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Oakland Operations Office, Oakland, California 94612

Lawrence Livermore National Laboratory

University of California, Livermore, California 94551

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Addendum to the Pit 6 Engineering Evaluation/Cost Analysis Lawrence Livermore National Laboratory Site 300

November 1996

Author

T. Berry*

Contributors

L. Berg*
R. Depue
C. Dibble
R. Ferry*
L. Hall
K. Heyward
R. Landgraf
D. MacQueen
J. Orloff
M. Ridley

*Weiss Associates, Emeryville, California

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1. Introduction

This report presents revisions to Alternative 3 of the *Pit 6 Engineering Evaluation/Cost Analysis* (EE/CA) initially released as the *Final Feasibility Study for the Pit 6 Operable Unit Lawrence Livermore National Laboratory Site 300* (Devany et al., 1994). In August 1995, the U.S. Environmental Protection Agency (EPA), Department of Toxic Substances Control (DTSC), Regional Water Quality Control Board (RWQCB)–Central Valley Region, and U.S. Department of Energy (DOE) agreed that the buried waste in pit 6 would be better addressed by a non-time-critical removal action/Action Memorandum pathway rather than a remedial action/Record of Decision (ROD) pathway. It was also agreed to incorporate ground water contamination and associated monitoring in the Site 300 Operable Unit (OU). However, each EE/CA alternative has a separate component that addresses ground water contamination. The ground water monitoring component of the selected alternative will be incorporated into the forthcoming Site 300 OU ROD.

This report also proposes a removal action alternative, presents the rationale for this choice, and outlines a schedule for implementation.

1.1. Background

Lawrence Livermore National Laboratory (LLNL) Site 300 is located in the eastern Altamont Hills about 13 miles southeast of the Livermore Site and 8.5 miles southeast of Tracy (Fig. 1). Pit 6 is located immediately north of Corral Hollow Road in the southwest portion of Site 300 (Fig. 2). Between 1964 and 1973, waste from LLNL and Lawrence Berkeley National Laboratory was buried in nine trenches including three solid waste trenches and six smaller animal pits. Records indicate that the solid waste in the trenches primarily consists of shop and laboratory materials (contaminated with residues of uranium and beryllium), capacitors, empty drums and tanks, compressed gas cylinders, pallets, and mercury-filled lamps and ignition tubes. The animal pits primarily contain animal carcasses and waste from biomedical experiments. None of these trenches were lined, and the waste was immediately covered with non-engineered native soil.

The active Small Firearms Training Facility (SFTF) is located in the vicinity of pit 6 and includes a rifle range over the covered burial trenches. The Carnegie State Vehicular Recreation Area (SVRA) is located south of pit 6 across Corral Hollow Road. A residence area for the SVRA ranger and staff members is located over 1,000 ft east of pit 6 on the north side of Corral Hollow Road. Pit 6, the SFTF firing ranges, and the SVRA property are shown on Figure 3. Also shown on Figure 3 are the locations of nearby ground water monitor wells and water-supply wells.

Since 1982, extensive ground water monitoring, surface and subsurface soil sampling, soil vapor surveys, radiation surveys, and air monitoring have been conducted in the vicinity of pit 6. Data results indicate that the only releases from pit 6 consist of the solvent trichloroethylene (TCE) and a few other volatile organic compounds (VOCs), which have migrated from the southernmost trench through about 20 ft of unsaturated alluvium to shallow ground water. In November 1988, the highest total VOC concentration detected in ground water was 253 micrograms per liter (parts per billion [ppb]), of which 250 ppb was TCE. Since then, total VOC concentrations in nearly all monitor wells have shown a distinct declining trend. The highest total VOC concentration in

May 1996 was 8.3 ppb (all TCE). Currently, the TCE plume extends about 500 ft east of the southern corner of pit 6.

Risk assessment calculations were performed for the pit 6 area and results were presented in the Final Site-Wide Remedial Investigation (SWRI) (Webster-Scholten, 1994). These calculations indicated that incremental lifetime cancer risks may exceed 1×10^{-6} and/or exceed a Hazard Index (HI) >1 for the pit 6 area:

- Inhalation of VOCs that volatilize from subsurface soil to air in the vicinity of the rifle range could potentially result in a 5×10^{-6} increased lifetime cancer risk for adult onsite workers,
- Inhalation of VOCs that volatilize from surface water of spring 7 to air could potentially result in a 4×10^{-5} increased lifetime cancer risk and a HI of 1.5 for adult onsite workers, and
- Inhalation of VOCs that volatilize from surface water to air in the vicinity of the SVRA residence pond could potentially result in a 3×10^{-6} increased lifetime cancer risk for residents of the SVRA.

Because spring 7 is currently dry and has been since June 1992, there is no potential exposure pathway for VOC inhalation in this area. Additionally, the inhalation risk associated with VOCs volatilizing from the residence pond was based on the assumption that the VOC plume will migrate offsite to the ranger station water-supply wells that are used to fill the pond. The VOC plume at pit 6 appears to be naturally attenuating and is not migrating further towards these wells. Therefore, this exposure pathway does not currently exist and is not expected to exist in the future.

1.2. Regulatory History

To expedite remediation of sites at Site 300, the DOE, EPA, DTSC, and RWQCB have agreed to pursue several response actions as “removal actions” in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S.C. Section 9601 *et seq.* CERCLA) (40 CFR Section 300 *et seq*.) as opposed to implementing response actions along a “remedial action” pathway. As agreed upon with the regulatory agencies in August 1995, the pit 6 ground water monitoring was incorporated into the Site 300 OU. The buried waste in pit 6 will be addressed by a removal action and the ground water contamination will be addressed in the Site 300 OU ROD.

As required under CERCLA, removal action alternatives are to be described in an EE/CA report. The Pit 6 Feasibility Study (FS) provides more documentation and analysis of remedial alternatives than is typically found in an EE/CA, and the regulatory agencies have agreed to accept the Pit 6 FS as equivalent to an EE/CA for pit 6 (EPA, 1995). Therefore, this addendum will refer to the former Pit 6 FS as the EE/CA. A public comment period and public workshop to discuss the EE/CA and the proposed removal action will follow, and an Action Memorandum will be prepared as the official decision document authorizing implementation of the removal action.

1.3. Remedial Action Objectives

The EE/CA identifies the following remedial action objectives (RAOs):

1. Prevent offsite ingestion of ground water containing VOC concentrations above the State and Federal drinking water Maximum Contaminant Levels (MCLs).
2. Reduce the potential for any future releases of or exposure to hazardous materials contained in pit 6.
3. Mitigate potential worker inhalation exposure to VOCs that may volatilize from spring 7 (Fig. 3) to levels below 10^{-4} to 10^{-6} excess cancer risk, and a HI <1.
4. Mitigate potential residential inhalation exposure to VOCs that may volatilize from the SVRA residence pond (Fig. 3) to levels below 10^{-4} to 10^{-6} excess cancer risk, and a HI <1.
5. Mitigate potential worker inhalation exposure to VOCs that may volatilize from subsurface soil beneath the rifle range (Fig. 3) to levels below 10^{-4} to 10^{-6} excess cancer risk, and a HI <1.

This addendum revises Alternative 3 by combining these RAOs into two groups: 1) those related to the buried waste and contaminated subsurface soils in the vicinity of the rifle range (RAOs 2 and 5), and 2) those related to potential migration of VOC-contaminated ground water, that may result in elevated human exposure risks in the future (RAOs 1, 3, and 4).

Alternative 3 still proposes a landfill cover to address RAOs 2 and 5, but in the context of the revised regulatory pathway, this cover would be installed as a “non-time-critical removal action” as opposed to a “remedial action”. This addendum presents revisions to the cover design.

