4.1 Sitewide Soil and Groundwater

This section discusses the Sitewide soil area and groundwater. These areas were included in WAG 6 and WAG 10 in the FFA/CO. On a Sitewide basis, groundwater concerns related to the Snake River Plain Aquifer are included in WAG 10. The groundwater portion of this section provides a general overview of groundwater contamination at the INEEL Site. Site-specific groundwater contamination is discussed in more detail in Sections 4.2, 4.3, 4.4, 4.5, and 4.7.

4.1.1 Sitewide Soil

The Sitewide soil area includes all INEEL land outside the fenced boundaries of the Site's primary facility areas. Remaining occupied or utilized facilities in the Sitewide soil area include the INEEL firing range (a security force training center), the Experimental Breeder Reactor I historical site, the entrance guard gate facilities, and small structures and utility buildings, such as pumphouses and communications buildings.

The consolidation and management of contaminated soil from the INEEL at a single location to prevent exposure of human and ecological receptors was one of the remedial decisions documented in the *Final Record of Decision, Idaho Nuclear Technology and Engineering Center, Operable Unit 3-13* (DOE-ID 1999b). The INEEL CERCLA Disposal Facility (ICDF), located just outside the INTEC facility fence, was constructed in 2003 (see Figure 4-3a1b). The facility includes waste storage and treatment areas, a landfill, and two evaporation ponds to manage landfill leachate and other liquids. The ICDF landfill (for soil and debris) and evaporation ponds (for liquids only) are engineered facilities for CERCLA hazardous and radioactive contaminants. To protect the aquifer, located 460 ft below ground, a system of multiple liners and liquid collection and diversion points is part of the design.

Sitewide soil includes WAG 6 and WAG 10, designated under the FFA/CO. WAG 6 includes the Experimental Breeder Reactor I and the nearby Boiling-Water Reactor Experiment (BORAX) Area, which includes the sites of five separate experimental reactors that have been deactivated, decontaminated, and decommissioned.

WAG 10 encompasses the INEEL Site area that falls outside of the other WAGs. Hazards associated with this area include potential unexploded ordnance (UXO) and associated explosive contaminants remaining from munitions testing activities. The hazard area is extensive, comprised of approximately 217,000 acres. As necessary, WAG 10 also encompasses areas beyond the INEEL boundaries that may have been impacted by INEEL activities. Consequently, WAG 10 comprises a large area, much of which is uncontaminated.

The *Declaration of the Record of Decision for Ordnance Interim Action Operable Unit 10-05* (DOE-ID 1992a), which addressed UXO known or suspected at six sites, was issued in 1992. A comprehensive investigation was completed in 2001, and the *Record of Decision for Experimental Breeder Reactor-1/Boiling Water Reactor Experiment Area and Miscellaneous Sites, Operable Units 6-05 and 10-04* (DOE-ID 2002b) was completed in 2002.

The *Comprehensive Remedial Investigation/Feasibility Study for Waste Area Groups 6 and 10 Operable Unit 10-04* (DOE-ID 2001a) included a comprehensive analysis of ecological risk information available from the INEEL WAGs. The purpose of the "INEEL-wide Ecological Risk Assessment" (DOE-ID 2001a) was to compile information from previous investigations of risk to ecological receptors performed for each WAG into a summary of the effects of contamination on the environment of the INEEL as a whole. The information sources used include assessments of the ecologically sensitive areas, ecological sampling onsite, the breeding bird survey, long-term vegetation transects, radiological biota studies, air dispersion modeling, biological surveys for sensitive species or habitat, and ecological risk assessment summaries for the various WAGs. The OU 10-04 ROD (DOE-ID 2002b) concluded that less than 20% of the habitat present on the INEEL is lost to facility activities, and minimal (de minimus) risk is expected to the INEEL's plant and animal communities. However, based on the multiple uncertainties, data gaps, and assumptions in the assessment, it was determined that the INEEL would implement long-term ecological monitoring. The OU 10-04 ROD (DOE-ID 2002b) states, "Monitoring will ensure that expectations regarding the protectiveness of the no action approach to the INEEL-wide ecological risk assessment are met." An ecological conceptual site model from the OU 10-04 ROD (DOE-ID 2002b) is included as Figure 4-1a2a and Table 4-1a. The *Long-Term Ecological Monitoring Plan for the Idaho National Engineering and Environmental Laboratory* (VanHorn, Fordham, and Haney 2003) was submitted to the agencies in September 2003. Fieldwork was initiated in 2003 to collect baseline samples.

4.1.1.1 Current State. Main sources of contamination in WAG 10 include the Organic Moderated Reactor Experiment Leach Pond (OMRE-01) and UXO areas (WAG 10). The UXO areas are shown on Figure 4-1a1b. The remaining CERCLA sites are too small to be visible on the map. Major contaminants are lead, mercury, cesium-137, strontium-90, trinitrotoluene (TNT), royal demolition explosive (RDX), and UXO (see Figure 4-1a2b). Cesium-137 is one of the more common contaminants of concern (COCs) at the INEEL. Cesium-137 is found in radioactive waste associated with the operation of nuclear reactors and spent fuel reprocessing plants. It can enter the body when it is inhaled or ingested. Exposure to cesium-137 can result in malignant tumors and shortening of life. The EPA has established an MCL of 4 mrem per year for beta-particle and photo radioactivity from man-made radionuclides in drinking water. Cesium-137 is covered under this MCL. The average concentration of cesium-137, which is assumed to yield 4 mrem per year, is 200 pCi/L. Cesium-137 has a half-life of 30 years and, therefore, often can be remediated within acceptable timeframes through natural decay.

Nine sites currently require institutional controls to protect against human exposure to contaminants. Institutional controls include warning signs and control of activities to restrict drilling and excavation. Each of these sites is briefly summarized below:

- EBR-08—Fuel Oil Tank—The EBR-08 Fuel Oil Tank is the site of an underground storage tank that was removed during the 1990 tank program. Soil under the tank showed evidence of leakage. The primary COC is diesel. All of the diesel-contaminated soil was removed, with the exception of two small areas that could not be accessed because of equipment limitations. The excavation was backfilled with clean soil (DOE-ID 2001a). The ROD selected remedy is institutional controls that restrict the site to industrial land use until discontinued, based on the results of a 5-year review.

- BORAX-01—Leach Pond Associated with BORAX Reactors—This site was used from 1954 to 1964 to collect low-level radioactively contaminated liquid discharges from the BORAX II through V experiments. In 1984, the pond was backfilled with clean soil, graded, and reseeded. In 1992, the associated piping and a small volume of underlying contaminated soil were removed. COCs at the leach pond associated with BORAX II through V reactors are primarily subsurface metals and radionuclides, with the primary COC being cesium-137. The ROD selected action is maintenance of institutional controls to prevent exposure to contaminated soil.

- BORAX-02—Site of Buried BORAX I Reactor—This BORAX I reactor was used between 1953 and 1954 for dozens of stress tests to explore reactor safety. The reactor was deliberately destroyed in 1954 during a final test designed to determine its inherent safety under extreme conditions. The excursion was more destructive than had been predicted, and the steam explosion scattered fuel plate fragments a distance of 200–300 ft. Immediately following the reactor excursion, a cleanup activity was conducted to physically remove and reprocess the scattered radioactive material. In 1955, the remaining aboveground structures were removed, the reactor was buried in place along with surrounding radionuclide-contaminated soil, and the area contaminated from the excursion was covered with 6 in. of gravel. The site was remediated in 1996 in accordance with the *Record of Decision: Stationary Low-Power Reactor-1 and Boiling Water Reactor Experiment-1 Burial Grounds (Operable Units 5-05 and 6-01), and 10 No Action Sites (Operable Units 5-01, 5-03, 5-04, and 5-11)* (INEEL 1996). All shrubs, roots, signs, fencing, and other debris were removed from the contaminated area and placed in a layer on top of the original burial ground. Soil, with radionuclide contamination exceeding action levels, was excavated to a depth of 1 ft and placed over the original burial ground. Soil sampling verified that no areas remained with contamination exceeding the action levels. An engineered barrier, consisting of basalt riprap, was constructed over the site. Subsequently, because of the presence of contamination in the soil to the south of the reactor burial ground, additional in situ surveys were performed, and a risk assessment for the residual radiological surface contamination at the site was prepared in 2002. From the results of the assessment, it was concluded that the dose to both current and future receptors is acceptable although two areas of contamination may exceed risk-based levels. However, the residual cesium-137 activity at the site will decay to acceptable risk levels in approximately 130 years, and current institutional controls and land-use restrictions will be adequately protective of human receptors until that time. This site was subsequently included in the OU 6-05 and 10-04 ROD (DOE-ID 2002b). The ROD selected remedy is no further action with institutional controls to maintain integrity of the containment barrier and to prevent unauthorized intrusion into the capped area. Institutional controls will be required for approximately 300 years until the cesium-137 decays to acceptable levels for unrestricted use.

- BORAX-08—BORAX V Ditch—The COC at this site is cesium-137. In 1995, a non-time-critical removal action was conducted at the site. Approximately 1,178 yd^3 of radionuclide-contaminated soil were removed from the ditch. Sampling in the summer of 2000 confirmed that remaining contamination was below action levels. The ROD selected remedy is no further action with institutional controls. Institutional controls are maintained to prevent exposure to contaminated soil.

