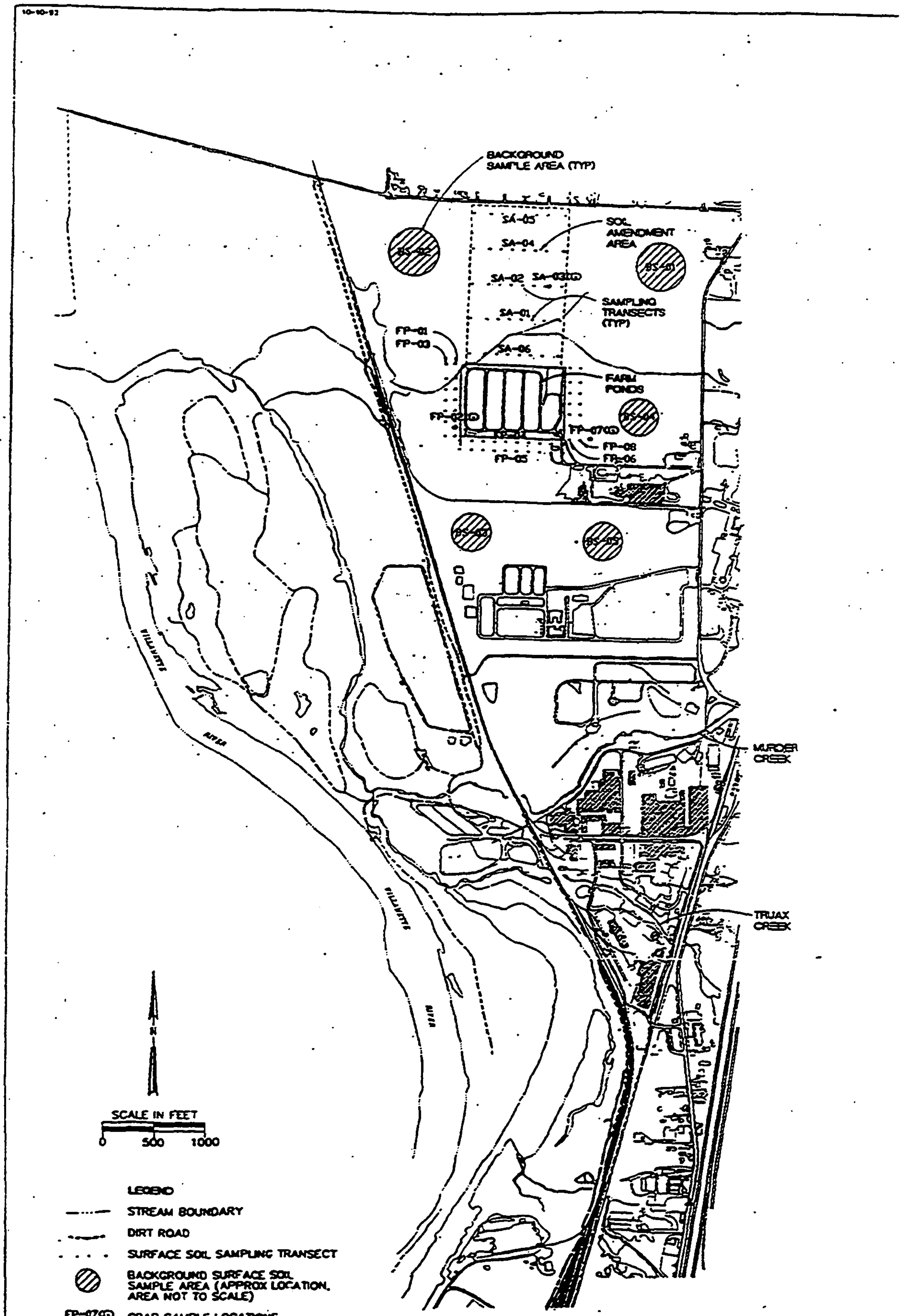

Figure 6-3c
Surface Soil Sampling Locations
Farm Ponds Area

The Surface Water Remedial Sector, and groundwater and sediment contamination in the other remedial sectors, was covered in the Record of Decision for Final Remedial Action of Groundwater and Sediments Operable Unit, Teledyne Wah Chang Albany Superfund Site, June 10, 1994.

Gamma radiation and radon were investigated as a supplemental Radiological Survey after the completion of the other portions of the RI/FS. The presence of radium in soils indicated that risks from exposure to gamma radiation and radon could potentially pose an unacceptable Site risk. In order to accurately investigate these risks, EPA determined that it would be appropriate to collect gamma radiation and radon measurements to supplement the Site investigation. Results of the supplemental investigation are presented separately in the Site Characterization Section (Section 6.0) and Summary of Site Risks (Section 7.0). The reason for this organization are two fold: 1) the investigation of gamma radiation and radon was carried out separately and with different methodology than the rest of the RI/FS, and 2) based on the results of the risk assessment (Section 7.0), risks from ingestion and inhalation of chemicals and radionuclides were not significant and do not require action, while the risks from exposure to gamma radiation and inhalation of radon are significant and do require remedial action.

6.3 Chemical and Radionuclide Contamination on the Main Plant and the Farm Ponds Area

In the following sections, tables of contaminant concentrations show only those contaminants with concentrations exceeding a risk level of 1×10^{-7} or a hazard index of 0.1 (and therefore meet contaminant of concern screening criteria, see Section 7.0 for an explanation of the risk assessment process, and the scenarios used). In addition to the tables, areas on the Site where surface or subsurface contaminant concentrations are noteworthy are discussed in the text. For radionuclides, this discussion covers only soil concentrations of radium and thorium. Radioactive daughter products, Gamma radiation and radon, are covered in Section 6.4.

6.3.1 Soil Contamination in the Farm Ponds Area

The Farm Ponds Area is located approximately 3/4 mile north of the Main Plant, and contains four 2-1/2-acre solids storage ponds (**Figure 6-3c**). These ponds received lime solids generated in TWCA's industrial wastewater treatment plant. The ponds are constructed with a soil-bentonite liner. The ponds received waste water treatment sludges between 1979 and 1993, and are regulated under the National Pollutant Discharge Elimination System (NPDES) program.

The lime solids are similar in composition to the sludges that were placed in the LRSP and Schmidt Lake prior to 1979. However, the Farm Ponds solids have a lower concentration of radionuclides.

The Soil Amendment Area, which was the main focus of the soil investigation in the Farm Ponds Area, is a 47.8-acre tract located directly north of the Farm Ponds (**Figure 6-3c**). In 1975 and 1976, TWCA obtained solid waste permits from the Oregon Department of Environmental Quality to use solids from the primary wastewater treatment plant experimentally as a soil amendment. These solids were applied once in 1976. The solids were similar in composition to that of the LRSP and Schmidt Lake and probably contained low-level metals, radionuclides, and organic compounds.

Contaminant concentrations in the surface and subsurface soils in the Farm Ponds Area are shown in **Tables 6-1a and b**. The Soil Amendment Area had elevated concentrations of PCBs, hexachlorobenzene (HCB), thorium, and radium.

6.3.2 Soil Contamination in the Extraction Area

The Extraction Area comprises the southern portion of the Main Plant (see **Figure 6-2**). Surface sample locations are shown in **Figure 6-3a.**

A list of contaminants and their concentrations which are found in the surface and subsurface soil of the Extraction Area is shown in **Tables 6-2a and b**. Surface soils collected from the chemical unloading area along the west side of the Extraction Area contain elevated levels of HCB, PCBs, polyaromatic hydrocarbons (PAHs), and thorium. The chemical unloading area serves as a point for rail and trailer unloading and temporary storage of chemicals and other production materials.

Soils surrounding the V2 Pond contain elevated amounts of thorium and radium. The V2 Pond was used from 1960 until 1979 as a wastewater solids holding pond as part of a previous wastewater treatment system. The pond solids consisted primarily of metal precipitates and unreacted lime. Radium concentrations up to 54 pCi/gram were found in residuals remaining in the sidewalls of the V2 pond after sludges from this area were removed in 1989. Excavation of the sidewalls was stopped pending imminent collapse of a tank over the excavation area. The pond was filled with soil and gravel. This area did not show an increase in surface gamma radiation during the gamma survey (see Section 6.4.1)

6.3.3 Soil Contamination in the Fabrication Area

The Fabrication Area occupies approximately 50 acres on the northern portion of the Main Plant (**Figure 6-2**). The area is bounded by Truax Creek to the south, Murder Creek to the north, Burlington Railroad tracks to the west, and Willamette Industries and Southern Pacific railroad tracks to the east.

Figure 6-3b shows sample locations in the Fabrication Area. A summary of surface and subsurface soil contamination in the Fabrication Area is shown in **Tables 6-3a and b**. High concentrations of PCBs were found in subsurface soils in the southeast portion of the Fabrication Area. The PCBs in the vicinity of the Emergency Services Building were previously excavated (see Section 3.4.3); however, they are still present in the southern region of this area where excavation did not take place (Boring B-02).

Relatively high radium concentrations were found in Boring B-2 and B91-06 ranging from 7.4 pCi/g to 26 pCi/g at 13 to 20 feet below grade.

6.3.4 Soil Contamination in the Solids Area

The Solids Area covers approximately 20 acres and is located west of the Main Plant between the Burlington Northern Railroad and the Willamette River (**Figure 6-2**). The area contains four separate potential source areas which are shown in **Figure 6-4.** These potential source areas include the Lower River Solids Pond (LRSP), Schmidt Lake, the Magnesium Resource Recovery Pile, and the Chlorinator Residue Pile. The LRSP and Schmidt Lake received solids from TWCA's existing

Table 6-1a

Farm Ponds Area Surface Soil Contaminant Concentrations

Analyte	Number of Detections (Number of Samples)	Average Detected Concentration	Maximum Detected Concentration	Location of Maximum	Background Level
Semivolatile Organic Compounds (ppb)					
Hexachlorobenzene	6 (14)	945	2,000	SA-02	ND
PCBs (ppm)					
Total PCBs	5 (14)	1.1	1.4	SA-06	ND
Metals (ppm)					
Chromium	14 (14)	39	69	SA-02	37
Thorium	14 (14)	10	25	SA-02	7.5
Zirconium	14 (14)	3,854	13,500	SA-02	ND
Radionuclide (pCi/g)					
Radium-226	14 (14)	2.5	8	SA-02	1.2
Radium-228	14 (14)	1.8	3.8	SA-02	1.5

ND = Not detected.

Table 6-1b

Farm Ponds Area Subsurface Soil Contaminant Concentrations

Analyte	Number of Detections (Number of Samples)	Average Detected Concentration	Maximum Detected Concentration	Location of Maximum	Background Level
Semivolatile Organic Compounds (ppb)					
Hexachlorobenzene	1(5)	240	2.40	SB-SA-02	ND
PCBs (ppm)					
Total PCBs	2(5)	0.035	0.041	SB-SA-05	ND
Metals (ppm)					
Thorium	16(18)	5.4	13.6	SB-SA-05	7.47
Radionuclide (pCi/g)					
Radium-226	5(5)	1.20	1.70	SB-SA-02	1.2
Radium-228	5(5)	1.22	1.60	SB-SA-02	1.5

ND = Not detected.

Table 6-2a

Extraction Area Surface Soil Contaminant Concentrations

Analyte	Number of Detections (Number of Samples)	Average Detected Concentration	Maximum Detected Concentration	Location of Maximum	Background Level
Semivolatile Organic Compounds (ppb)					
Benzo(a)anthracene	13 (26)	195	870	WW-03	ND
Benzo(a)pyrene	11 (26)	150	610	WW-03	ND
Benzo(b)fluoranthene	14 (26)	208	870	WW-03	ND
Benzo(k)fluoranthene	12 (26)	273	1,100	CU-03	ND
Chrysene	15 (26)	303	1,200	WW-03	ND
Dibenzo(a,h)anthracene	3 (26)	76	140	WW-03	ND
Hexachlorobenzene	13 (26)	1,370	8,000	CU-01	ND
Indeno(1,2,3-cd))pyrene	9 (26)	126	400	WW-03	ND
PCBs (ppm)					
Total PCBs	19 (26)	2.8	19	CU-07	ND
Metals (ppm)					
Chromium	26 (26)	251	1,010	CU-08	37
Thorium	26 (26)	12	69.9	CU-04	7.5
Zirconium	26 (26)	31,024	198,000	WW-02 (grab)	ND
Radionuclides (pCi/g)					
Radium-226	26 (26)	2.4	17.9	WW-02 (grab)	1.2
Radium-228	20 (26)	1.9	5.9	WW-02 (grab)	1.5

ND = Not detected.

Table 6-2b

Extraction Area Subsurface Soil Contaminant Concentrations

Analyte	Number of Detections (Number of Samples)	Average Detected Concentration	Maximum Detected Concentration	Location of Maximum	Background Level
Semivolatile Organic Compounds (ppb)					
Hexachlorobenzene	8(52)	279	670	V2-06 (3.0)	ND
PCBs (ppm)					
Total PCBs	10(37)	0.319	13.0	B91-13 (2.0)	ND
Metals (ppm)					
Thorium	55(55)	10.2	75.0	V2-05 (5.5)	7.47
Radionuclide (pCi/g)					
Radium-226	50(50)	6.0	54.2	V2-01 (3.0)	1.2
Radium-228	46(46)	2.01	11.43	V2-05 (5.5)	1.5

ND = Not detected.

Table 6-3a

Fabrication Area Surface Soil Contaminant Concentrations

Analyte	Number of Detections (Number of Samples)	Average Detected Concentration	Maximum Detected Concentration	Location of Maximum	Background Level
Semivolatile Organic Compounds (ppb)					
Benzo(a)anthracene	10 (31)	320	1,700	SS-04	ND
Benzo(a)pyrene	8 (31)	295	1,300	SS-04	ND
Benzo(b)fluoranthene	9 (31)	265	1,400	SS-04	ND
Benzo(k)fluoranthene	8 (31)	293	1,500	SS-04	ND
Chrysene	12 (31)	339	2,000	SS-04	ND
Dibenzo(a,h)anthracene	2 (31)	152	250	SS-04	ND
Hexachlorobenzene	9 (31)	859	5,100	TF-04	ND
Indeno(1,2,3-cd)pyrene	6 (31)	266	970	SS-04	ND
PCBs (ppm)					
Total PCBs	22 (31)	1.3	9.2	SS-02	ND
Metals (ppm)					
Chromium	31 (31)	234	2,810	FT-02 (grab)	36.5
Thorium	31 (31)	3.8	13.1	SS-05	7.5
Radionuclides (pCi/g)					
Radium-226	31 (31)	1.4	5	TF-03 (grab)	1.2
Radium-228	24 (31)	1.9	11.6	CW-01	1.5

ND = Not detected.

Table 6-3b

Fabrication Area Subsurface Soil Contaminant Concentations

Analyte	Number of Detections (Number of Samples)	Average Detected Concentration	Maximum Detected Concentration	Location of Maximum	Background Level
Semivolatile Organic Compounds (ppb)					
Benzo(a)anthracene	3(44)	530	1,100	B-2 (19.5)	ND
Chrysene	4(44)	558	1,300	B-2 (19.5)	ND
Hexachlorobenzene	7(44)	8,800	27,000	B-2 (19.5)	ND
PCBs (ppm)					
Total PCBs	36(50)	0.619	440.0	B92-13 Grab (12.5)	NA
Metals (ppm)					
Thorium	41(41)	8.2	170.0	B-2 (19.5)	7.5
Radionuclide (pCi/g)					
Radium-226	39(39)	1.98	26.0	B-2 (19.5)	1.2
Radium-228	27(27)	1.09	6.2	B91-06 (13.0)	1.5

NA = Not analyzed.
ND = Not detected.

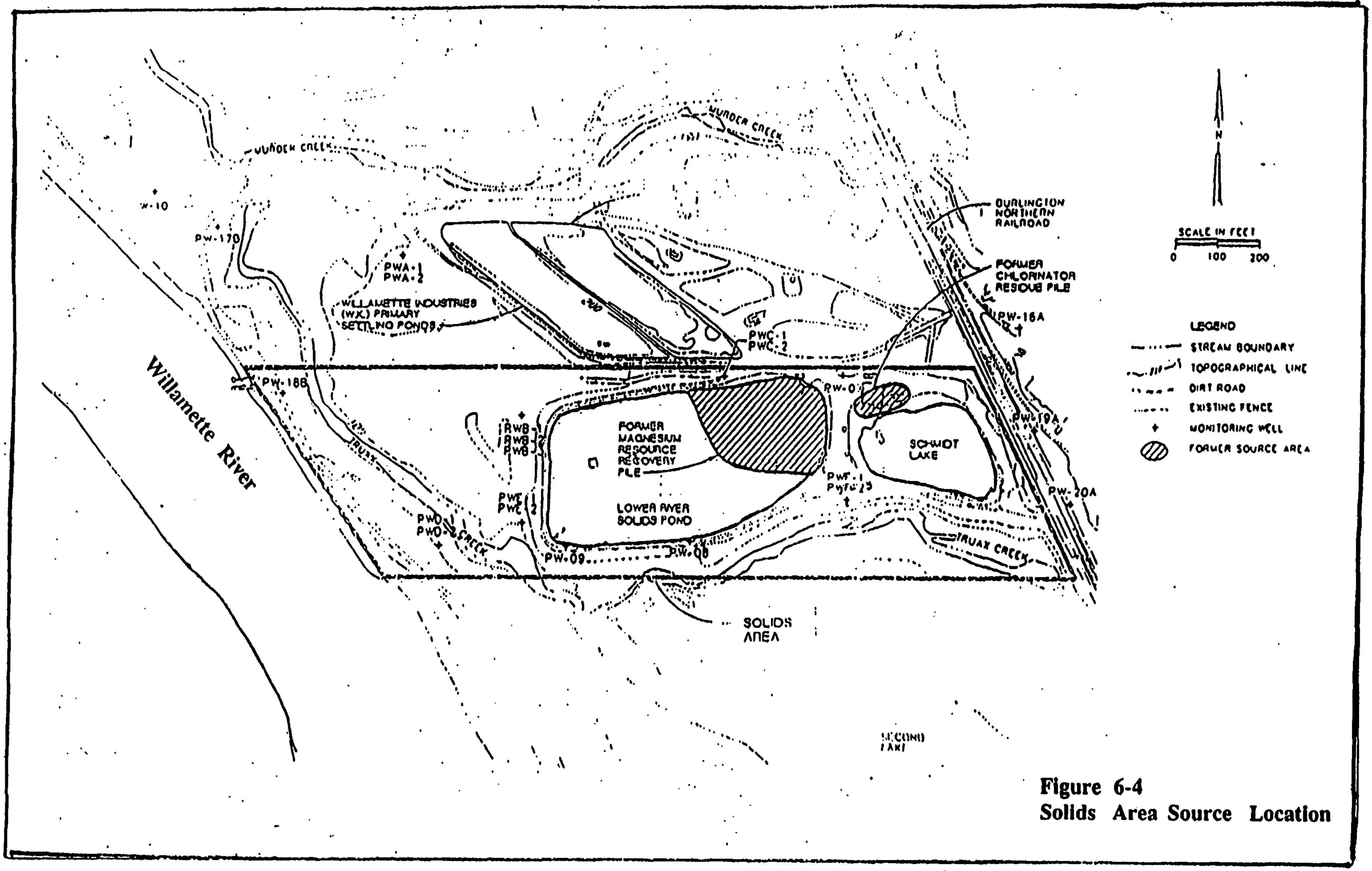

Figure 6-4
Solids Area Source Location

wastewater treatment plant from 1967 to 1979. These solids were the subject of a previous operable unit (see Section 3.4.1). In addition, an additional 2,016 cubic yards of materials containing zircon sands with elevated levels of thorium and uranium were removed from Schmidt Lake (see Section 3.4.2).

Soil sampling performed in the vicinity of the former Chlorinator Residue Pile, located north of Schmidt Lake, revealed the presence of barium sulfate and chloride salts. Source materials from the Chlorinator Residue Pile were removed in 1978 and barium sulfate was applied over the area to bind remaining radium that had been found in the residual chlorinator solids.

In 1988, approximately 44,000 cubic yards of magnesium chloride solids were removed by TWCA from the Magnesium Resource Recovery Pile, located at the northeast corner of the LRSP. TWCA then capped this area with asphalt and now uses it for materials handling.