RAOs 1, 3, and 4 will be addressed by a ground water monitoring plan with contingencies for fencing around spring 7 and ground water extraction and treatment. The contingencies presented in Alternative 3 of the 1994 EE/CA remain the same; however, this addendum revises the ground water monitoring plan to increase cost effectiveness without sacrificing reliability. Under Alternative 3, this monitoring plan and associated contingency actions would be incorporated into the future Site 300 OU ROD.

2. Revisions to Alternative 3

The following discusses revisions to Alternative 3 for the landfill cover design, the ground water monitoring plan, and post-construction maintenance of the landfill cover.

To meet the objectives of RAOs 2 and 5, the landfill cover is designed to:

- Mitigate potential infiltration of surface water into the buried waste,
- Prevent collapse into void spaces, and
- Prevent escape of VOC vapors in the vicinity of the buried waste to mitigate potential inhalation exposure to rifle range workers.

An added benefit of the landfill cover and associated surface water drainage is a reduction of recharge in the area of the ground water VOC plume. This further reduces the potential for offsite migration of VOCs, thereby reducing potential for offsite ingestion and/or inhalation of VOCs.

The conceptual design presented in the EE/CA has been revised to: 1) be more protective by accounting for uncertainties associated with buried waste location, 2) enhance long-term performance, and 3) be more cost effective. These revisions are described below.

2.1. Cover Design Revisions

Several revisions have been made to the landfill cover design, although the performance criteria for landfill cover over the buried waste at pit 6 remain the same.

2.1.1. Increased Areal Extent

Alternative 2 of the EE/CA showed the landfill cover covering an area of about 63,000 ft^2 (1.5 acres). Further review of geophysical data and historical survey data suggests that some of the buried wastes may be located further east than was presented in the SWRI. The uncertainty of the buried waste contents, potential for void space collapse under heavy equipment, and access restrictions preclude better definition of the areal extent of the buried waste. Therefore, the areal extent of the proposed landfill cover has been expanded to approximately 2.4 acres. Figure 4 shows the proposed expanded area for the landfill cover, as well as revised locations of the buried waste. Surface water drainage outfall has also been changed to drain to the south and the southwest of the landfill cover instead of only to the southwest.

Figure 5 shows a conceptual cross section of the landfill cover in relationship to the buried waste.

2.1.2. Revised Engineered Cover Layers

The revised design of the engineered layers for the landfill cover consists of:

- Installation of geogrid structural reinforcement in the lower portion of the foundation layer to prevent collapse into void spaces.
- Use of a geosynthetic clay liner system instead of a 2-ft clay layer for the low-hydraulic conductivity layer. This layer will meet or exceed the 1×10^{-7} cm/sec hydraulic conductivity requirement, and is less likely to develop desiccation cracks during or after construction, which is a potential problem with conventional clay layers. Additionally, installation is faster, material costs are less, and overall landfill cover weight is reduced.
- Replacing the cobble biotic layer and associated sand base with a geocomposite drainage layer, thus reducing the overall landfill cover weight and reducing the risk of significant subsidence into buried waste void spaces. This layer, in conjunction with the underlying 60-mm, high-density polyethylene liner, will deter animals from burrowing through the landfill cover.

2.2. Revised Ground Water Monitoring Plan

Figure 7 shows the ground water monitoring network for revised Alternative 3. The ground water monitoring plan reflects two objectives:

1. Monitor the existing ground water VOC plume to continue evaluating natural attenuation, or to trigger re-evaluating the need for implementing contingency actions, and
2. Monitor ground water in the immediate vicinity of the pit 6 cover to provide early detection of any future releases of contaminants to ground water from the buried waste.

Six proposed ground water monitor wells located in the buried waste area described in the EE/CA (wells P6-01 through P6-06) have been reduced to one proposed new well, K6-32 (formerly P6-06). Well K6-32 will be installed immediately upgradient of the landfill cover near the northwest corner (Fig. 3) to provide a location for monitoring water elevations and background concentrations. Wells P6-01 through P6-05 will not be installed because:

- They would penetrate the landfill cover, which could threaten the long-term integrity of the cover and/or the wells as the cover materials naturally subside.
- The existing ground water monitoring network at pit 6 is capable of detecting any future releases to ground water long before contaminants could reach the site boundary. Additionally, several of these existing wells can be used as interim extraction wells, if necessary, until additional extraction wells are installed. Table 1 lists the existing wells that replace initially proposed wells P6-01 through P6-06 to monitor the landfill for potential future releases. These wells were selected because they are in proximity to the edge of the landfill cover and will not penetrate the cover.
- Historical ground water elevation data indicate that ground water levels have remained more than 15 ft below the bottom of the buried waste, even after heavy rainy seasons. The current network of wells, plus well K6-32, will be adequate to monitor ground water levels.
- Although geophysical surveys and historical information have helped identify the general location and contents of the buried waste, the exact location and nature of the waste is uncertain. The possibility of void space collapse under heavy equipment makes well installation near the buried waste undesirable.

Additionally, not installing five of the initially proposed six wells reduces capital and ongoing monitoring costs.

Proposed monitor well K6-33 has been moved about 200 ft east of its initially proposed location. It is downgradient of well K6-18 and will monitor the shallow ground water plume along the gravel channel (Qt) depicted in Figure 1-19 of the EE/CA. Because the Qt is shallow and only a few feet thick at this location, the screen for K6-33 will probably need to extend into the underlying bedrock to reach below the water table. If VOCs are detected in K6-33, another shallow monitor well, and possibly a deeper monitor well, may be installed further downgradient.

Figure 8 shows the proposed locations for the contingency ground water treatment system and associated extraction and monitor wells. The installation schedule, and the number and location of wells would be re-evaluated at the time of actual design. The seismic exclusion zone and exploratory trench shown on Figure 8 are related to a location-specific limiting proximity of the ground water treatment system to the Holocene strand of the Carnegie Fault system.

The revised ground water monitoring plan for Alternative 3 is presented in Table 2. This table lists the purpose, sampling frequency, and analytes for the monitoring wells (existing, proposed, and potential contingency wells), and possible sampling frequency increases due to contingency ground water extraction. Table 2 shows sampling frequencies for 30 years, which was a time frame selected to prepare the cost estimates discussed in Section 3. DOE/LLNL and the regulatory agencies will address duration of monitoring in the post-closure monitoring plan.

To meet the first objective of the monitoring plan, we employed the Cost-Effective Sampling (CES) algorithm developed by LLNL (Nichols et al., 1996) to determine a baseline frequency for VOC sampling of the monitor wells. The results of the CES algorithm indicated that annual VOC sampling is adequate for monitoring the existing VOC plume. Quarterly monitoring would occur at clean monitor wells located at the downgradient end of the plume and at well BC6-13, which serves to monitor spring 7. Monitoring at these downgradient wells will provide early detection of any further migration of the plume or potential exposure risk at spring 7. Quarterly monitoring would also continue at downgradient, active water-supply wells CARNRW1 and CARNRW2.

To provide early detection of any future releases from the buried waste, we propose sampling frequencies based on site hydrogeology and history, and the characteristics of the buried waste. In Appendix P of the SWRI (Webster-Scholten, 1994), a value of 0.062 m/d (75 ft/yr) was conservatively calculated as the ground water velocity beneath pit 6. Therefore, under a worst-case scenario where released contaminants migrate at the same velocity as the ground water, contaminants would not move more than 75 feet past a monitoring well between annual sampling events. The proposed landfill cover over pit 6 and associated drainage diversion will reduce ground water recharge and velocity, thereby minimizing the potential for a release not being detected in a timely fashion.