- BORAX-09—Entombed BORAX II through V Reactor Buildings—Reactor experiments were conducted at this site between 1953 and 1964. The site consists of the entombed belowground structures remaining from the Argonne Experimental Facility (AEF-601), subfloor concrete foundations and reactor components, and other remaining artifacts of the BORAX V experiment. Concrete shield blocks seal the AEF-601 pits, trenches, and access shaft, all of which have been backfilled with soil. A DD&D removal and containment action was conducted at the site from 1996 through 1997. All remaining aboveground structures and systems were removed, and the subfloor levels of the reactor building were entombed. Lead shielding was removed from the BORAX V reactor pit and was sent off-Site for recycling. The mixed waste streams were incinerated at the Waste Experimental Reduction Facility. Belowgrade pits and trenches were backfilled with soil. Radioactively contaminated soil excavated from the head of the BORAX-08 ditch was placed in the reactor building access shaft. The concrete shield blocks were replaced over these areas. The remaining reactor building systems, including two reactor vessels (BORAX II, III, IV, and V) and approximately 780 ft^3 of materials containing asbestos, were buried in the belowgrade concrete structure. The reactor vessel was entombed with concrete and buried under clean soil. The primary COC is cesium-137. The ROD selected remedy is no further action and institutional controls to prevent unauthorized intrusion into the entombment structures and buried waste. Institutional controls include warning signs, control of activities (drilling and excavation), and property lease requirements to control future land use.

- OMRE-01—Organic Moderated Reactor Experiment Leach Pond—The leach pond was used for wastewater disposal from the Organic Moderated Reactor Experiment reactor. The reactor operated form 1957 to 1963. The COCs are radionuclides (primarily cesium-137). The ROD selected remedy is no further action and institutional controls to prevent exposure to contaminated soil. This is accomplished through warning signs, control of activities (drilling and excavating), and property lease requirements to control future land use.

- STF-02—Gun Range—The Security Training Facility area has been used since 1983 for security force practice maneuvers including small arms target practice in a berm. Approximately 61 tons of lead and 3.4 tons of copper may be present at the site. The human health risk is from lead. The average concentration exceeds the EPA's (Region 9) 400-mg/kg preliminary remediation goal for lead. The ROD selected remedy is removal, treatment, and disposal of soil. Institutional controls are used to prevent exposure to contaminated soil. These include visible access restrictions (warning signs) and control of activities (drilling or excavating.). Interim controls will be maintained to protect workers until the selected remedies have been implemented.

- WAG 10 UXO—Multiple Sites with Potential UXO—For ordnance areas, the COC is UXO from aerial bombing practice, naval artillery testing, explosive storage-bunker testing, and ordnance disposal. Munitions used for bombing and target practice are likely to be inert although it is suspected that some UXO might be present within the ranges. For the explosives sites, TNT and RDX were identified as COCs based on results of the human health risk assessment. Contamination consists of larger fragments of TNT and RDX that could pose an explosives hazard and TNT and RDX that have dissolved into the soil, resulting in unacceptable risk from ingestion and dermal exposure to current and future workers. Multiple sites with potential UXO include:

- Ordnance areas

  – ORD-03: CFA-633, Naval Firing Site and Downrange Area (including 17 smaller ordnance sites: ORD-04, ORD-05, ORD-07, ORD-11, ORD-12, ORD-13, ORD-14, ORD-16, ORD-17, ORD-18, ORD-19, ORD-20, ORD-22, ORD-25, ORD-26, ORD-27, and ORD-28)

  – ORD-09: Twin Buttes Bombing Range

  – ORD-01: Arco High-Altitude Bombing Range.

- TNT- and RDX-contaminated soil sites

  – ORD-15: Experimental Field Station

  – ORD-10: Fire Station II Zone and Range Fire Burn Area

  – ORD-24: Land Mine Fuse Burn Area

- ORD-08: National Oceanic and Atmospheric Administration

- ORD-06: Naval Ordnance Disposal Area.

- ORD-21—Juniper Mine—For the Juniper Mine, an estimated 16,000 lb of explosive material remain buried 135 ft below ground (buried in 1974). The ROD selected remedy is no further action with institutional controls. Institutional controls are warning signs and control of activities (drilling and excavating).

4.1.1.2 End State. A map showing the Sitewide soil area at the risk-based end state is included in Figure 4-1b1b. A Sitewide soil conceptual site model for the risk-based end state is provided as Figure 4-1b2b. No ecological conceptual site model for the risk-based end state is provided because adequate data are not yet available to accurately predict effects to ecological receptors from low levels (minimal risk) of contaminants over long periods of time. For these reasons, ecological monitoring is proposed. Monitoring will be focused on detecting possible effects to populations at the Site and providing necessary data to verify modeling and help eliminate uncertainties. The Sitewide ecological monitoring program will provide critical information for continued assessment of this ecosystem. It will also provide the baseline data needed to make informed decisions in the future.

The UXO sites are currently planned to be remediated as required by November 2015. The planned remediation involves visual and geophysical surveys of the areas that have been identified as having a higher risk of containing UXO. However, there are limits to the effectiveness of these methodologies. It is cost prohibitive to search every inch of land to a depth of several feet. In addition, because of freeze-thaw cycles, ordnance continues to work its way up to the surface over the years. These limitations, coupled with the large geographic area that potentially may contain UXO, make it very difficult to free release areas with potential UXO contamination, as it is not possible to ensure that every potential piece of UXO has been identified. Therefore, even if these sites are remediated as scheduled, they will still require permanent institutional controls to protect humans from potential contact with UXO. As a result, a potential variance from the selected remedy would be to survey and remediate only those areas that have planned future activities or where potential UXO has been identified.

For the explosives sites, TNT and RDX were identified as COCs based on results of the human health risk assessment. Contamination consists of larger fragments of TNT and RDX that could pose an explosives hazard and TNT and RDX that have dissolved into the soil, resulting in unacceptable risk from ingestion and dermal exposure to human health. These sites are to be remediated by 2015. If remediation is conducted as described in the ROD, it is anticipated that institutional controls will not be required.

The STF-02 gun range will be remediated by August 2018. If remediation is conducted as described in the ROD, it is anticipated that institutional controls will not be required following remediation of the site.

All of the BORAX sites are expected to remain under institutional control for radionuclide contamination past 2035 until the cesium-137 decays to acceptable levels. This is also true for the OMRE-01 leach pond site.

It is also anticipated that institutional controls will remain in effect for the EBR-08 Fuel Oil Tank site past 2035.

Although no remedial action is required for the Juniper Mine, there is significant uncertainty as to the explosive characteristics of the buried material. Institutional controls will therefore remain in effect past 2035.

The ICDF will be closed in accordance with the substantive and applicable requirements of the Hazardous Waste Management Act (HWMA) and RCRA. Closure requirements will include access restrictions to prevent intrusions into the closed area. Access restrictions, institutional controls, monitoring, and maintenance will remain in place for as long as the contents of the landfill remain a threat to human health or the environment if uncontrolled.

4.1.1.3 Variances. Potential variances have been identified for the UXO areas, areas contaminated with TNT and RDX, and the gun range. These variances are described in Table 5-1.

The ROD selected remedy for the UXO sites requires a survey of the entire 208,000 acres (325 square miles) that may contain UXO. A potential variance would be to clean up only those areas where UXO has been identified through other activities or where remediation is needed because of future planned activities. UXO poses a physical danger through the possibility of it exploding when handled or contacted, especially by machinery. UXO encounters are relatively uncommon, and there has never been an accidental detonation at the INEEL caused by human contact. No historical occurrences of unintentional detonation by ecological receptors have been recorded. It would be unlikely for an ecological receptor to strike an ordnance item with sufficient force to explode it. Therefore, UXO was determined by the ROD to pose no unacceptable risk to ecological receptors.

Geophysical investigations for buried munitions are seldom 100% effective. In many cases, a munition is buried too deep, is too small to be detected, or is constructed of a material difficult to detect. Undetected ordnance that is buried may be brought to the ground surface through frost heaving or erosion. In addition, because the total amount of munitions buried at a site is rarely known, complete recovery cannot be documented.

For the TNT and RDX areas and the STF-02 gun range, the ROD selected remedies were based on future-use scenarios that included residential receptors after 100 years. It is proposed that an evaluation be conducted to determine the level of cleanup required to protect occupational and ecological receptors.

