APPENDIX A1
CONCEPTUAL SITE MODEL

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PREFACE

This appendix is for guidance only, and is applicable on a case-by-case basis.

OVERVIEW OF A CONCEPTUAL SITE MODEL (CSM)

The following overview of a conceptual site model (CSM) is summarized from handouts provided in the U.S. Environmental Protection Agency's (EPA) short course entitled, *Best Practices for Efficient Soil Sampling Designs* (EPA, 2008).[1]

Definitions of a CSM

- Any representation of the nature, extent, and fate of contamination that allows assessment of the potential exposures to contamination, so that the decision maker can evaluate strategies to reduce the risks from contamination.
- The working hypothesis about the site's physical reality.
- The decision-maker's mental picture of the site characteristics pertinent to evaluating the risk posed by the site and deciding how to clean up a site.
- The scientific hypothesis that is tested, modified, and refined until confident decision-making is possible.

Uses of a CSM

- Organize project information.
- Point of consensus about sources of uncertainty.
- Identify uncertainty that prevents confident decision-making.
- Identify need for additional data collection either to reduce CSM uncertainties or to test CSM assumptions.
- Basis for all site decisions about risk, remediation, and reuse.
- Basis for cost-effective, confident decisions.
- Basis for identifying decision units (i.e., the area, volume, or set of objects that is treated as a single unit for decision-making).

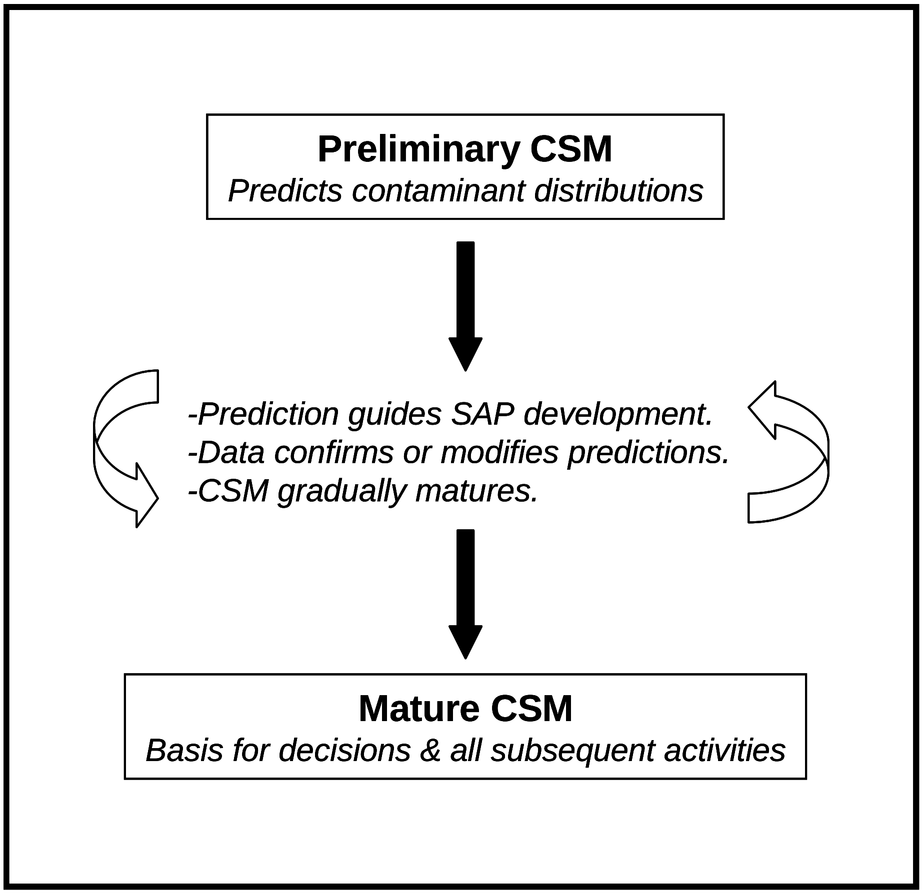
[1] EPA. 2008. Module 6, Truth Serum for Environmental Decision-Making: Efficient and Effective Program Designs. Short course manual for Best Practices for Efficient Soil Sampling Designs. CERCLA Education Center. January.

