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Public Scoping Comment Summary Report

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PUBLIC SCOPING COMMENT SUMMARY REPORT

A.1 INTRODUCTION

On April 28, 2023, the U.S. Department of Energy (DOE) Office of Environmental Management Los Alamos Field Office (EM-LA) gave notice of two public meetings to be held on May 8th and 9th to address scoping for the *Chromium Interim Measure and Final Remedy Environmental Assessment* (referred to as EA). Notices were published in the *Los Alamos Daily Post*, *Los Alamos Reporter*, *Santa Fe New Mexican*, and the *Rio Grande Sun*. Notices were also sent to interested stakeholders and non-governmental organizations.

The 2016 Compliance Order on Consent (Consent Order) between DOE and the State of New Mexico Environment Department (NMED) is the principal regulatory document governing legacy cleanup at Los Alamos National Laboratory (LANL). The Consent Order sets forth the corrective action process, including the submission of Corrective Measures Evaluation (CME) Reports. EM-LA is preparing an EA under the National Environmental Policy Act (NEPA) to evaluate alternatives for remedial action as part of the Chromium Interim Measure (IM) and Characterization Campaign identified in the Consent Order. The EA will give DOE sufficient evidence and analysis to determine whether to issue a Finding of No Significant Impact (FONSI). To ensure that a full range of issues related to the Proposed Action are addressed, EM-LA invited Federal agencies, state, local, and Tribal governments, and the general public to comment on the scope of the EA. Specifically, EM-LA invited comments on the EA's scope, including the identification of reasonable alternatives and specific environmental issues to be addressed.

EM-LA hosted two public scoping meetings: an in-person one on May 8, 2023, and an interactive webcast on May 9, 2023. The purpose of the public scoping meetings was two-fold: (1) provide the public with information about the NEPA process and this EA scope; and (2) invite public comments on the that scope.

Questions from the public were welcomed at both meetings. Participants at the in-person meeting were instructed to provide their comments that day either by providing verbal comments to the EA project's stenographer or completing a provided comment form to be given to the EM-LA representatives at the meeting. Webcast and in-person participants were invited to provide their comments after the meeting by submitting emails with "Chromium EA Scoping Comment" in the subject line to emla-nepa@em.doe.gov or by submitting comments by U.S. Mail to:

ATTN: NEPA Document Manager
U.S. DOE Environmental Management
Los Alamos Field Office
1200 Trinity Drive, Suite 400
Los Alamos, NM 87544

Participants at both meetings were instructed that comments should be postmarked by June 6, 2023, for consideration.

No comments were received at the meetings. After the meetings, DOE received seven comment documents in which 99 comments were identified. Table A-1 lists the comment documents received, commenters' affiliation (if any), and comment document number assigned by EM-LA upon receipt. Individual comments were reviewed; comments with similar input were grouped together and treated as a single comment, concern, or issue. The scoping comments and EM-LA's

responses are summarized in following sections by general comment categories (i.e., NEPA Process, Purpose and Need, etc.). The numbering after each comment summary corresponds to tracking numbers assigned to individual comments that were considered in developing the comment summaries.

This report contains a summary of the scoping comments received and EM-LA's responses to these comments.

Table A-1. List of the public scoping comment documents received, commenters' affiliation (if any), and comment document number assigned by EM-LA

Commenter(s)	Affiliation	Comment Document Number
Anna Hansen, Renee Villareal, JC Helms	Santa Fe County Commissioners	1
Anna Hamilton, Carol Romero-Wirth, Anna Hansen, Renee Villareal, JC Helms	BDD Board	2
John E. Wilks, III	Veterans For Peace, Donald and Sally-Alice Thompson Chapter #63	3
Denise Derkacs, Philo S. Shelton III, P.E.	Los Alamos County Council	4
Jay Coghlan, Scott Kovac	Nuclear Watch New Mexico	5
James C. Kenney, Cabinet Secretary	NMED	6
Rachel Conn, Beata Tsosie-Peña, Joni Arends, Marian Naranjo, Paula Garcia, Joan Brown, Marlene Perrotte	Communities for Clean Water	7

Key: # = number; BDD = Buckman Direct Diversion; NMED = New Mexico Environment Department

A.1.1 NEPA PROCESS

1. Comment Summary: Commenters requested that documents cited in this EA be publicly available. Comments: 1-6, 2-6, 5-27, 7-3

   EM-LA Response: Reference documents are a part of the administrative record for this EA. To the extent practical, reference documents will be available in the Electronic Public Reading Room (https://environment.lanl.gov/public-reading-room/), the public reading room located at 94 Cities of Gold Road, Pojoaque, New Mexico, and on the project website. DOE may not be able to include certain copyrighted materials and sensitive information.

2. Comment Summary: One commenter suggested that preparation of an EA will not address the complex technical and policy issues for the hexavalent chromium plume and that EM-LA needs to prepare an Environmental Impact Statement (EIS). Comments: 7-1, 7-2, 7-7

   EM-LA Response: In accordance with DOE's NEPA implementing regulations (10 CFR 1021.321(a)), DOE may prepare an EA at any time for a proposed action. In preparing the EA, EM-LA will consider the context (setting) and intensity (severity) of any potential environmental impacts. If no significant environmental impacts are identified, the EA is the appropriate level of analysis. If DOE determines that there may be potential significant environmental impacts resulting from a proposed action, then an EIS is appropriate. EM-LA

will prepare the EA and include information to determine the potential for significant environmental impact using accepted and appropriate science, technology, and expertise.

3. Comment Summary: One commenter stated they understand the *Environmental Assessment for Chromium Plume Control Interim Measure and Plume-Center Characterization, Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-2005, December 2015) expires at the end of 2023 and they were unable to identify a source of this statement. The commenter suggested that EM-LA include a citation to the document and the statement in this EA. Comment: 7-2

   EM-LA Response: The *Environmental Assessment for Chromium Plume Control Interim Measure and Plume-Center Characterization, Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-2005, December 2015) referred to an "approximate 8-year duration" of the IM project. The EA did not state that it "expires at the end of 2023."

4. Comment Summary: One commenter objected to the use of the term "final remedy," stating that it is premature to identify the final remedy without first determining the nature and extent of the hexavalent chromium plume. Comment: 7-4

   EM-LA Response: Under both the No Action Alternative and Adaptive Site Management (ASM) alternative, EM-LA would continue to further characterize the hexavalent chromium plume. The goal of ASM is to create a framework of structured and continuous planning, implementation, and monitoring that accommodates new information and changing site conditions to develop effective and efficient cleanup strategies. Remediation under ASM addresses what is known while acknowledging what is not fully understood. It includes plans to collect the necessary information to reduce uncertainties and achieve a final, protective remedy for the site. This approach allows work to proceed in some areas while additional data collection and testing of responses is conducted to determine the appropriate level of remediation in remaining areas. ASM has been implemented at many complex remediation sites and is recommended by the U.S. Environmental Protection Agency.

   "Final remedy" is the term used in the 2016 Consent Order. The 2016 Consent Order states the final remedy will be selected by NMED after EM-LA submits a CME Report to NMED. The CME Report will identify and evaluate potential corrective measures for removal, containment, and treatment of the hexavalent chromium plume. In the CME Report, DOE will also recommend a preferred alternative for remediation. NMED will then issue a Statement of Basis, engage in a public comment period, and select a remedy.

   The environmental analysis presented in this EA will (1) identify and describe the affected environment; (2) provide sufficient evidence and analysis for determining whether to prepare an EIS or issue a FONSI; and (3) evaluate the potential environmental consequences of reasonable alternatives to remediate the hexavalent chromium plume. EM-LA will use the results and analyses from this EA to evaluate alternatives and recommend a preferred alternative for remediation in the CME Report, which EM-LA will submit to NMED.

5. Comment Summary: One commenter asked if EM-LA has created interactive, publicly available models demonstrating in real-time the pumping effects of the extraction and injection wells to the regional drinking water aquifer and the U.S. Environmental Protection Agency-designated Española Basin Sole Source Aquifer, and recommended EM-LA create such a model. Comments: 7-24, 7-25, 7-26, 7-27, 7-28

EM-LA Response: Development of additional models is outside the scope of the environmental impacts evaluated in this EA. This EA will describe existing groundwater resources within the area of impact and analyze potential impacts on groundwater from extraction and injection wells, land application, and other actions associated with the reasonable alternatives. EM-LA will prepare the EA using groundwater models that are peer reviewed and calibrated.

6. Comment Summary: Commenter requested a definition of "downgradient migration" and "removing some." Comment: 7-33

   EM-LA Response: This EA will include a description of geology and soils, including a Conceptual Site Model to portray both known and hypothesized site information regarding contaminants, sources, and migration pathways, as well as a description of relevant terminology. Downgradient migration is the movement of a compound or contaminant in the direction of groundwater flow. During the IM, EM-LA estimates that approximately 700 pounds of hexavalent chromium has been removed from the regional aquifer.

7. Comment Summary: Commenter objects to the use of the Finite Element Heat and Mass Transfer Code (FEHM) for the hexavalent chromium plume and recommends that EM-LA use U.S. Geological Survey's modular hydrologic model, MODFLOW, for developing this EA. Comments: 7-30, 7-31

   EM-LA Response: This EA will analyze potential impacts on groundwater from extraction and injection wells, land application, and other actions associated with the reasonable alternatives. FEHM can account for complexities associated with partially penetrating wells, aquifer heterogeneity, and complex boundary conditions and has been benchmarked against MODFLOW (https://www.usgs.gov/mission-areas/wateR-resources/science/modflow-and-related-programs). FEHM is shown to be equal in accuracy and provide improved numerical stability relative to MODFLOW.

   FEHM is a well-vetted flow and transport code that has been used at LANL and by its collaborators for 50 years, has hundreds of peer-reviewed publications (https://www.lanl.gov/orgs/ees/fehm/pdfs/FEHM_references_list.pdf), and has been benchmarked and verified against many analytical and numerical solutions, including MODFLOW (https://www.lanl.gov/orgs/ees/fehm/docs/FEHM_VERIFICATION _V3.3.0.pdf).