In February 1995, TWCA submitted results of samples taken following the removal of sludges from the Lower River Solids Pond. The samples did not show any significant chemical or radionuclide contamination. This area was also surveyed during the gamma survey (see Section 6.4).

In May 1995, TWCA submitted results of samples taken following the removal of sludges and the additional material from Schmidt Lake. The samples did not show any significant chemical or radionuclide contamination. This area was also surveyed during the gamma survey (see Section 6.4).

In June 1995, TWCA submitted results of subsurface samples taken from the area of the former chlorinator residue pile. Total radium concentrations for this area ranged from 0.83 to 3.35 pCi/gram.

In July 1995, TWCA submitted the results of samples taken in the area of the magnesium resource recovery pile. No contaminant concentrations of significance were found.

6.4 Radiological Survey (Gamma Radiation and Radon Investigation at TWCA)

In September 1994, TWCA completed a Radiological Survey of the 1) Soil Amendment Area in the Farm Ponds Area, 2) the Extraction Area, 3) the Fabrication Area, and 4) the Solids Area. The purpose of this study was to collect gamma radiation readings across accessible areas of the Site, collect radon concentrations, assess potential risks posed by external gamma radiation and radon from surface soil, and evaluate potential remedial alternatives. EPA determined that it was appropriate to collect gamma radiation measurements for use in the risk assessment, rather than calculating potential gamma exposure from radium concentrations, because a survey would provide more data. Attempts to collect radon data were not successful, and therefore radon concentrations were modelled from radium data. Subsurface gamma radiation levels were not measured. In the Human Health Risk Assessment, risks from subsurface radionuclides were calculated using radium data (see Section 7.1). During the investigation, approximately 2,280 surface gamma radiation measurements were taken in 71 on-site areas.

6.4.1 Gamma Radiation Survey

6.4.1.1 Background Contaminant Levels

Background levels of gamma radiation were obtained for the Main Plant from property near the Site not directly impacted by TWCA operations. The background level for the Main Plant was 10.5 μrem/hour. For the Soil Amendment Area, a reference level was obtained from an adjacent agricultural field not impacted by the application of the lime solids spread on the Soil Amendment Area. The term "reference level" reflects the fact that agricultural areas already have an increase in gamma radiation levels over background resulting from radioactive elements in fertilizers. The reference gamma radiation level was 12.5 μrem/hour.

6.4.1.2 Main Plant

The results of the gamma survey on the TWCA Main Plant indicated that 90% of the survey readings were below 20.5 μrem/hour (10 μrem/hour over background, a level considered differentiable from background levels, and one half of the next increment evaluated, see Section 8.3.3), and 95% were below 30 μrem/hour (this level is 20 μrem/hour over background, a level used for screening areas requiring remediation in the Uranium Mill Tailings Radiation Control Action of 1978, see Section 8.1). A summary of gamma radiation data for the Main Plant is shown in **Table 6-4**. It should be noted that some data are higher than the average value for the areas. The average values are meaningful for risk assessment purposes because the risk assessment assumes that exposure takes place in all parts of an area, not just at an individual reading.

Areas with significantly elevated gamma radiation levels were located on three areas of the Main Plant (sample locations shown in parentheses): the parking lot outside of the boundary of the Extraction Area (PL-01 and PL-02), the former sand unloading area in the Fabrication Area (OC-01), and Schmidt Lake (SL-02) in the Solids Area (see **Figures 6-5a, b, and c**). The elevated levels of gamma radiation in these areas were hypothesized to be the results of the following Site activities:

Parking Lot:

This was the former location of the paint shop. Metal preparation for painting used black sand for sandblasting. The sand is the probable cause of the elevated gamma radiation.

Former Sand Unloading Area:

The Site was used to unload zircon sand from railcars as a raw material for the zirconium process. This resulted in sand being spilled from a conveyor belt onto the ground around the unloading site. The zircon sand used in the process contained naturally occurring radionuclides.

Schmidt Lake:

The area of elevated gamma radiation in Schmidt Lake was used as a temporary staging area for the Schmidt Lake Excavation Project (SLEP) (see Section 3.4.2) Stockpiled material included zircon sand that had elevated levels for gamma radiation due to naturally occurring radionuclides.

Table 6-4
Summary of Main Plant External Gamma Exposure Data

Main Plant Subarea	Number of Readings	Maximum Detected Value	Minimum Detected Value	Arithmetic Mean	Median	Standard Deviation	Number of readings >20.5 µrem/hr	Number of readings >30.5 µrem/hr	Number readings >57 µrem/hr
CU-01	12	14.28	8.19	10.06	9.56	1.90			
CU-03	16	10.92	6.11	8.01	7.50	1.58			
CU-04	12	14.28	8.19	10.63	9.90	1.81			
CU-05	11	16.92	7.50	9.48	8.19	2.90			
CU-06	15	8.87	4.71	7.03	7.50	1.28			
CU-07	12	12.27	5.41	8.41	8.19	1.61			
CU-08	13	10.24	4.71	7.86	7.50	1.90			
CU-09	8	10.24	4.71	7.83	8.53	2.40			
CW-01	20	26.46	6.11	9.68	7.50	5.47	2		
CW-02	16	14.28	6.11	9.29	8.87	2.53			
CW-03	7	8.87	6.11	7.49	7.50	1.13			
CW-04	25	8.87	4.01	5.97	6.11	1.15			
CW-05	35	8.87	4.71	7.06	7.50	1.34			
FT-01	17	20.81	6.80	11.09	9.56	3.63	1		
FT-03	9	10.92	8.19	8.80	8.19	0.93			
FT-04	9	10.24	7.50	8.57	8.19	0.85			
LRSP-01	200	15.61	4.71	10.21	10.24	2.59			
LRSP-02	196	23.35	4.71	11.21	11.60	3.59	2		
MF-01	8	9.56	7.50	8.10	7.84	0.77			
MF-02	16	9.56	6.80	8.49	8.19	0.83			
MF-03	16	9.56	6.11	8.31	8.19	0.92			
MF-04	10	10.24	6.80	8.32	8.19	1.25			
MF-05	8	10.92	6.80	9.04	8.87	1.41			
MP-01	34	8.87	4.71	6.88	6.11	1.03			

Table 6-4
Summary of Main Plant External Gamma Exposure Data

Main Plant Subarea	Number of Readings	Maximum Detected Value	Minimum Detected Value	Arithmetic Mean	Median	Standard Deviation	Number of readings >20.5 μrem/hr	Number of readings >30.5 μrem/hr	Number readings >57 μrem/hr
MP-03	30	10.92	7.50	8.83	8.53	0.84			
MP-04	18	8.87	5.41	7.15	7.50	1.07			
MP-05	16	10.24	4.71	7.23	7.50	1.45			
MP-06	15	10.24	7.50	8.87	8.87	0.90			
NW-01	11	10.92	6.80	8.68	8.87	1.11			
NW-02	11	9.56	6.80	8.56	8.87	0.94			
NW-03	11	9.56	6.11	7.93	8.19	0.99			
NW-04	5	9.56	6.80	8.05	8.19	1.23			
NW-05	9	9.56	6.11	8.11	8.19	1.22			
OC-01	97	80.17	6.80	26.24	25.08	17.33	54	35	9
PL-01	122	41.06	5.41	14.99	13.28	7.68	21	9	
PL-02	150	43.78	4.71	23.94	21.45	11.14	80	45	
SL-01	85	25.22	4.71	12.76	12.95	3.90	1		
SL-02	92	41.61	6.80	13.79	12.27	6.20	7	5	
SS-01	21	10.24	4.01	7.29	7.50	1.72			
SS-02	6	12.95	7.50	9.32	8.87	2.05			
SS-03	6	11.60	6.11	8.87	8.87	1.74			
SS-04	12	16.27	7.50	11.13	10.24	2.97			
SS-05	18	22.08	6.11	13.18	12.27	4.76	2		
ST-01	16	11.60	6.11	8.01	7.50	1.49			
ST-02	15	7.50	4.71	5.78	5.41	0.91			
ST-03	12	10.92	4.71	7.43	6.80	2.29			
ST-04	9	9.56	4.71	6.56	6.80	1.77			
ST-05	11	8.19	4.71	6.17	6.11	0.96			
TF-01	21	11.60	4.71	7.62	7.50	1.84			

Table 6-4
Summary of Main Plant External Gamma Exposure Data

Main Plant Subarea	Number of Readings	Maximum Detected Value	Minimum Detected Value	Arithmetic Mean	Median	Standard Deviation	Number of readings >20.5 μrem/hr	Number of readings >30.5 μrem/hr	Number readings >57 μrem/hr
TF-02	27	11.60	6.11	8.97	8.87	1.70			
TF-04	31	14.28	6.11	9.94	10.24	2.63			
TF-05	23	11.60	6.11	8.21	7.50	1.30			
WW-01	9	11.60	7.50	8.87	8.87	1.28			
WW-03	7	9.56	5.41	7.29	8.19	1.63			
WW-04	12	10.92	4.71	7.26	7.15	1.70			
WW-05	27	8.87	4.71	6.90	6.80	1.14			
WW-06	24	9.56	4.71	6.51	6.80	1.36			
WW-07	17	10.92	5.41	7.41	7.50	1.56			

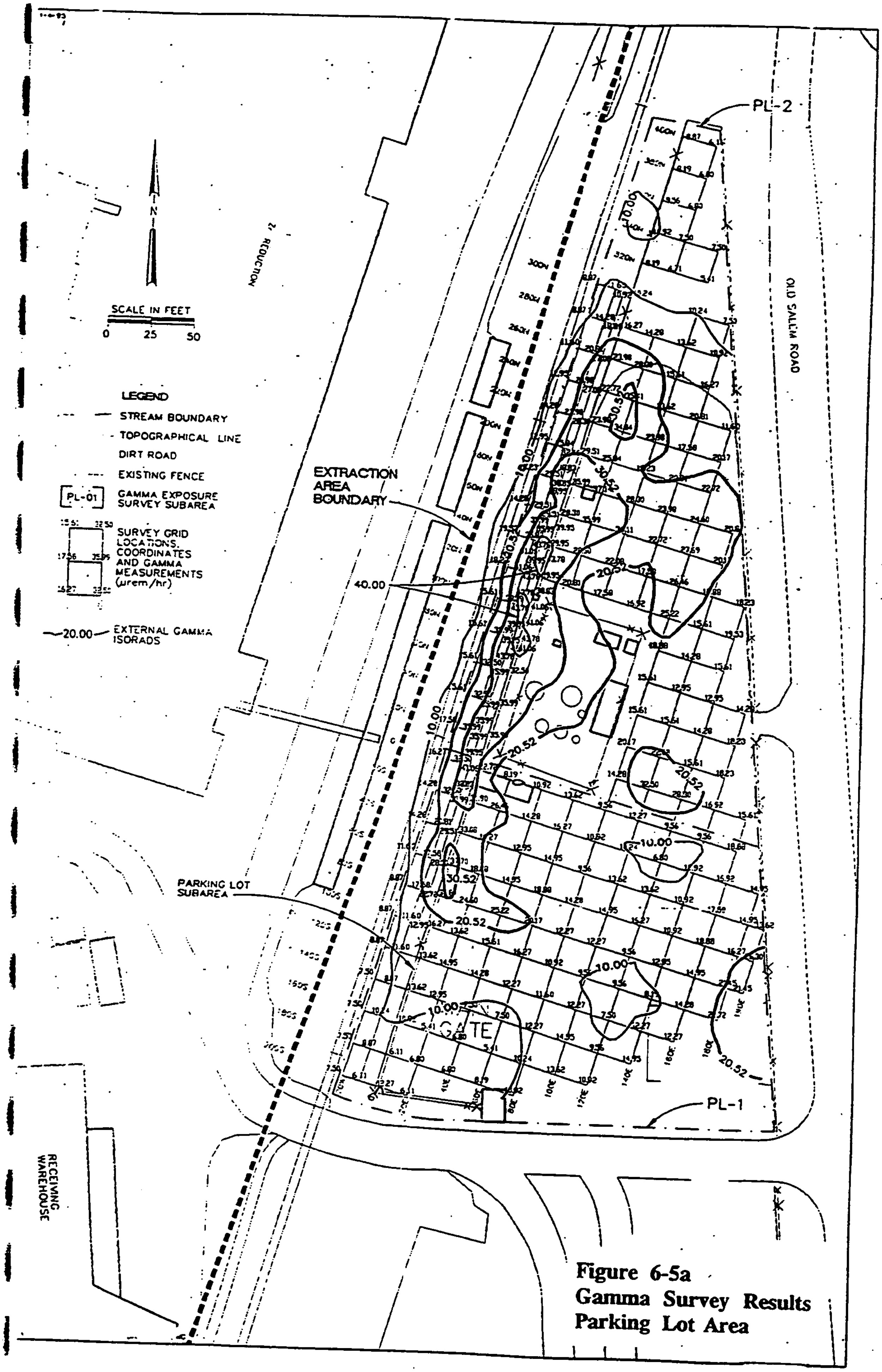

Figure 6-5a
Gamma Survey Results
Parking Lot Area

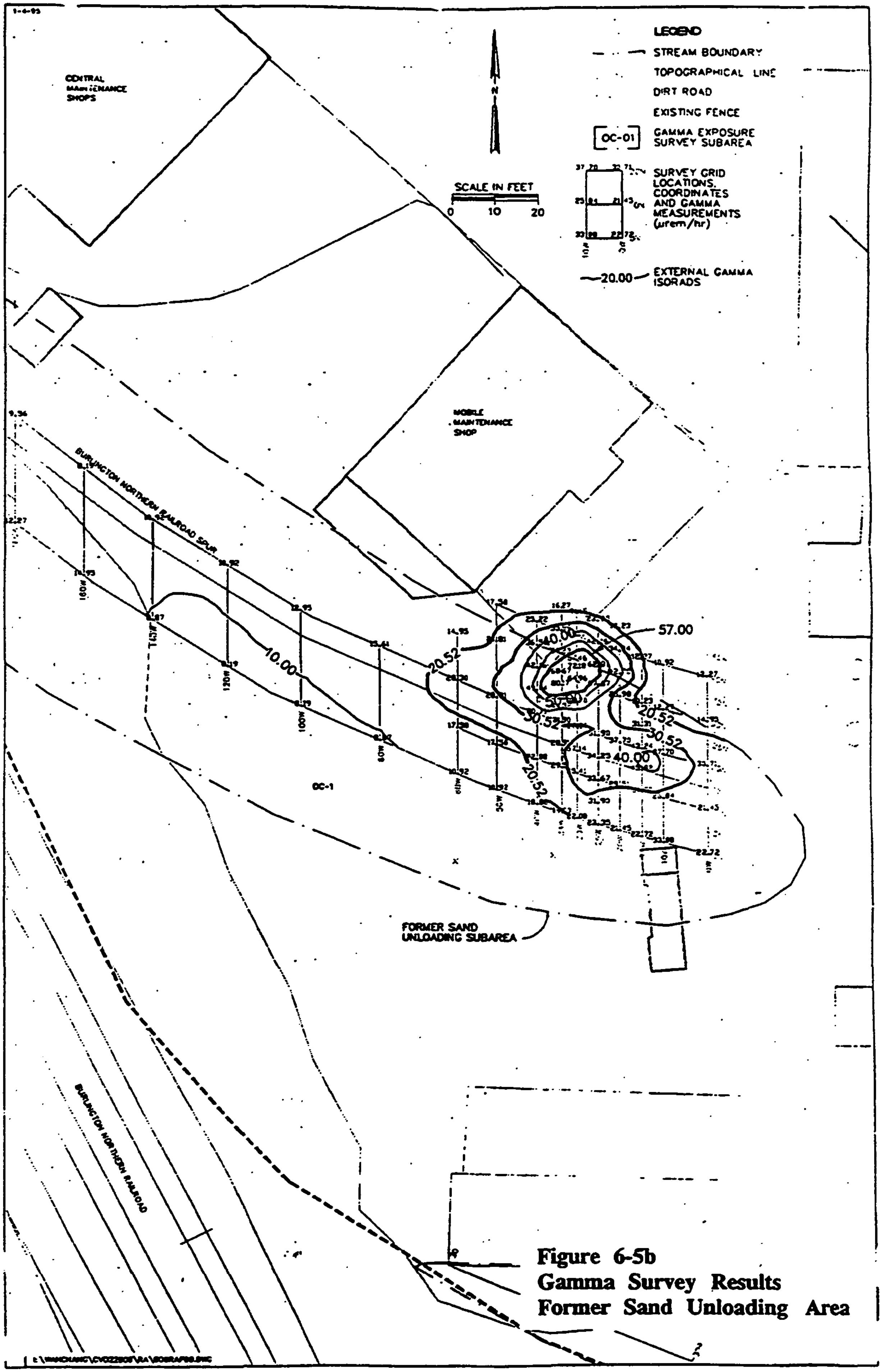

Figure 6-5b
Gamma Survey Results
Former Sand Unloading Area

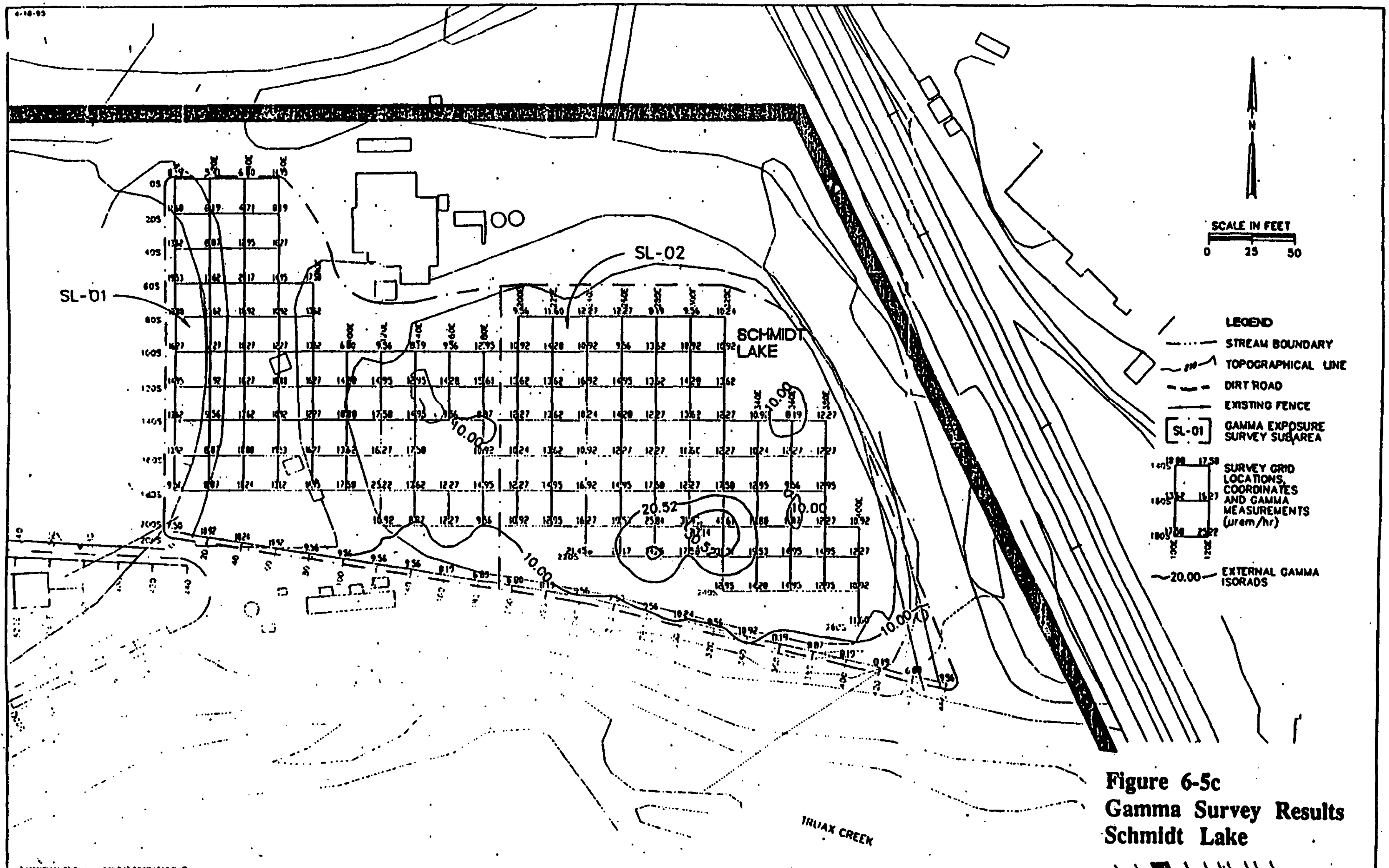

Figure 6-5c
Gamma Survey Results
Schmidt Lake

6.4.1.3 Soil Amendment Area.

The results of data from the Soil Amendment Area indicate that approximately 94 percent of the Soil Amendment Area survey readings were below 22.5 μrem/hour (10 μrem/hour over reference levels). None exceeded reference levels plus 20 μrem/hour. A summary of the results is shown in **Table 6-5**. Results are shown in **Figure 6-6**.