CSM Representations[2]

CSMs can be presented in a variety of forms. It usually takes more than one format to organize and display different types of site information. Examples of CSM representations include a text description supported by appropriate figures (e.g., site maps, cross-sections, block diagrams), a release-transport-exposure cartoon, and an exposure pathway CSM used to support the risk assessment. Computer model simulations or exposure scenario models may be a component of the CSM, but do not represent the entire CSM.

Evolution of a CSM

As illustrated by the following figure, a CSM evolves as new data become available, the new data is incorporated into the CSM and the CSM matures.



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[2] Suggested Reference: U.S. Environmental Protection Agency (EPA). 1996. Attachment A, Conceptual Site Model Summary. Soil Screening Guidance: User's Guide. Second Edition. EPA 540/R-96/018. July. www.epa.gov/superfund/health/conmedia/soil/pdfs/attacha.pdf

CONCEPTUAL SITE MODEL CHECKLIST

CSM REQUIREMENT	STATUS	REQUIRED ACTION
FACILITY		
Identify current and historical structures (e.g., buildings, drain systems, sewer systems, underground utilities)		
Identify process areas, including historical processing areas (e.g., loading/unloading, storage, manufacturing)		
Identify current and historical waste management areas and activities		
Other		
LAND USE AND EXPOSURE		
Identify specific land uses on the facility and adjacent properties		
Identify beneficial resources (e.g., groundwater classification, wetlands, natural resources)		
Identify resource use locations (e.g., water supply wells, surface water intakes)		
Identify subpopulation types and locations (e.g., schools, hospitals, day care centers)		
Identify applicable exposure scenarios (e.g., residential, industrial, recreational, farming)		
Identify applicable exposure pathways (e.g., contaminant sources, releases, migration mechanisms, exposure media, exposure routes, receptors)		
Other		
PHYSICAL FEATURES		
Identify topographical features (e.g., hills, gradients, surface vegetation, or pavement)		
Identify surface water features (e.g., routes of drainage ditches, links to water bodies)		
Identify surface geology (e.g., soil types, soil parameters, outcrops, faulting)		
Identify subsurface geology (e.g., stratigraphy, continuity, connectivity)		
Identify hydrogeology (e.g., water-bearing zones, hydrologic parameters, impermeable strata, direction of groundwater flow)		
Identify existing soil boring and monitoring well logs and locations		
Other		

CONCEPTUAL SITE MODEL CHECKLIST (CONTINUED)

CSM REQUIREMENT	STATUS	REQUIRED ACTION
RELEASE INFORMATION		
Identify potential sources of releases		
Identify potential contaminants of concern associated with each potential release		
Identify confirmed source locations		
Identify confirmed release locations		
Identify existing delineation of release areas		
Identify distribution and magnitude of COPCs and COCs		
Identify migration routes and mechanisms		
Identify fate and transport modeling results		
Other		
RISK MANAGEMENT		
Summarize the risks		
Identify impact of risk management activities on release and exposure characteristics		
Identify performance monitoring locations and media		
Identify contingencies in the event performance monitoring criteria is exceeded		
Other		
CLEANUP		
Identify study options		
Identify study requirements		
Identify cleanup options		
Identify cleanup requirements		
Other		

EXAMPLE FOR CONCEPTUAL SITE MODEL IN NARRATIVE FORMAT

Site Description

The Project Site (site) is an active wood treatment facility located on approximately 12 acres near the town of Redding in Shasta County. The site is currently owned by Company X and was previously owned by Company Y. Site operations have been relatively stable since operations began in 1955 and have generally consisted of a process area, drip pad, and a pole yard used for treated wood storage. The current and historical configuration of the facility is shown on Figure 1. Although the property was used for pasture prior to 1955, there is no record of any pesticide or herbicide applications.