   LANL recalibrates the FEHM chromium model regularly as new data becomes available. The calibration compares to concentrations, drawdowns, water levels, and water-level gradient targets with excellent results.

8. Comment Summary: Several comments questioned the robustness of available monitoring data to support the analysis of impacts in this EA. Comments: 5-11, 6-4, 6-6

   EM-LA Response: LANL has a robust, laboratory-wide environmental monitoring program. This program prepares Annual Site Environmental Monitoring Reports (https://environment.lanl.gov/environmental-report/). In addition, the Chromium IM program reports monitoring results in their own reports (https://eprr.em-la.doe.gov/). Future monitoring would be performed, as appropriate and as approved by pertinent regulatory agencies (e.g., NMED), and may be verified by quality assurance comparisons with duplicate and split sampling data taken by oversight agencies (e.g., NMED).

9. Comment Summary: Several comments requested EM-LA extend the public comment period for this EA. The requests for extending the public comment period for this EA ranged from 30 to 120 days. Comments: 1-8, 2-8, 3-1

   EM-LA Response: EM-LA will evaluate extending the public comment period referred to during the public scoping meetings for this EA and will make proper notifications on the determination.

A.1.2 PURPOSE AND NEED

10. Comment Summary: One commenter stated that the purpose and need must be thoroughly addressed. Comment: 5-18

    EM-LA Response: This EA is being prepared in accordance with applicable Council on Environmental Quality and DOE NEPA regulations. The purpose of the Proposed Action is to remediate hexavalent chromium-contaminated groundwater below Sandia and Mortandad Canyons. DOE is evaluating potential reasonable alternatives for a final remedy using the threshold criteria and balancing criteria set forth in the 2016 Consent Order. The primary objective of the interim measure is to prevent migration of the hexavalent chromium plume beyond the LANL boundary. In contrast, the final remedy will be focused on groundwater remediation to achieve compliance with groundwater quality standards.

A.1.3 ALTERNATIVES

11. Comment Summary: One commenter suggested that all requests from the NMED be analyzed as alternatives and EM-LA analyze all impacts of land applying the treated water as well as all impacts of injecting the water into the ground and/or the plume. Comment: 5-22

    EM-LA Response: Through its internal scoping, EM-LA identified potential reasonable alternatives for this EA using the threshold criteria and balancing criteria set forth in the Consent Order. For alternatives to be reasonable, they must meet the threshold criteria and be evaluated using the balancing criteria. This EA will discuss the alternatives evaluated and the alternatives considered and dismissed from detailed evaluation.

    In addition, this EA will include information to determine the potential for significant environmental impact, and it will analyze potential impacts on resources, including cumulative impacts. As stated in the scoping alternatives presented at the public scoping meetings, this EA will address treated water land application and injection.

12. Comment Summary: One commenter urged EM-LA to focus on the Enhanced Chromium IM alternative, including activities directly related to compliance with the New Mexico Water Quality Act, the 2016 Consent Order and any other applicable regulations. They also requested EM-LA focus on expanded remedial activities to address the chromium plume above and beyond what is legally required, account for DOE's past cleanup commitments and obligations, and consider expanded remedial activities and definite timelines, such as those that may be encompassed by a new compliance order on consent as the litigation on the 2016 Consent Order is resolved. Comments: 6-3, 6-5, 6-8

EM-LA Response: The EA will address adherence of the potential reasonable alternatives to applicable Federal, state, and local laws and regulations, including the Consent Order. The remedy selected by NMED and implemented by EM-LA must comply with the Consent Order. The timeline for implementation of the remedy will depend, in significant part, on how long it takes NMED to select a remedy, as well as the remedy that NMED selects.

13. Comment Summary: One commenter suggested EM-LA include additional characterization activities in an alternative, including the installation of additional monitoring wells, that will be implemented under a work plan approved by NMED. DOE-EM should also include an assessment of converting current well infrastructure (injection wells or monitoring wells) into future extraction wells under this alternative. Comment: 6-9

    EM-LA Response: Additional wells are part of the alternatives to be analyzed in the EA. Under the Consent Order, EM-LA would submit a work plan to NMED for approval (and obtain Office of the State Engineer drilling permits) prior to construction of wells. A discussion of converting current well infrastructure will be included in the EA.

    Through its internal scoping, EM-LA identified potential reasonable alternatives for this EA. EM-LA identified two alternatives—the No Action Alternative and Adaptive Site Management. The No Action Alternative is a continuation of the preferred alternative in the *Environmental Assessment for Chromium Plume Control Interim Measure and Plume-Center Characterization, Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-2005) and FONSI (December 2015). Under the No Action Alternative, EM-LA would control plume migration and maintain hexavalent chromium contamination levels within the LANL boundary while long-term corrective action remedies continue to be evaluated, implemented, and continue to further characterize the plume to evaluate the effectiveness and feasibility of implementing a final remedy.

    Under the Proposed Action, EM-LA would use ASM to remediate the hexavalent chromium plume. The goal of ASM is to create a framework of structured and continuous planning, implementation, and monitoring that accommodates new information and changing site conditions to develop effective and efficient cleanup strategies.

    This EA will discuss the alternatives evaluated and the alternatives considered but dismissed from detailed evaluation, including additional characterization activities and any converted, new, or decommissioned wells.

14. Comment Summary: One comment noted that EM-LA needs to clearly delineate the land application locations, volumes, and times under DP-1793 and Option 2, "Land Application." Comment: 7-22

    EM-LA Response: The specifics of land application of treated water (i.e., locations, volumes, and times) was previously addressed in the 2015 EA (DOE/EA-2005). In this EA, land application is further addressed in Section 2.2., *Option 2: Mass Removal via Expanded Treatment with Land Application*, of Appendix B as part of the alternatives discussion. Treated water constituents would meet NMED Ground Water Quality Bureau permit requirements for land application.

15. Comment Summary: One commenter recommended that EM-LA provide interim measures to prevent migration of the plume beyond the laboratory boundary and that the *Interim Measures and Characterization Work Plan* (Work Plan) must be revised to include a

discussion of alternative injection scenarios (i.e., shallow infiltration gallery, conversion of existing well outside the plume to an injection well, constructing a new injection well outside the plume boundary, etc.). They also noted that the Work Plan needs to be revised to include a proposal from DOE for an investigation activity that will achieve the regulatory requirement to implement an alternative injection well location for the treated water. Comment: 7-6

EM-LA Response: This EA will discuss the alternatives evaluated and the alternatives considered but dismissed from detailed evaluation, including injection scenarios and additional well locations. Whereas a discussion of activities encompassed within the alternatives are factors considered in identifying reasonable alternatives and environmental impacts, work plan development and revision are administrative aspects of the activity that are outside the scope of the environmental impacts evaluated in this EA.

16. Comment Summary: Several commenters stated that EM-LA must clearly define, explain, and provide adequate supporting documentation of the four options under Alternative 1: ASM, including additional infrastructure for remediation and monitoring, timeframes to complete the options, coordination and consultation with regulators and opportunities for public participation. Comments: 1-4, 5-3, 2-4, 4-4, 6-10, 7-18, 7-20, 7-21

    EM-LA Response: This EA will discuss the alternatives evaluated and the alternatives considered and dismissed from detailed evaluation per NEPA regulations. The description of the alternatives will include a discussion of additional infrastructure for remediation and monitoring, timeframes to complete the options, engagement with regulators, and opportunities for public participation.

17. Comment Summary: One commenter noted EM-LA needs to specify that this EA would not include implementation of a final remedy for addressing the hexavalent chromium groundwater contamination. Rather, the results and analyses from the alternative would be used to develop recommendations for a final remedy to be presented to NMED for approval in accordance with the CME process. Comment: 6-8

    EM-LA Response: Comments noted. EM-LA intends to use the analysis of environmental impacts in this EA to develop a CME Report, which will identify and evaluate potential corrective measures alternatives for removal, containment, and treatment of the hexavalent chromium plume. In the CME Report, EM-LA will also recommend a preferred alternative for remediation. After receiving the CME Report from EM-LA, NMED will issue a Statement of Basis, engage in a public comment period, and select a remedy.

18. Comment Summary: Several commenters noted that the evaluated alternatives should be designed to protect public drinking water. Comments: 4-6, 5-5, 7-31

    EM-LA Response: This EA will discuss the alternatives evaluated and the alternatives considered and dismissed from detailed evaluation, including measures to protect public drinking water consistent with applicable environmental laws, regulations, permits, and agreements.

19. Comment Summary: Several commenters requested clarification of the No Action Alternative. Comments: 1-5, 2-5, 6-7, 7-19

    EM-LA Response: This EA will include consideration of a No Action Alternative per NEPA regulations. The No Action Alternative is a continuation of the preferred alternative in the

Environmental Assessment for Chromium Plume Control Interim Measure and Plume-Center Characterization, Los Alamos National Laboratory, Los Alamos, New Mexico (DOE/EA-2005, December 2015) and FONSI (December 2015). Under the No Action Alternative, EM-LA would control plume migration and maintain hexavalent chromium contamination levels within the LANL boundary while long-term corrective action remedies continue to be evaluated, implemented, and continue to further characterize the plume to evaluate the effectiveness and feasibility of implementing a final remedy.

20. Comment Summary: Commenters requested information on options for hexavalent chromium source removal. One commenter suggested that EM-LA analyze an alternative that pumps or trucks treated water to the head of Sandia Canyon to the location where the chromium-contaminated water was released. Comments: 4-8, 5-4

    EM-LA Response: EM-LA has considered disposition options, other than injection of treated groundwater via injection wells, including land application at the head of Sandia Canyon into the same pathway that the chromium source initially followed. There is a potential risk associated with the outfall option if implemented in Sandia Canyon, with accelerating the release of chromium that may reside in the vadose and perched water zones between the approximate 1,000 feet between the ground surface and the regional aquifer (N3B, 2022).