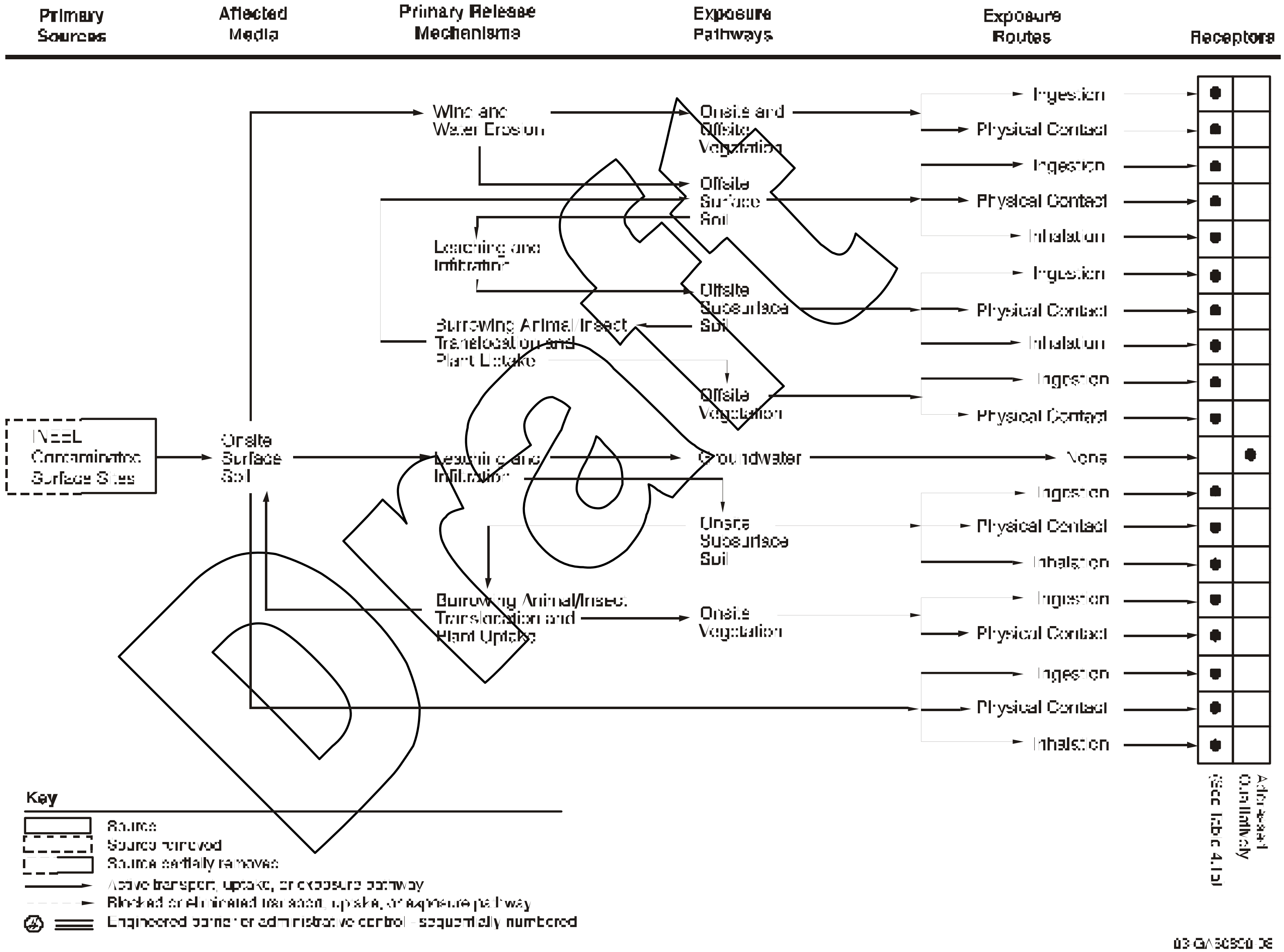

Figure 4-1a2a. Site ecological receptors conceptual site model—current state.

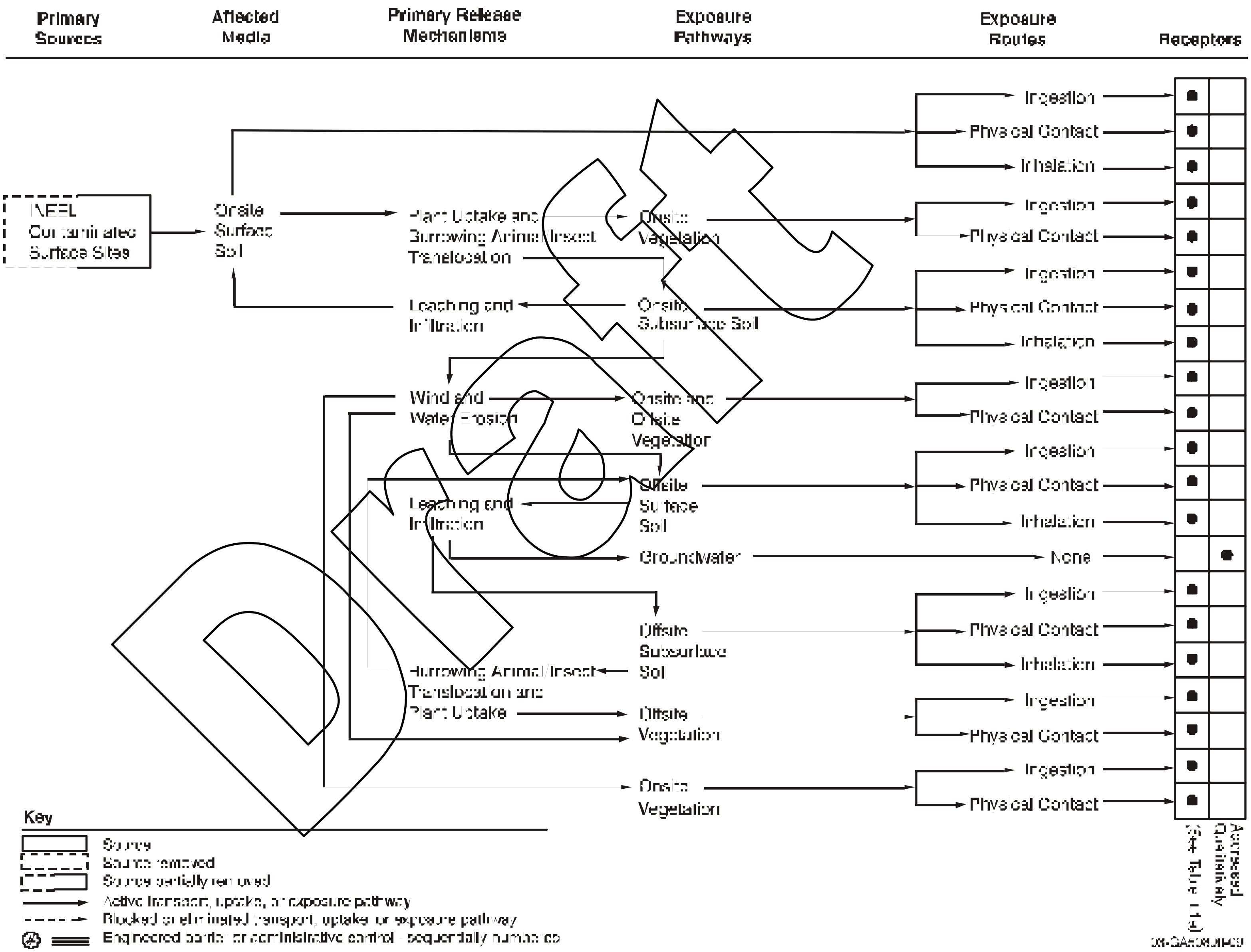

Figure 4-1a2a (continued). Site ecological receptors conceptual site model—current state.

Table 4-1a. Summary of exposure media and ingestion routes for Idaho National Engineering and Environmental Laboratory functional groups.

Receptor	Surface Soil	Subsurface Soil	Vegetation	Sediment	Prey Consumption		
					Invertebrates	Mammals	Birds
Amphibians (A232)	X	X			X		
Great Basin spadefoot toad	X	X			X		
Avian herbivores (AV122)	X						
Mourning dove	X						
Avian (aquatic) herbivores (AV143)			X	X			
Blue-winged teal			X	X			
Avian insectivores (AV222)	X				X		
Sage sparrow	X				X		
Avian carnivores (AV322)						X	
Loggerhead shrike						X	X
Ferruginous hawk						X	
Avian carnivores (AV322A)	X	X			X	X	
Burrowing owl	X	X			X	X	
Avian omnivores (AV422)			X		X	X	X
Black-billed magpie			X		X	X	X
Mammalian herbivores (M122)	X		X				
Mule deer	X		X				
Mammalian herbivores (M122A)	X	X	X				
Pygmy rabbit	X	X	X				
Mammalian insectivores (M210A)	X				X		
Townsend's western big-eared bat	X				X		
Mammalian carnivores (M322)	X					X	
Coyote	X					X	
Mammalian omnivores (M422)	X	X	X		X		
Deer mouse	X	X	X		X		
Reptilian insectivores (R222)	X	X			X		
Sagebrush lizard	X	X			X		
Plants	X	X					