6.4.2 Calculated Radon Levels in Future Buildings.

Potential future indoor radon concentrations were modelled from known soil concentrations of the parent isotope radium-226. The methodology was obtained from Diffuse NORM WASTES: Waste Characterization and Preliminary Risk Assessment, Office of Radiation and Indoor Air, RAE-9232/1-2, Volume I, Appendix D Risk Assessment Methodology, Sections 1.2.1 and 1.2.4, (USEPA 1993). This approach was taken after an attempt to collect radon measurements was unsuccessful.

The model used the following equation:

$$C_{Rn} = [(C_{Ra} \times SD \times E)/(H \times RC)] \times (\lambda \times Df_s)^{1/2} \times e\text{-}((\lambda/Df_f)^{1/2} \times Th)$$

where:

C_{Rn}	=	**Indoor radon concentration (pCi/m³)**
C_{Ra}	=	**Soil radium-226 concentration (pCi/g)**
SD	=	**Soil density (g/m³)**
E	=	**Radon emanation coefficient (unitless)**
H	=	**Height of a standard room (m)**
RC	=	**Room air changes per year**
λ	=	**Radon decay constant (yr^{-1})**
Df_s	=	**Radon diffusion coefficient through soil (m^2/yr)**
Df_f	=	**Radon diffusion coefficient through foundation (m^2/yr)**
Th	=	**Thickness of building foundation (m)**

Table 6-6 shows the values of the parameters used in the model.

Radon, which emanates from radium-226 in the surface soil, is assumed to enter a building through the concrete floor foundation. The building is assumed to be built on top of the soil where radium concentrations were measured.

The model was applied to all surface soil radium data. Results where modelling of radon in future buildings exceeds background concentrations are shown in **Table 6-7** for the Main Plant and **Table 6-8** for the Soil Amendment Area. The areas referenced are shown on **Figures 6-3a, b and c.**

Table 6-5

Summary of Soil Amendment Area External Gamma Exposure Data

SAA Subarea	Number of Readings	Maximum Detected Value	Minimum Detected Value	Arithmetic Mean	Median	Standard Deviation	Number >20.5 (μrem/hr)	Number >30.5 (μrem/hr)	Number >57 (μrem/hr)
SA-01	15	22.08	9.56	14.72	14.28	4.33			
SA-02	15	20.81	8.87	14.81	15.61	4.05			
SA-03	15	23.98	10.24	15.91	14.95	4.25	2		
SA-04	15	23.35	11.60	18.1	18.88	3.54	1		
SA-05	15	27.08	11.60	16.70	15.61	4.23	2		
SA-06	15	23.98	12.95	18.41	16.92	3.56	3		
SA-07	15	18.23	10.24	15.20	15.61	2.13			
SA-08	15	25.84	10.92	18.78	19.53	4.40	2		
SA-09	15	16.92	7.50	13.63	15.61	3.25			
SA-10	15	20.81	8.87	13.13	12.95	3.67			
SA-11	15	20.17	8.87	13.26	12.95	3.81			
SA-12	15	22.08	11.60	16.19	15.61	3.52			
SA-13	10	22.72	8.87	17.01	16.60	4.20	1		

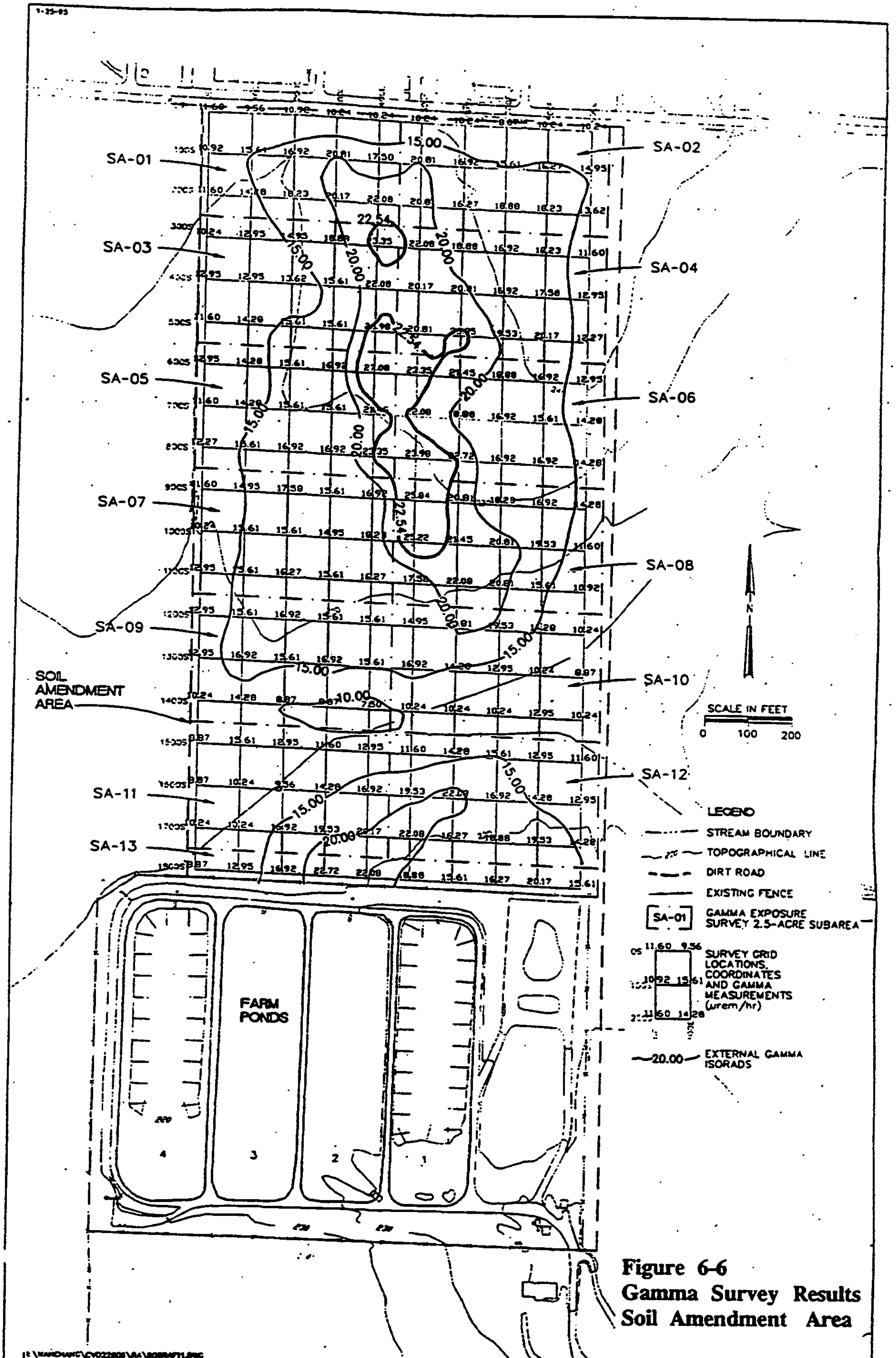

Figure 6-6
Gamma Survey Results
Soil Amendment Area

Table 6-6

Parameters for Radon Model

Model Parameters	Parameter Value
Radium-226 concentration (pCi/g)	From Phase 2 RI
Soil Density (g/cm^3)	1.29
Radon Emanation Coefficient (unitless)	0.55
Height of Standard Room (m)	2.3
Room Air Changes per Year	4,400
Radon Decay Constant (yr^{-1})	66
Radon Diffusion Coefficient Through Soil (m^2/yr)	22
Radon Diffusion Coefficient Through Building Foundation (m^2/yr)	3
Thickness of Building Foundation (m)	0.15

Table 6-7

Potential Radon Concentrations in Future Buildings Main Plant Subareas

Main Plant Subarea	Radium-226 Concentration [a] (pCi/g)	Estimated Radon Concentration [b] (pCi/l)
ST-01	8.8	11.63
ST-02	6.19	8.18
WW-01	5.3	7.01
CW-01	3.6	4.76
SS-02	3.5	4.63
SS-05	3.5	4.63
SS-04	2.8	3.70
CU-03	2.3	3.04
CU-04	2.3	3.04
MP-05	1.9	2.51
NW-03	1.9	2.51
WW-03	1.9	2.51
CU-05	1.7	2.25
CW-02	1.7	2.25
MP-06	1.5	1.98
CU-01	1.4	1.85
SS-03	1.4	1.85
TF-04	1.4	1.85
WW-07	1.4	1.85
CU-02	1.3	1.72
NW-01	1.3	1.72
Background Areas		
BS-01	1	1.32
BS-02	1	1.32
BS-03	1	1.32
BS-04	1.2	1.59
BS-05	1	1.32

a. Surface soil radium-226 concentrations measured during the RI.
b. Radon concentrations modeled from surface soil radium-226.

Table 6-8

Potential Radon Concentrations in Future Buildings
Soil Amendment Area

Soil Amendment Area Subarea	Radium-226 Concentration [a] (pCi/g)	Estimated Radon Concentration [b] (pCi/l)
SA-01	4.4	5.82
SA-02	8	10.57
SA-04	6.1	8.06
SA-05	1.4	1.85
SA-06	4.7	6.21
Background Areas		
BS-01	1	1.32
BS-02	1	1.32
BS-03	1	1.32
BS-04	1.2	1.59
BS-05	1	1.32

a. Surface soil radium-226 concentrations measured during the RI.
b. Radon concentrations modeled from surface soil radium-226.

7.0 SUMMARY OF SITE RISKS

CERCLA response actions at the TWCA Site as described in this ROD are intended to protect human health and the environment from risks related to current and potential exposure to hazardous substances at the Site.

To assess the risk posed by Site contamination, a Baseline Risk Assessment was completed by CH2M Hill on behalf of Teledyne Wah Chang Albany, as part of the TWCA RI/FS. The Baseline Risk Assessment evaluated human health risks from exposure to chemically contaminated groundwater, surface water, and surface and subsurface soil. In addition, as part of the Radiological Survey conducted by TWCA, risks associated with gamma radiation and radon, the result of radium contamination in the Site soil, were also evaluated.

This ROD only addresses risks associated with contaminants in surface and subsurface soil in the areas investigated during the RI/FS. Information on groundwater and surface water may be found in the Record of Decision for Final Remedial Action of Groundwater and Sediments Operable Unit, Teledyne Wah Chang Albany Superfund Site, June 10, 1994.

7.1 Human Health Risks

7.1.1 Approach to Human Health Risk Assessment for Chemicals and Radionuclides

Section 7.1 describes EPA's standard risk assessment methodology. This was the methodology used for calculating risks associated with exposure to chemicals in surface and subsurface soil, risks from exposure to radionuclides in subsurface soil (including gamma exposure), and risks from exposure to radionuclides excluding gamma radiation and radon in surface soils. An alternative methodology was used to calculate risks associated with exposure to external gamma radiation from surface soils, and from inhalation of radon. This approach is described in Section 7.2. EPA determined that the alternative methodology was appropriate given the data collected.

TWCA is an active operating facility and is expected to remain so in the foreseeable future. The percentage of time that workers at an operating facility would spend in a potentially contaminated area is generally less than if the Site were used for residential purposes. Therefore, for purposes of characterizing human health risks on the plant site, the RI/FS used an approach that is less conservative than if the TWCA property were used for residential purposes. This less conservative approach assumed that only workers would be exposed to risks from contaminants at the plant site. Residential exposure may be higher than worker exposure because residential exposure is likely to be for as much as 24 hours per day, rather than 8 hours per work day for worker exposure.

In an attempt to realistically estimate potential human health risks at the TWCA Site, based on information presented in the RI, risks were calculated on a sample-specific basis. Summation of risks at this Site would not have presented a meaningful approach because of the varied contaminant source areas caused by the large and complex chemical and manufacturing processes at the TWCA facility. In these circumstances, the sample-specific approach allows more accurate delineation of risks from specific contaminant source areas. This approach also enables retention of information on the geographic distribution of risk throughout the study area. The sample-specific approach to calculating risk has also provided information on the spatial discreetness and concentration of risk which was readily visualized by mapping risks. The sample-specific risks were used to distinguish areas that potentially exceed target risk levels from areas where exposure to contaminants results in calculated risk levels below EPA's acceptable risk range (see **Figures 6-3 a, b, and c** for surface soil sample locations).

For contaminants at the TWCA Site, the calculation of risk involved a 4-step process which included the identification of contaminants of concern, an assessment of contaminant toxicity, an exposure assessment of the population at risk, and a characterization of the magnitude of risk. Sections 7.1.2 through 7.1.4 cover the steps taken for chemical and radionuclide risks at the Site. Risks associated with exposure to gamma radiation and radon are covered in Section 7.2.

7.1.2 Chemicals of Concern

The chemicals of concern were selected based on: 1) the concentration of the chemical exceeding naturally occurring levels, (2) there being EPA-derived slope factors or reference doses available for the chemical, and (3) the maximum detected concentration exceeding a conservative health-based screening concentration. For surface or subsurface soils, chemicals were eliminated from consideration if the maximum detected concentration and protective screening level exposure assumptions resulted in a risk less than or equal to the one in ten million cancer risk value, or less than or equal to 0.1 hazard quotient for noncancer effects using the industrial scenario for the Main Plant and the residential scenario for the Farm Ponds Area (see Section 7.1.4). **Table 7-1** provides a list of the contaminants of concern at the Site.

Because of the presence of radium in soils, risks from exposure to gamma radiation and radon were considered to be important for consideration. The Radiological Survey performed after the completion of the other portions of the RI/FS investigated the presence of surface gamma radiation and radon and calculated risks from exposure to these radium daughter products. Risks from exposure to surface gamma radiation and radon are discussed in Section 7.2.

7.1.3 Toxicity Assessment

The Baseline Human Health Evaluation provides toxicity information for the chemicals of concern. Generally, cancer risks are calculated using toxicity factors known as slope factors (SFs), while noncancer risks rely on reference doses (RfDs).

EPA has developed SFs for estimating excess lifetime cancer risks associated with exposure to potential chemical carcinogens. SFs for chemical intake (ingestion or inhalation) are expressed in units of $(mg/kg\text{-}day)^{-1}$ and are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SFs. Use of this approach makes it highly unlikely that the actual cancer risk would be underestimated. SFs for individual chemicals are derived from the results of human epidemiological studies, or chronic animal bioassay data, to which mathematical extrapolation from high to low dose, and from animal to human dose, have been applied.

RfDs have been developed by EPA to indicate the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure for humans, including sensitive subpopulations likely to be

Table 7-1

Chemicals of Concern and Selection Criteria

Chemical	Surface Soils		Subsurface Soils
	Farm Ponds	Plant Site	
VOLATILE ORGANIC COMPOUNDS [a]			
SEMIVOLATILE ORGANIC COMPOUNDS			
Benzo(a)anthracene	ND	d	d
Benzo(a)pyrene	ND	c	g
Benzo(b)fluoranthene	ND	d	ND
Benzo(k)fluoranthene	ND	d	ND
Chrysene	ND	d	d
Dibenz(a,h)anthracene	ND	d	ND
Hexachlorobenzene	c	c	c
Indeno(1,2,3-cd)pyrene	ND	d	ND
PCBs			
Total Aroclors	c	c	c
METALS [f]			
Chromium (total)	g	c	g
Thorium	c	c	c
Zirconium	g	b	g
Radionuclides			
Radium 226	e	e	e
Radium 228	e	e	e

ND = Not detected.
a. Volatile Organic Compounds not analyzed for in surface soil, in subsurface soil maximum values were below risk based concentrations.
b. Selected based on having a reference dose value.
c. Selected based on having a cancer slope factor.
d. Selected based on being a carcinogenic PAH and slope factor based on benzo(a)pyrene.
e. Selected based on the UMTRCA standard of 5 pCi/g.
f. Metals not listed were either at or below background levels, or below risk based concentrations.
g. Concentration below risk based levels.

without risk of adverse effect. Estimated intakes of contaminants of concern from environmental media (e.g., the amount of a contaminant of concern ingested from incidental contact with contaminated soil) can be compared to the RfD. RfDs for individual chemicals are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied.

The Baseline Human Health Evaluation relied on oral and inhalation SFs and RfDs. The toxicity factors shown in **Table 7-2** were drawn from the Integrated Risk Information System (IRIS) or, if no IRIS values were available, from the Health Effects Assessment Summary Tables (HEAST).

7.1.4 Exposure Assessment

The exposure assessment identified potential pathways for contaminants of concern to reach the exposed population. Exposure assumptions were based primarily on EPA regional and national guidance, including EPA Superfund Standard Default Exposure Factors, except where tailored to meet specific Site conditions. Current Site use is industrial, except for the Soil Amendment Area (located within the Farm Ponds Remedial Sector) which is currently being used for agricultural purposes. The Baseline Human Health Evaluation evaluates exposure to current and future workers on the plant site, and to potential future residents in the Farm Ponds Area (a conservative approach for this area). EPA further supplemented the evaluation in the Farm Ponds Area by evaluating an agricultural worker (farm worker) scenario in the Soil Amendment Area of the Farm Ponds Area.
Exposures to contaminants in surface soils could occur via inadvertent ingestion, skin contact, or by inhaling dusts and vapors. The frequency, duration, extent, and route of exposure to surface soils would depend on the particular activity of the receptor and location of the activity. In the Baseline Human Health Evaluation, incidental ingestion exposures were estimated for current or future workers contacting surface soil during regular working hours. Risks from skin contact with soils were not quantified because information is not available on the efficiency of chemical absorption from soil across the skin, and no toxicity values exist for this exposure route. Risks from inhalation were evaluated, found to not be a significant risk driver, and are not included in the risk calculations.

Workers may be exposed to chemicals in subsurface soils during excavations and/or trenching to repair or place utility lines or pipes. Workers coming into contact with chemicals in subsurface soils may become exposed through incidental ingestion, skin contact, inhalation of vapors, or external exposure to gamma radiation. Exposures under this scenario would generally be infrequent. The risk assessment evaluated risks from ingestion of chemicals and radionuclides, and from exposure to gamma radiation. Risks from skin contact were not evaluated for the reasons discussed above. Risks from inhalation were not evaluated because excavation trenches would likely be damp and protected from wind, therefore dusts would generally not be available for inhalation. The exposure frequency (i.e., days per year exposed) and the exposure duration (i.e., total number of years exposed) were based on TWCA Site specific employee practice information provided to EPA by TWCA.