The treatment operations primarily used inorganic treatment solutions, some of which contained arsenic, chromium, copper, and zinc. Wastes generated at the site are consistent with those typically associated with wood treatment facilities and include retort drippings, tank and retort sludges, process water, wastewater, drying area drippings, storage area drippings, empty containers, and spilled raw preservative compounds. Several leaks and direct discharges of wood treatment chemicals from the process area have been reported from the 1960s through 1970s.

The site is fenced and access is controlled. As shown in Figure 2, the site is located at the edge of a mixed industrial/commercial area and is bordered to the south by an undeveloped field. The wood treatment facility is active and is projected to operate for the foreseeable future.

The site is largely unpaved and unvegetated. The site slopes at about a 1 percent grade toward the southeast. Surface water runoff is intercepted by a drainage ditch that borders the southern and eastern margin of the property. No other surface water features are present.

There are no known cultural resources at the site. The nearest school is located about one mile north of the site.

Source Areas

The process area (about 2 acres) includes the engine room, chemical mix building, and related structures. The engine room houses two retorts that are used to pressure inject treatment solutions into the wood. An underground storage tank that stored spent treatment solutions was located below the retorts until it was closed in 1983. Now and in the past, wood treatment chemicals are prepared at the chemical mix building and placed in storage vessels within the retort area.

The drip pad area (about 1 acre) includes the railroad tracks and surrounding land immediately east of the engine room building. Treated wood removed from the retorts is held in the drip pad area until dripping ceases. Concrete drip pads were installed in this area in 1982.

The pole yard (about 9 acres) includes the eastern portion of the site. The area is used for storage of treated and untreated wood.

Site Geology and Hydrogeology

The geology and hydrogeology of the site have been presented in several documents. These include the Remedial Investigation Report (Consultant X, 1989) and the Characterization and Treatability Study Report of Results (Consultant Y, 1993). The site is generally underlain by five stratigraphic units (discussed in order of increasing depth).

Artificial Fill. Artifical fill is present across the site at thickness ranging from 1 to 3 feet. The fill material typically consists of gravelly sand derived from local quarries.

Younger Clastic Assemblage (YCA). The YCA is a poorly-sorted, unstratified pyroclastic debris flow, consisting of silty, gravelly sand. Gravel is angular to subangular, and can be greater than 2.5 inches in diameter. Locally it contains alternating beds of silty sand, sandy silt, and rounded gravel. The transition to the underlying unit occasionally is marked by a sandy-silt to silty-sand layer. The unit has a distinctive pinkish-brown to pinkish-gray color. It ranges up to 20 feet thick at the site.

Younger Alluvial Assemblage (YAA). The YAA is a well-sorted unit of fluvial origin. The unit consists of fine to medium sand to silty sand and gravelly medium coarse sand. Gravels in this unit are generally less than one inch in diameter. Locally on the site the YAA can be poorly sorted and very silty, which may represent transitional environments of a fluvial system. The YAA is brown to gray and can have a reddish or greenish hue. The YAA ranges from 15 to 18 feet thick.

Older Clastic Assemblage (OCA). The OCA is a distinctive unit that is present beneath the YAA. The OCA caps the older pyroclastic flows and the lower aquifer. In air rotary drill cuttings, the OCA is described as brown gravelly clay. In split-spoon samples, the OCA is described as dense greenish-gray silt or sandy silt. The boring logs indicate that the OCA ranges from 20 to 29 feet thick beneath the site. The OCA acts as the confining layer that separates the uppermost aquifer from the lower aquifer.

Older Alluvial Assemblage (OAA). The OAA is a well-sorted unit of fluvial origin. The unit consists of medium to coarse sand to gravelly sand. Gravels in this unit are generally less than one inch in diameter. The OAA is brown to gray. The OAA ranges from 30 to 40 feet thick.

Two water-bearing units have been identified at the site and are separated by the OCA aquitard. The shallower water-bearing unit is referred to as the uppermost aquifer and occurs within the YAA. The second water-bearing unit occurs in the OAA and is used as a local water supply. Depth to groundwater at the site generally ranges from 27 to

30 feet below ground surface (bgs). Hydrographs from monitoring wells indicate that there is a persistent downward vertical gradient across the Site between the two water-bearing units. The head difference can be as much as 10 feet. The regional groundwater flow direction is toward the northwest. Beneath the site, the ground water flow direction in the uppermost water-bearing unit is generally to the north-northwest. The groundwater flow direction in the lower water-bearing unit is generally toward the west reflecting the influence of local water supply wells.