The nearest potential receptors, water-supply wells CARNRW1 and CARNRW2, are located almost 1,000 ft downgradient of the furthest downgradient compliance well, EP6-06. If contaminants move at 75 ft/yr, adequate time is available to evaluate and implement an appropriate corrective action plan in the event of a new release without imposing additional potential risk to downgradient receptors. Although spring 7 is located closer to the buried waste than the water-supply wells, it is not currently an exposure pathway because it is dry. The monitoring plan provides for quarterly sampling of well BC6-13, which includes visual inspection of spring 7. If spring 7 is flowing, and results from the upgradient compliance wells indicate that there may be a release, BC6-13 will be sampled for the analytes of concern.

2.3. Post-Construction Maintenance

After the landfill cover is constructed, a program will be implemented to maintain the cover, associated drainage controls, and the monitoring network. This program will consist of annual inspections performed under the direct supervision of a registered civil engineer or a certified engineering geologist and includes:

- A site walk to visually inspect the cover for excessive erosion, animal burrowing or other penetrative damage, and differential settlement or other earth movement,

- An elevation survey by a licensed surveyor using existing surveyed markers on nearby monitor wells as reference points to check for differential settlement,
- Visual inspection of all drainage layer drain pipes, and surface water drainage ditches and outfalls, and
- Visual inspection of monitor wells.

Maintenance will be performed to ensure that the landfill cover, drainage controls, and monitoring network continue to meet the intended performance criteria.

3. Evaluation of Revised Alternative 3

The revised landfill cover will be constructed to meet performance criteria necessary to ensure that RAOs 2 and 5 are met. The monitoring plan and contingency actions, if necessary, will meet RAOs 1, 3, and 5. Revisions presented in this addendum compare favorably to the initial design presented in the EE/CA, Chapter 5, with respect to the following evaluation criteria:

- Overall protection of human health and the environment,
- Compliance with ARARs,
- Long-term effectiveness and permanence,
- Reduction of toxicity, mobility, and volume,
- Short-term effectiveness,
- Implementability, and
- Cost.

Surface water will not percolate down through the landfill cover and contact the buried waste. Geogrid layers will provide additional structural support to protect onsite workers from safety hazards associated with potential void space collapse during construction and over the long term. The combined soil and synthetic layers will mitigate migration of VOCs that may flux from the subsurface in the immediate vicinity of the rifle range.

The seventh criterion, cost, is discussed below. Two other criteria, State and community acceptance, will be addressed via the public comment period and workshop, and subsequent Action Memorandum.

Table 3 presents initial cost estimates for revised Alternative 3. Costs are separated into those: 1) associated with the proposed removal action (i.e., landfill capping capital costs, post-construction maintenance, and ground water monitoring), and 2) that may be incurred if contingency actions need to be implemented.

Landfill cover construction costs (± 20%) include the following main elements:

- Landfill cover design (Conceptual, Title I, and Title II),
- Title III landfill cover construction and Construction Quality Assurance, and
- Rifle range replacement.

Title I design (30% completion) was submitted to the regulators for review on August 15, 1996 and Title II design (90-100% completion) will be submitted by December 18, 1996.

Construction (Title III) will consist of demolishing the existing rifle range, grading the site, installing the engineered cover layers and associated surface water diversion system, and rifle range replacement.

A significant cost variable is the source of soil for the landfill cover construction. DOE/LLNL is investigating the possibility of obtaining soil onsite near pit 6. However, if a suitable onsite source cannot be found, soil from a commercial offsite source will add an additional cost of about $219,000.

To restore the current land use, a new rifle range will be constructed in approximately the same location as the old one immediately after completion of the landfill cover.

Cost estimates include project oversight by LLNL and associated overhead costs. Ground water monitoring will be continued after the landfill cover construction and will be incorporated in the Site 300 OU ROD.

Although the proposed landfill cover area has been increased by about 50%, and costs for the replacement rifle range also increased, landfill cover design revisions have resulted in an overall estimated cost savings of over $75,000.

Total costs for Alternative 3 have been significantly reduced as a result of several factors, including:

- Redesign of the landfill cover,
- Reduced capital costs associated with well installation, and
- Reduced monitoring costs as a result of fewer wells, applying the CES algorithm to reduce sampling frequencies, and competitive bidding for analytical laboratories.

Additionally, because we now have a more accurate estimate of the landfill cover capital costs, we have correspondingly reduced associated contingency costs in the original estimate. As a result of these efforts, we have reduced the Alternative 3 cost estimate from approximately $11.25 million to $5.57 million, less than half of the original cost of Alternative 3.

If the ground water plume continues to naturally attenuate, and no future releases occur, these contingency actions will not be necessary.

4. Proposed Removal Action

DOE/LLNL propose implementing the revised Alternative 3 described in this addendum as a non-time-critical removal action. DOE/LLNL believe that this alternative provides the best balance of CERCLA evaluation criteria. All of the risk reduction components of the alternative are readily implementable.

Because the ground water plume is naturally attenuating, no ground water remediation is proposed at this time. Monitoring will continue to ascertain that the concentrations are naturally attenuating, potentially to background, and that offsite ground water concentrations remain protective of human health and the environment.

Although Alternative 2 and 3 contain the same measures for mitigating potential risks associated with the buried waste, Alternative 3 adds provision for contingent ground water extraction and treatment if natural attenuation does not continue and potential exposure risks do not decrease to acceptable levels. Significant cost savings will be realized if natural attenuation continues because active ground water extraction and treatment will not be needed.

While both Alternative 3 and 4 meet all of the RAOs, Alternative 4 is significantly more expensive due to the cost of installing subsurface permeability reduction barriers. Although these subsurface barriers may provide added isolation of the buried waste, the surface water infiltration mitigation of the landfill cover combined with the unlikelihood of ground water rising into the waste, will provided adequate waste isolation.

If DOE/LLNL implement this remedial action as a non-time-critical removal action, the landfill cover construction could be completed by December 1, 1997. Proposed interim milestones are presented in Table 4. This schedule allows DOE/LLNL to begin landfill cover construction shortly after the removal action has been approved via acceptance of the Action Memorandum, thereby making the best use of available resources and expediting site closure.

5. References

Devany, R., R. Landgraf, and T. Berry (1994), *Final Feasibility Study for the Pit 6 Operable Unit Lawrence Livermore National Laboratory Site 300*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-113861).

Nichols, E. M., L. L. Berg, M. D. Dresen, R. J. Gelinas, R. W. Bainer, E. N. Folsom, and A. L. Lamarre (1996), *Compliance Monitoring Plan for the Lawrence Livermore National Laboratory Livermore Site*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-120936).

U.S. Environmental Protection Agency (EPA) (1995), Letter to Donna Sutherland (U.S. DOE), Environmental Restoration Division Site 300 Remedial Project Manager, from Lida Tan (U.S. EPA) regarding the Site 300 Proposed Revised Federal Facility Agreement Schedule, dated August 8, 1995.

Webster-Scholten, C. P. (Ed.) (1994), *Final Site-Wide Remedial Investigation Report, Lawrence Livermore National Laboratory Site 300*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-108131).