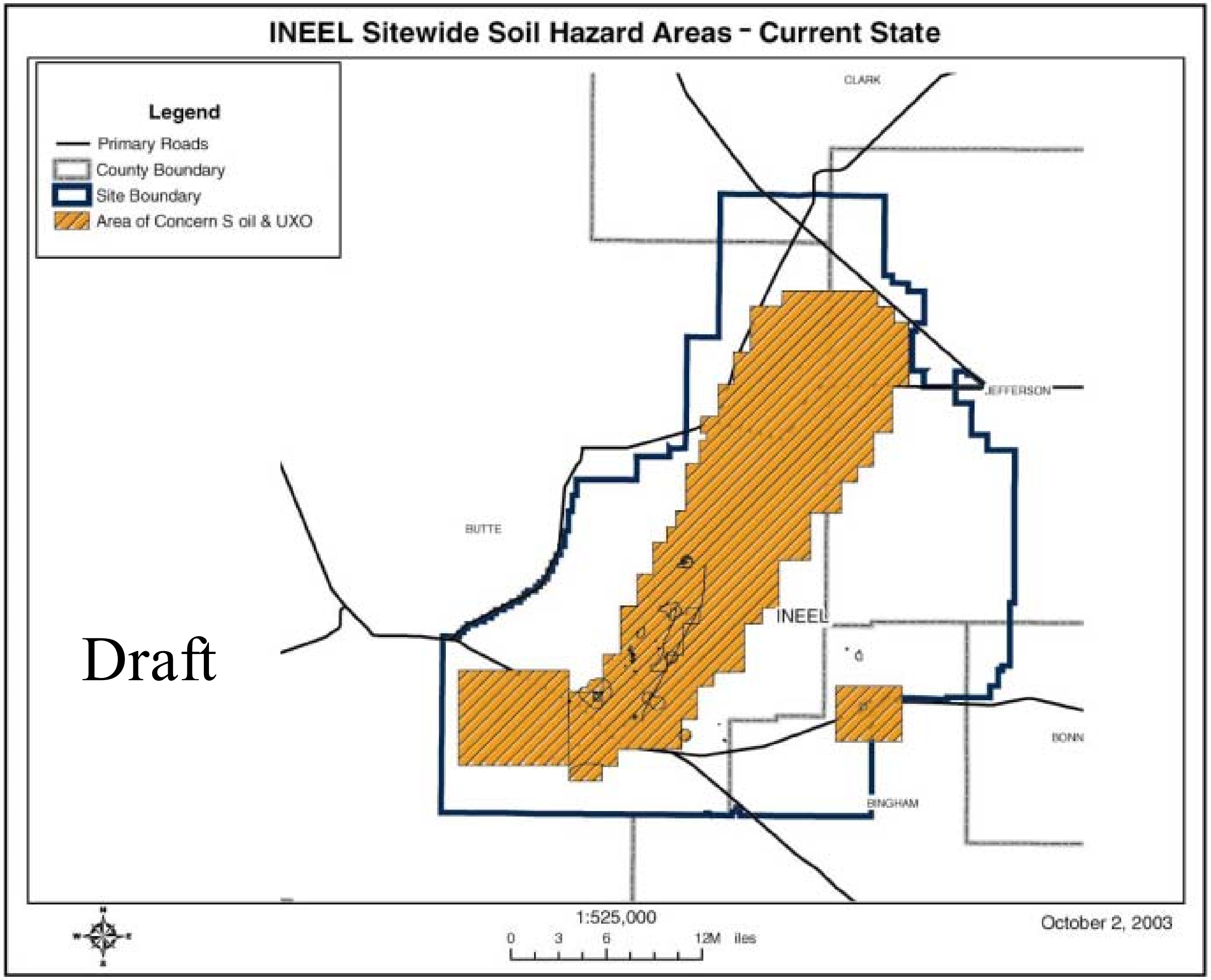

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Figure 4-1a1b. Sitewide soil map—current state.

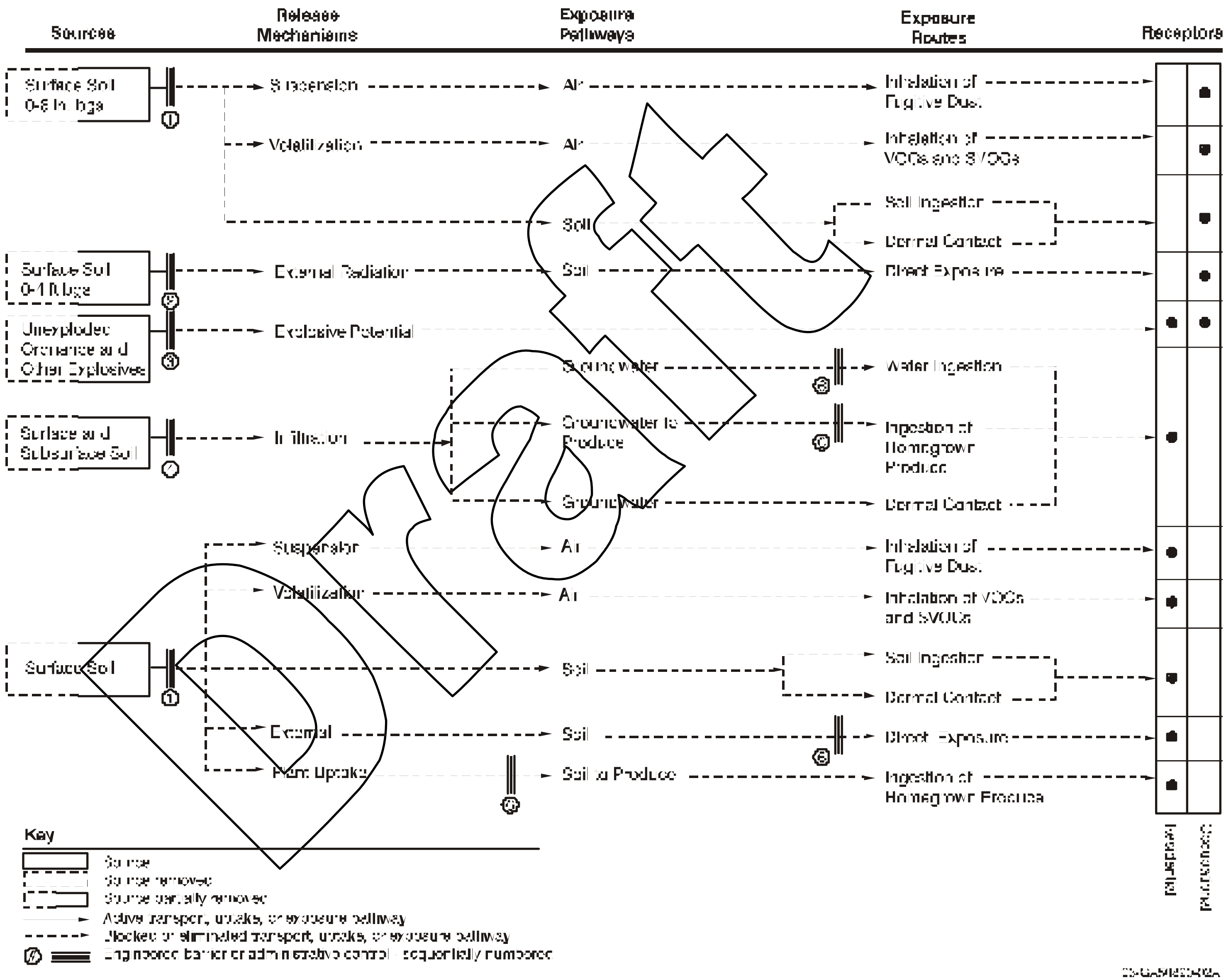

Figure 4-1a2b. Sitewide soil conceptual site model—current state.