Nature and Extent of Contamination

Investigations at the site have identified arsenic as the COC most commonly detected in soil above the estimated background concentration (8 milligrams per kilogram (mg/Kg)) at concentrations ranging from 40 to 32,000 mg/Kg. Chromium, copper, and zinc exceed the respective background concentrations in localized areas, but are co-located with elevated arsenic concentrations. The data indicate that impacted surface soil (0 to 2 feet bgs) is found throughout the process area and pole yard as well as along the drainage ditch. The majority of surface soil samples contained in excess of 100 mg/Kg of arsenic. Soil impacts below 2 feet bgs were only observed in the vicinity of the chemical mix building and engine room. The maximum depth of impact in these localized areas was 6 feet bgs.

The data suggest a lack of mobility of arsenic at the site because concentrations decrease rapidly with depth and arsenic is found in the subsurface only near the chemical management areas. In addition, arsenic has not been detected above background concentrations in groundwater.

Figure 3 shows the extent of surface soil impacted with metals, an area covering approximately 8.5 acres. The extent of impacted soil at depths greater than 2 feet bgs in shown in Figure 4 and covers about 0.3 acres. The estimated volume of metals-impacted soil is 18,750 cubic yards.

Human Health Risk

The Remedial Investigation identified potential risk to human receptors. The risk assessment identified chemicals of concern (COCs) for human receptors. The chemicals were selected primarily on the basis of the concentration detected, or the known or suspected toxicological properties of the substance. The wood treatment COCs include arsenic, chromium, copper, and zinc, with arsenic being identified as a high threat contaminant. Chromium, copper, and zinc have been identified as secondary COCs because they are considered to be less toxic than arsenic, are not widespread, are relatively immobile, and/or do not consistently exceed health-based standards.

The Remedial Investigation identified the principal exposure pathways by which human receptors could potentially be exposed to site contaminants as:

- Direct contact with contaminated soils; and
- Inhalation of fugitive dust emissions.

The evaluation performed under the risk assessment indicated that, under current land-use conditions, the principal exposure pathways by which human receptors could potentially be exposed to site contaminants are direct contact by site workers with contaminated soils and inhalation of fugitive dust emissions on and off site. It is anticipated that future land use of the site will continue to be industrial. Within the risk assessment, the exposure point concentrations of site chemicals were estimated using measured concentrations and models to estimate fugitive dust emissions.

The risk assessment evaluated two main baseline (no action) scenarios: continued use of the property as industrial (wood treatment) and future-use development of the property as residential. Exposure was assessed for both an average case and a maximum plausible case for each exposure scenario. For the average case, geometric mean concentrations were used, together with what were considered to be the most likely exposure conditions. For the maximum plausible case, the highest measured concentrations were generally used, together with high, although plausible, estimates of the range of potential exposure parameters relating to frequency and duration of exposure and quantity of contaminated media contact.

The highest current-use potential health risk due to arsenic was identified as exposure by site workers to the soil by direct contact (plausible maximum case risk of 8×10^{-2}). The maximum non-carcinogenic risks from direct contact with soil by workers at the site exceeded a hazard index of 1.0. Inhalation of arsenic-contaminated fugitive dust by adults working in the area of Front Street poses a current use maximum potential excess cancer risk of 2×10^{-3} and a noncancer risk from inhalation of less than one.

Higher health risks are associated with future residential use of the site. Children in direct contact with site soil have a maximum excess cancer risk of 1×10^{-2} from arsenic and a non-cancer risk greater than 1. Adults in direct contact with site soil have a maximum excess cancer risk of 5×10^{-2} and a corresponding non-cancer risk greater than 1.

Potential remedies to remove these exposure pathways include: excavation and off-site disposal; excavation, treatment, and off-site disposal; and capping or paving the site.