Figures

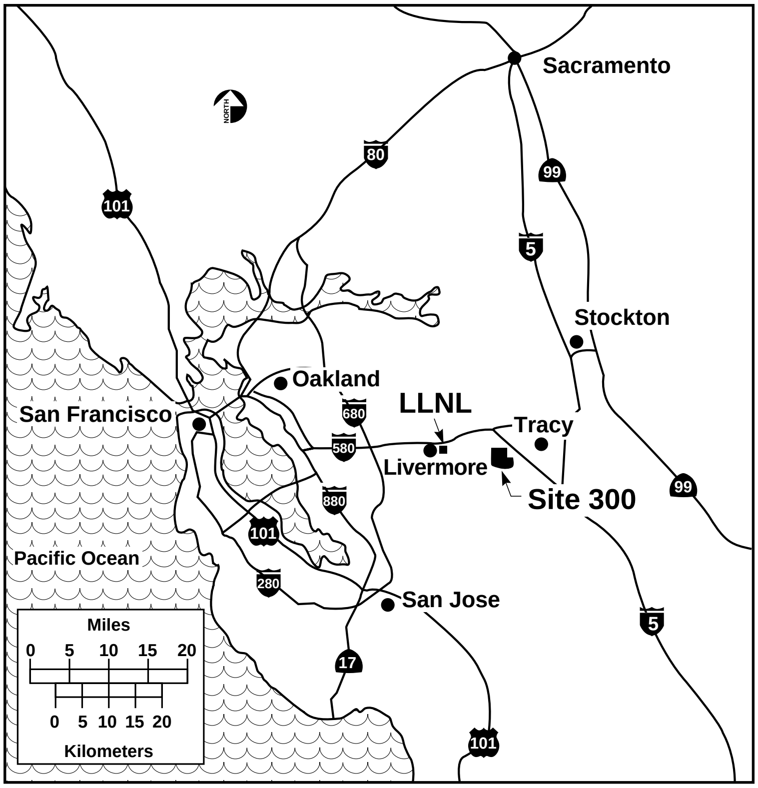

Figure 1. Locations of LLNL Livermore Site and Site 300.

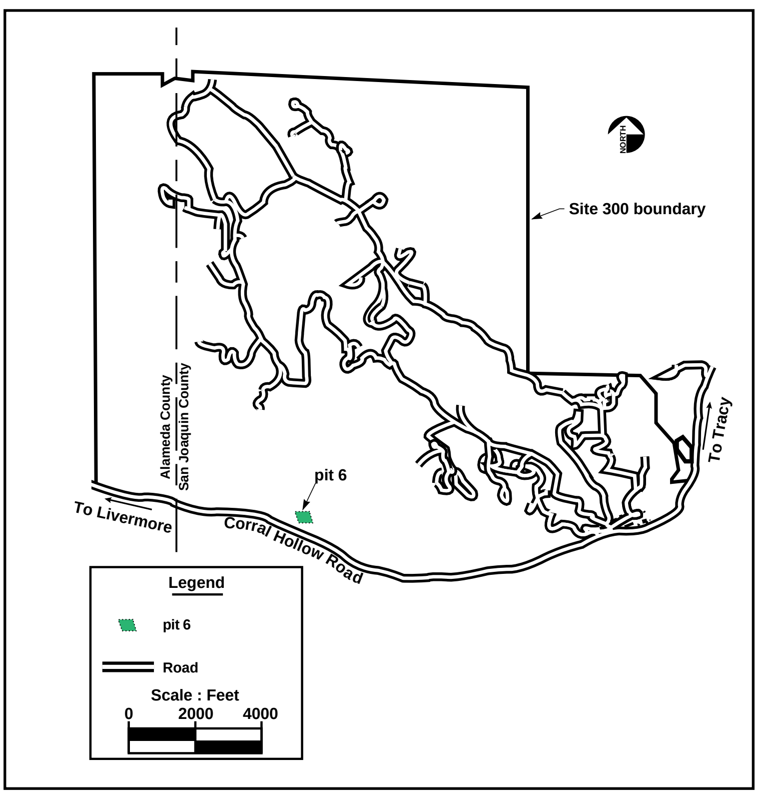

Figure 2. Location of pit 6 at LLNL Site 300.

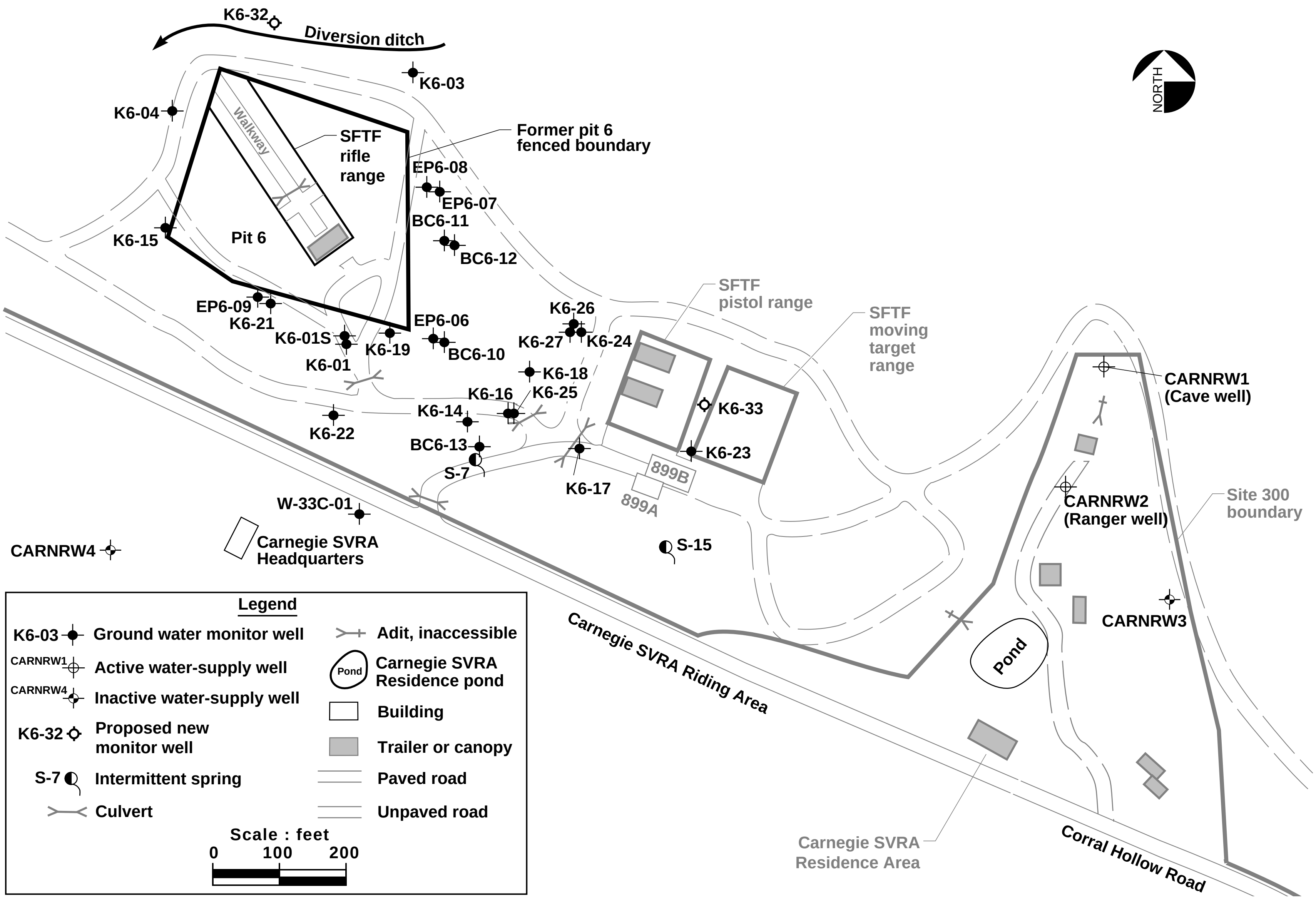

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Figure 3. Location of pit 6 and nearby facilities.