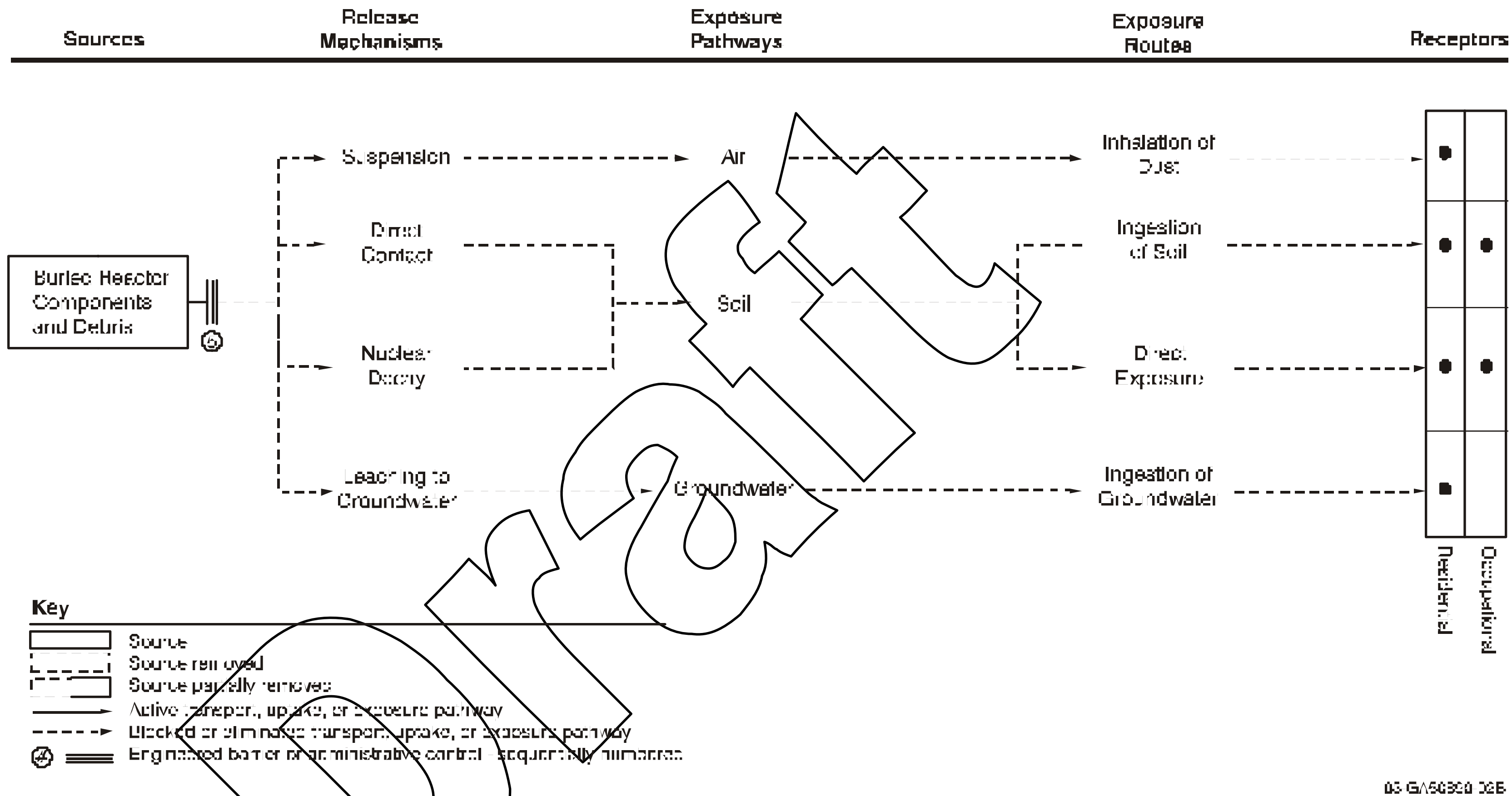

Figure 4-1a2b (continued). Sitewide soil conceptual site model—current state.

SVOC = semivolatile organic compound

Narrative for Figure 4-1a2b Sitewide Soil Conceptual Site Model—Current State

In the Sitewide soil hazard area, Sites EBR-08, Borax-01, Borax-02, Borax-08, and Borax-09 have been remediated. No further action is planned for these sites or for OMRE-01 and ORD-21. Remedial actions are still required for the STF-02 gun range, which has lead and copper contamination, and for the ordnance areas, which contain potential UXO and soil contaminated with explosive chemicals. Institutional controls are in place for all of the sites listed above, so there are no open pathways to human receptors.

The steps taken to mitigate or remove these hazards are as follows:

1. The only sites with remaining surface contamination are the STF-02 gun range and the ordnance areas. The surface contaminated soil was removed from EBR-08 and BORAX-08. The contaminated soil was covered with clean soil or an engineered barrier at BORAX-01, BORAX-02, and BORAX-09. Although some surface contamination was identified at OMRE-01, levels were below action levels, and no further action is required at this site.

   Institutional controls are in place at the STF-02 gun range and the ordnance areas to protect workers and the public. The entire INEEL Site has restricted access to prevent intrusion by the public. Workers are protected through posting of signs at contaminated sites, by recording contaminated sites in the Site institutional controls database, and through the work control process used to identify hazards and mitigation measures for planned work activities.

2. Radionuclide-contaminated soil was excavated and removed from BORAX-08. Some radionuclide-contaminated soil remains at BORAX-01, BORAX-02, and BORAX-09. Radionuclide contamination at OMRE-01 was determined to be below risk-based levels, so no further action is needed.

   Workers are protected from direct exposure to radionuclide contamination through institutional controls. These controls include posting of signs at contaminated sites, radiological training, and work control processes used to identify hazards and mitigation measures for planned work activities.

3. Some UXO has been removed at some of the higher-risk ordnance sites. However, the majority of the areas with potential UXO have not been surveyed or cleaned up. In addition, the Juniper Mine site (ORD-21) contains buried explosive material.

   Institutional controls are in place to protect workers and the public from inadvertent contact with explosive materials. The entire INEEL Site has restricted access to prevent intrusion by the public. Workers are protected through posting of signs at contaminated sites, by recording contaminated sites in the Site institutional controls database, and through the work control process used to identify hazards and mitigation measures for planned work activities. The Juniper Mine has institutional controls in place, including visible access restrictions (warning signs) and work control processes to prevent drilling and excavation.

4. Institutional controls to protect the public include site access restrictions and warning signs.

5. Buried reactor components are found at BORAX-02 and BORAX-08. The BORAX-02 reactor and contaminated soil were buried in place, and an engineered barrier was constructed over the site. The BORAX-09 reactor was entombed with concrete and buried under clean soil. Long-term institutional controls, including visible access restrictions (warning signs) and work control processes to restrict drilling and excavation, are in place while the cesium-137 decays to acceptable risk-based levels.

6. The entire INEEL Site has restricted access to prevent intrusion by the public. Visible access restrictions (warning signs) are in place at sites with institutional controls.

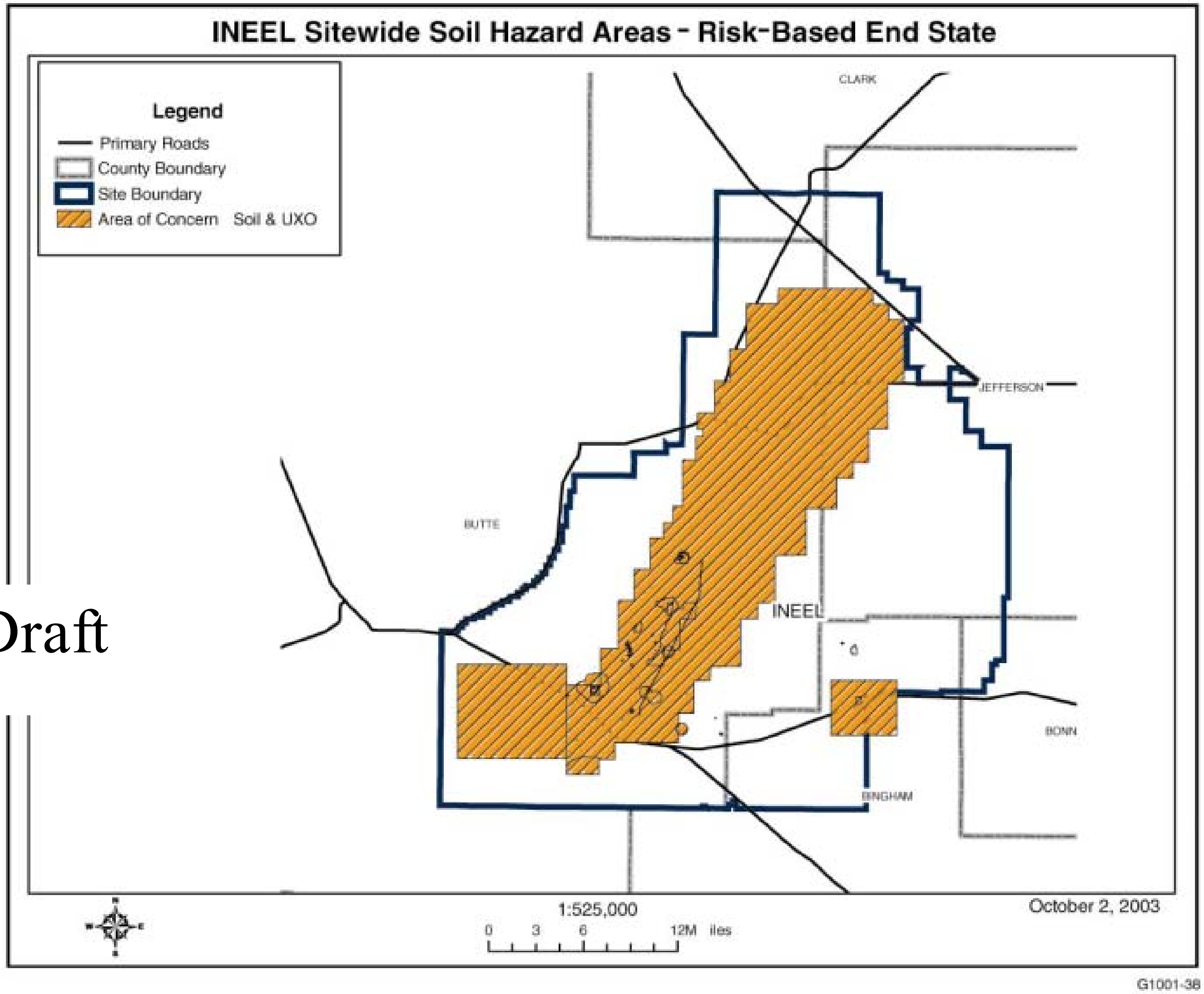

Figure 4-1b1b. Sitewide soil map—risk-based end state.