21. Comment Summary: One comment noted a preference for Option 1: Expanded Pump and Treat with Expanded Injection. Comment: 4-5

    EM-LA Response: Comment noted. EM-LA intends to use the analysis of environmental impacts in this EA to develop a CME Report, which will identify and evaluate potential corrective measures alternatives for removal, containment, and treatment of the hexavalent chromium plume. In the CME Report, EM-LA will also recommend a preferred alternative for remediation. After receiving the CME Report from EM-LA, NMED will issue a Statement of Basis, engage in a public comment period, and select a remedy.

A.1.4 ENVIRONMENTAL IMPACTS

22. Comment Summary: One commenter noted that EM-LA must evaluate the environmental impacts from construction and well drilling. Comment: 5-19

    EM-LA Response: This EA will analyze potential impacts from remediation activities, including construction and well drilling.

23. Comment Summary: One commenter suggested that EM-LA include an analysis of climate change impacts. Comment: 5-23

    EM-LA Response: This EA will consider greenhouse gas emissions and climate change impacts.

24. Comment Summary: Several commenters requested that EM-LA evaluate impacts to endangered species, water, air and soil, environmental justice, transportation, economics (including tourism), emergency preparedness, visual resources, future land use plans, and waste generation. Comments: 5-20, 5-24, 5-25, 5-28

    EM-LA Response: This EA will analyze potential impacts on the environment. This includes impacts on threatened and endangered species, water resources, air quality, geology

and soils, environmental justice, transportation, socioeconomics, visual resources, land use, and waste management. Although emergency preparedness is not an environmental resource area, an Emergency Operations Plan (LAC, 2018) and a Local Hazard Mitigation Plan (LAC, 2016) were published by Los Alamos County to assess the potential risks associated within the region.

25. Comment Summary: Several commenters requested EM-LA evaluate impacts to water resources, including hexavalent chromium concentration increases in downgradient monitoring wells in response to injection operations, the ability to adequately control plume migration and maintain hexavalent chromium contamination within the LANL boundary, and the regulatory directive from NMED to cease injection into the plume beginning April 1, 2023. They also recommend this EA include information on impacts to the Rio Grande and the springs along the Rio Grande, including the groundwater and surface water connection and methods for offsetting or identifying consumptive uses, cumulative effects from this and other projects on the hydrologic conditions of the analysis area and vicinity, whether specific permits will be needed, and measures that would be taken to protect drinking water for communities. Comments: 1-1, 1-2, 1-3, 2-1, 2-2, 2-3, 6-7, 7-5, 7-15, 7-16, 7-17

    EM-LA Response: This EA will analyze potential impacts on surface and groundwater resources, including cumulative impacts, commensurate with the potential for impacts.

26. Comment Summary: Commenters requested that EM-LA evaluate the impacts of alternatives on water rights. Comments: 4-7, 7-12

    EM-LA Response: This EA will analyze potential impacts on surface and groundwater resources, including water rights.

27. Comment Summary: One commenter stated this EA should give some description of costs to date, estimated future costs, the anticipated time duration of the project, and the number of workers needed. Comment: 5-15

    EM-LA Response: EM-LA does not plan to present cost information in this EA. Estimates of construction and operation duration and the number of workers needed for the alternatives and options analyzed will be provided.

A.1.5 HUMAN HEALTH

28. Comment Summary: One commenter noted that Federal standards for protection of human health, such as limits on how much residual radiation will be allowed in contaminated soil, are based on "Reference Man," and recommended that the analysis address the risk to a pregnant woman farmer, her fetus, and her other children under age 18, rather than "Reference Man."

    EM-LA Response: This EA will analyze the direct, indirect, and cumulative impacts. Potential impacts on human health will be estimated using accepted scientific methods. Radiation is not a component of the hexavalent chromium plume and, therefore, is out of scope and will not be addressed in this EA.

29. Comment Summary: One comment requested that the draft environmental assessment have a good description of the negative health impacts of chromium, particularly hexavalent chromium, correlating to different amounts of parts per billion. Comment: 5-13

EM-LA Response: This EA will analyze the direct, indirect, and cumulative impacts. Potential impacts on human health will be estimated using accepted scientific methods. The applicable regulatory limits for hexavalent chromium concentrations in environmental media will be described in this EA.

A.1.6 CONSULTATION AND COORDINATION

30. Comment Summary: One commenter suggested this EA include a discussion of the relationship between EM-LA and NMED, including the roles of each. Comment: 5-14

    EM-LA Response: EM-LA regularly engages with NMED. In support of this EA, EM-LA will continue to hold discussions with NMED and other regulatory agencies consistent with past practice and the Consent Order. EM-LA intends to use the analysis of environmental impacts in this EA to support development of a CME Report, which will identify and evaluate potential corrective measures alternatives for removal, containment, and treatment of the hexavalent chromium plume. In the CME Report, EM-LA will also recommend a preferred alternative for remediation. After receiving the CME Report from EM-LA, NMED will issue a Statement of Basis, engage in a public comment period, and select a remedy.

31. Comment Summary: One comment noted that strong intergovernmental coordination is essential to ensure progress in addressing impacts to human health and the environment from ongoing and proposed activities at LANL. Comment: 6-1

    EM-LA Response: Comment noted. EM-LA is committed to strong intergovernmental coordination. This EA will evaluate potential environmental impacts on resource areas (consistent with NEPA regulations and implementing requirements and guidance) from activities associated with the hexavalent chromium plume and not ongoing and proposed activities at LANL.

    In addition, the National Nuclear Security Administration (NNSA) is preparing a Site-Wide Environmental Impact Statement (SWEIS) for LANL that will update the analysis in the 2008 LANL SWEIS (see Notice of Intent at 87 Federal Register [FR] 51083; https://www.energy.gov/sites/default/files/2022-08/noi-eis-0552-lanl-site-wide-2022-08.pdf). The SWEIS will analyze the potential environmental impacts of reasonable alternatives for continuing operations of LANL for approximately the next 15 years. The SWEIS will also analyze environmental impacts of waste remediation activities conducted by DOE-EM.

A.1.7 NATURE AND EXTENT OF THE HEXAVALENT CHROMIUM PLUME

32. Comment Summary: Several commenters noted that EM-LA needs to fill in data gaps and continue to assess the nature and extent of the hexavalent chromium plume. One commenter stated there are differences in professional opinion regarding the depth and extent of the hexavalent chromium plume. Comments: 4-1, 4-2, 5-6, 5-7, 5-8, 5-10, 5-12, 6-3, 6-8, 7-4, 7-7, 7-32

    EM-LA Response: This EA will include a description of hydrology, geology and soils, and water resources, including a Conceptual Site Model to portray both known and hypothesized site information regarding contaminants, sources, migration pathways, and impacts from extraction, injection, land application, etc. The options evaluated for the final remedy

include monitoring to address data gaps and continue assessing the nature and extent of the hexavalent chromium plume. Most of the options include installation of additional wells.

33. Comment Summary: One comment noted in 2020 LANL switched from the Thin-Plate Spline (TPS) interpolation method to the Bayesian Canonical Correlation Regression and reverted to TPS in calendar year 2023 Quarter 1. The commenter requested that NMED require LANL to run the data from 2020 to 2023 in the TPS interpolation method in order to understand the difference between the two models, to create a consistent source of data, and to alleviate public concern about the switch between models. Comment: 7-29

    EM-LA Response: LANL switched from the TPS interpolation method upon request from NMED. This EA will be prepared in accordance with applicable Council on Environmental Quality and DOE NEPA regulations. The commenter's preference for deriving and displaying data are outside the scope of this EA.

A.1.8 PUBLIC PARTICIPATION

34. Comment Summary: Several comments requested EM-LA improve engagement with stakeholders, Native American groups, pueblos, local governments, and utilities and for clarification on the mechanism of cooperation with San Ildefonso Pueblo. Comments: 1-7, 2-7, 5-9, 6-2

    EM-LA Response: Maintaining an open dialog with the public is central to EM-LA's mission. This includes keeping stakeholders and the public informed about EM-LA's activities. See the webpage at https://www.energy.gov/em-la/information-center for more information about EM-LA's mission, the current status of cleanup campaigns and Consent Order milestones, recent presentations given at public meetings, and contracts related to the EM-LA mission.

    DOE maintains Tribal outreach programs with Native American groups surrounding applicable sites and routinely meets with interested Native American governments to discuss various issues.

35. Comment Summary: One comment noted support for the comments submitted by the Buckman Direct Diversion Board about the scope of this EA. Comment: 7-14

    EM-LA Response: Comment Noted. See the responses to Comments 2-1 through 2-8.

36. Comment Summary: Commenter suggested that EM-LA mail notices of the comment period to people on the NMED Facility Mailing List for LANL, post the notices to the LANL Electronic Public Reading Room, host in-person and virtual community meetings, place informative ads in local and statewide newspapers, and produce paid broadcasts on local radio stations. Comment: 7-23

    EM-LA Response: EM-LA provided notice of the public scoping meetings in four local media distributions. This provided adequate notice of the in-person and webcast meetings. Notifications were also sent directly to interested stakeholders and Non-Governmental Organizations. This notice process will be similar for this EA. EM-LA will also hold two public meetings on this EA.

37. Comment Summary: One commenter recommended improvements to scoping materials. Comments: 7-34, 7-35.

EM-LA Response: Comments noted.

A.1.9 REGULATORY REQUIREMENTS

38. Comment Summary: Several comments requested information regarding LANL applications to the state engineer regarding the IM be included in this EA along with updated status of compliance with permits, consultations, and notifications; permit renewals; and permit compliance. Comments: 5-26, 7-8, 7-9, 7-10, 7 -11, 7-13

    EM-LA Response: This EA will describe applicable environmental laws, regulations, permits, and agreements.