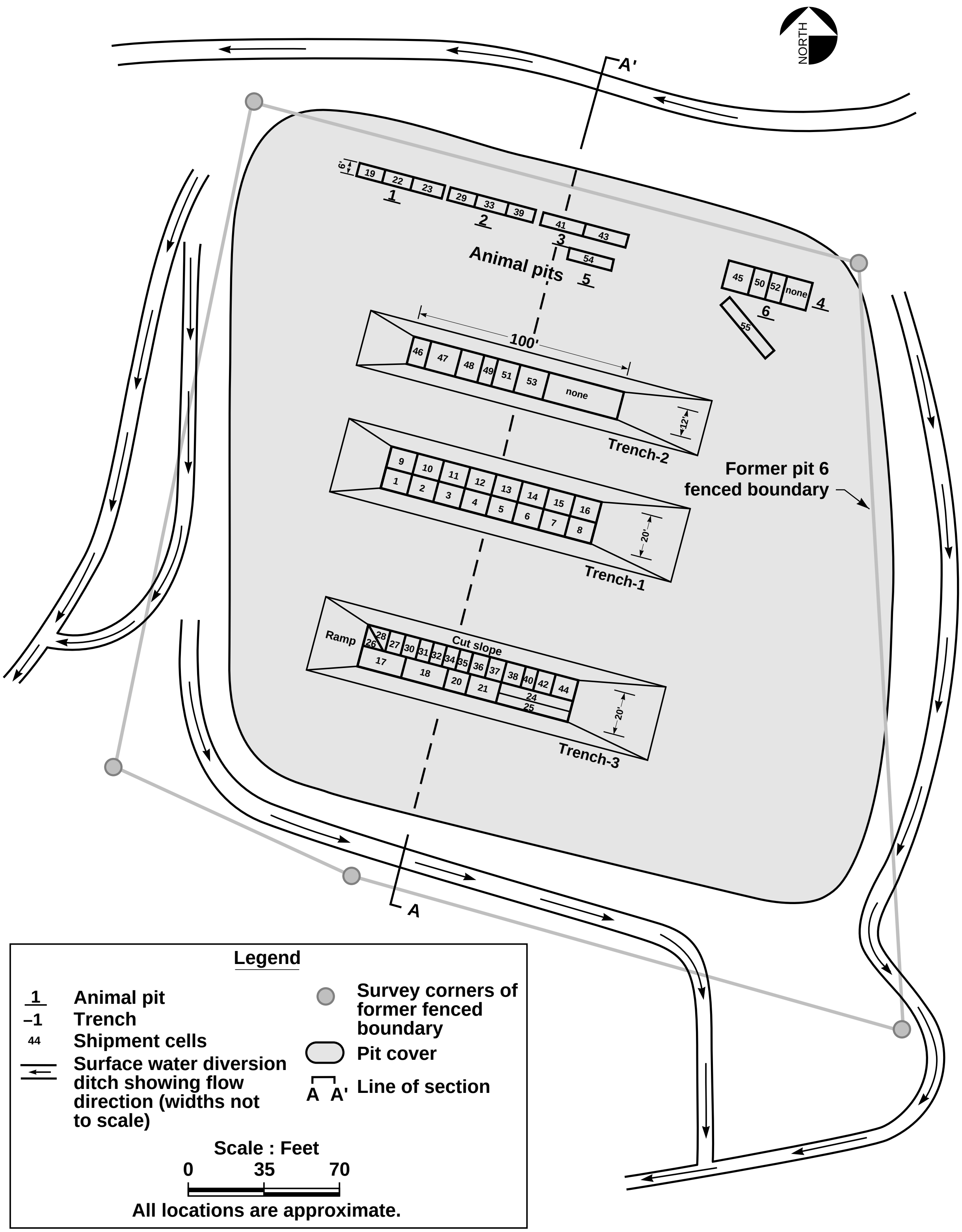

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Figure 4. Proposed location of pit 6 cover and surface water diversion ditches.

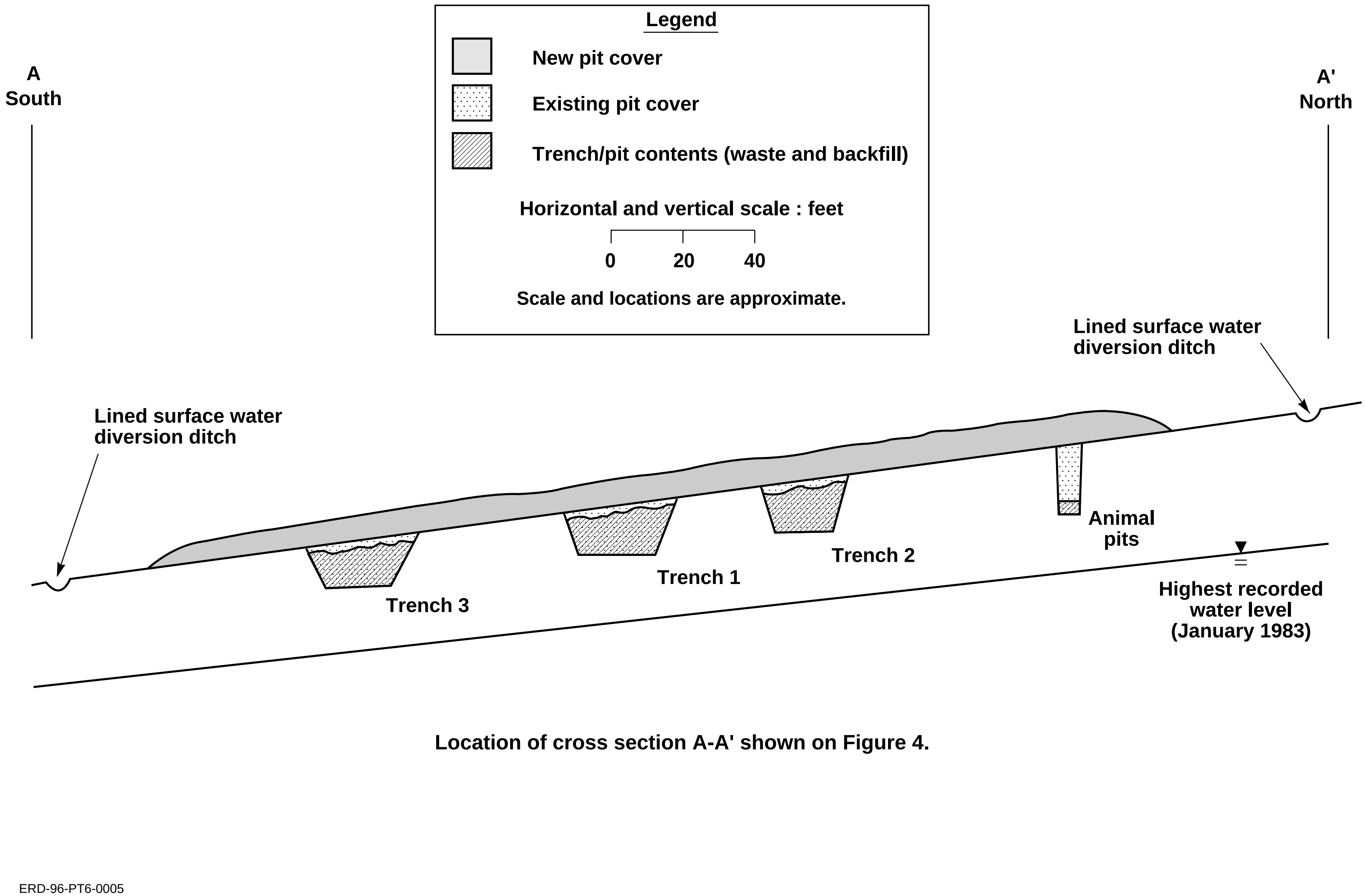

Figure 5. Conceptual south-north cross section showing proposed location of pit 6 cover.