Ecological Risk

Based on a field summary by a qualified biologist, the potential risk to ecological receptors is considered to be limited because of the low quality habitat at and near the site.

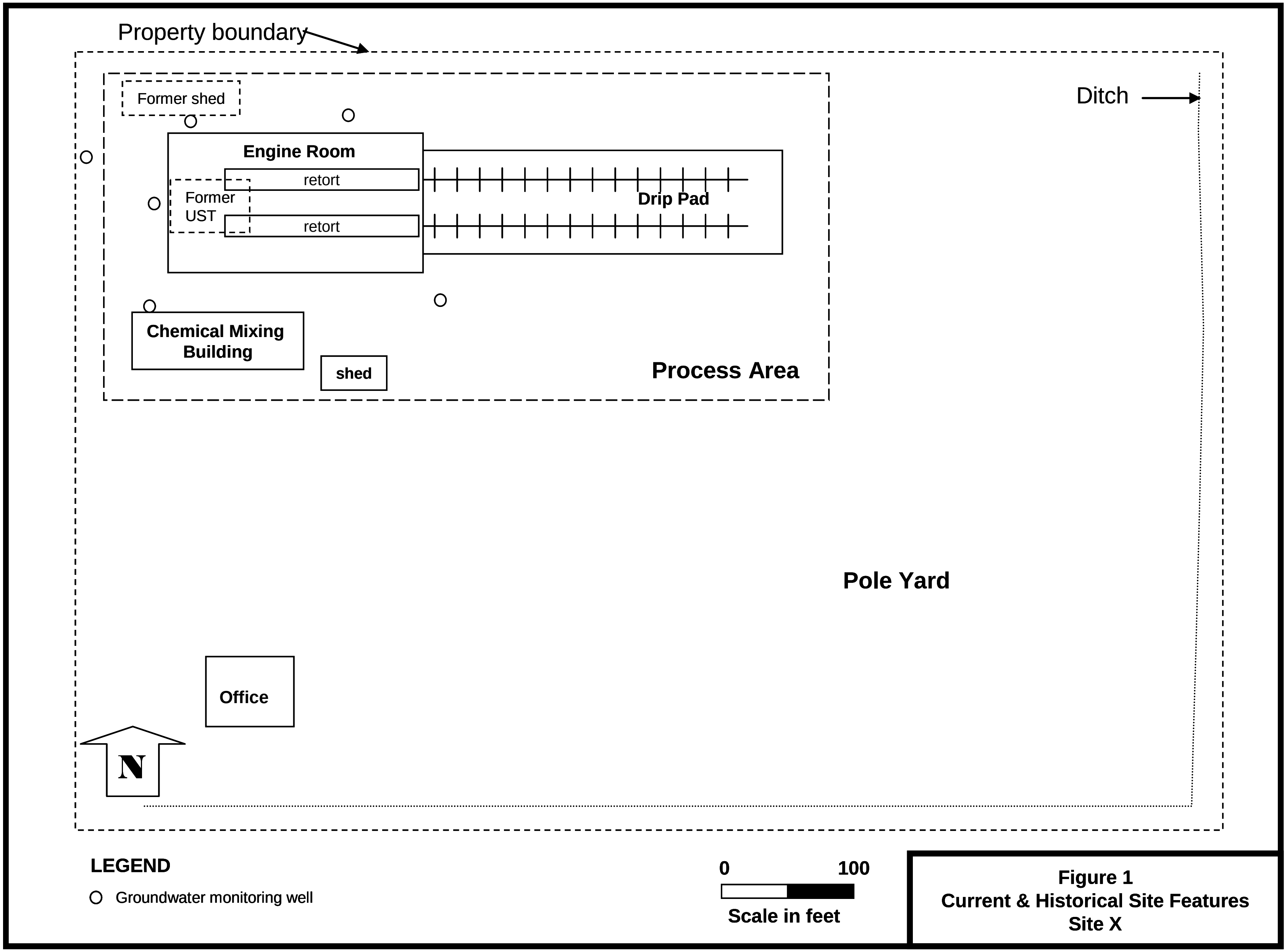

Figure 1
Current & Historical Site Features
Site X