Exposure point concentrations for the TWCA Site Baseline Human Health Evaluation were derived in a manner consistent with the EPA guidance to evaluate Reasonable Maximum Exposures (RMEs). The RME is defined as the highest exposure that is reasonably expected to occur at a Site. In addition the Baseline Human Health Evaluation incorporates information that incorporates both the

Table 7-2

Toxicity Factors

CARCINOGENS	Slope Factor		Unit Risk		Weight of Evidence	
COMPOUND	Oral	Source	Inhalation	Source	Oral	Inhalation
Arsenic	2.00E+00	IRIS	4.30E-01	IRIS	A	A
Benzene	2.90E-02	IRIS	8.30E-06	IRIS	A	A
Chloroform	6.10E-03	IRIS	2.30E-05	IRIS	B2	B2
Chromium VI			1.20E-02	IRIS		A
1,2-Dichlorethane	9.10E-02	IRIS	2.60E-05	IRIS	B2	B2
1,1-Dichloroethene	6.00E-01	IRIS	5.00E-05	IRIS	C	C
Hexachlorobenzene	1.60E+00	IRIS	4.60E-04	IRIS	B2	B2
1,1,2,2-Tetrachloroethane	2.00E-01	IRIS	5.80E-05	IRIS	C	B2
Tetrachloroethene	5.10E-02	HEAST	5.20E-07	HEAST	B2	B2
Trichloroethylene	1.10E-02	HEAST	1.70E-06	HEAST	B2	B2
Vinyl Chloride	1.90E+00	HEAST	8.40E-05	HEAST	A	A
Benzo(a)pyrene	7.30E+00	IRIS	1.70E-03	HEAST	B2	B2
Benzo(a)anthracene	*	*	*	*	*	*
Benzo(b)fluoranthene	*	*	*	*	*	*
Benzo(k)fluoranthene	*	*	*	*	*	*
Chrysene	*	*	*	*	*	*
Dibenz(a,h)anthracene	*	*	*	*	*	*
Indeno(1,2,3-cd)pyrene	*	*	*	*	*	*
Polychlorinated biphenyls	7.70E+00	IRIS			B2	

Slope factor, units - risk per milligram per kilogram of body weight per day ((mg/kg-day)-1)

Unit Risk, units - risk per microgram per cubic meter, ((ug/m3)-1)

* Indicates that risks were considered equivalent to Benzo(a)pyrene

IRIS - Integrated Risk Information System, USEPA, 1992
HEAST -Health Effects Assessment Summary Tables, Annual Summary, USEPA, 1992

Table 7-2 (cont.)

Toxicity Factors

NON-CARCINOGENS	REFERENCE DOSE						CONFIDENCE LEVEL	SYSTEM EFFECTED
COMPOUND	Oral	Source	UF/MF	Inhalation	Source	UF/MF	Oral/ Inhalation	
Acetone	1.00E-01	IRIS	1,000	NA			Low	Liver & Kidney
Chloroform	1.00E-02	IRIS	1,000	NA			Med	Liver
1,1-Dichloroethane	1.00E-01	HEAST	1,000	5.00E-01	HEAST	1,000		Kidney
1,1-Dichloroethene	9.00E-03	IRIS	1,000	NA			Med	Liver
cis1,2-Dichloroethene	1.00E-02	HEAST	3,000	NA				Blood
Methylisobutylketone	2.00E-02	IRIS	1,000	NA				Liver Enzyme
1,1,1-Trichloroethane	9.00E-02	HEAST	1,000	1.00E+00	HEAST	1,000		Liver
1,1,2-Trichloroethane	4.00E-03	IRIS	1,000				Med	Clinical Chemistry
Bis(2-ethylhexyl)Phthalate	2.00E-02	IRIS	1,000					Liver
Hexachlorobenzene	8.00E-04	IRIS	100				Med	Liver
Antimony	4.00E-04	IRIS	1,000				Low	Clinical Chemistry
Arsenic	3.00E-04	IRIS	3				Med	Skin
Barium	7.00E-02	IRIS	3	5.00E-04	HEAST	1,000		Blood, Fetus
Cadmium	5.00E-04	IRIS	10					Kidney
Chromium (total)	1.00E+00	IRIS	500				Low	Not Reported
Copper	3.70E-02	HEAST	NR					GI Tract
Magnesium	9.70E+00	ECAO	1,000					GI Tract
Manganese	1.00E-01	IRIS	1	4.00E-04	IRIS	300	Med/Med	CNS, Respiratory
Mercury	3.00E-04	HEAST	1,000	3.00E-04	HEAST	30		Kidney, Nervous
Nickel	2.00E-02	IRIS	100				Med	Body Weight
Thallium	7.00E-05	HEAST	3,000					Clinical Chemistry
Uranium	3.00E-03	IRIS	1,000					Kidney
Zinc	2.00E-01	HEAST	10					Blood

Table 7-2 (cont.)

Toxicity Factors

NON-CARCINOGENS	REFERENCE DOSE						CONFIDENCE LEVEL	SYSTEM EFFECTED
COMPOUND	Oral	Source	UF/MF	Inhalation	Source	UF/MF	Oral/ Inhalation	
Zirconium	3.00E+00	ECAO	1,000					No Effect Level
Ammonia	6.00E-02	HEAST	1					Taste
Fluoride	6.00E-02	IRIS	1				High	Teeth
Nitrate	1.60E+00	IRIS	1				High	Blood

Reference Dose, units - milligrams per kilogram of body weight per day (mg/kg/day)
UF - Uncertainty Factor
MF - Modifying Factor
NA - Not available
NR - Not Reported
IRIS - Integrated Risk Information System, USEPA, 1992
HEAST - Health Effects Assessment Summary Tables, Annual Summary, USEPA, 1992
ECAO - Environmental Criteria and Assessment Office, USEPA, Cincinnati, 1992

RADIONUCLIDES	SLOPE FACTOR		SOURCE	WEIGHT OF EVIDENCE
COMPOUND	Ingestion	Inhalation		
Radium-226D	1.20E-10	3.00E-09	HEAST	A
Radium-228D	1.00E-10	6.90E-10	HEAST	A
Thorium-228	5.50E-11	7.80E-08	HEAST	A
Thorium-230	1.30E-11	2.90E-08	HEAST	A
Thorium-232	1.20E-11	2.80E-08	HEAST	A

D - Risks from decay products also included
Slope Factor, units - risk per unit picocurie intake or exposure (risk/pCi)
HEAST - Health Effects Assessment Summary Tables, Annual Summary, USEPA, 1992

average and the high-end RME portions of the risk distribution. Presentation of the plausible range of risk allow risk management decisions to incorporate the relative uncertainty in the risk estimates. The average case exposure assumptions largely represent the 50th percentile values within a normally distributed population.

The exposure assumptions used to estimate potential RME and average case exposures to chemicals of concern in soils at the TWCA Site are summarized in **Tables 7-3a, b, and c**.

7.1.5 Risk Characterization

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated by multiplying the chemical specific SF (see "Toxicity Assessment" above) by the "chronic daily intake" for that chemical developed using the exposure assumptions. These risks are probabilities generally expressed in scientific notation (e.g. 1×10^{-4}). An excess lifetime cancer of 1×10^{-4} means that an individual has a 1 in 10,000 chance of developing cancer as a result of site-related exposure to a carcinogen under the specific exposure conditions assumed.

The potential risk for non-carcinogenic effects are evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a chemical specific reference dose (see "Toxicity Assessment" above) derived for a similar exposure period. Hazard quotients are calculated by dividing the chronic daily intake by the specific RfD. By adding the hazard quotients for all contaminants of concern, the hazard index (HI) can be generated.

The RME provides a conservative but realistic exposure in considering remedial action at a Superfund site. Based on the RME, when the excess lifetime cancer risk estimates are below 1×10^{-6} (1 in 1,000,000), or when the noncancer HI is less than 1, EPA generally considers the potential human health risks to be below levels of concern. Remedial action is generally warranted when excess lifetime cancer risks (hereafter excess cancer risks) exceed 1 x 10-4 or the hazard index exceeds 1. Between 1×10^{-6} and 1×10^{-4}, cleanup may or may not be selected, depending on individual site conditions including human health and ecological concerns.

The potential human health risks at the TWCA Site were characterized by estimating risks on a sample-specific basis. This approach retains information on the geographic distribution of risk throughout the study area. The sample specific risks were used to distinguish specific areas of the TWCA Site that exceed risk-based levels.

7.1.6 Chemical and Radionuclide Risks

Tables 7-4a and b summarize the excess risks from exposure to surface and subsurface soils at the Site. For surface soil, risks include ingestion of chemicals and radionuclides, but do not include risks from exposure to gamma radiation and radon (see Section 7.2). Risks from exposure to subsurface soils include ingestion of chemicals and radionuclides, and exposure to subsurface gamma radiation.

As described below, risks from exposure to chemical and radionuclide contamination (excluding gamma radiation and radon) were generally low. For surface soils, the chemicals with the most significant contribution to Site risks were PCBs, hexachlorobenzene, and PAHs. For subsurface soils,

Table 7-3a

Exposure Assumptions for Subsurface Soil Pathways

Exposure Parameters	Average	RME
Exposed Individual	Trench Worker	Trench Worker
Body Weight (kg)	70	70
Ingestion Rate (mg/day)	100	480
Days/year Exposed	24	24
Years Exposed	5	5

Table 7-3b

Exposure Assumptions for Surface Soil Pathways

Exposure Parameters	Plant Area		Farm Ponds Area	
	Average	RME	Average	RME
Exposed Individual	Worker	Worker	Resident	Resident
Body Weight (kg)	70	70	70	15 (0-6yr) 70 (>6yr)
Ingestion Rate (mg/day)	50	50	100	200 (0-6yr) 100 (>6yr)
Days/year Exposed	250	250	275	350
Years Exposed	9	25	9	30

Table 7-3c

Exposure Assumptions for Agricultural Pathways

Exposure Parameter	Average	RME
Exposed Individual	Farm Worker	Farm Worker
Body Weight (kg)	70	70
Ingestion Rate (mg/day)	480	480
Days/year Exposed	30	30
Years Exposed	9	25

Table 7-4a

Summary of Sample-Specific Risks for Surface Soils

Remedial Sector	Hazard Index > 1.0		Cancer Risk ≥ 10^{-4}		Cancer Risk ≥ 10^{-5}		Cancer Risk ≥ 10^{-6}	
	Average	RME	Average	RME	Average	RME	Average	RME
Farm Ponds Area-Residential								
Chemical Risk	0/14	0/14	0/14	0/14	0/14	4/14	4/14	5/14
Radionuclide Risk	NA	NA	0/14	0/14	0/14	0/14	0/14	5/14
Farm Ponds Area - Farm Worker								
Chemical Risk	0/6	0/6	0/6	0/6	0/6	0/6	1/6	4/6
Radionuclide Risk	NA	NA	0/6	0/6	0/6	0/6	0/6	0/6
Extraction Area								
Chemical Risk	0/26	0/26	0/26	0/26	0/26	3/26	9/26	13/26
Radionuclide Risk	NA	NA	0/26	0/26	0/26	0/26	0/26	1/26
Fabrication Area								
Chemical Risk	0/31	0/31	0/31	0/31	0/31	3/31	7/31	13/31
Radionuclide Risk	NA	NA	0/31	0/31	0/31	0/31	0/31	0/31
Background								
Chemical Risk - Res.	0/10	0/10	0/10	3/10	1/10	9/10	9/10	10/10
- Ind.	0/10	0/10	0/10	0/10	0/10	4/10	5/10	10/10
Radionuclide Risk - Res.	NA	NA	0/10	0/10	0/10	0/10	0/10	0/10
- Ind.	NA	NA	0/10	0/10	0/10	0/10	0/10	0/10

Values listed are the number of surface soil samples in the remedial sector that had sample-specific noncancer hazard index estimates exceeding 1.0, or excess lifetime cancer risk estimates of greater than or equal to $1x10^{-4}$, $1x10^{-5}$, or $1x10^{-6}$, under assumed reasonable maximum or average case exposure conditions. Risks from radon inhalation and gamma exposure are not included.
NA = Not applicable.

Table 7-4b
Summary of Sample-Specific Risks for Subsurface Soils

Remedial Sector	Hazard Index > 1.0		Cancer Risk ≥ 10^{-4}		Cancer Risk ≥ 10^{-5}		Cancer Risk ≥ 10^{-6}	
	Average	RME	Average	RME	Average	RME	Average	RME
Farm Ponds Area[a]								
Chemical Risk	0/18	0/18	0/18	0/18	0/18	0/18	0/18	0/18
Radionuclide Risk	NA	NA	0/18	0/18	0/18	0/18	5/18	5/18
Extraction Area								
Chemical Risk	0/69	0/69	0/69	0/69	0/69	0/69	0/69	2/69
Radionuclide Risk	NA	NA	4/63	4/63	13/63	13/63	54/63	54/63
Fabrication Area								
Chemical Risk	0/58	0/58	0/58	0/58	0/58	3/58	3/58	7/58
Radiocuclide Risk	NA	NA	1/44	1/44	4/44	4/44	39/44	39/44
Background								
Chemical Risk	0/10	0/10	0/10	0/10	0/10	0/10	0/10	5/10
Radiation Risk	NA	NA	0/10	0/10	0/10	0/10	10/10	10/10

Values listed are the number of subsurface soil samples in the remedial sector that had sample-specific noncancer hazard index estimates exceeding 1.0 or excess lifetime cancer risk estimates of greater than or equal to $1x10^{-4}$, $1x10^{-5}$, or $1x10^{-6}$, under assumed reasonable maximum or average case exposure conditions. NA = Not applicable.

a. Residential risks

the most significant contributions to Site risks came from PCBs and radionuclides.

In the Farm Ponds Area, surface and subsurface excess risks were all less than $1x10^{-5}$ and a non-cancer hazard index of 1 for the farm worker scenario. For residential risks, the risks were $2x10^{-5}$ or less, and the hazard index less than 1. In the risk assessment, risks using an industrial exposure scenario were not calculated for the Farm Ponds Area. However, because the exposure duration for the industrial scenario is approximately half that of the residential scenario, risks from this scenario would be proportionally lower.

On the Main Plant, no surface soil or subsurface soil non-cancer hazard index exceeded 1. For surface soils, some samples resulted in excess cancer risk estimates exceeding $1x10^{-5}$, but less than $1x10^{-4}$. The excess risks were from exposure to PCBs and PAHs in subareas of the Fabrication Area. For subsurface soils, some chemical risks in the Fabrication Area exceeded $1x10^{-5}$, but were less than $1x10^{-4}$. In the Extraction Area, a small number of samples posed a radiation risk of $1x10^{-4}$.

For subsurface PCBs and subsurface radionuclides in the Fabrication Area, and subsurface radionuclides under the V-2 Pond in the Extraction Area, the contamination in these areas could pose a risk greater than $1x10^{-4}$ if it were subject to the exposure assumptions for surface material.

7.2 Human Health Risks from Exposure to Surface Gamma Radiation and Inhalation of Radon

When radionuclides decay, radiation is produced. Other unstable radioactive decay products such as radon can result. The major pathways for human exposure from radium contamination in the soil are the inhalation of radon, which will accumulate in buildings, and exposure to gamma radiation.

Gamma radiation is continuously emitted from soil contaminated with radionuclides. The extent of exposure is dependent on how close one is to the source, and whether or not the source is shielded by something which partially absorbs the gamma radiation. Gamma radiation emitted by unshielded radium contaminated soil gives anyone standing over a contaminated area a radiation dose over the whole body. The greater the duration and intensity of this exposure, the larger the dose, and hence the greater the risk of adverse health effects.

The exposure pathway for radon is through inhalation. Radon has short-lived decay products which can expose the internal tissue of the lungs to bursts of energy if they decay within the lungs. Prolonged inhalation of air containing high concentrations of radon decay products has been shown to increase the risk of contracting lung cancer.

When radon seeps into open spaces from radium contaminated soil, it mixes with large amounts of air which generally dilutes the radon. However, radon decay products can accumulate to higher concentrations in buildings built over contamination, because structures tend to trap radon.

In order to estimate excess lifetime cancer risk from the gamma exposure measurements, assumptions were made to estimate a lifetime radiogenic dose of gamma radiation. **Table 7-5** lists the exposure assumptions used for this risk analysis for external gamma radiation exposure. For the Main Plant areas, only an industrial scenario was considered. For the Soil Amendment Area, farm worker (current use), industrial (most likely future use), and residential (hypothetical maximum future use) scenarios were considered.

Table 7-5

Exposure Assumptions for External Gamma Radiation Pathways

Exposed Individuals	Exposure Parameters			
	Main Plant Area	Soil Amendment Area		
	Industrial Workers	Farm Workers	Industrial Workers	Residents
Hours/Week Outdoors	10	40	10	42
Hours/Week Indoors	30	None	30	126
Gamma Shielding Factor Indoors	0.66	0.25	0.66	0.20
Days/Year Exposed	250	30	250	350
Years Exposed	25	25	25	30
Cancer Slope Factor (Risk/Lifetime Millirem)	$6.2x10^7$	$6.2x10^7$	$6.2x10^7$	$6.2x10^7$

The potential cancer risks from gamma radiation exposure were estimated using the following equation from Human Health Evaluation Manual, Part B: "Development of Risk-based Preliminary remediation Goals", OSWER Directive 9285.7-01B (USEPA 1991):

$$R = CSF \times ER \times CF \times (1\text{-}Sh) \times ET \times EF \times ED$$

where:

R	=	Excess Lifetime Cancer Risk
CSF	=	Cancer Slope Factor (risk/lifetime millirem)
ER	=	Gamma Emission Rate (μrem/hour)
CF	=	Unit Conversion Factor (10^{-3} mrem/μrem)
Sh	=	Gamma Shielding Factor (unitless)
ET	=	Exposure Time (hours/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)

For this assessment an average lifetime risk of radiogenic cancer of 6.2×10^{-7} per lifetime millirem was used.

Excess cancer risks for radon inhalation were estimated from indoor radon concentrations using the following equation from Diffuse NORM WASTES: Waste Characterization and Preliminary Risk Assessment, Office of Radiation and Indoor Air, RAE-9232/1-2, Volume I, Appendix D Risk Assessment Methodology, Sections 1.2.1 and 1.2.4, (USEPA 1993):

$$Risk = C_{Rn} \times Fr \times CSF_{yr} \times ED$$

where:

C_{Rn}	=	Indoor Radon Concentration (pCi/m^3)
Fr	=	Fraction of Year Exposed
CSF_{yr}	=	Cancer Slope Factor: Cancer risk per pCi/l radon per year exposed (4.3×10^{-8})
ED	=	Exposure Duration (years)

The indoor radon concentrations were modelled using the equation in Section 6.4.2. **Table 7-6** shows the exposure assumptions used for calculating risks from radon inhalation. For the Main Plant areas, only an industrial scenario was considered. For the Soil Amendment Area, an industrial (most likely future use), and residential (hypothetical maximum future use) scenarios were considered. The agricultural scenario is not used because the increased risk associated with radon comes from the increase in contaminant concentration inside a building.

Table 7-6

Exposure Assumptions for Radon Inhalation Pathways

Exposure Parameters	**Parameter Value**
Fraction of Year Exposed	Worker - 0.23 Resident - 1.0
Fraction of Time Spent Indoors	Worker - 0.75 Resident - 0.75
Years Exposed	Worker - 25 Resident - 30
Cancer Slope Factor (Risk per pCi/m^3 of Radon)	4.3×10^{-8}

7.2.1 Gamma Radiation Risks

Tables 7-7a, b, c, and d show the results of the risk assessment for gamma radiation. Naturally occurring levels of radionuclides result in significant risks from gamma radiation. Therefore, the background risk level for the Main Plant, and the reference[1] risk level for the Soil Amendment Area also need to be considered when evaluating contaminant related risks. For this reason, the tables present total excess lifetime cancer risks (risks including background or reference levels), and incremental excess lifetime cancer risks (risks in excess of background or reference levels). Remedial decisions will be based on the incremental excess lifetime cancer risks (hereafter referred to as incremental excess risks). Risks were calculated for the same sample areas as used to calculate the chemical risks.

The highest Main Plant incremental excess risks were for the three areas with the elevated gamma radiation levels. These areas had the following incremental excess risks above background levels: the chemical unloading area $2.4x10^{-4}$ (OC-1), the parking lot $2.1x10^{-4}$ (PL-2), and $6.9x10^{-5}$ (PL-1), and Schmidt Lake $5.1x10^{-5}$ (SL-2) (sample locations are shown in **Figures 6-3a, b, and c**). The background risk from gamma radiation exposure for the Main Plant was $1.6x10^{-4}$.
For the Soil Amendment Area, the highest incremental excess risks were $9.7x10^{-5}$ for the industrial scenario ($1.9x10^{-4}$ reference risk); $9.1x10^{-6}$ for the farm worker scenario ($3.5x10^{-5}$ reference risk); and $9.6x10^{-4}$ for the residential scenario ($1.7x10^{-3}$ reference risk).