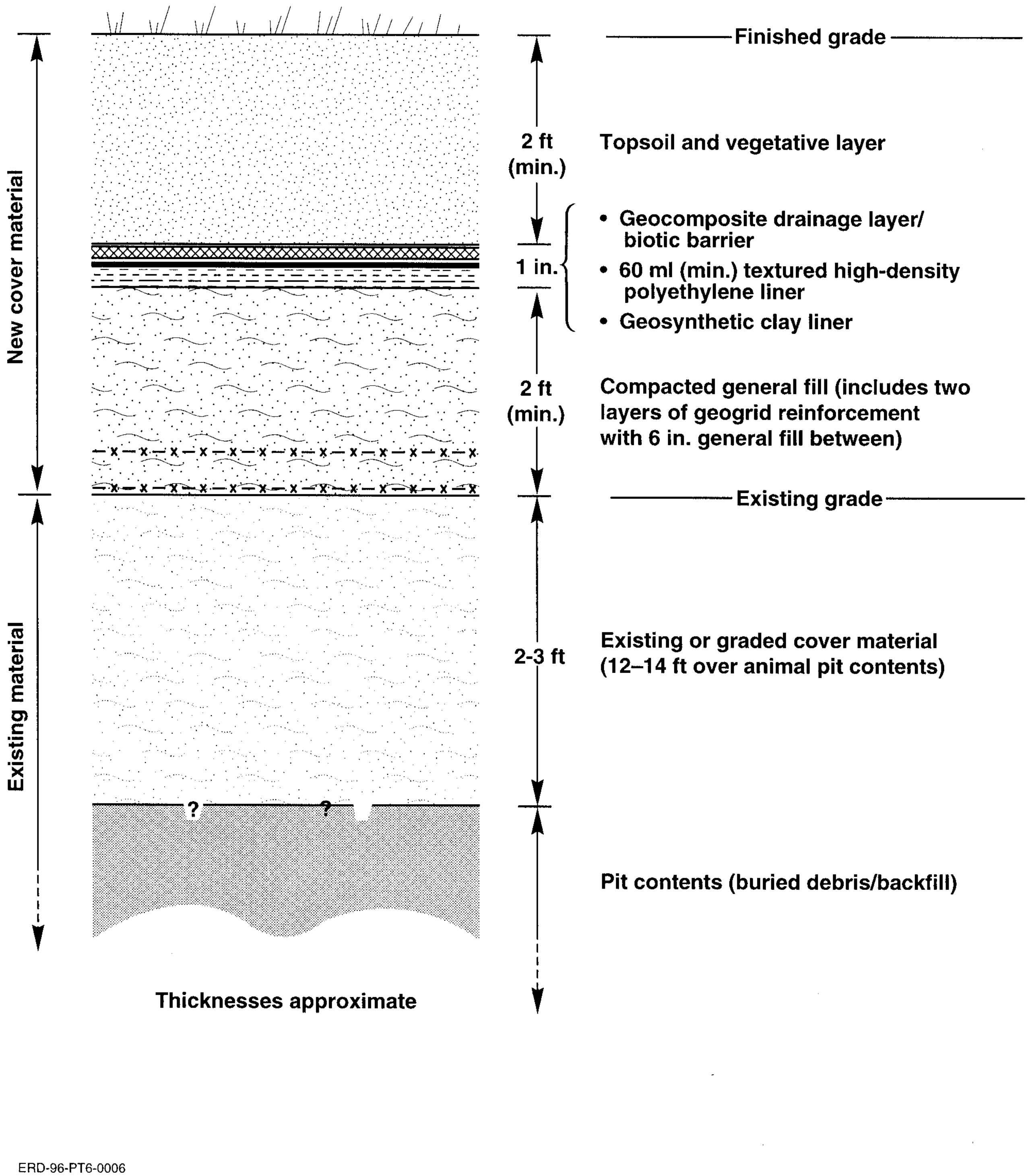

Figure 6. Typical section for the proposed pit 6 cover.

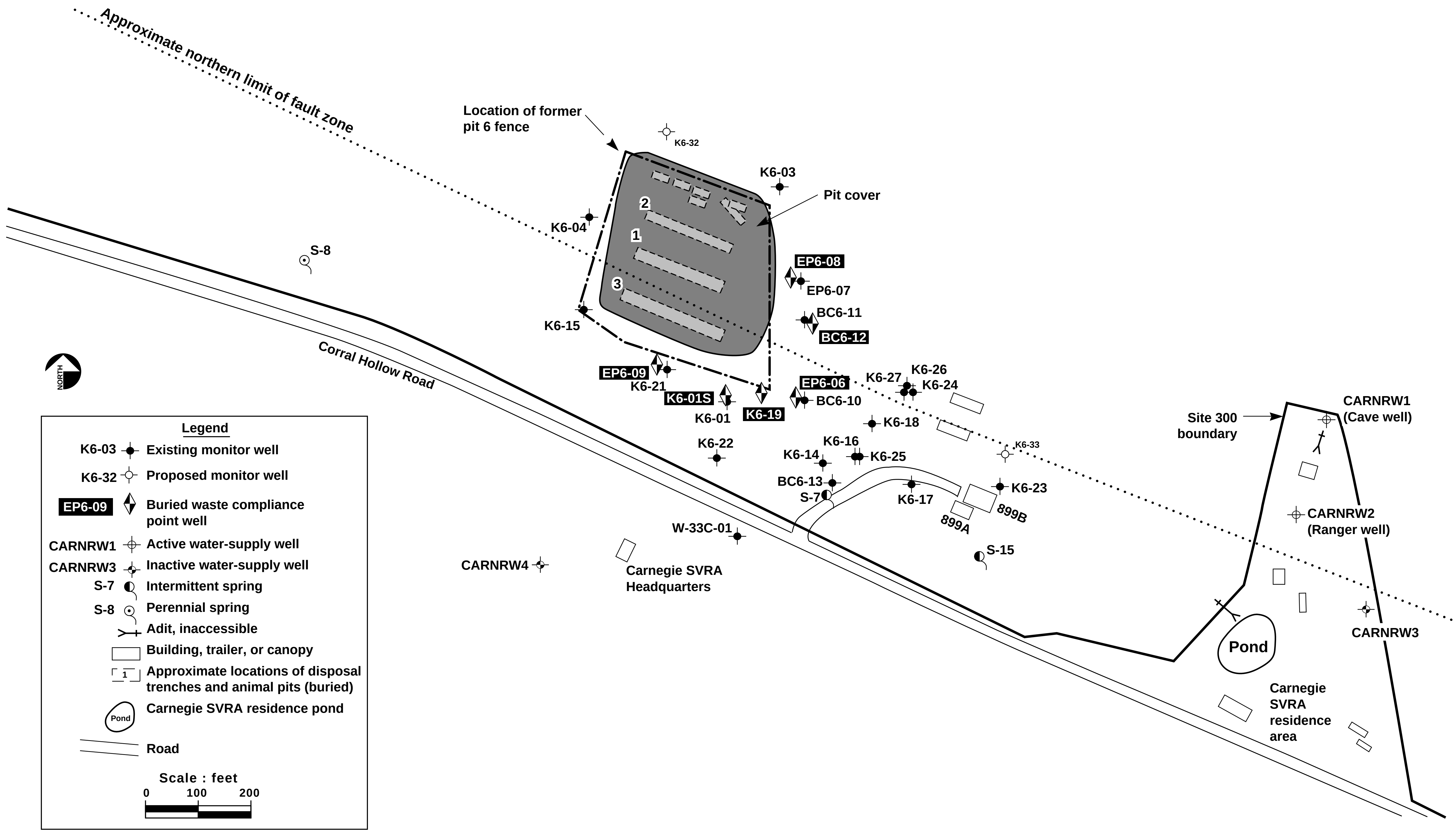

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Figure 7. Ground water monitoring network — revised Alternative 3.