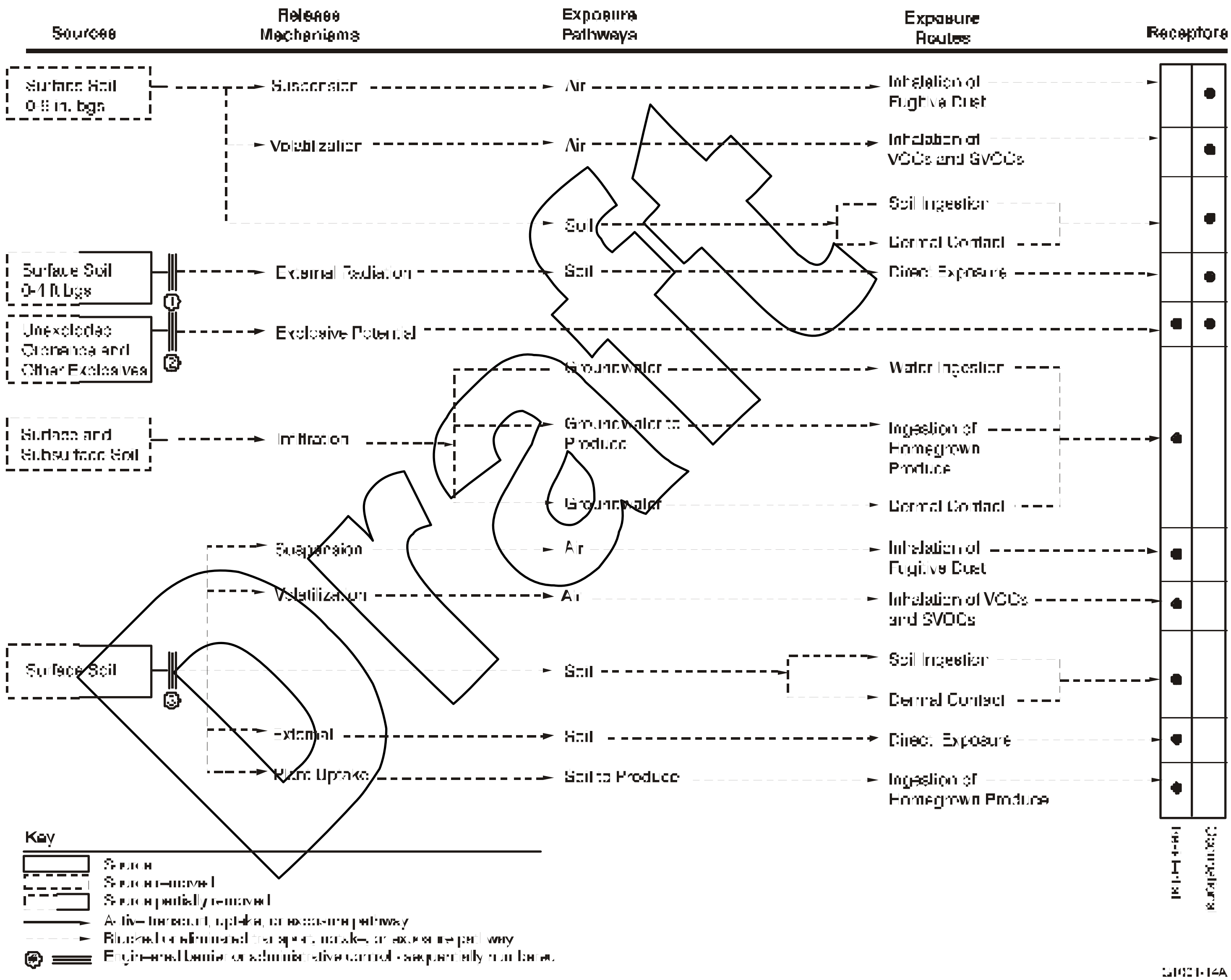

Figure 4-1b2b. Sitewide soil conceptual site model—risk-based end state.

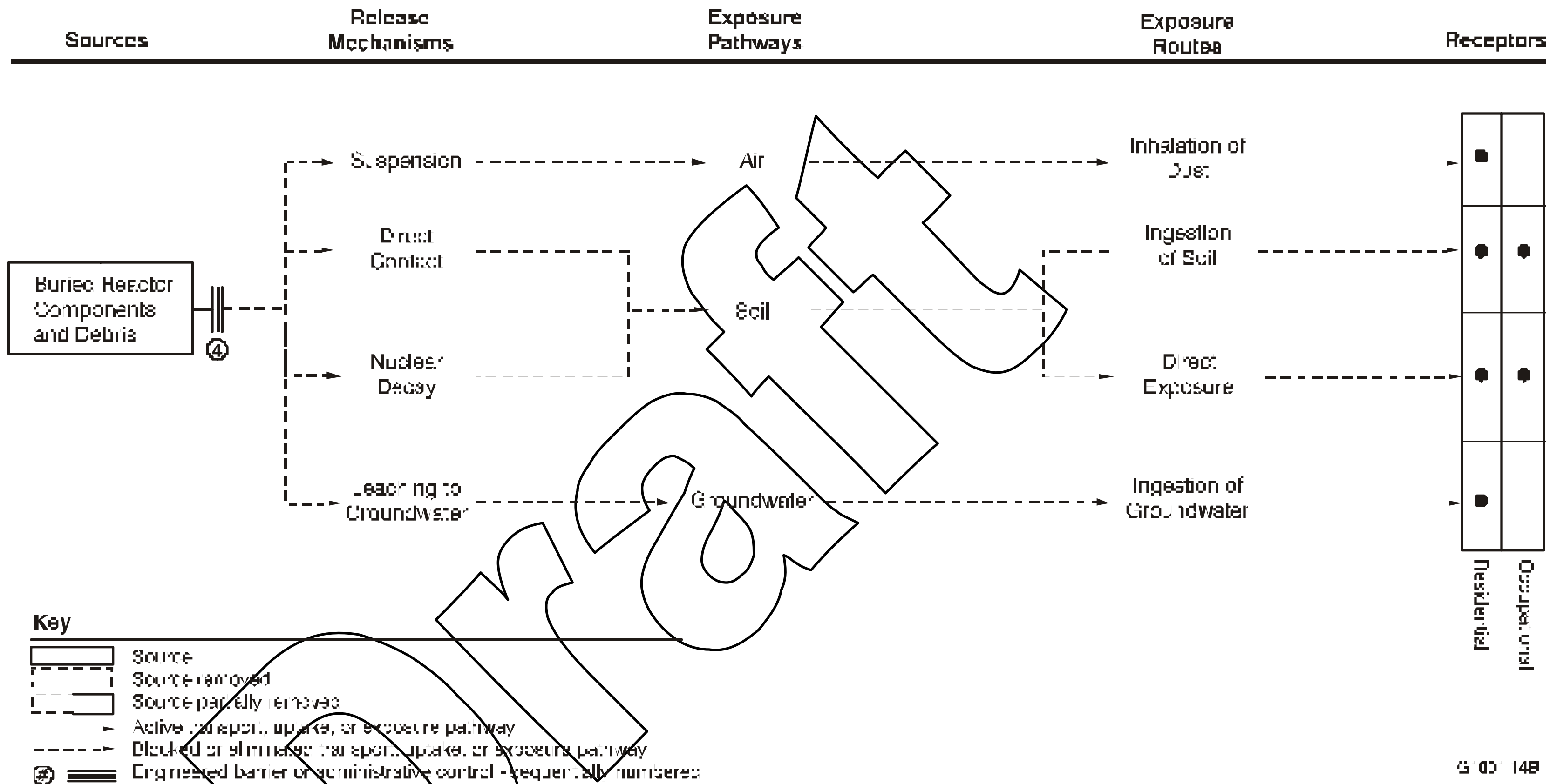

Figure 4-1b2b (continued). Sitewide soil conceptual site model—risk-based end state.

SVOC = semivolatile organic compound

Narrative for Figure 4-1b2b Sitewide Soil Conceptual Site Model—Risk-Based End State

Remedial actions will be completed for the STF-02 gun range, which has lead contamination. The selected remedy is excavation of contaminated soil and disposal in the ICDF. Lead that can be recovered from the soil will be recycled off-Site or treated before disposal. If the ROD selected remedy is implemented, no institutional controls are expected to be required at the gun range after cleanup. The ordnance areas will require long-term institutional controls. Institutional controls will also be required at the ORD-21 Juniper Mine. The BORAX sites and OMRE-01 leach pond site will require long-term institutional controls until cesium-137 decays to acceptable levels. It is also possible that EBR-08 Fuel Oil Tank site may require institutional controls past 2035 because of residual diesel contamination in subsurface soil.

The entire INEEL Site will continue to have restricted access to prevent intrusion by the public. Workers will be protected through posting of signs at contaminated sites, by recording contaminated sites in the Site institutional controls database, and through the work control process used to identify hazards and mitigation measures for planned work activities.

The steps taken to mitigate or remove these hazards are as follows:

1. Some radionuclide-contaminated soil will remain at BORAX-01, BORAX-02, BORAX-09, and OMRE-01. Although no further action is needed, long-term institutional controls will be required at these sites. Workers will continue to be protected from direct exposure to radionuclide contamination through institutional controls. These controls include posting of signs at contaminated sites, radiological training, and work control processes used to identify hazards and mitigation measures for planned work activities.