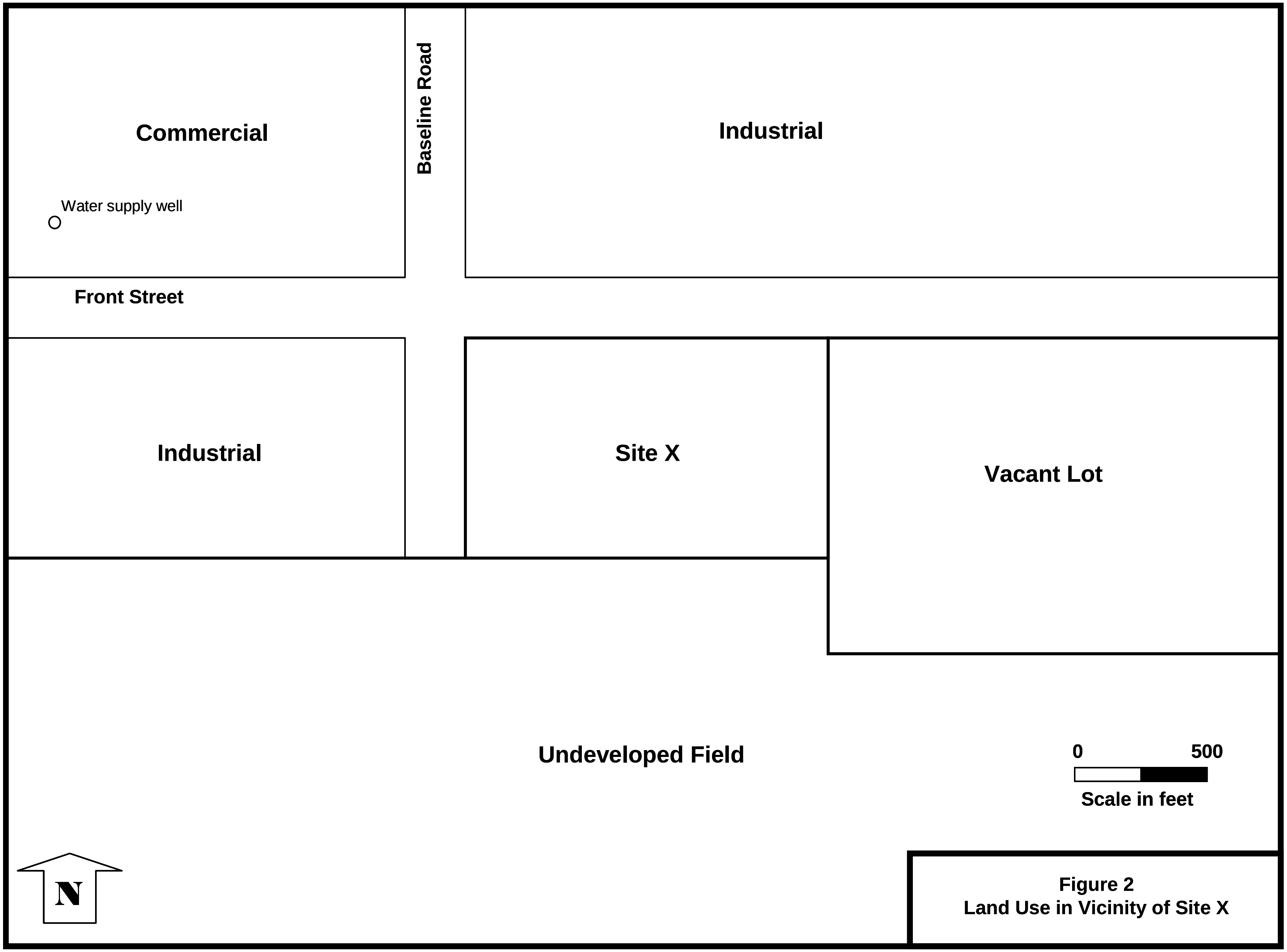

Figure 2
Land Use in Vicinity of Site X

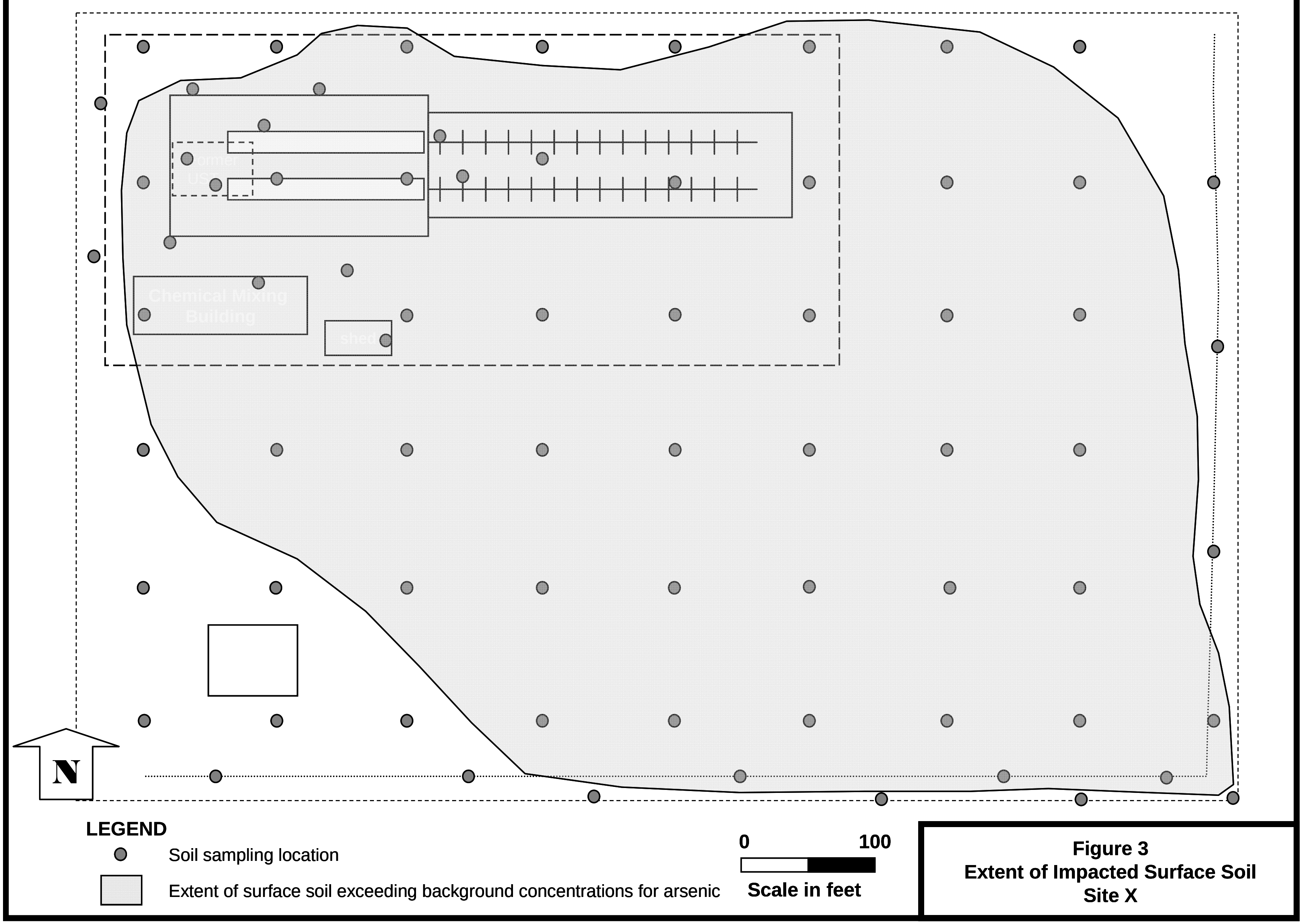

Figure 3
Extent of Impacted Surface Soil