A.1.10 OUT OF SCOPE

39. Comment Summary: One commenter noted that this EA must be unprejudiced by the fact that hundreds of millions of dollars are spent on nuclear weapons research and production at LANL and voiced their desire for NNSA to diversify its missions away from nuclear weapons programs and move more toward critically needed programs, such as nonproliferation efforts, other new national security priorities (for example, port security), and pure science and energy efficiency programs. Comments: 5-1, 5-2, 5-17

    EM-LA Response: Remediation activities are funded separately from NNSA nuclear weapons programs and other LANL missions. NNSA programs are outside the scope of this EA.

40. Comment Summary: One comment suggested that additional revisions to the Work Plan are required as a result of the NMED Hazardous Waste Bureau directing DOE to not restart operations at CrEX-1, CrEX-2, CrEX-3, CrIN-1, CrIN-2, and CrIN-3, and the NMED Ground Water Quality Bureau directing DOE to cease all injections authorized under DP-1835 by April 1, 2023. Comment: 7-5

    EM-LA Response: This EA will discuss the alternatives evaluated and the alternatives considered but dismissed from detailed evaluation, including groundwater withdrawal and injection scenarios (considering land application of some of the treated water) and additional well locations. This EA's alternatives and options have been formulated after consideration of these recent developments. Whereas a discussion of activities encompassed within the alternatives are factors considered in identifying reasonable alternatives and environmental impacts, work plan development and revision are administrative aspects of the activity that are outside the scope of the environmental impacts evaluated in this EA.

41. Comment Summary: One commenter noted that the Los Alamos County Department of Public Utilities (DPU) is in the process of making a substantial investment in upgrading well controls for Pajarito Well No. 3, but is concerned that this investment would go to waste should the plume advance closer to this well. DPU staff has met with EM-LA regarding these issues and DPU is receptive to DOE performing a spinner log test on the well to determine the fate of Pajarito Well No. 3. We have requested a work plan for review and approval prior to performing a spinner log test. Comment: 4-3

    EM-LA Response: Comment noted. This EA will discuss the environmental impacts, including behavior of the hexavalent chromium plume, under the alternatives evaluated. Whereas a discussion of activities encompassed within the alternatives are factors

considered in identifying environmental impacts, work plan development and revision are administrative aspects of the activity that are outside the scope of the environmental impacts evaluated in this EA.

A.2 REFERENCES

LAC. (2016). *Los Alamos County Local Hazard Mitigation Plan: Comprehensive Update.* March 2016. Developed by the Los Alamos County Hazard Mitigation Planning Committee with professional planning assistance from AMEC.

LAC. (2018). *Emergency Operations Plan.* Los Alamos County, New Mexico.

N3B. (2022). *2021 Sandia Wetland Performance Report*. Los Alamos, New Mexico: Newport News Nuclear BWXT-Los Alamos, LLC. EM2022-0012. April 2022.

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Appendix B
Description of Alternatives Supporting Information

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DESCRIPTION OF ALTERNATIVES SUPPORTING INFORMATION

B.1 INTRODUCTION

This appendix includes an in-depth discussion of alternatives that the U.S. Department of Energy (DOE) Office of Environmental Management Los Alamos Field Office (EM-LA) is considering for chromium mass removal in source areas and in the groundwater below Sandia and Mortandad Canyons. Table B-1 at the end of this appendix includes a breakdown of the supporting information for each potential alternative.

B.2 NO ACTION ALTERNATIVE

This alternative would be a continuation of the preferred alternative in the *Final Environmental Assessment for Chromium Plume Control Interim Measure and Plume-Center Characterization, Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE, 2015) (and Finding of No Significant Impact (FONSI) (December 2015)), which prioritized the Chromium Plume Interim Measure and Plume Characterization. Under the No Action Alternative, EM-LA would control plume migration and maintain chromium contamination concentrations within the LANL boundary while continuing to evaluate long-term corrective action remedies, including options for chromium mass removal. EM-LA would continue conducting field-scale studies to further characterize the plume to evaluate the effectiveness and feasibility of implementing a final remedy.

B.2.1 FACILITIES AND INFRASTRUCTURE

In addition to the continuation of the Interim Measure, the No Action Alternative also has the potential to include up to 16 new monitoring wells to the existing treatment facility. These additional monitoring wells are permitted by the *Assessment for Chromium Plume Control Interim Measure and Plume-Center Characterization, Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE, 2015), which only limits pumping volume. The location of the additional monitoring wells has not been determined, but EM-LA will continue avoidance measures for cultural and ecological resources.

B.2.2 DECOMMISSIONING AND FINAL CONTOURING

If EM-LA determines there is no future use for the installations, the disturbed areas will be restored and rehabilitated according to requirements in place at that time. EM-LA would consult with the surrounding Pueblos and others to develop the final state of the chromium final remedy operations areas.

B.3 PROPOSED ACTION

The Proposed Action for a final remedy is a combination of treatment options. Under this alternative, EM-LA would use adaptive site management (ASM) to select, implement, and manage removal of hexavalent chromium from source areas and the groundwater. Given the long timeframes associated with remedy decisions, an evolving conceptual site model and a flexible and iterative approach with multiple intermediate steps is needed to manage site uncertainty and achieve effective and efficient progress toward groundwater cleanup and protection. ASM uses science and technology to routinely re-evaluate and prioritize site remedial actions and characterization activities. The goal of the approach is to create a framework of structured and continuous planning,

implementation, and monitoring processes that accommodate new information and changing site conditions to develop effective and efficient cleanup approaches that achieve required outcomes, as seen in Figure B-1.

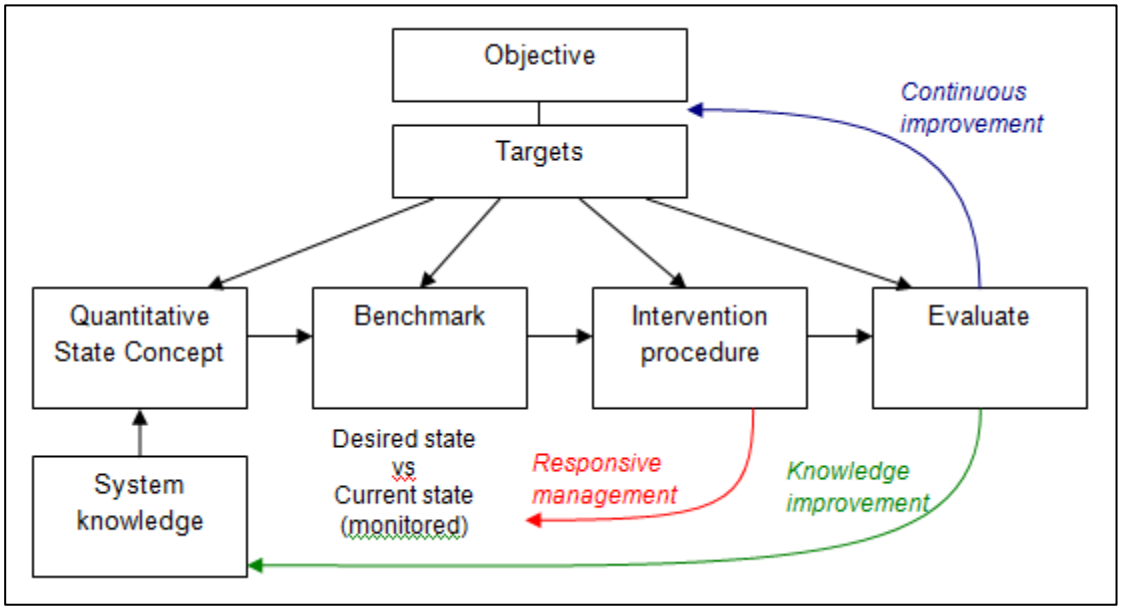

Figure B-1. Adaptive site management model

ASM promotes flexible decision making that can be adjusted as outcomes from management actions and other events become better understood. ASM includes active stakeholder involvement, management objectives, management alternatives, predictive models, monitoring plans, decision making, monitoring responses to remedial actions, and adjustment to remedial actions. Monitoring typically involves collecting groundwater samples to analyze them for the presence of contaminants and other site characteristics. An ASM approach for the mass removal of hexavalent chromium would include identifying the following:

- Site objectives that support the development of a long-term management approach.
- Interim goals that provide quantifiable, stepwise progress for achieving site objectives.
- Remedial actions that address key uncertainties and data gaps.

Under this alternative, EM-LA is considering utilization of the following options, or a combination of these options, to remediate chromium-contaminated groundwater below the Sandia and Mortandad Canyons.

B.3.1 OPTION 1: MASS REMOVAL VIA EXPANDED TREATMENT

Facilities and Infrastructure

Under this option, EM-LA would construct a 10,000-square-foot (ft^2) groundwater treatment facility situated in a previously disturbed area within Mortandad Canyon, as seen in Figure B-2. This facility would have a designed treatment capacity of 500 gallons per minute (gpm), with expansion capabilities to 1,000 gpm, and would treat water for hexavalent chromium contamination. The treatment system would consist of a 1,000-gpm dual ion exchange treatment system with prefiltration, associated piping, flow controls, and programmable logic controls and monitoring.