2. Selected removal of UXO will have taken place at some of the higher-risk ordnance sites. In addition, cleanup of the TNT and RDX sites to appropriate and approved levels will have been completed. The ORD-21 Juniper Mine site will still contain buried potentially explosive material 135 ft below ground.

   Institutional controls will be required at the ordnance areas and the Juniper Mine to protect workers and the public from inadvertent contact with explosive materials. The INEEL Site will continue to have restricted access to prevent intrusion by the public. Workers will be protected through posting of signs at contaminated sites, by recording contaminated sites in the Site institutional controls database, and through the work control process used to identify hazards and mitigation measures for planned work activities. The Juniper Mine will continue to have institutional controls in place, including visible access restrictions (warning signs) and work control processes to prevent drilling and excavation.

3. Some radionuclide-contaminated soil will remain at BORAX-01, BORAX-02, BORAX-09, and OMRE-01. Although no further action is needed, long-term institutional controls will be required to protect the public from exposure at these sites. The entire INEEL Site has restricted access and use to prevent intrusion by the public. Visible access restrictions (warning signs) are in place at sites with institutional controls.

4. Buried reactor components are found at BORAX-02 and BORAX-08. The BORAX-02 reactor and contaminated soil were buried in place, and an engineered barrier was constructed over the site. The BORAX-09 reactor was entombed with concrete and buried under clean soil. Long-term institutional controls, including visible access restrictions (warning signs) and work control processes to restrict drilling and excavation, will be required while the cesium-137 decays to acceptable risk-based levels.

4.1.2 Groundwater

Past and current activities at the INEEL, including reactor research, nuclear fuel reprocessing, nuclear waste storage, and other nuclear research, represent real or perceived risks to the eastern Snake River Plain Aquifer. Quantification of these risks requires improved understanding of local (e.g., waste disposal practices) and regional (groundwater recharge and mixing) processes that influence the quality of groundwater in the aquifer.

The aquifer is composed of two systems. The shallow, or effective, portion of the aquifer occurs from the water table (200–650 ft below land surface) to a depth of 980–1640 ft below land surface. Fast-moving, (5–34.5 ft/day), cold (48–60ºF) calcium- and magnesium-rich water characterizes this part of the aquifer. The deeper portion of the aquifer is characterized by slower moving (0.02–0.3 ft/day), warm (>85ºF) water. Recharge to the aquifer is primarily from the drainage of highlands north of the plain. Water in the aquifer flows generally southwestward and is discharged to the Snake River through a series of springs near Hagerman, Idaho, approximately 160 miles southwest of the INEEL. The INEEL covers about 9% of the aquifer. Depth to water varies from approximately 200 ft in the northeast corner of the INEEL to 1,000 ft in the southeast corner. Water-table contours for the aquifer below the INEEL are depicted in Figure 4-1c. The regional flow is to the south-southwest, though locally the direction of groundwater flow is affected by recharge from rivers, surface water spreading areas, groundwater pumping, and heterogeneity in the aquifer. Across the southern INEEL, the average gradient of the water table is approximately 5 ft/mile.

In areas where significant surface water percolates into the subsurface, lenses of water perch on low-permeability layers above the regional aquifer. These zones of perched water are associated with sources of surface water, such as the Big Lost River and unlined percolation ponds at facilities. They are of no economic importance but, where contaminated, can act as a continuing source of contamination with the potential of driving contaminants to the underlying aquifer.

Currently, approximately 290 wells are used to monitor the aquifer and perched water beneath the INEEL. DOE and the U.S. Geological Survey monitor the wells to satisfy various site-specific program objectives, while a few wells are monitored independently by smaller programs (e.g., ANL-W and the State of Idaho Oversight Program). The wells are monitored as often as quarterly, ranging to annually, depending upon the data needs.

WAG 10 includes regional aquifer concerns related to the INEEL that cannot be addressed on a WAG-specific basis. To address Sitewide groundwater issues and potential new sites, OU 10-08 was added under WAG 10. Information from the OU 10-08 investigation will be used to develop a baseline for groundwater information for institutional control and monitoring at the INEEL.

4.1.2.1 Current State. Figure 4-1a1c shows the current extent of plumes at the INEEL. Only those constituents above the Idaho Groundwater Quality Standards (or MCLs) for each facility are plotted. These plumes have generally reached a state of equilibrium with natural processes of diffusion, dispersion, sorption, and decay and appear stagnant or, in the case of tritium (caused by radioactive decay), appear to be retreating. The outermost contour value and constituent for each plume are listed in Table 4-1b. Discussions of plumes at the scale of individual facilities can be found in the following sections. In addition to the plumes shown, one monitoring well at INTEC is above MCLs for technetium-99, and two monitoring wells at CFA are above MCLs for nitrate. These are further discussed in Sections 4.3 and 4.5.

Table 4-1b. Idaho National Engineering and Environmental Laboratory Sitewide groundwater plumes—current state outermost contour values and constituents.

Facility	Contaminant	Contoured Value at Outer Edge of Plume (maximum contaminant level)
WAG 1 Test Area North	Trichloroethene	5 µg/L
WAG 2 Test Reactor Area	Chromium	100 µg/L
WAG 3 Idaho Nuclear Technology and Engineering Complex	Strontium-90	8 pCi/L
WAG 7 Radioactive Waste Management Complex	Carbon tetrachloride	5 µg/L

WAG = waste area group

Contaminated perched water has been identified at INTEC, TRA, and RWMC. Contaminated perched water exceeding MCLs will not be used for human consumption, and, therefore, the distribution of contaminants in perched water is not shown on a summary map. The preferred remedial action for sites with contaminated perched water is to remove or isolate the source of surface water contributing to the perched zone. Uncontaminated perched water may continue to be present because of the influence of the Big Lost River.

4.1.2.2 End State. Although active cleanup at the INEEL Site is expected to be completed by 2035, remediation of the aquifer at some sites is expected to continue beyond that date. CERCLA decisions and selection of remedies have been based on no contaminants above MCLs remaining in the aquifer by 2095. CERCLA 5-year reviews will be conducted to evaluate progress toward the RAOs. If trends indicate that the RAO may not be achieved, additional remediation actions may be identified as required by CERCLA. There are no plumes shown on Figure 4-1b1c because no modeling has been conducted to predict the condition of groundwater contamination in 2035, and all COCs are expected to be below MCLs at the points of compliance by 2095. Ability to reduce COCs below MCLs was one of the considerations used to select the CERCLA remedies.

4.1.2.3 Variances. No potential variances related to groundwater remediation have been proposed.

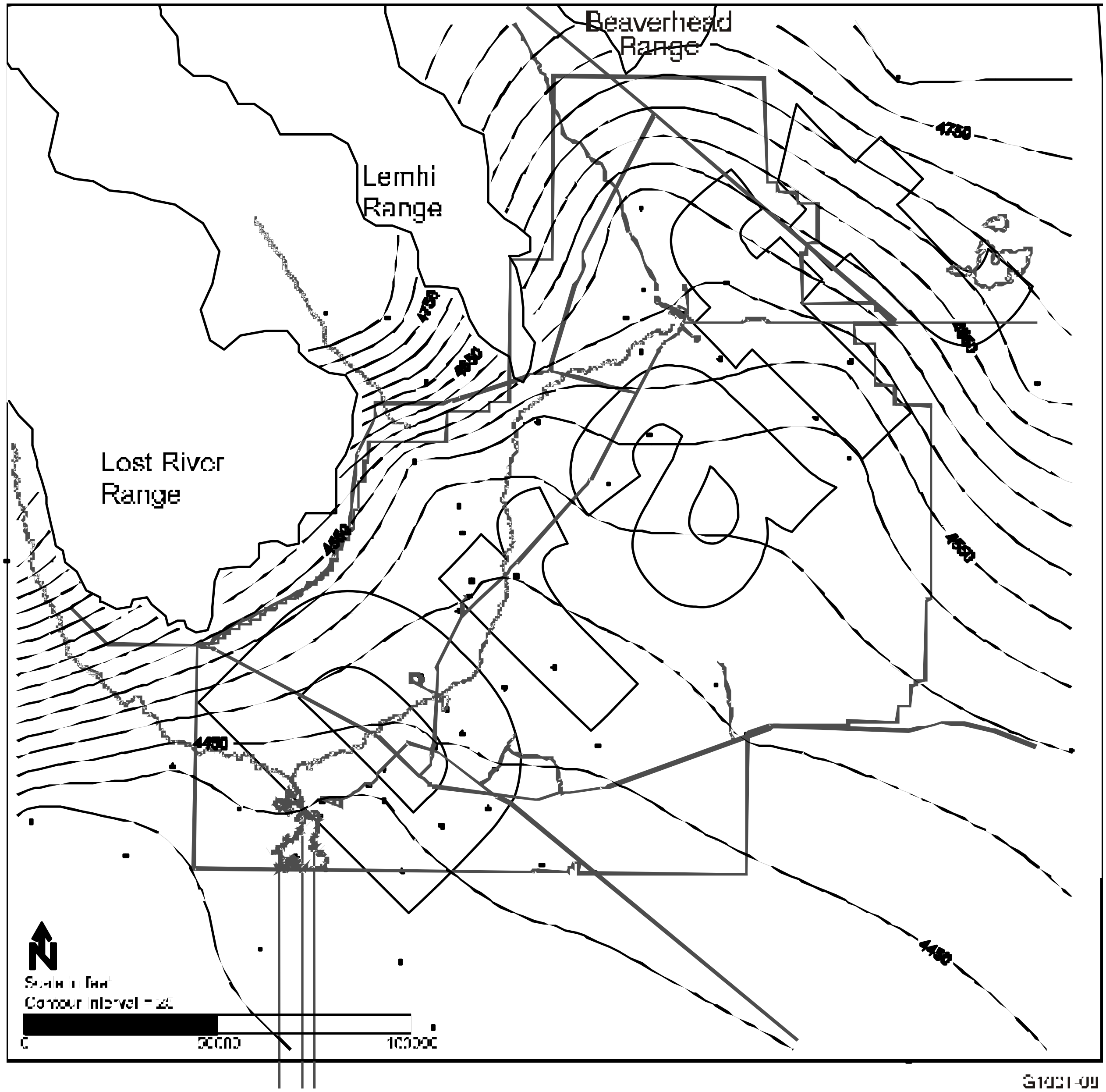

Figure 4-1c. Idaho National Engineering and Environmental Laboratory water table.