7.2.2 Risks from Radon Inhalation

Estimated excess risks from modelled radon concentrations in future buildings are shown in **Tables 7-8a, b, and c**. As discussed in Section 7.2.1 for gamma radiation, naturally occurring levels of radionuclides also result in significant radon risks. Therefore, the tables present total excess lifetime cancer risks (risks including background or reference levels), and incremental excess lifetime cancer risks (risks in excess of background or reference levels). Risks were calculated for the same sample areas as used to calculate the chemical risks. The highest incremental excess risks for the Main Plant ranged to $2.5x10^{-3}$. For the Soil Amendment Area, excess incremental risks ranged to $2.2x10^{-3}$ for the industrial scenario, and to $8.4x10^{-3}$ for the residential scenario (sample locations are shown in **Figures 6-3a, b, and c**).

7.3 Risk Assessment Uncertainty

The accuracy of the risk characterization depends in large part on the accuracy and representativeness of the sampling, exposure, and toxicological data. Many assumptions are intentionally conservative so the risk assessment will be more likely to over-estimate risk than to underestimate it.

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[1] As discussed in Section 6.4.1.1 a reference level is used for the Soil Amendment Area to take into account the use of fertilizers on the agricultural area.

Table 7-7a

Summary of Cancer Risk Estimates for Gamma Radiation
Main Plant Area - Industrial Scenario

Soil Amendment Area Sample	Arithmetic Mean Gamma Exposure Rate μrem/hour	Excess Lifetime Cancer Risk [a]	Incremental Excess Lifetime Cancer Risk [b]
OC-01	26.24	4.1E-04	2.4E-04
PL-02	23.94	3.7E-04	2.1E-04
PL-01	14.99	2.3E-04	6.9E-05
SL-02	13.79	2.1E-04	5.1E-05
SS-05	13.18	2.0E-04	4.1E-05
SL-01	12.76	2.0E-04	3.5E-05
LRSP-02	11.21	1.7E-04	1.1E-05
SS-04	11.13	1.7E-04	9.4E-06
FT-01	11.09	1.7E-04	8.8E-06
CU-04	10.63	1.6E-04	1.7E-06
background	10.52	1.6E-04	0.0E-00

a. Calculated as the total gamma risk including background risk.
b. Risk in excess of background risk.

Table 7-7b

**Summary of Cancer Risk Estimates for Gamma Radiation
Soil Amendment Area - Farm Worker Scenario**

Soil Amendment Area Sample [a]	Arithmetic Mean Gamma Exposure Rate μrem/hour	Excess Lifetime Cancer Risk [b]	Incremental Excess Lifetime Cancer Risk [c]
SA-Total	15.81	4.45E-5	9.1E-6
Reference Area	12.54	3.5E-5	0.0E+00

a. Gamma data from the whole Soil Amendment Area were aggregated for this scenario.
b. Calculated as the total gamma risk including reference risk.
c. Risk in excess of the reference risk.

Table 7-7c

Summary of Cancer Risk Estimates for Gamma Radiation
Soil Amendment Area - Industrial Scenario

Soil Amendment Area Sample [a]	Arithmetic Mean Gamma Exposure Rate μrem/hour	Excess Lifetime Cancer Risk [b]	Incremental Excess Lifetime Cancer Risk [c]
SA-1	14.72	2.3E-4	3.4E-5
SA-2	14.81	2.3E-4	3.5E-5
SA-3	15.91	2.5E-4	5.2E-5
SA-4	18.15	2.8E-4	8.7E-5
SA-5	16.7	2.6E-4	6.4E-5
SA-6	18.41	2.9E-4	9.1E-5
SA-7	15.20	2.4E-4	4.1E-5
SA-8	18.78	2.9E-4	9.7E-5
SA-9	13.63	2.1E-4	1.7E-5
SA-10	13.13	2.0E-4	9.2E-5
SA-11	13.26	2.1E-4	1.1E-5
SA-12	16.19	2.5E-4	5.7E-5
SA-13	17.01	2.6E-4	6.9E-5
Reference Area	12.54	1.9E-4	0.0E+00

a. gamma data from 2.5 acre subplots were aggregated to estimate future occupational exposure.
b. Calculated as the total gamma risk including reference risk.
c. Risk in excess of the reference risk.

Table 7-7d

Summary of Cancer Risk Estimates for Gamma Radiation
Soil Amendment Area - Residential Scenario

Soil Amendment Area Sample [a]	Arithmetic Mean Gamma Exposure Rate μrem/hour	Excess Lifetime Cancer Risk [b]	Incremental Excess Lifetime Cancer Risk [c]
SA-1	14.72	2.0E-3	2.9E-4
SA-2	14.81	2.0E-3	3.0E-4
SA-3	15.91	2.1E-3	4.5E-4
SA-4	18.15	2.4E-3	7.5E-4
SA-5	16.70	2.2E-3	5.5E-4
SA-6	18.41	2.4E-3	7.8E-4
SA-7	15.20	2.0E-3	3.5E-4
SA-8	18.78	2.5E-3	8.3E-4
SA-9	13.63	1.8E-3	1.5E-4
SA-10	13.13	1.7E-3	7.9E-4
SA-11	13.26	1.8E-3	9.6E-4
SA-12	16.19	2.1E-3	4.8E-4
SA-13	17.01	2.3E-3	5.9E-4
Reference Area	12.54	1.7E-3	0.0E+00

a. gamma data from 2.5 acre subplots were aggregated to estimate future occupational exposure.
b. Calculated as the total gamma risk including reference risk.
c. Risk in excess of the reference risk.

Table 7-8a

Summary of Cancer Risk Estimates for Radon Inhalation
Main Plant Subareas - Industrial Scenario

Main Plant Subarea	Radium-226 Concentration [a] (pCi/g)	Estimated Radon Concentration [b] (pCi/l)	Total Excess Lifetime Cancer Risk [c]	Incremental Excess Lifetime Cancer Risk [d]
ST-01	8.8	11.63	2.9E-03	2.5E-03
ST-02	6.19	8.18	2.0E-03	1.6E-03
WW-01	5.3	7.01	1.7E-03	1.3E-03
CW-01	3.6	4.76	1.2E-03	7.8E-04
SS-02	3.5	4.63	1.1E-03	7.5E-04
SS-05	3.5	4.63	1.1E-03	7.5E-04
SS-04	2.8	3.70	9.1E-04	5.2E-04
CU-03	2.3	3.04	7.5E-04	3.6E-04
CU-04	2.3	3.04	7.5E-04	3.6E-04
MP-05	1.9	2.51	6.2E-04	2.3E-04
NW-03	1.9	2.51	6.2E-04	2.3E-04
WW-03	1.9	2.51	6.2E-04	2.3E-04
CU-05	1.7	2.25	5.5E-04	1.6E-04
CW-02	1.7	2.25	5.5E-4	1.6E-04
MP-06	1.5	1.98	4.9E-04	9.7E.05
CU-01	1.4	1.85	4.5E-04	6.5E-05
SS-03	1.4	1.85	4.5E-04	6.5E-05
TF-04	1.4	1.85	4.5E-04	6.5E-05
WW-07	1.4	1.85	4.5E-04	6.5E-05
CU-02	1.3	1:72	4.2E-04	3.2E-05
NW-01	1.3	1.72	4.2E-04	3.2E-05
Background Areas				
BS-01	1	1.32	3.2E-04	---
BS-02	1	1.32	3.2E-04	---
BS-03	1	1.32	3.2E-04	---
BS-04	1.2	1.59	3.9E-04	---
BS-05	1	1.32	3.2E-04	---

a. Surface soil radium-226 concentrations measured during the RI.
b. Radon concentrations modeled from surface soil radium-226.
c. Calculated as the total subarea radon risk, including background risk.
d. Calculated as the subarea radon risk in excess of the background risk of 3.9x10-4.
The calculated risk at the EPA action level of 4.0 pCi/l is 9.8x10-4 for an industrial scenario.

Table 7-8b

Summary of Cancer Risk Estimates for Radon Inhalation
Soil Amendment Area - Industrial Scenario

Soil Amendment Area Subarea	Radium-226 Concentration [a] (pCi/g)	Estimated Radon Concentration [b] (pCi/l)	Total Excess Lifetime Cancer Risk [c]	Incremental Excess Lifetime Cancer Risk [d]
SA-01	4.4	5.82	1.4E-03	1.0E-03
SA-02	8	10.57	2.6E-03	2.2E-03
SA-04	6.1	8.06	2.0E-03	1.6E-03
SA-05	1.4	1.85	4.5E-04	6.5E-05
SA-06	4.7	6.21	1.5E-03	1.1E-03
Background Areas				
BS-01	1	1.32	3.2E-04	---
BS-02	1	1.32	3.2E-04	---
BS-03	1	1.32	3.2E-04	---
BS-04	1.2	1.59	3.9E-04	---
BS-05	1	1.32	3.2E-04	---

a. Surface soil radium-226 concentrations measured during the RI.
b. Radon concentrations modeled from surface soil radium-226.
c. Calculated as the total subarea radon risk, including background risk.
d. Calculated as the subarea radon risk in excess of the background risk of 3.9x10-4.
The calculated risk at the EPA action level of 4.0 pCi/l is 9.8x10-4for an industrial scenario.

Table 7-8c

Summary of Cancer Risk Estimates for Radon Inhalation
Soil Amendment Area - Residential Scenario

Soil Amendment Area Subarea	Radium-226 Concentration [a] (pCi/g)	Estimated Radon Concentration [b] (pCi/l)	Total Excess Lifetime Cancer Risk [c]	Incremental Excess Lifetime Cancer Risk [d]
SA-01	4.4	5.82	7.5E-03	5.5E-03
SA-02	8	10.57	1.4E-02	1.2E-02
SA-04	6.1	8.06	1.0E-02	8.4E-03
SA-05	1.4	1.85	2.4E-03	3.4E-04
SA-06	4.7	6.21	8.0E-03	6.0E-03
Background Areas				
BS-01	1	1.32	1.7E-03	---
BS-02	1	1.32	1.7E-03	---
BS-03	1	1.32	1.7E-03	---
BS-04	1.2	1.59	2.0E-03	---
BS-05	1	1.32	1.7E-03	---

a. Surface soil radium-226 concentrations measured during the RI.
b. Radon concentrations modeled from surface soil radium-226.
c. Calculated as the total subarea radon risk, including background risk.
d. Calculated as the subarea radon risk in excess of the background risk of 3.9x10-4.
The calculated risk at the EPA action level of 4.0 pCi/l is 5.2x10-3 for a residential scenario.

The sample-specific approach used for the assessment of risks at the TWCA Site could potentially over or under estimate risk. Much of the sampling was directed rather than random. This could lead to higher calculated risks for suspected source areas where concentrations of chemicals exceed average on-site levels. Since the sampling at the Site, however, was not exhaustive, under-estimation of risk may occur as areas of higher concentration (i.e., "hot spots") may have been missed.

Uncertainty in the chemical toxicity evaluation may overestimate risks by relying on slope factors that describe the upper confidence limit on cancer risk for carcinogens. Some underestimation of risk may occur due to lack of quantitative toxicity information for some contaminants detected at the TWCA Site. Qualitative uncertainty (over or underestimation) exists when assuming chemicals that cause cancer in animals may also cause cancer in humans.

A source of uncertainty which could lead to underestimation of risk is that chemical concentrations in environmental media will remain constant over the assumed exposure period. As TWCA is an active operating facility leaks or spill of hazardous materials from pipes and structures could pose additional risks at the Site. In addition, as the RI was only designed to characterize contamination in areas which were not under existing buildings and structures on the TWCA Site, it is uncertain whether contamination which may pose further risks exists in the uncharacterized areas.

The assumption that concentrations will remain constant over the assumed exposure period may also lead to overestimation because some compounds may degrade or disseminate over time.

7.4 Environmental Risk Characterization

To assess the environmental effects of the contaminants present at the TWCA Site, TWCA conducted an evaluation of potentially affected terrestrial and aquatic species. The results of this Environmental Risk Characterization, and remedial alternatives to remediate the environmental risk are covered in the Record of Decision for Final Remedial Action of Groundwater and Sediments Operable Unit, Teledyne Wah Chang Albany Superfund Site, June 10, 1994.

7.5 Conclusions

For exposure to chemicals and radionuclides, there were no surface or subsurface sample-specific non-cancer hazard indices for soils which exceeded 1. A limited number of surface soil samples resulted in excess lifetime cancer risk estimates exceeding $1x10^{-5}$, but were less than $1x10^{-4}$. Excess - risks from exposure to gamma radiation and radon exceeded the $1x10^{-4}$ risk level.

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response actions selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

7.6 Risk Management Decisions

For this ROD, EPA has determined that the industrial scenario is most appropriate for determining the need for remedial action on the Main Plant, and the industrial and farm worker scenarios are the most appropriate for determining the need for remedial action for the Soil Amendment Area.

For the areas investigated during the RI/FS, cleanup is needed for surface gamma radiation in certain areas on the Main Plant and for radon on the Main Plant and the Soil Amendment Area. Cleanup is needed because risks exceed acceptable risk levels.

Risks from exposure to chemicals and radionuclides in surface and subsurface soils are within acceptable levels. No cleanup is required as a result of these constituents. This determination is based on the current and expected future uses for these areas (industrial for the Main Plant, agricultural or industrial for the Soil Amendment Area). For subsurface contamination, this determination is based on this material remaining in place. Cleanup action will be required if any areas are found to be a groundwater contamination source during future groundwater sampling performed as part of the requirements of the 1994 ROD.

To address the potential risks from the Site, the following cleanup objectives were developed:

Reduce the exposure to radon that would occur in future buildings constructed on the Main Plant and the Soil Amendment Area.

Reduce surface gamma radiation exposure to acceptable levels.

Where surface and subsurface chemical risks are acceptable based on industrial or agricultural use, ensure that these areas are not used for other purposes, and that proper handling and disposal of soil occurs when it is disturbed.

For areas with subsurface contamination, provide easily accessible information on the locations of the material for TWCA plant workers, future Site purchasers, or regulatory agencies. This includes the PCB contamination in the Fabrication Area, and the residual radionuclide contamination in the Fabrication Area and Extraction Area.

8.0 DESCRIPTION OF ALTERNATIVES

The TWCA Site was divided into two areas in order to facilitate evaluation of remedial alternatives. These areas are the Main Plant Area and the Farm Ponds Area. In the Farm Ponds Area, the Soil Amendment Area is the area where remediation is required. The Main Plant Area was further subdivided into the Extraction, Fabrication, and the Solids Area. Remedial alternatives were analyzed in detail for each area of the Site.

Estimated costs for each of the alternatives are accurate within the range of +50 percent to -30 percent. Estimated present worth costs are based on a 30-year life of the remedial alternative using a discount rate of 5 percent.

All of the evaluated alternatives would result in contaminants remaining on Site above health-based levels (if Site use changed). Therefore, CERCLA requires that Site conditions be reviewed at intervals of at least every five years. If warranted by the review, additional remedial actions would be initiated at that time.

8.1 Significant ARARs for the Remedial Actions Proposed for the Site

8.1.1 Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR Part 192.12)

Portions of this regulation referred to as UMTRCA are considered relevant and appropriate to the remedial action requirements. The regulation applies to uranium mill tailings, and is therefore not an applicable regulation. It has been cited as relevant and appropriate in a number of previous EPA Records of Decision dealing with remediating risks from gamma radiation[2]. The discussion below describes how this regulation will be applied to determine remedial requirements.

192.12 provides the following standards[3]:

(a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than-

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[2] see among others:

Monticello Mill Tailings, UT, 1990 (EPA/ROD/R08-90/024
Glen Ridge Radium, NY, 1989 (EPA/ROD/R02-89/079), and
1990 (EPA/ROD/R02-90/125)
Radium Chemical, NY, 1990 (EPA/ROD/R02-90/103)
Denver Radium (OU 8), CO, 1992, (EPA/ROD/R0-8-92/063)

[3] For radon gas at 50% equilibrium, an annual average exposure of 0.02 Working Level (WL) of radon decay products corresponds to an annual average exposure to a concentration of 4.0 pCi/liter of air. For this ROD this conversion will be used. In addition, a microroentgens per hour will be considered the equivalent of a μrem/hour (microrem per hour).

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and

(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

(b) In any occupied or habitable building-

(1) The objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and

(2) The level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

At the TWCA Site, the standard of 5 pCi/gram, averaged over the first 15 cm of soil below the surface, and 15 pCi/gram radium-226, averaged over 15 cm thick layers of soil more than 15 cm below the surface is not applicable because the material at TWCA is from a different source than that covered in 40 CFR 192. At this site, it is also not a relevant and appropriate requirement based on situational and risk differences between TWCA and sites regulated under UMTRCA. The radium contaminated material at TWCA differs from uranium mill tailings in that it has a lower maximum radium concentration. The anticipated uses of the TWCA Site also differ from those contemplated in UMTRCA. Because of these and other differences, areas of TWCA exceeding the limits for radium-226 in UMTRCA did not exceed risk based levels for ingestion of radionuclides, or exposure to gamma radiation. However, the soil activity standards provided in UMTRCA are higher than those which would be protective for addressing risks posed by exposure to indoor radon.

The gamma radiation exposure level of 20 μRoentgens (20 μrem/hour in this ROD) has been evaluated as a potential cleanup level. Gamma radiation at or near this level has been used to include properties for remedial action in implementing UMTRCA at properties which may have received mill tailings. The averaging of the concentration over 100 meters square will also be used.

The indoor radon concentration of 4 pCi/liter (converted from 0.02 WL, see footnote 3) is the selected action level. Action will be required where measured levels, or appropriate modelling predicting radon concentration in future buildings, exceeds this level. This concentration will be used as the industrial action level for the TWCA Site. Because the remedial actions were developed for an industrial scenario, a residential action level for radon is not being provided in this ROD.

Using the model in Section 6.4.2, a soil radium-226 concentration greater than 3 pCi/gram could result in a radon concentration in future buildings exceeding the 4 pCi/liter radon action level. This standard will be applied to surface and subsurface soil to designate areas requiring action for radon.

8.1.2 Oregon Statutes and Regulations

Oregon Environmental Cleanup Law, Oregon Revised Statute (ORS) Chapter 465; Oregon Environmental Cleanup Rules, Oregon Administrative Rule (OAR) Chapter 340, Division 122, Sections 10 through 110. These regulations are applicable for Site soils. They require cleanup to background or the lowest feasible level.

Energy Conservation, Oregon Revised Statute (ORS) Chapters 469.375, 469.525, 469.556, 469.559; Oregon Administrative Rules (OAR) Chapter 345, Division 50, Section 006 through 130, Energy Facility Siting Council, Radioactive Waste Materials. These rules govern disposal of radioactive material in Oregon. They are applicable. The rules include a Pathway Exemption (OAR) Chapter 345, Division 50, Section 035, which exempts certain materials from the rules. The pathway exemption applies to material which does not exceed 500 millirem/year (57 μrem/hour). This standard for gamma radiation was evaluated during the remedial alternative analysis.

8.2 Remedial Action Alternatives

8.2.1 Alternative 1 - No Further Action

Estimated cost: $0
Time to implement: No time required to implement

The NCP requires that a "no action" alternative be evaluated as a potential remedial alternative for each Superfund site. For this alternative, no further action would be taken at the TWCA Site beyond those remedial measures which have already been implemented (see Section 3.4 of this ROD). The TWCA property is zoned for industrial use, and no zoning changes are planned for the foreseeable future. The no further action alternative would not comply with the remedial action objectives for the Site, as concentrations of contaminants which are above acceptable risk levels would remain on Site.

8.2.2 Alternative 2 - Limited Excavation and Off-Site Disposal of Soil with Gamma Radiation Levels Exceeding 57 μrem/hour Over Background; Radon Controlling Construction Methods Required for Future Buildings; Control of Future Site Use; 5 Year Reviews

Estimated Cost: $20,000 capital costs (no O&M costs are associated with this remedy)
Time to Implement: 1 year

Chemical and Radionuclide Contamination

No further cleanup action is required to address risks from ingestion of surface and subsurface chemical and radionuclide contamination and subsurface gamma radiation exposure under current and projected Site uses. Zoning, building codes, deed notices and/or deed restrictions would be relied on to ensure that Site land use (for both the Main Plant and the Soil Amendment Area) does not change to residential. Should excavation occur as part of future development of the TWCA Main Plant or the Soil Amendment Area, excavated, material from the Site must be properly handled, and excavation and disposal of Site material must comply with Federal and State laws.