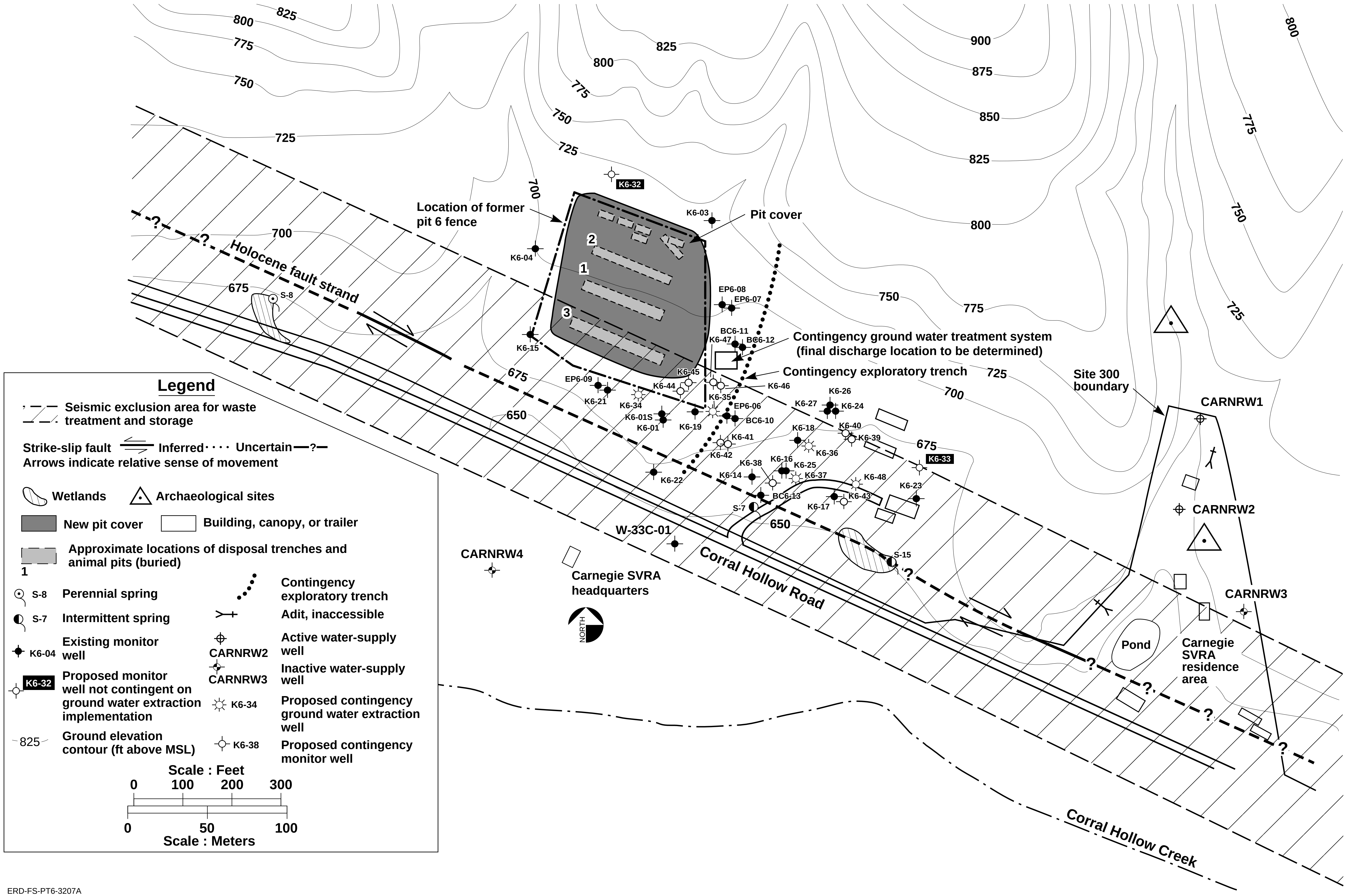

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Figure 8. Potential locations of contingency ground water extraction and treatment system and related monitoring network — revised Alternative 3.

Tables

Table 1. Substitute monitor wells to replace proposed wells P6-01 through P6-06.

Initially proposed well	Existing and new substitute well(s)
P6-01	EP6-09
P6-02	K6-01S
P6-03	K6-01S, EP6-06, K6-19
P6-04	EP6-08, BC6-12
P6-05	EP6-08, BC6-12
P6-06	Will be installed, but named K6-32

Table 2. Revised ground water monitoring program for Alternative 3.

Analysis	VOCs by EPA 8010			Tritium, uranium isotopes, and general minerals[a]		Other analyses[b]		
Monitoring period (years)	1–5	6–10[c]	11–30	1–5	6–30	1–5	6–30	Comments
<u>Well ID</u>								
BC6-10	A	A (Q)	A	—	—	—	—	Deep, clean monitor well
BC6-11	—	—	—	—	—	—	—	Same screened interval as and adjacent to BC6-12
BC6-12	A	A (S)	A	A	A	A	A	Buried waste compliance well, monitor well within plume
BC6-13[d]	Q	A (Q)	A	A	A	A	A	Spring 7 monitor well, acts as plume boundary well
CARNRW1	Q	A (Q)	A	—	—	—	—	Active water-supply well
CARNRW2	Q	A (Q)	A	—	—	—	—	Active water-supply well
CARNRW3	—	—	—	—	—	—	—	Inactive water-supply well
CARNRW4	—	—	—	—	—	—	—	Inactive water-supply well
EP6-06	A	A (Q)	A	A	A	A	A	Buried waste compliance well/shallow, clean monitor well
EP6-07	A	A (S)	A	—	—	—	—	Deep, clean monitor well
EP6-08	A	A (S)	A	A	A	A	A	Buried waste compliance well/monitor well within plume
EP6-09	A	A (S)	A	A	A	A	A	Buried waste compliance well/monitor well within plume
K6-01	A	A (S)	A	—	—	—	—	Monitor well within plume
K6-01S	A	A (S)	A	A	A	A	A	Buried waste compliance well/monitor well within plume
K6-03	A	A (A)	A	A	A	A	A	Upgradient, clean monitor well for background monitoring
K6-04	A	A (A)	A	A	A	A	A	Upgradient, clean monitor well for background monitoring
K6-14	Q	A (Q)	A	—	—	—	—	Downgradient, clean plume boundary well
K6-15[d]	A	A (A)	A	—	—	—	—	Cross-gradient, clean monitor well
K6-16	A	A (Q)	A	—	—	—	—	Monitor well within plume
K6-17	Q	A (Q)	A	—	—	—	—	Clean plume border well
K6-18	A	A (Q)	A	—	—	—	—	Monitor well within plume
K6-19	A	A (Q)	A	A	A	A	A	Buried waste compliance well/monitor well within plume
K6-21[d]	A	A (S)	A	—	—	—	—	Monitor well within plume
K6-22	Q	A (Q)	A	—	—	—	—	Downgradient, clean plume boundary well

Table 2. (Continued)

Analysis	VOCs by EPA 8010			Tritium, uranium isotopes, and general minerals[a]		Other analyses[b]		
Monitoring period (years)	1–5	6–10[c]	11–30	1–5	6–30	1–5	6–30	Comments
K6-23	Q	A (Q)	A	—	—	—	—	Downgradient, clean plume boundary well
K6-24	A	A (S)	A	—	—	—	—	Cross-gradient, clean monitor well
K6-25	A	A (Q)	A	—	—	—	—	Deep, clean monitor well
K6-26	A	A (A)	A	—	—	—	—	Deep, clean monitor well
K6-27	A	A (A)	A	—	—	—	—	Deep, clean monitor well
Spring 15	Q	A (Q)	A	—	—	—	—	Downgradient spring
W-33C-01	A	A (Q)	A	—	—	—	—	Clean, offsite monitor well
K6-32	Q	A (Q)	A	A	A	A	A	Proposed upgradient, clean monitor well for background monitoring
K6-33	Q	A (Q)	A	—	—	—	—	Proposed downgradient, clean plume boundary well
Contingency ground water extraction or monitor wells								
K6-34	NA	(Q)	(A)	NA	—	NA	—	Proposed ground water extraction well
K6-35	NA	(Q)	(A)	NA	—	NA	—	Proposed ground water extraction well
K6-36	NA	(Q)	(A)	NA	—	NA	—	Proposed ground water extraction well
K6-37	NA	(Q)	(A)	NA	—	NA	—	Proposed ground water extraction well
K6-38	NA	(Q)	(A)	NA	—	NA	—	Proposed monitor well at southern edge of plume
K6-39	NA	(Q)	(A)	NA	—	NA	—	Proposed monitor well at northern edge of plume
K6-40	NA	(Q)	(A)	NA	—	NA	—	Proposed monitor well at northern edge of plume
K6-41	NA	(Q)	(A)	NA	—	NA	—	Proposed monitor well at southern edge of plume
K6-42	NA	(Q)	(A)	NA	—	NA	—	Proposed monitor well at southern edge of plume
K6-43	NA	(Q)	(A)	NA	—	NA	—	Proposed monitor well at leading edge of plume
K6-44	NA	(Q)	(A)	NA	—	NA	—	Proposed monitor well within plume
K6-45	NA	(Q)	(A)	NA	—	NA	—	Proposed monitor well within plume