Site X

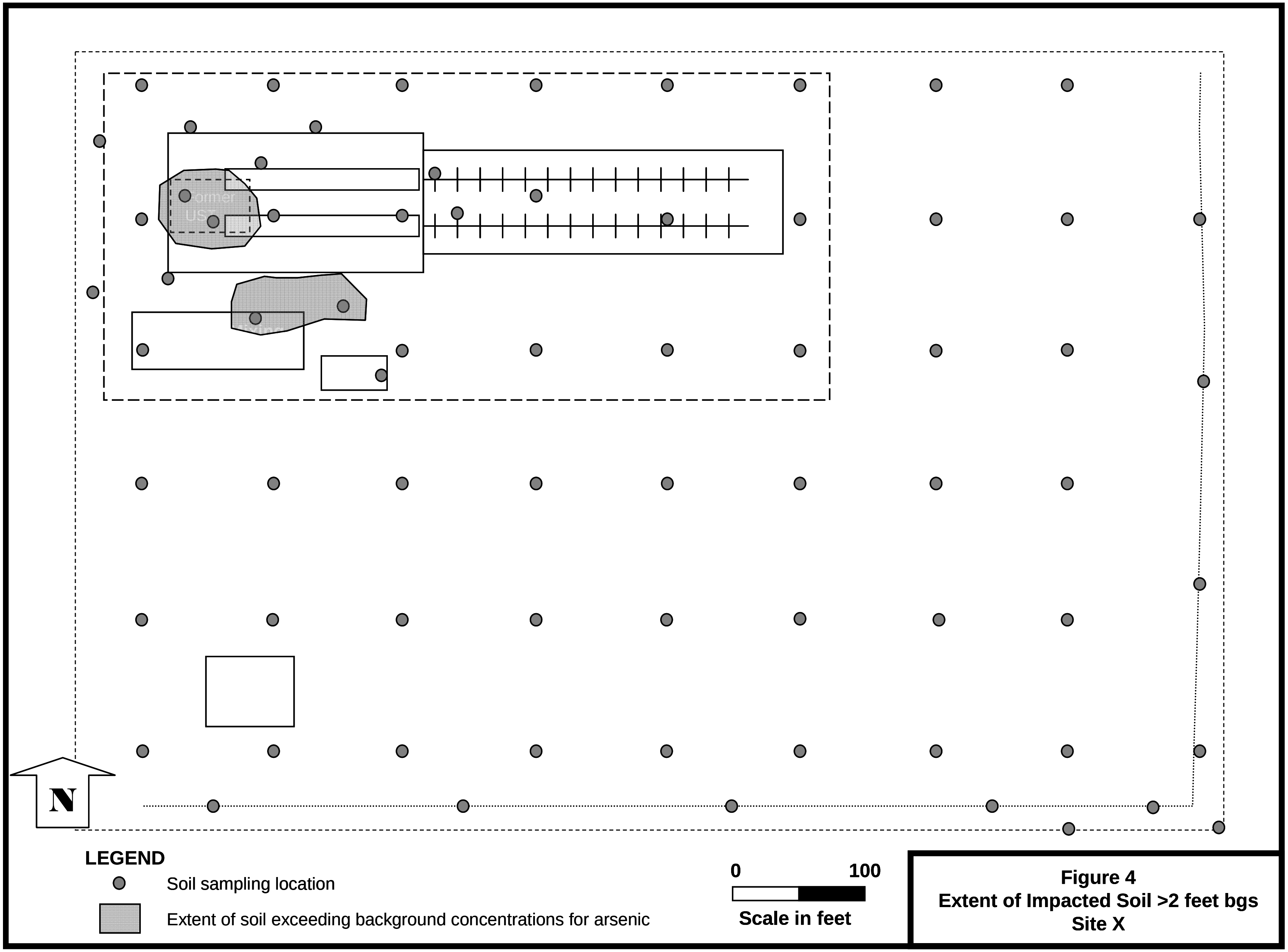

Figure 4
Extent of Impacted Soil >2 feet bgs
Site X

EXAMPLE FOR PATHWAY-EXPOSURE CSM