If future activities disturb the subsurface radionuclides or PCB contamination in the southern Fabrication Area and/or the subsurface radionuclide contamination under the former V-2 Pond in the Extraction Area, or if these or other locations are subsequently found to act as sources of contamination to the groundwater, action could be required for these areas. Actions required for groundwater sources are covered under the Record of Decision for Final Remedial Action of Groundwater and Sediments Operable Unit, Teledyne Wah Chang Albany Superfund Site, June 10, 1994.

Action will be required to address risks posed by surface gamma radiation and radon (see below). Additional action may be required for radionuclides as part of plant closure requirements administered by the Oregon Department of Health.

Gamma Radiation

Areas with surface gamma radiation greater than 57 μrem/hour over background levels will be excavated and disposed of off Site. If this material does not pass the Oregon pathway exemption, disposal will be in a low level radioactive waste landfill.

Contamination resulting in gamma radiation exposure greater than 57 μrem/hour (500 millirem/year) above background may fail the Oregon pathway exemption (OAR, 345-50-35, see Section 11) and could be regulated as radioactive in the state of Oregon (OAR, 345-50-006 to 130).

Radon

Institutional controls, zoning, building codes, deed restrictions, or deed notices requiring radon control in future buildings would be implemented for the Soil Amendment Area, and Main Plant areas where radon in future buildings could pose an unacceptable risk. The controls would require that 1) future buildings be constructed using radon controlling construction methods; and 2) following construction, the air would be periodically tested for radon. If radon concentration exceeded the EPA target level in effect at the time testing is done, additional controls would be required to reduce radon levels below the EPA target levels. Compliance with these restrictions would meet EPA's remedial objective of reducing radon exposure. The cost of complying with the construction requirements is not included in the estimated cost. However, the additional building costs are estimated to be small. Other remedies for radon control were not explored except where they were part of the alternatives for control of gamma radiation.

5 Year Reviews

Because waste is left in place above levels allowing unrestricted use a five year review would be conducted. The five year review would ensure that the remedy remains protective and that current and expected Site use does not change, or trigger the initiation of potential future action if needed.

8.2.3 Alternative 3 - Limited Excavation and Off-Site Disposal of Soil with Gamma Radiation Levels Exceeding 57 μrem/hour Over Background; Radon Controlling Building Methods Required for Future Buildings; Control of Future Site Use; 5 Year Reviews; Capping of Areas Above Selected Gamma Radiation Action Levels

This Alternative includes all measures in Alternative 2, plus the additional actions described below.

Areas with gamma radiation above the proposed action levels are capped with an asphalt cap designed to provide a shield from gamma radiation exposure.

Three action levels for cleanup were evaluated, 20 μrem/hour above background, 10 μrem/hour above background, and background. Areas with gamma radiation exceeding the action level, but below 57 μrem/hour would be capped to bring gamma radiation levels to the selected action level. The rationale for evaluating the three levels was as follows:

1) Contamination resulting in gamma radiation exposure greater than 20 μrem/hour above background exceeds the cleanup level prescribed in the Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (42 CFR 192). Parts of this regulation are relevant and appropriate (see Section 8.1).

2) Cleanup of soil exceeding 10 μrem/hour above background was evaluated to meet the requirement in the Oregon Environmental Cleanup Rules (OAR 340-122-040) which requires that cleanup meet the lowest feasible level if cleanup to background levels is not feasible; and

3) Cleanup to background was evaluated to meet the requirement in the Oregon Environmental Cleanup Rules for cleanup to background levels if feasible.

Table 8-1 shows the risks after cleanup to the three action levels evaluated. The areas slated for remediation are "hot spots" within larger areas. It is appropriate to calculate risks over the larger Site areas. Using this approach, there is no significant difference between remediation to 10 μrem/hour or 20 μrem/hour over background.

In addition to protection from gamma radiation exposure, capping on the Main Plant and the Soil Amendment Area would provide some radon control provided that the cap remained intact during future construction. Additional radon control would be provided through the building restrictions described in Alternative 2.

<u>a) Capping of Areas Exceeding Background plus 20 μrem/hour</u>

Estimated Cost: $100,000 capital cost
$33,000 operation and maintenance
(present worth for 30 years at 5% discount rate)
Time to Implement: 1 year

The affected area under Alternative 3a totals 8240 square feet and includes portions of the parking lot outside of the boundary of the Extraction Area, the former sand unloading area in the Fabrication Area, and Schmidt Lake in the Solids Area (see **Figures 6-5a, b, and c**).

<u>b) Capping of Areas Exceeding Background plus 10 μrem/hour</u>

Estimated Cost: $740,000 capital cost
$74,000 operation and maintenance
(present worth for 30 years at 5% discount rate)
Time to Implement: 1 year

The affected area under Alternative 3b totals 108,275 square feet and includes areas in the parking lot outside of the boundary of the Extraction Area, the former sand unloading area in the Fabrication Area, and Schmidt Lake in the Solids Area (see **Figures 6-5a, b, and c**).

Although a significantly greater area is capped under this action level, selection of 10 μrem/hour would not provide a significant reduction in the risk from exposure to gamma radiation, when

Table 8-1

Residual Risk Following Remediation to Specified Action Level

TWCA Subarea	Average Gamma Exposure Rate (μrem/hour)			Incremental Excess Lifetime Cancer Risk[a]		
	Before Remediation	After Remediation to:		Before Remediation	After Remediation to:	
		< 20.5[b] μrem/hour	< 30.5[b] μrem/hour		< 20.5[b] μrem/hour	< 30.5[b] μrem/hour
OC-01	26.24	16.59	21.03	2.4E-4	9.4E-5	1.6E-4
PL-01	14.99	13.50	14.63	6.9E-5	4.6E-5	6.4E-5
PL-02	23.94	17.44	21.58	2.1E-4	1.1E-4	1.7E-4
SL-02	13.79	12.92	13.53	5.1E-5	3.7E-5	4.7E-5
SAA	15.81	15.72	15.72	9.1E-6	8.9E-6	8.9E-6

a. Risks for industrial scenario except for SAA which used a farm worker scenario

b. 20.5 μrem/hour = background plus 10 μrem/hour. 30.5 μrem/hour = background plus 20 μrem/hour.

compared to the action level of 20 μrem/hour evaluated in Alternative 3a (see **Table 8-1**).

c) Capping of Areas Exceeding Background Average Gamma Radiation

Estimated Cost: $4,520,000 capital cost
$1,860,000 operation and maintenance
(present worth for 30 years at 5% discount rate)
Time to Implement: 2 years

The affected area under Alternative 3c totals 1,862,305 square feet. On the Main Plant, this alternative addresses large areas in the parking lot outside of the boundary of the Extraction Area, the former sand unloading area in the Fabrication Area, and Schmidt Lake in the Solids Area, and includes the entire Soil Amendment Area (see **Figures 6-5a, b, and c, and Figure 6-6**).

Following this action, there would not be any excess risk from exposure to gamma radiation in the remediated areas.

8.2.4 Alternative 4 - Limited Excavation and Off-Site Disposal of Soil with Gamma Radiation Levels Exceeding 57 μrem/hour Over Background; Radon Controlling Building Methods Required for Future Buildings; Control of Future Site Use; 5 Year Reviews, Additional Excavation of Soil in Areas Above Selected Gamma Radiation Action Levels; Disposal of Soil in an Off-Site Landfill

This Alternative includes the measures in Alternative 2 plus the additional actions described below.

This Alternative differs from Alternative 3 in that soil exceeding gamma radiation action levels is excavated and disposed of in an off-site landfill rather than capped (the remedy in Alternative 3). The same three potential action levels for excavation were evaluated: 20 μrem/hour above background, 10 μrem/hour above background, and background.

Areas with gamma radiation exceeding the action level are excavated to bring gamma radiation levels to the selected action level. Excavated material is then disposed of off Site in accordance with applicable regulations. Cost estimates are based on a presumed one foot depth of excavation.

In addition to protection from gamma radiation exposure, excavation on the Main Plant and the Soil Amendment Area would provide some radon control by removing the source of the radon (the radium contaminated soil). Additional radon control would be provided through the building restrictions described in Alternative 2.

a) Excavation of Areas Exceeding Background plus 20 μrem/hour.

Estimated Cost: $110,000 capital costs (no O&M costs are associated with this remedy)
Time to Implement: 1 year

The affected area under Alternative 3a totals 8240 square feet and includes portions of the parking lot outside of the boundary of the Extraction Area, the former sand unloading area in the Fabrication Area, and Schmidt Lake in the Solids Area (see **Figures 6-5a, b, and c**).

b) Excavation of Areas Exceeding Background plus 10 μrem/hour.

Estimated Cost: $920,000 capital costs (no O&M costs are associated with this remedy)
Time to implement: 1 year

The affected area under Alternative 3b totals 108,275 square feet and includes areas in the parking lot outside of the boundary of the Extraction Area, the former sand unloading area in the Fabrication Area, and Schmidt Lake in the Solids Area (see **Figures 6-5a, b, and c**).

Although a significantly greater area is excavated under this action level, selection of 10 μrem/hour would not provide a significant reduction in the risk from exposure to gamma radiation, when compared to the action level of 20 μrem/hour evaluated in Alternative 4a (see **Table 8-1**).

c) Excavation of Areas Exceeding Background

Estimated Cost: $14,720,000 capital costs (no O&M costs are associated with this remedy)
Time to Implement: 2 years

The affected area under Alternative 3c totals 1,862,305 square feet. On the Main Plant this alternative addresses large areas of the parking lot outside of the boundary of the Extraction Area, the former sand unloading area in the Fabrication Area, and Schmidt Lake in the Solids Area, and includes the entire Soil Amendment Area (see **Figures 6-5a, b, and c, and Figure 6-6**).

Following this action, there would not be any excess risk from exposure to gamma radiation or radon in future buildings constructed on the remediated areas.

Control of radon in areas not requiring excavation would be provided through the radon controlling buildings restrictions described in Alternative 2. These areas had radium concentrations which indicated that radon would be a health risk, but did not show elevated gamma radiation levels.

9.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The NCP requires that each remedial alternative analyzed in detail in the Feasibility Study be evaluated according to specific criteria. The purpose of this evaluation is to promote consistent identification of the relative advantages and disadvantages of each alternative, thereby guiding selection of remedies offering the most effective and efficient means of achieving Site cleanup goals. There are nine criteria by which feasible remedial alternatives are evaluated. While all nine criteria are important, they are weighed differently in the decision-making process depending on whether they describe a required level of performance (threshold criteria), provide for consideration of technical merits (primary balancing criteria), or involve the evaluation of non-EPA reviewers that may influence an EPA decision (modifying criteria).

9.1 Threshold Criteria

The remedial alternatives were first evaluated by comparison with the threshold criteria: overall protection of human health and the environment and compliance with Applicable or Relevant and Appropriate Requirements (ARARs). The threshold criteria must be fully satisfied by candidate alternatives before the alternatives can be given further consideration in remedy selection.

9.1.1 Overall Protection of Human Health and the Environment

This criterion determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.

Alternative 1 does not protect human health and the environment. Alternative 2 is not protective for exposure to gamma radiation, but is protective for risks from chemical and radon exposure. Alternative 3a, b, and c, and 4a, b, and c are adequately protective of human health and the environment.

9.1.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

This criterion evaluates whether the alternative meets State and Federal environmental laws, regulations, and other requirements that pertain to the site or, if not, determines if a waiver is justified. CERCLA requires that remedial actions satisfy all identified ARARs.

An "applicable" requirement directly and fully addresses the situation at the site. It would legally apply to the response action if that action were undertaken independently from any CERCLA authority. A "relevant and appropriate" requirement is one that is designed to apply to problems which are sufficiently similar to the problem being addressed at the site, that its use is well suited to the particular site.

Alternatives 1 and 2 do not comply with all Federal and State ARARs; a waiver is not justified for these alternatives. The remaining alternatives comply with Federal ARARs.

The Oregon Environmental Cleanup Rules (OAR 340-122-040) require cleanup to background levels, or the lowest concentration level feasible. Permanent solutions are preferred over other remedies. Alternative 3a, b, and c may not meet the Oregon Rule preference for permanent remedies, because waste is capped and remains on the Site. Alternative 3a, 3b, and 3c, and 4a, and 4b, may meet the

Oregon cleanup rule requirement for a cleanup action to meet the lowest feasible cleanup level (the feasibility is based on analyzing the alternatives against each other). Only Alternative 4c meets the requirement of the Oregon Rule for cleanup to background, but this alternative may not satisfy the feasibility requirement of the rule.

9.2 Primary Balancing Criteria

For those alternatives satisfying the threshold criteria (Alternatives 3 and 4), five primary balancing criteria are used to evaluate other aspects of the potential remedies. No single alternative will necessarily receive the highest evaluation for every balancing criterion. The five primary balancing criteria are: Long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost.

9.2.1 Long-Term Effectiveness and Permanence

This criterion evaluates the ability of a remedial alternative to maintain reliable protection of human health and the environment over time, once cleanup goals have been achieved.

Alternatives 1 and 2 do not provide adequate long-term effectiveness for control of gamma radiation. Alternative 2 does provide long term effectiveness for radon control through the required building controls. Alternatives 3a, b, and c provide protectiveness as long as the cap is maintained. Alternatives 4a, b, and c do not require maintenance because waste is removed from the Site. Alternative 4c is the only alternative which does not require future radon control.

9.2.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

This criterion evaluates the anticipated performance of the various treatment technologies and addresses the statutory preference for selecting remedial actions that employ treatment technologies which permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances. This preference is satisfied when treatment is used to reduce the principal threats at a Site through destruction of toxic contaminants, irreversible reductions in contaminant mobility, or reductions in the total volume of contaminated media.

There is no treatment technology for gamma radiation or radon. None of the alternatives provide treatment.

9.2.3 Short-Term Effectiveness

The short-term effectiveness criterion focuses on the period of time needed to achieve protection of human health and the environment, and adverse impacts which may occur during remedial construction and remedial action, until cleanup goals are achieved.

Alternative 1 has no implementation time, but does not provide protection. All the other alternatives are adequate with respect to their short-term effectiveness. Alternatives 3c and 4c take the longest time to achieve the desired action levels. The likelihood of an impact on public health during implementation of any of the remedial alternatives is remote. Except for Alternative 1, worker protection will be required during remedy implementation for all alternatives.

9.2.4 Implementability

This evaluation addresses the technical and administrative feasibility of implementing the alternatives, including the availability of materials and services required to construct the remedy.

Alternative 2 is the easiest alternative to implement. Alternatives 3a and b, and 4a and b are easily implemented in a short time frame. Alternative 3c will take longer to implement because of the large area to be capped. Alternative 4c is the hardest to implement based on the amount of material that requires excavation.

9.2.5 Projected Costs

Present worth costs are used to evaluate and compare the estimated monetary value of each remedial alternative. Present worth costs are determined by summing the estimated capital costs and estimates of the discounted operation and maintenance (O&M) costs over the projected lifetime of the remedial alternative. Estimated present worth costs are based on a 30-year life of the remedial alternative using a discount rate of 5 percent.

The 30-year present worth cost for each alternative is identified in the Summary of Alternatives, Section 8. The costs range from $0 for Alternative 1 (No Action) to $14,720,000 for Alternative 4c. Alternatives 3a and 4a provide the most cost effective protection. Alternatives 3b and 4b do not provide a significantly greater risk reduction, but their cost is almost 10 time greater. Alternatives 3c and 4c provide the most risk reduction, but the cost of the incremental reduction in risk is not cost effective.

Alternative 4c is the only alternative where additional radon control would not be required, but the cost of the alternative is cost prohibitive when compared to the cost of using radon controlling building methods.

9.3 Modifying Criteria

The modifying criteria are used in the final analysis of remedial alternatives and are generally considered in altering an otherwise viable alternative rather than deciding between very different alternatives. The two modifying criteria are state and community acceptance.

9.3.1 State Acceptance

The state of Oregon has analyzed the alternatives provided in the RI/FS. The State believes that the excavation remedies meet the Oregon cleanup rule preference for permanent remedies more than the capping remedies. The State accepts 20 μrem/hour over background as the proposed cleanup standard for gamma radiation. The State of Oregon considers alternative 4a to meet State ARARs.

9.3.2 Community Acceptance

EPA did not receive any comments during the public comment period.

10.0 SELECTED REMEDY

Based on CERCLA, the NCP, the administrative record, the comparative analysis of alternatives, and public comments, EPA has selected Alternative 4a. This remedial alternative includes the following:

Excavation of contaminated material exceeding the gamma radiation action level of 20 μrem/hour above background levels;

Transportation of the excavated material to an appropriate off-site facility for disposal;

For areas of the Site where modelling indicates that radon concentrations in future buildings could exceed 4 pCi/liter, institutional controls requiring that future buildings be constructed using radon resistant construction methods;

Requirement that information on areas of subsurface PCB and radionuclide contamination which do not pose a risk if they are not disturbed, be incorporated into the TWCA facilities maintenance plan, and be made available to future Site purchasers or regulatory agencies;

Because the determination that action is not required for certain areas of the Site is based on scenarios which do not allow unrestricted use, should excavation occur as part of future development of the TWCA Main Plant or the Soil Amendment Area, excavated material must be properly handled and disposed of in accordance with Federal and State laws; and

Institutional controls requiring that land use remain consistent with current industrial zoning.

Except as expressly stated in CERCLA, in the NCP, or in this ROD, this ROD is not designed to address TWCA's ongoing operations or to preclude the need for TWCA's ongoing operations to comply with other environmental laws or regulations. Regulation of TWCA's ongoing operations is covered under RCRA and under other State and Federal environmental laws. Except as otherwise stated in this ROD, determinations in this ROD are intended to apply to Site geographic areas rather than to ongoing plant operations.

The determinations made in this ROD regarding contamination of surface and subsurface soils apply to areas of the Site investigated during the RI/FS, and are based on information from the RI/FS. As TWCA is an active operating facility, some on-site conditions may have changed since the RI/FS. Material placed in CERCLA investigated areas subsequent to the RI/FS sampling may not necessarily be addressed by this ROD, but may be investigated and addressed under RCRA. Similarly, not all excavations on the Site are covered by this ROD.

Areas of surface and subsurface soil contamination not addressed during the RI/FS and therefore not addressed in this ROD, but which are later found to be sources or potential sources of groundwater contamination are addressed in the Record of Decision for Final Remedial Action of Groundwater and Sediments Operable Unit, Teledyne Wah Chang Albany Superfund Site, June 10, 1994. Areas of the Site or contamination at the Site, not addressed by either the groundwater ROD or this ROD, are subject to investigation and corrective action under RCRA. For conditions or contamination at the Site previously unknown that are later discovered, such conditions or contamination may be addressed under either RCRA or CERCLA. In addition, under the NORM license administered by the Oregon

Department of Health, TWCA will be required to remediate remaining radioactive material when the plant closes.

The following section provides an additional description of the selected remedy.

10.1 Remedial Action for Gamma Radiation

Areas with surface gamma radiation levels exceeding 20 μrem/hour over background levels (equal to 30.5 μrem/hour) averaged over 100 square meters will be excavated, and the soil disposed of off Site. These areas are located on the Main Plant and include areas in the parking lot outside of the boundaries of the Extraction Area, the former sand unloading area in the Fabrication Area, and Schmidt Lake. The approximate areas to be excavated are shown in **Figures 10-1a, b, and c.** Material which does not pass the Oregon Pathway Exemption (OAR 345-50-035), most likely material from the former sand unloading area, will be disposed of in a low level radioactive disposal facility, which meets the requirements of the Offsite Rule (40 C.F.R. §300.440). Material which meets the Oregon Pathway Exemption must be disposed of in a facility meeting the requirements of the Offsite Rule.

The cost estimates and feasibility analyses used in the selection of this remedy were based on an assumed excavation depth of one foot. This remedy may be reconsidered if it is determined that a significantly greater amount of material requires excavation. Two potential methodologies are offered here to further quantify the amount of material to be excavated. Other methodologies may also be appropriate:

1) During remedial design, the depth of gamma emitting material can be evaluated to determine volumes and the nature of the material;

2) During remedial action, after one foot of excavation, areas are resurveyed, and if gamma survey readings exceed 20 μR/hour over background, additional samples may be taken, and other options may be evaluated before proceeding.