Table 2. (Continued)

Analysis	VOCs by EPA 8010			Tritium, uranium isotopes, and general minerals[a]		Other analyses[b]		
Monitoring period (years)	1–5	6–10[c]	11–30	1–5	6–30	1–5	6–30	Comments
K6-46	NA	(Q)	(A)	NA	—	NA	—	Proposed monitor well within plume
K6-47	NA	(Q)	(A)	NA	—	NA	—	Proposed monitor well within plume
K6-48	NA	(Q)	(A)	NA	—	NA	—	Proposed ground water extraction well
<u>Total samples</u>								
Quarterly	10	0 (32)	0	0	0	0	0	
Semiannually	0	0 (8)	0	0	0	0	0	
Annually	20	30 (5)	30 (45)	10	10	10	10	

Notes:

A = Annual sampling frequency.
NA = Not applicable; well not installed.
Q = Quarterly sampling frequency.
S = Semiannual sampling frequency.
— = No sampling.
( ) = Sampling frequency if ground water extraction contingency is implemented.

[a] General minerals = Nitrate, Ni, pH, conductivity. Bicarbonate, carbonate, hydroxide, Al, Ca, Cl, Cu, Fe, Mg, Mn, K, Na, sulfate, and Zn will be monitored for ion balance purposes only.

[b] Other analyses = PCBs, beryllium, other radionuclides by gross alpha/gross beta, and dissolved drinking water metals (As, Ba, Cd, Cr, Pb, Hg, Se, Ag).

[c] Triggers for implementing contingency actions will be presented in the Site 300 OU ROD. Installation schedule, number, location, and sampling frequency of contingency wells will be determined at the time of action implementation.

[d] Well is often dry so actual sampling may be less frequent.

Table 3. Estimated cost for revised Alternative 3.

	Total (1997 $)
Capital costs for pit cover	
Title I and II design	
Contractor design services (including onsite borrow source investigation)	181,000
LLNL Plant Engineering design review and project management	12,000
Subtotal Title I and II design cost	**193,000**
Title III landfill cover construction	
Pit cover construction (including rifle range demolition)	751,000
Additional cost if offsite soil borrow source is necessary	219,000
Replacement of rifle range (includes DOE-required safety upgrades)	363,000
LLNL construction project management and inspections	106,000
Title III contractor design services (including as-built drawings)	48,000
Independent Construction Quality Assurance (inspections and final report)	89,000
Subtotal Title III construction cost	**1,576,000**
10% contingency	**176,900**
Total pit 6 landfill construction costs	**1,945,900**
Post-construction maintenance	
Annual pit cover/drainage control maintenance	
Quarterly field inspections, routine maintenance	6,600
Total annual costs for pit cover/drainage control maintenance	**6,600**
Total present worth of pit cover maintenance for 30 yr (factor 18.39)	**121,374**

Table 3. Estimated cost for revised Alternative 3.

	Total (1997 $)
Post-construction ground water monitoring	
Installation of two monitor wells	**60,000**
Annual costs, years 1-5	
Quarterly water level measurements (30)	1,650
Quarterly sample collection (9 wells and 1 spring)	4,400
Annual sample collection (20 wells)	2,200
VOC analyses (60)	3,000
Tritium analyses (10)	700
Uranium isotopes (10)	1,050
General minerals analyses (10)	750
Suites of other analyses (10)	3,000
QA/QC analyses (10% of analytic costs)	850
Maintenance of sampling systems	12,500
Annual monitoring report	10,000
Project management, data mgmt., QA/QC	25,000
Total annual cost, years 1-5	**65,100**
Total present worth, years 1-5 (factor = 4.52)	**294,252**
Annual costs, years 6-30	
Quarterly water level measurements (30)	1,650
Annual sample collection (30 wells)	3,300
VOC analyses (30)	1,500
Tritium analyses (10)	700
Uranium isotopes (10)	1,050
General minerals analyses (10)	750
Suites of other analyses (10)	3,000
QA/QC analyses (10% of analytic costs)	700
Maintenance of sampling systems	12,500
Annual monitoring report	10,000
Project management, data mgmt., QA/QC	15,000
Total annual cost, years 6-30	**50,150**
Total present worth, years 6-30 (factor = 13.87)	**695,581**

Table 3. Estimated cost for revised Alternative 3.

	Total (1997 $)
Subtotal present worth of maintenance and monitoring, years 1-30	**1,171,207**
LLNL overhead charges on maintenance and monitoring	
General & Administration Tax (7.5%)	87,840
Subtotal	**1,259,047**
Lab-Directed Research and Development Tax (6.0%)	75,543
Subtotal	**1,334,590**
Total for revised Alternative 3 (without contingency actions)	**3,280,490**
Potential costs for implementing contingency actions	
Contingency action captial costs	
Ground water extraction and treatment major equipment and installation	300,000
Trenching for piping and fault location work	90,000
Installation, development and testing of 5 extraction wells and 10 monitor wells	550,000
Building for treatment system (plus geotechnical testing)	320,000
Point-of-Use treatment system	60,000
Fencing and signs at spring 7	3,000
LLNL Plant Engineering design review and project management	198,450
Remedial Design Report and treatability testing	300,000
Total contingency action capital costs	**1,821,450**
Contingency action operation and maintenance, and monitoring costs	
Annual costs for operating and maintaining the ground water extraction and treatment system, years 6-30	150,000

Table 3. Estimated cost for revised Alternative 3.

	Total (1997 $)
Additional annual ground water monitoring costs, years 6-10	
Additional sampling on existing wells (59 events)	6,490
Quarterly sampling on new wells (15)	6,600
Quarterly water level measurements on new wells (15)	825
VOC analyses (119)	5,950
QA/QC analyses (10% of analytic costs)	595
Maintenance of sampling systems (15 additional wells)	6,250
Additional project management, data mgmt., QA/QC	10,000
Total annual cost, years 6-10	**30,220**
Total present worth, years 6-10 (factor = 3.80)	**114,836**
Additional annual ground water monitoring costs, years 11-30	
Quarterly water level measurements on new wells (15)	825
Annual sampling on new wells (15)	1,650
VOC analyses (15)	750
QA/QC analyses (10% of analytic costs)	75
Maintenance of sampling systems (15 additional wells)	6,250
Additional project management, data mgmt., QA/QC	5,000
Total annual cost, years 6-10	**14,550**
Total present worth, years 11-30 (factor = 10.07)	**146,519**
Total additional operation and maintenance, and monitoring costs related to contingency actions	**411,355**
LLNL overhead charges on maintenance and monitoring	
General & Administration Tax (7.5%)	30,852
Subtotal	**442,206**
Lab-Directed Research and Development Tax (6.0%)	26,532
Subtotal	**468,738**
Total additional costs related to contingency actions	**2,290,188**