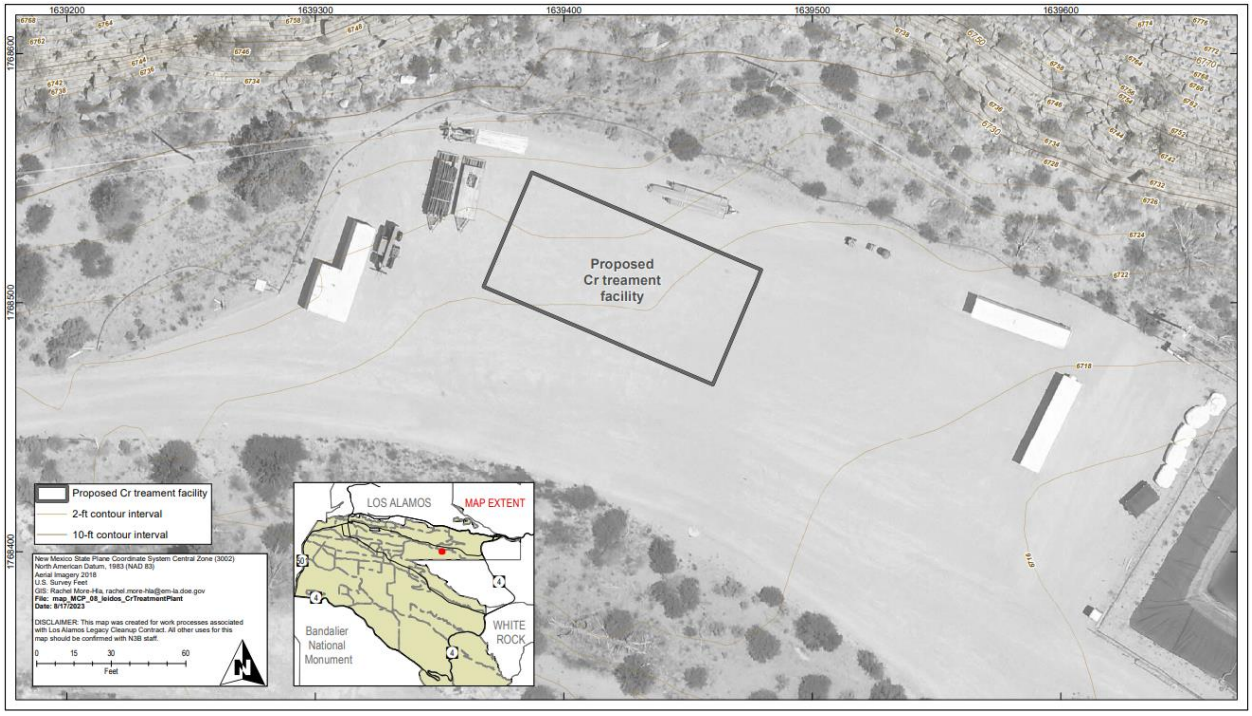

Figure B-2. Proposed hexavalent chromium treatment facility

The treatment facility would include the following:

- Contactors (e.g., disk or drum)
- Ion exchange vessels
- An electrical room
- A control room
- Feed tanks
- Injection pumps
- Electrical connection to the Los Alamos National Laboratory (LANL)
- Bathroom with septic system

In addition to the new treatment facility, this option also includes designs for 15 extraction wells; 15 injection wells; 16 monitoring wells, including one converted monitoring well; 20 shallow piezometers in the Sandia Wetlands source area; and 10 piezometers in the deep vadose zone.

These additional wells are expected to increase groundwater extraction and injection rates from 150,000,000 gallons per year (gpy) to a maximum rate of 550,000,000 gpy. The locations of the additional wells have not been determined; however, EM-LA would avoid disturbing sensitive ecological and cultural resources.

Up to 16 new monitoring wells, including one converted well, would be distributed between Sandia and Mortandad Canyons. These wells would continue to determine the nature and extent of the chromium plume. Both water-quality and pumping-volume monitoring are required under the various permits issued by the State of New Mexico for extraction, treatment, injection, land

application, and evaporation. Monitoring would consist of sampling untreated and treated water and aquifer metering for both extraction and injection to ensure the system is performing as designed.

The additional 20 shallow piezometers in and around the Sandia Wetlands and 10 deep vadose zone piezometers in Mortandad Canyon would be installed for water-level monitoring and occasional water-quality sampling. These tests would involve injection at the piezometers and monitoring at nearby monitoring wells. These studies would use tracers, chemicals, or bio-stimulants to evaluate the feasibility of in-situ remedies to convert chromium to the stable, nonmobile, non-toxic trivalent form. The additional piezometers would also be used to characterize lateral and vertical variability in water levels within the shallow alluvium in the canyon floor and the deeper vadose zone and would vary in depth with a maximum depth of approximately 1,400 feet, depending on depth to bedrock.

Directional drilling could be used to access areas under extreme slopes. Pump stations would include skid-mounted pumps enclosed within portable structures, minimizing the need for excavation. Associated electrical service would be extended from existing power lines in Mortandad Canyon.

Facility Piping

Untreated water from the additional extraction wells would be directed to the new treatment facility through existing valves in chromium extraction well 5-MH-2 and a new double-walled pipeline. It is estimated that approximately 30,000 linear feet of new double-walled pipe would be installed from the new extraction wells to the treatment system. An additional 500 feet of double-walled pipe would be necessary to tie the existing piping infrastructure into the new treatment plant.

The new treatment facility would continue to utilize existing feed tanks and injection pumps located at the R-28 well site for injection into existing wells. However, new injection wells would require new feed tanks and injection pumps to be installed in the new treatment facility. EM-LA estimates that approximately 30,000 feet of new single-walled pipe would be installed from the treatment system to the new water injection wells. An additional 500 feet of single-walled pipe would be necessary to tie the existing piping infrastructure into the new treatment plant.

Buried pipes would convey treated water from the treatment system to injection wells. The flexible piping would be buried approximately 4 feet below ground surface for freeze protection and routed along existing roads or utility corridors wherever possible. Trenching footprints would be minimized using equipment such as a Ditch Witch® or an excavator equipped with a narrow bucket.

Hexavalent Chromium Treatment

In the current operations of the Interim Measure, chromium is removed from extracted groundwater via an ion exchange system. The treatment system is modular in nature and uses portable storage tanks, skid-mounted pumps, and ion exchange vessels. The pumps and ion exchange vessels are located inside portable structures to protect them from damage; no additional contaminants are being analyzed for treatment.

Hexavalent chromium treatment at the new facility would be completed by ion exchange. The ion exchange resin is loaded into vessels. The contaminated groundwater enters the top of the vessel, runs through the resin, which removes the contaminants (in this case chromium), and the treated

water exits the vessel at the bottom. Flow rate through the vessel is regulated by valves to ensure there is enough contact time for the ion exchange to take place.

The spent resin tanks may be put into a truck and taken to an offsite facility where the chromium is removed, and the resin tanks are regenerated for further use. Chromium from the spent resin would be managed or disposed of in accordance with state and Federal regulations.

Based on the increase in pumping rates and with the additional wells, EM-LA estimates to remove approximately 1,800 pounds per year of hexavalent chromium assuming concentrations of 400 parts per billion (ppb) in the untreated water. This increased treatment capacity would be gained by increased pumping volumes and continued 24-hour-per-day operation.

Facility Influent and Effluent Filtration

Both the influent and effluent filtration would use a duplex bag filter system that may be equipped with automated sequencing based on differential pressure. During preliminary design, alternative influent filtration methods, such as sand filters, may be evaluated. The differences in filtration method are not expected to contribute to differences in environmental consequences.

B.3.2 OPTION 2: MASS REMOVAL VIA LAND APPLICATION

This option uses land application and evaporation of treated water as a disposition method. Instead of injecting all treated water into the aquifer as a method of plume control, some treated water would be stored in existing synthetically lined storage basins in Mortandad Canyon, then conveyed through an existing system of basin pumps and piping for disposition by any of the following methods: (1) irrigation-type sprinklers using an array of sprinkler heads, (2) mechanical evaporators, or (3) 3,000 to 10,000 gallon water trucks with high-pressure sprayers. Use of the irrigation system and/or mechanical evaporators would be prioritized over the use of water trucks to minimize vehicle traffic.

The land application method would only occur in permitted areas per a National Pollutant Discharge Elimination System (NPDES) land permit, only up to land application allowable/permitted limits (currently 350,000 gallons per day [gpd]), and is limited in geographic area, months of the year, and time of day, for when it can be applied (per requirements of the NMED discharge permit). The current land application areas, and areas not suitable for this disposition pathway, are shown in Figure B-3.