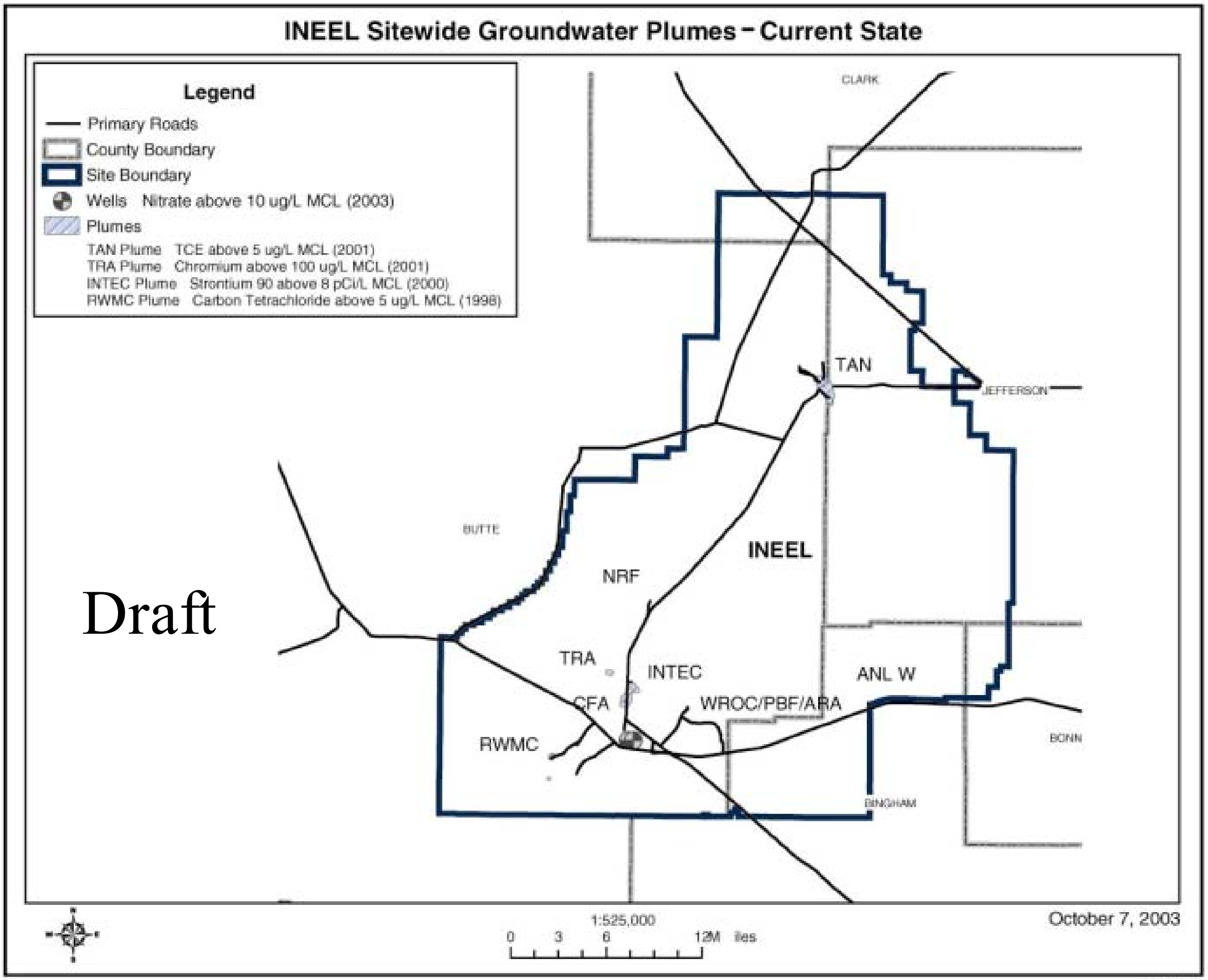

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Figure 4-1a1c. Sitewide groundwater map—current state.

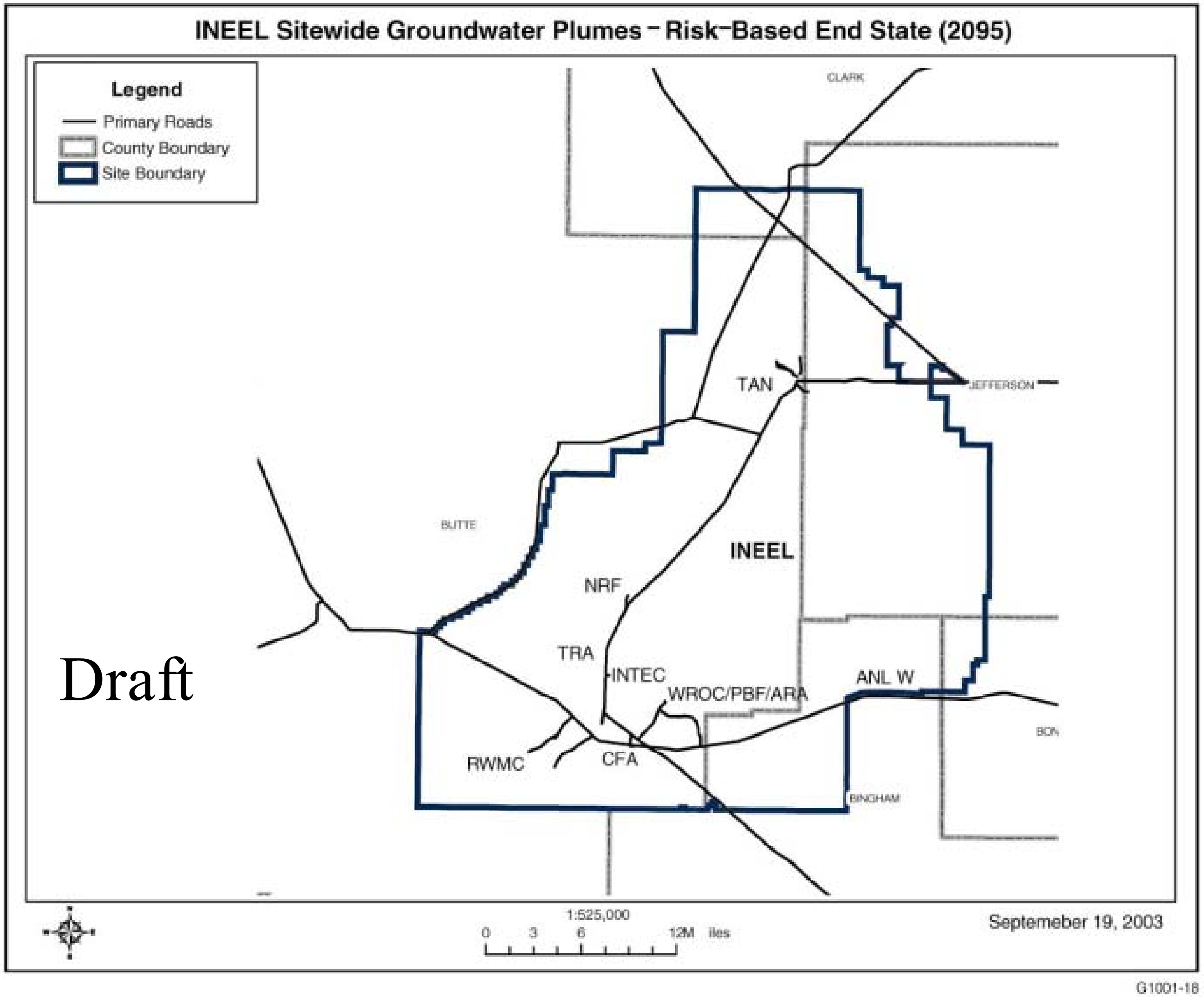

Figure 4-1b1c. Sitewide groundwater map—risk-based end state.