Among the factors which may be considered by EPA in determining the additional amount of material to excavate will be, satisfying surface exposure requirements, the type of material which is found and whether the material in question is leachable (or has leached) posing a potential groundwater source, whether the surface readings result in finding buried radioactive material, and State acceptance.

10.2 Remedial Action for Radon

Action for radon is required for the entire Soil Amendment Area, and for areas on the Main Plant plan where surface and subsurface soil radium-226 concentrations exceed 3 pCi/gram. These areas could exceed the action level for radon of 4 pCi/liter if buildings are constructed in the future.

On the Main Plant, the soil radium standard applies to both areas where surface soil exceeds 3 pCi/gram (shown in **Table 6-7**) and areas where subsurface soil radium-226 concentrations exceed this standard (samples from borings B-1, B-2, B 91-6, PW-03A, and the V-2 Pond exceed this standard). The locations are shown on **Figures 10-2a, b, and c**.

The selected remedy requires that future buildings be constructed using radon controlling construction

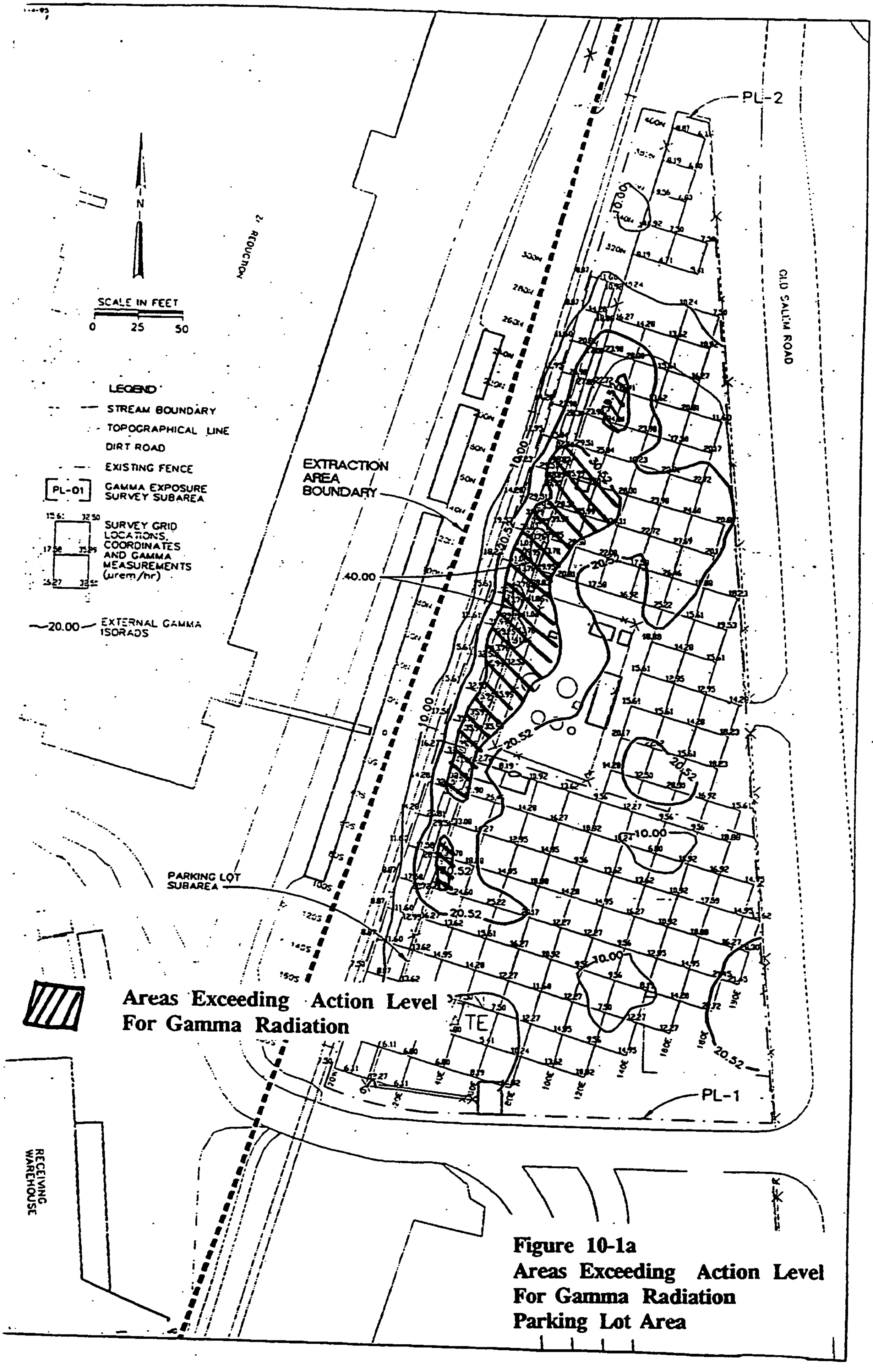

Figure 10-1a
Areas Exceeding Action Level For Gamma Radiation Parking Lot Area

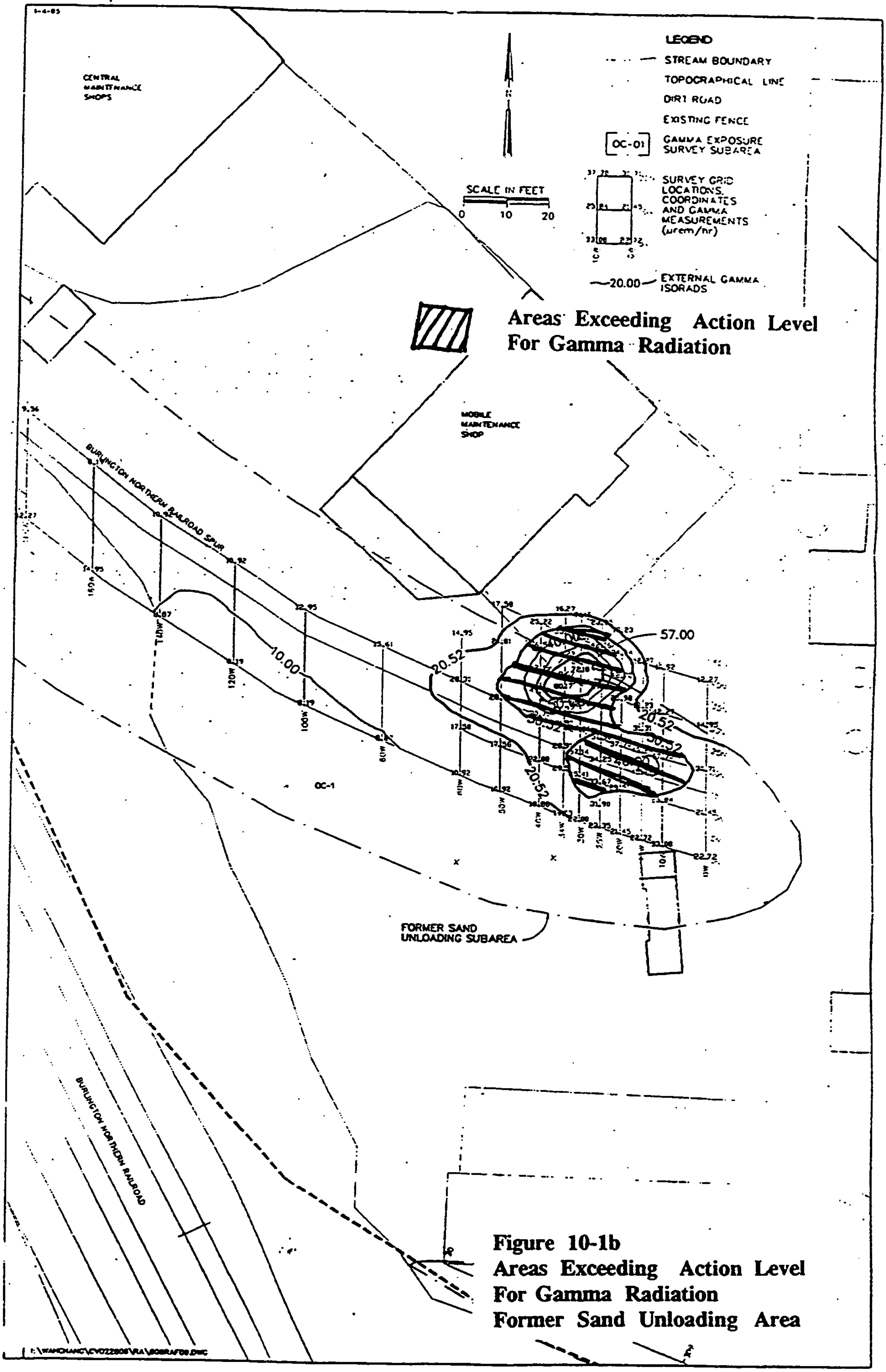

Figure 10-1b
Areas Exceeding Action Level For Gamma Radiation Former Sand Unloading Area