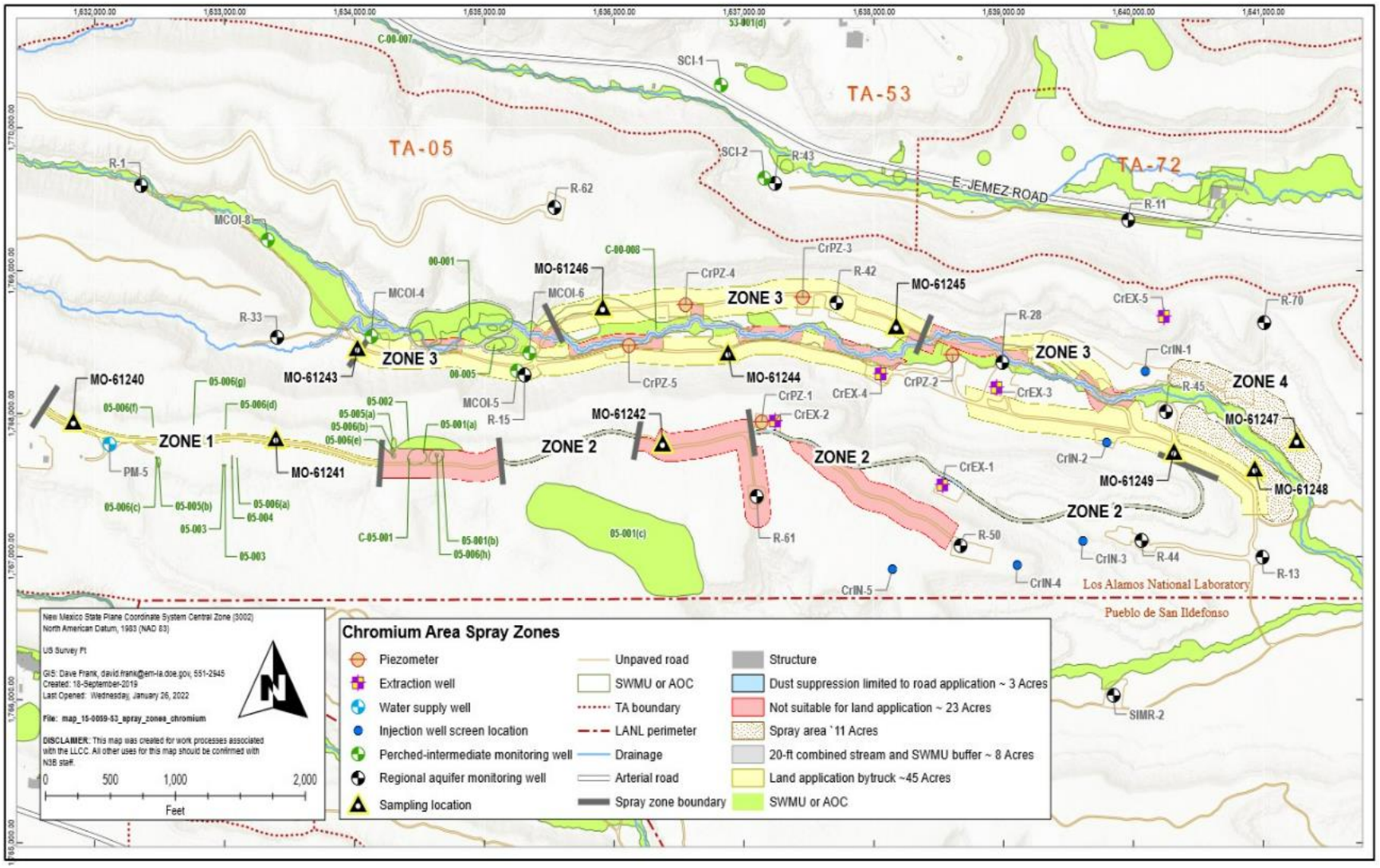

Figure B-3. Treated water land application area

B.3.3 OPTION 3: MASS REMOVAL VIA IN-SITU TREATMENT

This option uses in-situ treatments to supplement groundwater extraction and treatment of the contaminated groundwater. In-situ treatment involves introducing amendments in untreated water and relies on chemical processes to immobilize and detoxify contaminants within soil or groundwater without extracting them from the ground. Naturally occurring compounds that can act as reducing agents in a monitored natural attenuation (MNA) scenario include ferrous minerals, selected sulfur minerals, natural organic carbon, and reduced nitrogen species. Many chemicals can also be added to the aquifer to serve as reducing agents (see list). These amendments will be reviewed for use and will not contribute to additional contamination.

Potential methods for in-situ treatment include the following:

- Electrokinetic Treatment
- In-Situ Chemical Reduction Agents
    - Dithionite
    - Calcium polysulfide
    - Ferrous sulfate
    - Ferrous ammonium sulfate
    - Sodium bi/meta sulfite
    - Sulfur dioxide gas phase
    - Iron-biochar
    - Nano zero-valent iron (ZVI)
    - Activated carbon coated nanoparticles
    - Nano iron sulfide
    - Nano bimetallic ZVI, aluminum coated iron
    - Permeable Reactive Barrier with ZVI, nano ZVI, bimetallic ZVI
    - Metals Remediation Compound TM (Regenesis)
- In-Situ Biological Reduction Agents
    - Lactate
    - Emulsified vegetable oil
    - Molasses
    - Algae/fungi
    - Bacteria cultures

In addition to these Proposed Action options in the regional aquifer, other measures to achieve the final remedy through source removal could be instituted in the shallow and vadose zone groundwater, alluvium, and intermediate groundwater, mostly up-canyon from the currently identified chromium groundwater plume. The discharge of treated waters could be released into

Sandia Canyon or through the laboratory's NPDES outfall for treated effluent. The details related to these other measures are shown in Table B-1.

B.3.4 OPTION 4: MONITORED NATURAL ATTENUATION

This approach relies on natural physical, chemical, or biological processes to reduce concentrations, toxicity, or mobility of chromium. Regular monitoring must be conducted to ensure that MNA is working. EM-LA would consider MNA when contamination poses relatively low risks, the plume is stable or shrinking, and the natural attenuation processes are projected to achieve remedial objectives in a reasonable timeframe, compared to more active methods.

The *Final Environmental Assessment for the Expansion of the Sanitary Effluent Reclamation Facility and Environmental Restoration of Reach S-2 of Sandia Canyon at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1736) (NNSA, 2010) evaluated the environmental impacts of installing grade control structures in the Sandia Canyon source area to create a stable area of moist soils to minimize erosion of contaminated sediment. These grade control structures were installed in 2015, and periodic wetlands sampling indicates that chromium in wetland sediments is predominantly geochemically stable as trivalent chromium, Cr(III), and is not likely to become a future source of chromium contamination in groundwater, especially if saturated conditions are maintained within the wetland. Prior to the installation of the grade control structures, natural reducing conditions in the Sandia Canyon wetland had created a viable MNA scenario, which the grade control structures supplemented with more active water level and saturation control. Therefore, continuation of MNA is the proposed treatment option for the Sandia Canyon source area.

Adaptive Site Management Alternatives

Table B-1, Description of the Proposed Adaptive Site Management Alternatives, includes a breakdown of the supporting information and implementation needs for each potential ASM option.

This table is best read in coordination with the full analysis provided in Chapter 3 of the EA. The analysis in Chapter 3 uses a bounding approach to assess the maximum impacts based on the ASM options. This approach assumes that EM0LA would implement all of the ASM options in combination and is designed to identify the maximum range of potential impacts.

Alternatively, Table B-1 provides supporting information for each individual option. The approach in this table is used to display the separate implementation needs should EM-LA choose to select the options individually.

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
Schedule	This EA assumes well drilling occurs 24 hrs a day, 7 days a week. Approximately 4 wells can be drilled per yr, and each well takes approximately 5 months to drill. Two wells can be drilled simultaneously, with about 6 well pads being constructed per yr. Expanded treatment facility would take approximately 2 yrs to construct and connect piping to existing wells. Treatment facility would operate 24 hours a day, 7 days a week.	Same as Option 1. Land application is limited in geographic area, months of the year, and time of day, for when it can be applied (per requirements of the NMED discharge permit).	Same as Option 1. There are no additional schedule limitations for in-situ treatment.	EM-LA would consider MNA when contamination poses relatively low risks, the plume is stable or shrinking, and the natural attenuation processes are projected to achieve remedial objectives in a reasonable timeframe, compared to more active methods. Routine monitoring must be conducted to ensure that MNA is working.
Wells and Piezometers	**Existing wells:** • 5 injection wells: 70 gpm (1,000 gpm max capacity) • 5 extraction wells: 70 gpm (1,000 gpm max capacity) • 13 monitoring wells • 5 Piezometers **New Wells:** • Up to 15 injection wells: 70 gpm (1,000 gpm max capacity) • Up to 15 extraction wells: 70 gpm (1,000 gpm max capacity) • Up to 16 monitoring wells with 1 monitoring well converted from an	**Existing wells:** Same as Option 1 **New Wells:** Same as Option 1	**Existing wells:** Same as Option 1 **New Wells:** Same as Option 1 This option introduces amendments in untreated water and rely on chemical processes to immobilize and detoxify contaminants within soil	**Existing Wells:** Same as Option 1 **New Wells:** Same as Option 1 DOE would only implement MNA when it can verify contamination poses relatively low risks, the plume is stable or shrinking, and the natural

[1] Because the specific combination of remedial options to be implemented for effective and efficient cleanup is unknown, the analysis of impacts in this EA is based on conservative assumptions using maximum reasonably foreseeable disturbance and impact levels from a combination of all four remedial options. EM-LA could choose from the "menu" of the four Proposed Action options based on changing site conditions and could implement the options individually or in combination. The bounding approach to the analysis of environmental impacts in this EA assumes that EM-LA would implement all of the Proposed Action options in combination and is designed to identify the maximum range of potential impacts. Therefore, the impacts of the activities that could occur under the Proposed Action evaluated in this EA are considered bounding.

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
	existing well • Sandia Wetlands Source area: 20 wells (shallow piezometers) • Deep vadose zone: 10 wells (0–1,400 ft)		or groundwater without removing them from the ground. As a stand-alone option, in-situ treatment may involve infrastructure (e.g., monitoring wells) constructed as part of other ASM options.	attenuation processes are projected to achieve remedial objectives in a reasonable timeframe. MNA may involve infrastructure (e.g., monitoring wells) constructed as part of other ASM options.
New Piping	Piping from the extraction wells to the treatment system would be double-walled pipe. Piping to injection wells would be single-walled pipe. EM-LA estimates that 30,000 ft of double-walled pipe and 30,000 ft of single-walled pipe would be needed. Pipelines supporting any new treatment facility or pumping station would be installed in previously disturbed or developed areas.	Same as Option 1, additional piping to synthetically lined storage basins, irrigation-type sprinklers, and mechanical evaporators already exists.	Same as Option 1, additional piping for in-situ treatment would not be needed.	New piping would be dependent on what ASM Options EM-LA decides to implement, and in which order.
Maximum Total Annual Extraction, Injection, and Land Application Rates	**Extraction Rate:** 550,000,000 gpy **Injection Rate:** 550,000,000 gpy	**Extraction Rate:** 550,000,000 gpy **Injection Rate:** 462,500,000 gpy **Land Application Rate:** 87,500,000 gpy (350,000 gpd * 250 days/yr)	**Extraction Rate:** Same as Options 1 and 2. Rates of extraction, injection, and land application would be dependent on what ASM Options EM-LA decides to implement, and in which order. As a stand-alone option, in-situ treatment is not dependent on rates of extraction, injection, and land application. **Injection Rate:** Same as Options 1 and 2. Rates of extraction, injection, and land application would be dependent on	**Mortandad Canyon:** The process of extraction, injection, and land application are not a necessary part of MNA. However, rates of extraction, injection, and land application would be dependent on what ASM Options EM-LA decides to implement, and in which order. **Sandia Canyon:** There would be no extraction, injection, or land application in Sandia Canyon.