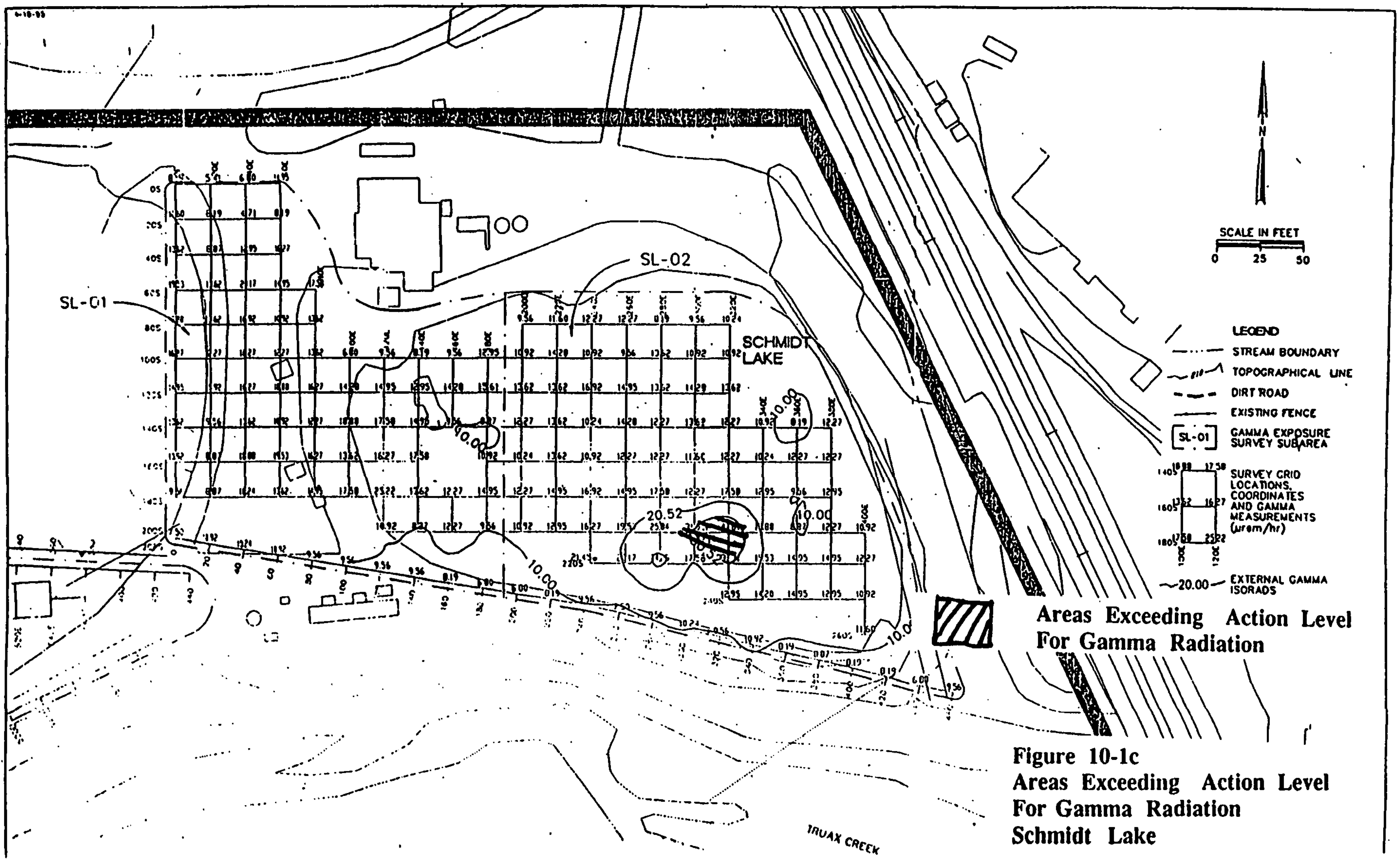

Figure 10-1c
Areas Exceeding Action Level For Gamma Radiation Schmidt Lake

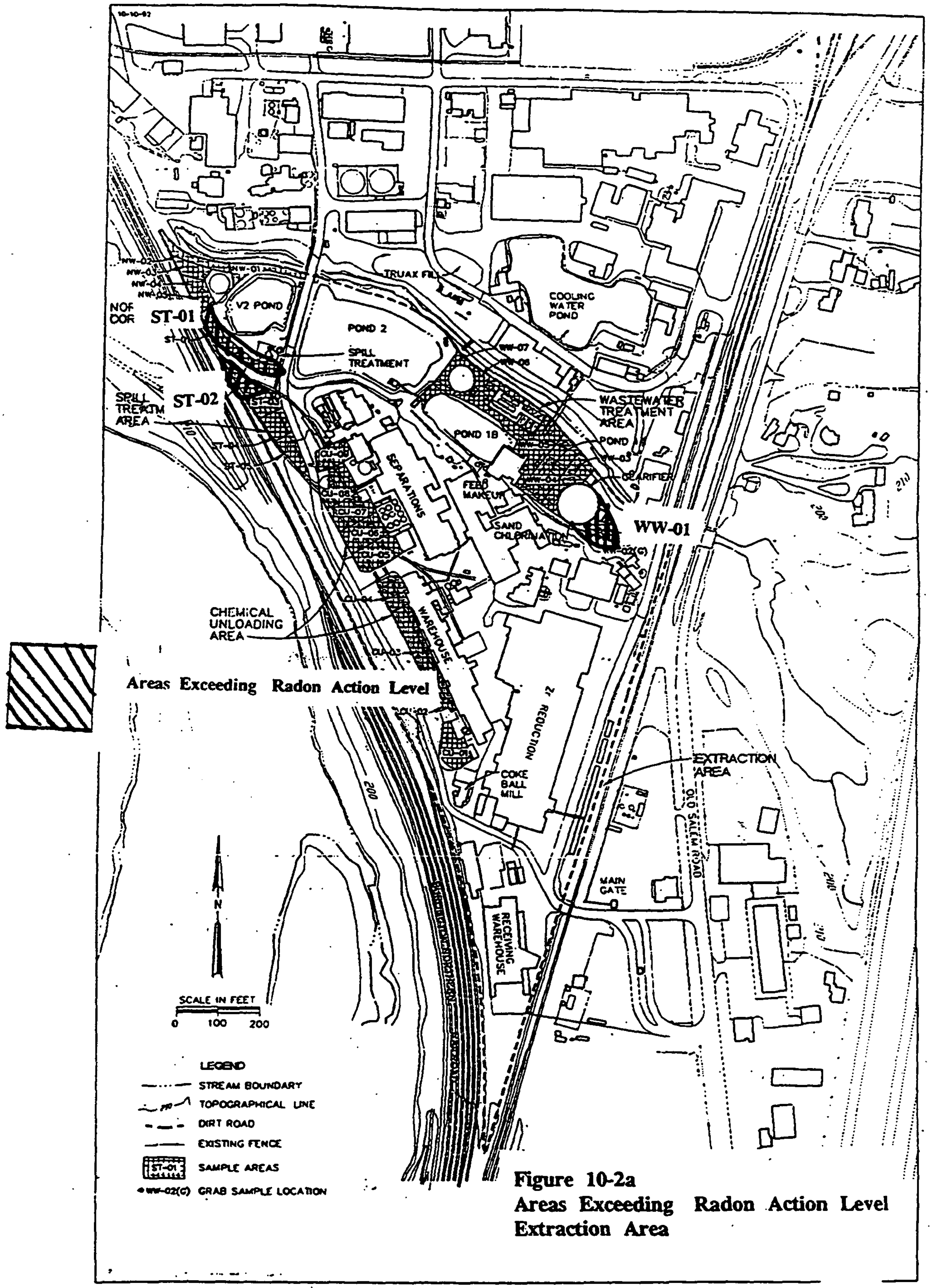

Figure 10-2a
Areas Exceeding Radon Action Level
Extraction Area

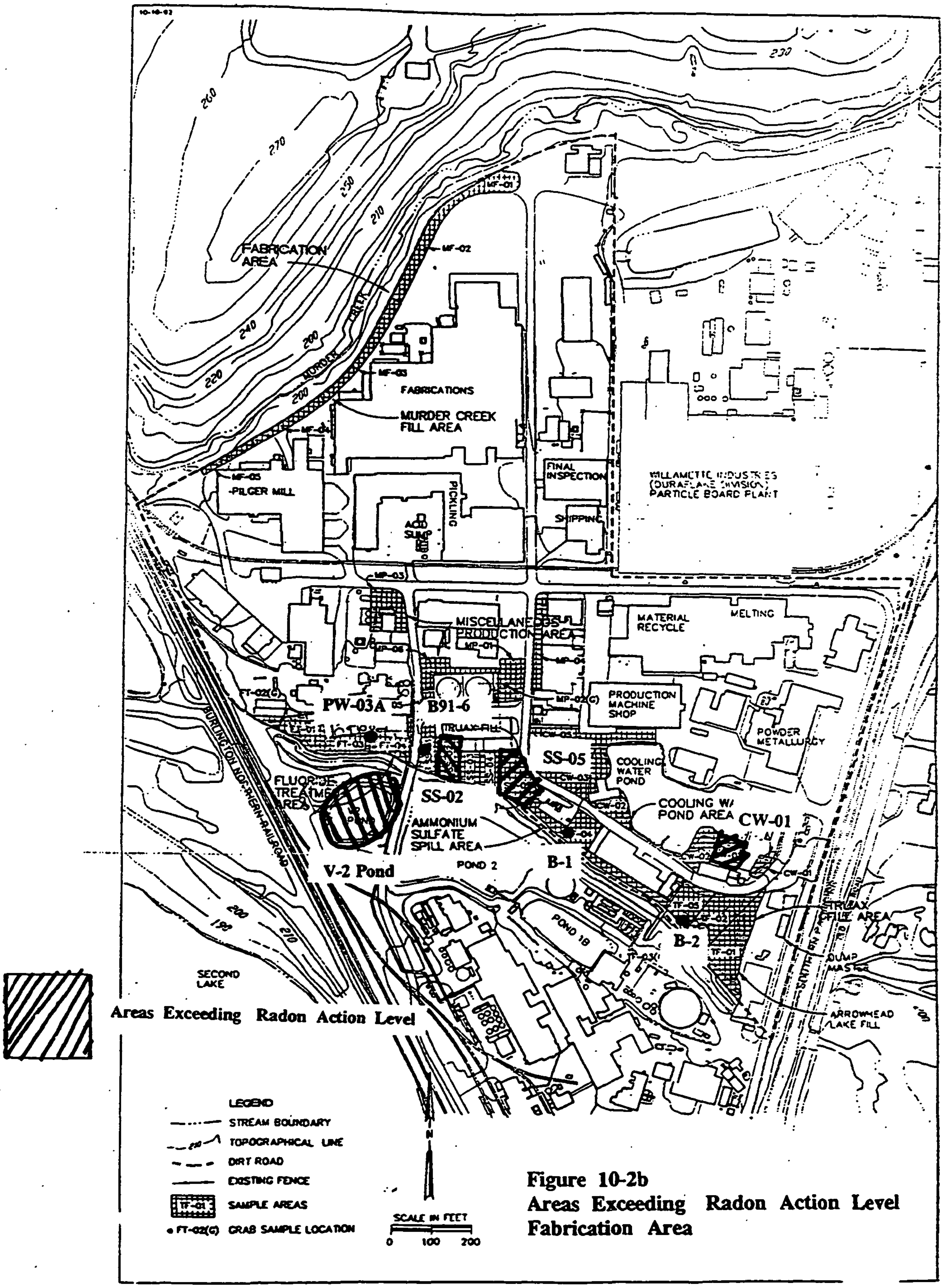

Figure 10-2b
Areas Exceeding Radon Action Level
Fabrication Area

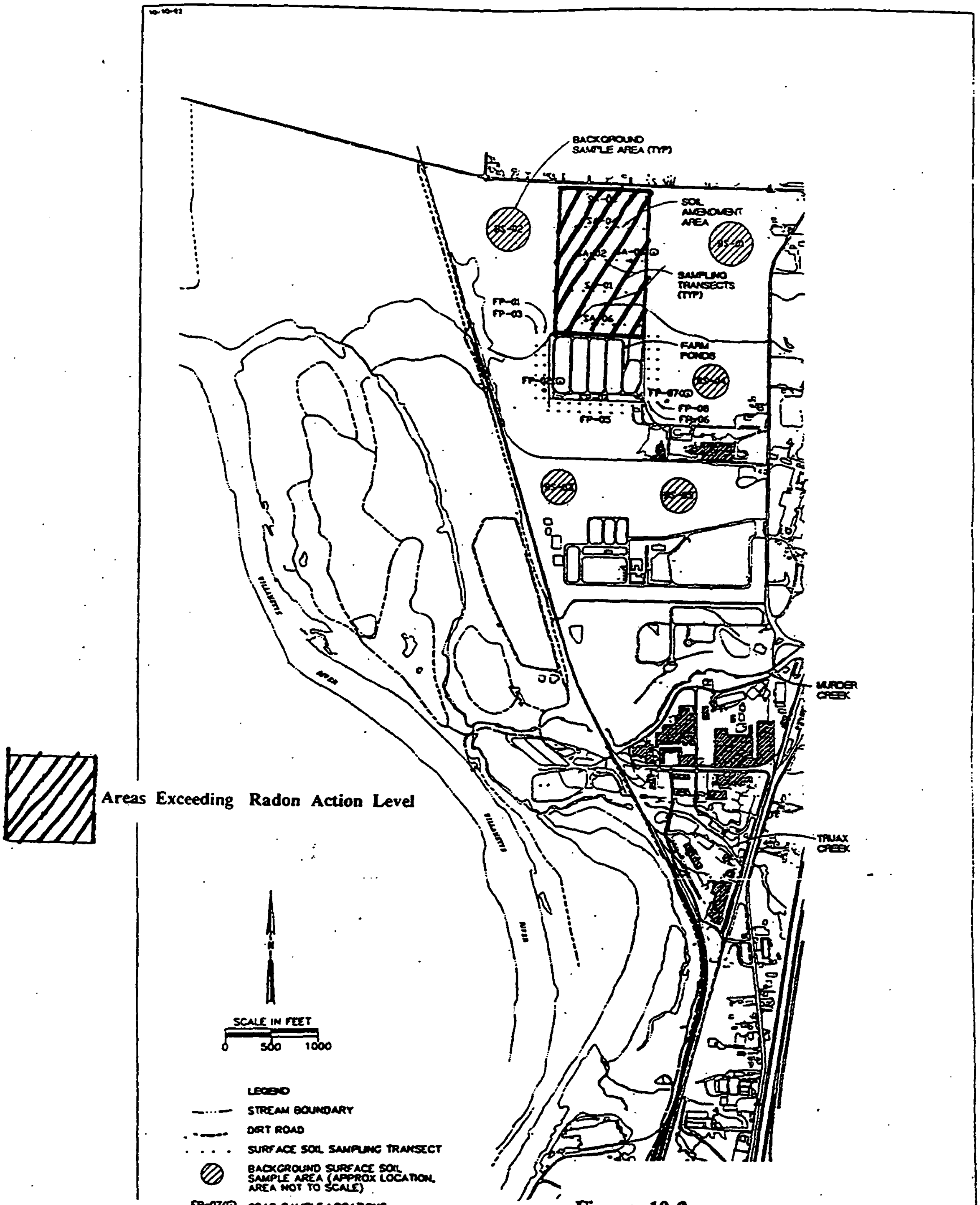

Figure 10-2c
Areas Exceeding Radon Action Level
Soil Amendment Area

methods. Following construction, the air shall be periodically tested for radon. If radon concentration exceeded the EPA target level or promulgated standard in effect at the time of these future sampling events, additional controls will be required to reduce radon levels below the EPA target level or promulgated standard. Because the action level of 4 pCi/liter is a technology based standard, rather than a risk based level, this ROD does not "freeze" the required level.

The requirements would be embodied in zoning, institutional controls, building codes, deed restrictions, or deed notices placed on the entire Soil Amendment Area, and the Main Plant areas exceeding the radium standard. For the Soil Amendment Area, it is expected that the City of Millersburg, the current owner of the property, will institute a zoning requirement.

Current technology for construction of radon resistant buildings is described in the document Radon Prevention in the Design and Construction of Schools and Other Large Buildings (EPA/626/R-92/016, 1994) Compliance with these restrictions would meet EPA's remedial objective of reducing radon exposure.

The only other effective remedial alternative for mitigation of radon in the Soil Amendment Area was excavation of soil to background levels. This option was eliminated as being prohibitively expensive. Current plans for the Soil Amendment Area are for use as an industrial park. During a meeting with the city of Millersburg, it was suggested that the contaminated material in the Soil Amendment Area might be excavated and used to construct landscaping and berms. The efficacy of this potential option has not been considered. However, if it is later offered as a potential option by

the City, proves viable, and meets the remedy selection criteria, EPA may reconsider this portion of the selected remedy.

10.3 Chemical and Radionuclide Contamination

No further cleanup action is required to address risks from ingestion of surface and subsurface chemical and radionuclide contamination and subsurface gamma radiation exposure under current and projected Site uses. Zoning, building codes, deed notices and/or deed restrictions would be relied on to ensure that Site land use (for both the Main Plant and the Soil Amendment Area) does not change to residential. The current zoning for the Main Plant and the Soil Amendment Area is industrial. Industrial zoning in the Soil Amendment Area allows for agricultural use. As shown in the risk assessment, this use is acceptable. The five year review would be required to ensure that the remedy remains protective and that current and expected Site use does not change.

Three sample locations had high concentrations of subsurface radium-226. These were B-2, and B-91-6 in the south end of the Fabrication Area, and the former V-2 Pond in the Extraction Area. For this subsurface radionuclide contamination, restrictions for radon control will be required (discussed below). Action may be required for this material as part of plant closure requirements administered by the Oregon Department of Health. There were also high subsurface levels of PCBs in the southern Fabrication Area in the vicinity of boring B-2. Should excavation occur in the areas with subsurface radionuclides or PCBs, the excavated material will require proper handling and disposal. Information on the subsurface areas of contamination shall be made available to future TWCA workers as part of the TWCA Facilities Excavation Plan, and to potential Site purchasers, and regulatory agencies. In addition, if these locations or other currently unknown areas are subsequently found to act as sources of contamination to the groundwater, action could be required for these areas. Actions required for groundwater sources are covered under the Record of Decision for Final Remedial Action of Groundwater and Sediments Operable Unit, Teledyne Wah Chang Albany Superfund Site, June 10, 1994.

For radionuclide contamination, action will be required to address risks posed by surface gamma radiation and radon (see above). Additional action may be required for radionuclides as part of plant closure requirements administered by the Oregon Department of Health.

As stated above, concentrations of chemical and radionuclide contamination in the surface and subsurface soils of the Main Plant and Soil Amendment Area are within acceptable risk levels (except as discussed for remediation of gamma radiation and radon). However, this determination only applies to certain risk scenarios, and assumes the material stays where it is currently located. The soils may be above standards that allow its unrestricted use or disposal (i.e., excavated material from the TWCA Main Plant or the Soil Amendment Area cannot be used as fill material in residential areas, and must be disposed of in accordance with the Offsite Rule). Should excavation occur during future development of the TWCA Main Plant or the Soil Amendment Area, excavated material must be properly handled, and excavation and disposal of Site material must comply with Federal and State laws.

10.4 CERCLA Five-Year Review

Section 121(c) of CERCLA and Section 300.430(f)(4)(ii) of the NCP require a review of the remedial action no less often than once every five years if the selected remedy "results in hazardous substances, pollutants, or contaminants remaining on the Site above levels that allow for unlimited use and unrestricted exposure". Statutory reviews must continue at least every five years until contaminant levels allow for unlimited use and unrestricted exposure.

The selected remedy relies on an industrial scenario, and therefore does not allow unlimited and unrestricted use. As contaminants will remain on Site that are above risk-based levels, the selected remedy requires that statutory reviews be conducted at least every five years. This element of the selected remedy also recognizes that TWCA is an active facility with ongoing operations which have impacted and limited the scope of the RI/FS, and which may continue to influence the effectiveness of remedial actions.

10.5 Costs

The selected remedy is expected to cost $110,000 for capital costs. There are no operation and maintenance costs associated with the remedy. The cost consists of $20,000 for removal and disposal of material with gamma radiation levels greater than 57 μrem/hour, and $90,000 for removal of the remaining material above 20 μrem/hour over background. The costs for construction of buildings using radon resistant technology is not included. A cost breakdown is shown in **Table 10-1.**

Table 10-1

Cost Breakdown for the Selected Remedy

Remedy Component	Quantity	Unit Price	Component Cost
Excavation of Material over 57 μRem/hour	6 tons	$59	$354
Disposal	95 Cubic Feet	$70.37	6685
Excavation/Disposal of Material over 20 μRem/hour	500 tons	$59	$29,500
Backfilling	506 tons	$18	$9108
Oversight			$3000
Field Management			$4800
Capital Cost Subtotal			$53,000
Mobilization and General Requirements @ 15%	$8000		
Construction Cost Subtotal			$61,000
Bid and Scope Contingencies 20%		$12,100	
Subtotal			$73,100
Administrative and other Costs 20%		$14,600	
Total Implementation Costs			$87,700
Engineering Design @20%		$22,000	
Total Capital Costs			**$110,000**

11.0 STATUTORY DETERMINATIONS

Under CERCLA, EPA's primary responsibility is to ensure remedial actions are undertaken which protect human health, welfare, and the environment. In addition, Section 121 of CERCLA, 42 U.S.C. §9621, establishes cleanup standards which require that the selected remedial action complies with all ARARs established under Federal and State environmental law, unless such requirements are waived by EPA in accordance with established criteria. The selected remedy must also be cost-effective and must utilize permanent solutions, alternative treatment technologies, or resource recovery technologies to the maximum extent practicable. Finally, CERCLA regulations include a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous waste. The following sections discuss how the selected remedy for the TWCA Site meets these CERCLA requirements.

11.1 Protection of Human Health and the Environment

The selected remedy combines institutional controls, excavation and off-site disposal, and mitigation measures which are designed to be protective of human health and the environment. The selected remedy takes into account the fact that TWCA is an active facility and that it may not be possible to completely eliminate or reduce all potential sources of contamination without substantially interfering with TWCA's ongoing processes. The goal of the selected remedy is to achieve protection of human health and the environment while giving reasonable consideration to those factors.

The selected remedy uses institutional controls to ensure that Site use remains consistent with current usage. Under the current usage, risks associated with exposure to chemicals and radionuclides (with the exceptions of radon and surface gamma radiation exposure) are within acceptable levels.

Excavation of surface soil resulting in gamma radiation greater than 20 μrem/hour over background reduces the health risk posed by exposure to gamma radiation to within acceptable levels. The requirement that future buildings be constructed using radon resistant technology will reduce the risk from exposure to radon.

Implementation of the remedy will not pose unacceptable short term risks.

11.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

The selected remedy will comply with all chemical-specific, action-specific, and location-specific ARARs that have been identified. In addition, other regulations and guidance were considered in the selection of the remedy. No waiver of any ARAR is being sought or invoked for any component of the selected remedy.

The ARARs identified for the TWCA Site include the following:

1. **Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, 40 C.F.R. §192, Authority: Sec. 275 of the Atomic Energy Act of 1954, 42 U.S.C. §2022, as added by the Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. 95-604, as amended.** Portions of these standards are **relevant and appropriate.**

2. **Solid Waste Disposal Act, also known as the Resource Conservation and Recovery Act (RCRA), Subchapter III, (42 U.S.C §§6921-6939) RCRA Land Disposal Treatment Standards, 40 C.F.R. Part 268, Subpart D; RCRA Transportation regulations, 40 C.F.R. Part 263.** Excavated soil will be analyzed to determine whether or not it exhibits RCRA hazardous waste characteristics. If the soil is a RCRA hazardous waste, or must be managed as RCRA hazardous waste, then the above ARARs are **applicable**.

3. **Toxic Substances Control Act (TSCA 15 U.S.C. §§2601-2671) PCB Disposal regulations at 40 C.F.R. §761.60; Oregon Hazardous Waste Management Rules for PCBs, OAR 340-110.** These regulations may be **applicable** for PCB-contaminated materials that are disposed off Site.

4. **Clean Air Act, 42 U.S.C. §§7401 <u>et</u> <u>seq</u>., (CAA), National Primary and Secondary Ambient Air Quality Standards, 40 C.F.R. Part 50; CAA National Emissions Standards for Hazardous Air Pollutants, 40 C.F.R. Part 60; CAA New Source Performance Standards, 40 C.F.R. Part 61.** The CAA regulations are **applicable** for control of dust particles emitted into the air during remediation construction activities.

5. **Amendment to NCP, Procedures for Planning and Implementing Off-Site Response Actions, 40 C.F.R. §300.440.** These rules and requirements are **applicable** to off-site management of CERCLA hazardous substances, pollutants or contaminants resulting from this ROD.

6. **Oregon Environmental Cleanup Law, Oregon Revised Statute (ORS) Chapter 465; Oregon Environmental Cleanup Rules, Oregon Administrative Rule (OAR) Chapter 340, Division 122, Sections 10 through 110.** These regulations are **applicable** for Site soils. These rules require cleanup to background or the lowest feasible level.

7. **Energy Conservation, Oregon Revised Statute (ORS) Chapters 469.375, 469.525, 469.556, 469.559; Oregon Administrative Rules (OAR) Chapter 345, Division 50, Section 006 through 130, Energy Facility Siting Council, Radioactive Waste Materials.** These rules govern disposal of radioactive material in Oregon. They are **applicable**. The rules include a Pathway Exemption, (OAR) Chapter 345, Division 50, Section 035, which exempts certain materials from the rules.

8. **Oregon Hazardous Waste Management Rules, OAR 340-100; Oregon Standards Applicable to Generators of Hazardous Waste, OAR 340-102; Identification and Listing of Hazardous Wastes, OAR 340-101.** These regulations may be **applicable** for the off-site disposal and on-site management of hazardous wastes.

9. **Administrative Rules for Waste Management, Oregon Revised Statue (ORS) Chapter 459, Oregon Administrative Rules (OAR) Chapter 340 Division 93 through 97.** These rules cover the disposal of solid waste (material that is not hazardous waste). They are applicable to the disposal of site soils.

10. **Executive Order 11988, Floodplain Management, and Executive Order 11990, Protection of Wetlands, May 24, 1977, incorporated in Appendix A to 40 C.F.R. Part 6.** These orders are applicable if wetlands are impacted. The selected remedy is not expected to have an impact on wetlands at the Site.

11. **Oregon's statewide planning goals, Goal 5 (Open Spaces, Scenic and Historic Areas, and Natural Resources), Goal 6 (Air, Water and Land Resources Quality), Goal 7 (Areas Subject to Natural Disaster and Hazards) and Goal 15 (Willamette River Greenway).** These regulations are applicable for those portions of the TWCA Site that lie within the Willamette River floodplain. The City of Millersburg is the local jurisdiction responsible for ensuring the objectives of these goals are satisfied. Remedial actions planned for these areas will need to be cleared through the City of Millersburg under its floodplain ordinance.

The policy, guidance, and regulations considered in the selection of the remedy,or which impact the remedy include the following:

1. **Occupational Safety and Health Act (OSHA), 29 U.S.C. 651; the implementing regulations under OSHA, 20 C.F.R. Parts 1910 and 1926.** These regulations must be complied with.

2. **Oregon Administrative Rules, OAR 333 Division 120 Sections 020 and 180, Oregon Rules for the Control of Radiation. The OAR, Chapter 333, Division 120 - Health Division,** General Provisions states each licensee or registrant shall conduct operations so that the total effective dose equivalent to individual members of the public from the licensed or registered operation does not exceed 0.1 rem (100 mrem) in a year. Also, the provision states that the dose in any unrestricted area from external sources shall not exceed 0.002 rem (2000 μrem) in any one hour. Application can be made for authorization to operate up to an annual dose limit for an individual member of the public of 0.5 rem (500 mrem). These regulations may be applied by the Oregon Health Department upon plant closure.

3. The EPA action level of 4.0 pCi/l of indoor radon is commonly recognized by Federal (and ODEQ) agencies as an upper limit on radon exposure in the home. This is equivalent to 0.02 WL (*Lung Cancer Risk from Indoor Exposures to Radon Daughters*, Internal Commission on Radiological Protection (ICRP) Publication 50, 1987, Pergamon Press, Oxford).

4. <u>Radon Prevention in the Design and Construction of Schools and Other Large Buildings, Third Printing with Addendum, 1994, (EPA/625/R-92/016)</u>. This guidance describes construction methods for radon resistant buildings.

11.3 Cost Effectiveness

EPA has determined that the combination of remedial actions identified as the selected remedy will reduce or eliminate the risks to human health in a cost-effective manner. The costs associated with the selected action level is almost an order of magnitude less than the cost of remediation to the next lowest action level (which did not provide significantly greater protection). The use of radon resistant construction for radon remediation is the only cost effective alternative.

11.4 Utilization of Permanent Solutions and Resource Recovery Technologies to the Maximum Extent Practicable

The selected remedy does not employ treatment technologies or resource recovery technologies. No such technology is available for the principle threats posed by the Site, risks from exposure to gamma radiation and radon. Removal provides a permanent solution because waste is removed from the Site.

11.5 Preference for Treatment as a Principal Element

The selected remedy does not contain treatment as a principal element. There is no treatment technology for the principal threats posed by the Site, risks from gamma radiation and radon.

11.6 Community Acceptance

There were no public comments received during the public comment period held from August 1 to August 30, 1995.

11.7 Conclusions

The selected remedy achieves the best balance among the nine evaluation criteria. The selected remedy achieves the best balance of tradeoffs with respect to the primary balancing criteria of long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; short term effectiveness; implementability; and cost.

12.0 DOCUMENTATION OF SIGNIFICANT DIFFERENCES

The selected remedy does not differ from the preferred alternative in the Proposed Plan.

APPENDIX A

Responsiveness Summary

The purpose of this responsiveness summary is to summarize and respond to public comments submitted regarding the Proposed Plan for the cleanup of the Teledyne Wah Chang Albany (TWCA) Superfund Site. The public comment period for the Proposed Plan was held from August 1 to August 30, 1995

This responsiveness summary meets the requirements of Section 117 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA).

In the Proposed Plan, issued July 21, 1995, the U.S. Environmental Protection Agency (EPA) described alternatives considered for the cleanup of surface and subsurface soils at the TWCA Site. These cleanup alternatives were based on information collected during a Remedial Investigation and Feasibility Study (RI/FS) conducted on the Site. The purpose of an RI/FS was to conduct a study of the Site and to assess possible plans to clean up the Site. The RI/FS and Proposed Plan were available at the Albany Public Library. Copies of the Proposed Plan and/or a fact sheet describing the Proposed Plan were mailed to the citizens whose names were on a list developed as part of the Community Relations Plan.

EPA offered the public the opportunity to have a public meeting. Only one person called to express interest. EPA responded by sending the caller a copy of the proposed plan. Later attempts to contact the caller by phone to determine whether there were any additional concerns were unsuccessful. Because only one request for a meeting was received, EPA did not hold a public meeting. No comments were received during the public comment period.

Teledyne Wah Chang
Surface and Subsurface Soil Operable Unit

Administrative Record
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DUE TO ITS LARGE SIZE,
THE ADMINISTRATIVE RECORD
HAS BEEN OMITTED