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
			what ASM Options EM-LA decides to implement, and in which order. As a stand-alone option, in-situ treatment is not dependent on rates of groundwater extraction, injection, and land application.	
Other New Facilities and Infrastructure	**New Facilities:** Construct a new 10,000 ft^2 treatment facility situated in a previously disturbed area. The facility would require about 20,000 ft^2 of land for construction. The new treatment facility would continue to utilize existing feed tanks and injection pumps located at the R-28 well site for injection into existing wells CrIN-1, CrIN-2, CrIN-3, CrIN-4 and CrIN-5. New injection wells would require new feed tanks and injection pumps that could be installed in the new treatment facility. Cr treatment facility (contactors, ion exchange vessels, electrical room, control room, bathroom, septic, feed tanks, injection pumps). Electrical connection to LANL system. Requirement for power to be determined based upon final facility design. Three-phase, 480-volt power is available at the anticipated location. No new electrical lines would be needed to connect to the 3-phase 480-volt power.	**New Facilities:** Same as Option 1 Note: The permitted land application rate is unlikely to be increased under the currently permitted areas. EM-LA currently does not approach or exceed the permitted application rate, and land application appears to be a logistically infeasible method to disposition extracted water without the addition of a new outfall for large-scale application. Permit modification applications for 1835 (injection) and 1793 (land application) are being reviewed by the state.	**New Facilities:** Same as Option 1 Option 3 involves injecting amendments into the aquifer and does not itself involve construction of new facilities or infrastructure.	**New Facilities:** Same as Option 1 DOE would only implement MNA when it can verify contamination poses relatively low risks, the plume is stable or shrinking, and the natural attenuation processes are projected to achieve remedial objectives in a reasonable timeframe. MNA may involve infrastructure (e.g., monitoring wells) constructed as part of other ASM options.

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
	Heating and ventilation would be required. Air conditioning is recommended for electrical and control room(s). Potable (or possibly non-potable) water would be needed if toilets are installed. Wastewater disposal via septic system or other method would be needed if toilets are installed. Design and construction require compliance with LANL and Institutional Biological Safety Committee. The existing Cr systems were exempt from IBC because the structures were unmanned, temporary and were environmental related. The new facility would not be located on or near cultural resources. Roads, pipeline, temporary pump sheds, and other support infrastructure would be located to avoid known cultural resources. Ground disturbing activities would be monitored for cultural resources according to laboratory procedures.			
Hexavalent Chromium Treatment and Removal	Untreated groundwater would be delivered to new treatment facility from extraction wells through existing valve in CrEX-5 and new double-walled pipeline. The treatment system would consist of a 1,000-gpm dual ion exchange	Under this option, treated water would be disposed of using an array of sprinkler heads, mechanical evaporators, or trucks with high-pressure sprayers. Land application would only occur in permitted areas per NPDES land	This option introduces amendments in untreated water and rely on chemical processes to immobilize and detoxify contaminants within soil or groundwater without removing them from the ground. In-situ options will be evaluated as technologies emerge and will only	This option relies on natural physical, chemical, or biological processes to reduce concentrations toxicity, or mobility of chromium. Routine monitoring must be conducted to ensure that MNA is working. DOE would only implement MNA when it can verify contamination

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
	treatment system with prefiltration, associated piping, flow controls, and programmable logic controls and monitoring. **Amount of Chromium Removed:** Approximately 1,800 lbs/yr assuming 400 ppb Cr in extracted water and the increased pumping rate. **Ion Exchange options for Cr treatment system include:** 1. Exchangeable ion exchange vessels 2. Permanent treatment contactors with ion exchange resin would be regenerated off site and delivered via tanker truck. The use of 60 ft^3 contactors is the preferred method for treatment. Current Super 30 vessels contain a media volume of 30 ft^3; media weight is 1,685 lbs. When vessels are sent back to the vendor, a total of 3–4 are sent back at a time (90–120 ft^3 of media). The media remains in the tanks when sent back and the vendor handles the waste according to state and Federal regulations. The resin is regenerated and reused multiple times. Metals are	permit (not on cultural sites or within waterways/drainages, etc.) and up to land application permitted limits (currently 350,000 gpd).	be used if they do not contribute to additional contamination of the aquifer. For a full list of options that EM-LA is considering, see Section 1.2.	poses relatively low risks, the plume is stable or shrinking, and the natural attenuation processes are projected to achieve remedial objectives in a reasonable timeframe.

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
	stripped from the resin and captured as metal hydroxide sludge. The sludge is shipped to a recycling facility by the vendor. EM-LA does not handle waste disposal of this material.			
Facility Effluent and Influent	Influent and effluent filtration would be completed using single or duplex bag filter systems that may be equipped with automated sequencing based on differential pressure. During preliminary design, alternative filtration methods may be evaluated.	Treated water would be land applied in accordance with the permits. Permit requirements are found NMED Ground Water Quality Bureau discharge permit DP-1793 (NMED, 2015). All areas used for land application of treated effluent would be located to avoid known historic properties.	Depending on where and when EM-LA determines in-situ is a viable option, the rates of effluent and influent filtration and application rates have the potential to be the same as Options 1 and 2. Option 3 involves injecting amendments into the aquifer and does not itself involve facility effluent and influent treatment.	A facility for treating groundwater is not a necessary component for MNA. However, MNA would be dependent on what ASM Options EM-LA decides to implement, and in which order.
Equipment for Well Drilling and Other Activities	**Combustion Equipment for Construction of One Well and Pad (~1,500 ft)**			

Equipment	Duration	Purpose
2 Air Compressors	5 months	Used with drill rig
4 Generators	12 months	Used with drill rig and pumping systems
6 Light Plants	6 months	Used during night drilling operations
1 Drill rig	6 months	Drill and install well
1 Smaller rig to set pump/Baski System	1 months	Install pump/Baski system
1 Cement/grout pump	6 months	Used to install cement into well
1 Power washer	6 months	Used to clean equipment after pumping cement
1 Smooth roller	3 months	Well pad construction
1 Sheep foot roller	3 months	Well pad construction
1 Pay loader	3 months	Well pad construction
1 Excavator	3 months	Well pad construction
1 Bulldozer	3 months	Well pad construction
1 Water truck	9 months	Supplies water during well drilling and construction
10 deliveries per month for drill pipe, well construction materials, well pad construction materials, frac tanks, etc.		

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
	Additional Notes This chart applies to all options; however, the following also apply: • **Option 2**: Includes additional trucks for land application and potentially mechanical evaporators • **Option 3:** Additional vehicles and equipment for introduction of treatment amendments and for additional well monitoring • **Option 4:** Additional vehicles and equipment for routine well monitoring			
Employment	120 **Personnel for construction of one Well and Pad:** 38-person teams working concurrently throughout the year with December off. • 8 drilling employees and 30 support/administrative personnel per well (see breakdown) • Total duration of 5 months per well **Drilling personnel:** • 2 Drillers • 4 Hands • 2 Task Managers **T2S support/admin:** • 1 Program Manager • 2 STR • 2 Project Managers • 4 FTL • 1 Engineer • 1 GIS **N3B support/admin:** • 1 Program Manager	120 **Personnel for construction of one Well and Pad:** Same as Option 1 **Drilling personnel:** Same as Option 1 **T2S support/admin:** Same as Option 1 **N3B support/admin:** Same as Option 1	120 **Personnel for construction of one Well and Pad:** Same as Option 1 **Drilling personnel:** Same as Option 1 **T2S support/admin:** Same as Option 1 **N3B support/admin:** Same as Option 1	120 **Personnel for construction of one Well and Pad:** Same as Option 1 **Drilling personnel:** Same as Option 1 **T2S support/admin:** Same as Option 1 **N3B support/admin:** Same as Option 1

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
	• 2 STR • 2 Project manager • 2 FETL • 1 Craft foreman • 10 Crafts Crew • 1 SOM			
New Land Disturbance	**Land disturbance during construction:** About 75 ac of total disturbed area for additional wells and access roads (1.33 ac each)	**Land disturbance during construction:** Same as Option 1, land application areas would not otherwise be increased.	**Land disturbance during construction:** Same as Option 1 Option 3 involves injecting amendments into the aquifer and does not itself involve new disturbance. Depending on where and when EM-LA determines in-situ is a viable option, in-situ treatment has the potential to involve the same amounts of land disturbance as Options 1 and 2.	**Land disturbance during construction:** Same as Option 1 New land disturbance is not anticipated for MNA as a stand-alone option. However, MNA would be dependent on what ASM Options EM-LA decides to implement.
Excavation and Backfill	**Cut/Fill Estimates:** Average cut is 550 yd^3; average fill is 600 yd^3. The grading design is completed to balance the cut and fill to the extent possible, and then can be field adjusted to balance even more. Any areas requiring fill are made up with base course material when completing the well pad.	**Cut/Fill Estimates:** Same as Option 1	**Cut/Fill Estimates:** Same as Option 1 Option 3 involves injecting amendments into the aquifer and does not itself involve activities requiring excavation and backfill. Depending on where and when EM-LA determines in-situ is a viable option, excavation and backfill for in-situ treatment have the potential to be the same as for Option 1.	**Cut/Fill Estimates:** Same as Option 1 Excavation and backfill are not anticipated for MNA as a stand-alone option. However, MNA would be dependent on what other ASM Options EM-LA decides to implement.

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
	Base Course (crushed stone) Material: It is assumed that base course material would be applied to a depth of 4 ft over the entire well pad and access road. It is estimated that about 800 yd^3 of base course material is needed for each well and access road. Therefore for 45 additional wells, about 36,000 yd^3 of base course material would be needed. No additional fill would be needed.	**Base Course (crushed stone) Material:** Same as Option 1	**Base Course (crushed stone) Material:** Same as Option 1 Option 3 involves injecting amendments into the aquifer and does not itself involve activities requiring excavation and backfill. Depending on where and when EM-LA determines in-situ is a viable option, excavation and backfill for in-situ treatment have the potential to be the same as for Option 1.	**Base Course (crushed stone) Material:** Same as Option 1 Excavation and backfill are not anticipated for MNA as a stand-alone option. However, MNA would be dependent on what other ASM Options EM-LA decides to implement.
Utility Usage	**Electricity:** Well construction would use portable generators. Operations: Wells/treatment facility will be connected to the existing electrical line system in place for the IM – 3-phase 480-volt power Total electricity use for construction and operation under this option would be 473,040 kilowatt-hours per year.	**Electricity:** Same as Option 1. Land application would require minor additional electricity requirements	**Electricity:** Same as Option 1. In-situ does not require additional electricity	**Electricity:** Same as Option 1
	Water: Well construction would use offsite water and portable toilets. Operations: Water is pumped into production lines, and booster pump stations lift this water to reservoir tanks for distribution. DOE purchases water from Los Alamos County for LANL	**Water:** Same as Option 1	**Water:** Same as Option 1	**Water:** Same as Option 1

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
	use.			
Site Access	No Change	No Change	No Change	No Change
Truck Transportation	**Estimated number of truckloads of fill:** Approximately 3,960 truckloads of fill for 45 wells and 10 deep vadose zone piezometers (2,173 loads of fill + 1,788 crushed stone)	**Estimated number of truckloads of fill:** Same as Option 1	**Estimated number of truckloads of fill:** Same as Option 1 Option 3 does not itself involve activities requiring transportation of fill material. Depending on where and when EM-LA determines in-situ is a viable option, excavation and backfill for in-situ treatment have the potential to be the same as for Option 1.	**Estimated number of truckloads of fill:** Same as Option 1 Excavation and backfill are not anticipated for MNA as a stand-alone option. However, MNA would be dependent on what other ASM Options EM-LA decides to implement.
	Estimated number of truckloads of crushed stone: 1,788 crushed stone	**Estimated number of truckloads of crushed stone:** Same as Option 1	**Estimated number of truckloads of crushed stone**: Same as Option 1	**Estimated number of truckloads of crushed stone:** Same as Option 1
	Estimated number of truckloads of concrete: Extraction and injection well pads would require a total of 110 truckloads of concrete into the site. Shallow piezometers in Sandia Canyon would require approximately 5 truckloads of concrete.	**Estimated number of truckloads of concrete:** Same as Option 1	**Estimated number of truckloads of concrete:** Same as Option 1	**Estimated number of truckloads of concrete:** Same as Option 1
	Estimated number of truckloads of well casing: 4,950 total truckloads for 45 wells and 10 deep vadose zone piezometers – 10 deliveries per month per well for drill pipe, well construction	**Estimated number of truckloads of well casing:** Same as Option 1	**Estimated number of truckloads of well casing:** Same as Option 1	**Estimated number of truckloads of well casing:** Same Option 1

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
	materials, well pad construction materials, frac tanks, etc.			
	Estimated number of truckloads of piping: 16 truckloads of piping would be needed to transport the 61,000 ft of new piping.	**Estimated number of truckloads of piping:** Same as Option 1	**Estimated number of truckloads of piping:** Same as Option 1	**Estimated number of truckloads of piping:** Same as Option 1
	Estimated number of truckloads of Ion Exchange Resin: 75–100 (or an average of 88) truck shipments annually	**Estimated number of truckloads of Ion Exchange Resin:** Same as Option 1	**Estimated number of truckloads of Ion Exchange Resin:** Same as Option 1	**Estimated number of truckloads of Ion Exchange Resin:** Same as Option 1
	Estimated number of truckloads of other materials and equipment: Construction and operation of the new wells and piezometers would need about a total of about 3, 960 truckloads of course base fill, about 130 truckloads of concrete and piping, 4,950 truck deliveries for the drilling operations, 2,011 truckloads of road fills, and 88 truckloads ion exchange resin for the annual road maintenance and treatment facilities operation.	**Estimated number of truckloads of other materials and equipment:** Same as Option 1	**Estimated number of truckloads of other materials and equipment:** Same as Option 1	**Estimated number of truckloads of other materials and equipment:** Same as Option 1
Waste Management	No sources of hazardous materials or waste are known that would substantively contribute to potential project efforts. Small quantities of construction debris, approximately 30 gpy of hazardous waste; industrial waste (i.e., construction debris) generated from the project would be approximately 50 yd^3 per yr. This waste would be shipped to various	Same as Option 1	Same as Option 1	Same as Option 1

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
	facilities outside Los Alamos for disposal. Ion exchange resin would be tracked and a vessel would be removed from service once the resin capacity is exhausted. Resin vessel would be sampled and analyzed to determine if it is a hazardous waste before the resin is returned to the vendor for regeneration and/or shipped as hazardous waste but still returned to vendor for regeneration. Injection well maintenance would occur once per year, per well. Approximately 50,000 gal of treated water with chemical additives would be produced from each well annually. If 4 wells are drilled in one year a total of 200,000 gal of treated water with chemical additives would be produced each year.			
Hazardous Materials and Waste Generation	**Annual Volumes of Nonhazardous Waste Generated:** 50 yd^3 per yr **Annual Volumes of Hazardous Waste Generated:** 30 gpy **Annual Volume of Wastewater Generated:** 50,000 gpy of treated water from maintenance and monitoring at each injection well.	**Annual Volumes of Nonhazardous Waste Generated:** Same as Option 1 **Annual Volumes of Hazardous Waste Generated:** Same as Option 1 **Annual Volume of Wastewater Generated:** Same as Option 1	**Annual Volumes of Nonhazardous Waste Generated:** Same as Option 1 **Annual Volumes of Hazardous Waste Generated:** Same as Option 1 **Annual Volume of Wastewater Generated:** Same as Option 1	**Annual Volumes of Nonhazardous Waste Generated:** Same as Option 1 **Annual Volumes of Hazardous Waste Generated:** Same as Option 1 **Annual Volume of Wastewater Generated:** Same as Option 1

Table B-1. Description of the proposed adaptive site management alternatives[1]

Issue	ASM Option 1: Mass Removal with Expanded Pump and Treat and Expanded Injection	ASM Option 2: Mass Removal with Land Application	ASM Option 3: Mass Removal with In-situ Treatment	ASM Option 4: Monitored Natural Attenuation (MNA)
	Waste Treatment and Disposal Pathways: All wastes are handled, treated, and disposed of in accordance with state regulations; applicable to specific waste classifications.	**Waste Treatment and Disposal Pathways:** Same as Option 1	**Waste Treatment and Disposal Pathways:** Same as Option 1	**Waste Treatment and Disposal Pathways:** Same as Option 1
Noise	**Schedule for construction of wells (i.e., days per well, hours of operation, etc.):** See schedule information. **Schedule of operation for water trucks for dust control (i.e., hours and days of operation):** fugitive dust suppression activities would be necessary during construction of wells, access roads, and other ground disturbing activities.	**Schedule for construction of wells (i.e., days per well, hours of operation, etc.):** Same as Option 1 **Schedule of operation for water trucks for dust control (i.e., hours and days of operation):** Same as Option 1 **Schedule of operation for water trucks for land application (i.e., hours and days of operation):** See schedule information above.	**Schedule for construction of wells (i.e., days per well, hours of operation, etc.):** Same as Option 1 **Schedule of operation for water trucks for dust control (i.e., hours and days of operation):** Same as Option 1	**Schedule for construction of wells (i.e., days per well, hours of operation, etc.):** Same as Option 1 **Schedule of operation for water trucks for dust control (i.e., hours and days of operation):** Same as Option 1

Key: < = less than; % = percent; ac = acre; AOCs = areas of concern; ASM = adaptive site management; Cr = chromium; CrIN = chromium injection; CrEX = chromium extraction; DOE = U.S. Department of Energy; DP = discharge permit; EA = Environmental Assessment; EM-LA = Environmental Management Los Alamos; FETL = Field Execution Team Leader; ft = feet; ft^2 = square feet; ft^3 = cubic feet; FTL = Field Team Leader; gal = gallon; GIS = geographic information systems; gpd = gallons per day; gpm = gallons per minute; gpy = gallon per year; hr = hour; IBC = International Building Codes; IM = interim measure; IM EA = Interim Measure Environmental Assessment; ISBR = in-situ biological reduction ; ISCR = in-situ chemical reduction; LANL = Los Alamos National Laboratory; lbs = pounds; MNA = monitored natural attenuation; N3B = Newport News Nuclear BWXT-Los Alamos, LLC; N/A = not applicable; NMED = New Mexico Environmental Department; NPDES = National Pollutant Discharge Elimination System; ppb = parts per billion; SME = subject matter expert; SOM = ; Shift Operations Manager; STR = Subcontractor Technical Representative; SWMU = Solid Waste Management Unit; yd^3 = cubic yard; yr = year

B.4 ALTERNATIVES CONSIDERED BUT NOT EVALUATED

EM-LA considered other alternatives in the development of potential actions to remediate the hexavalent chromium plume. Many technologies were considered for mass removal and control of chromium migration in regional groundwater and treatment of the chromium sources in Sandia Canyon sediment, shallow or vadose zone groundwater, and intermediate groundwater. Those evaluated, but removed from consideration, are listed in Table B-2.

B.5 REFERENCES

DOE. (2015). *Environmental Assessment for Chromium Plume Control Interim Measure and Plume Center Characterization.* U.S. Department of Energy.

LANL. (2009). Investigation Report for Sandia Canyon. *Los Alamos National Laboratory document LA-UR-09-6450*. Los Alamos, New Mexico: October.

NMED. (2015). *Ground Water Quality Bureau discharge permit DP-1793.* New Mexico Environmental Department.

NNSA. (2010, August 24). Final Environmental Assessment for the Expansion of the Sanitary Effluent Reclamation Facility and Envrionmental Restoration of Reach S-2 of Sandia Canyon at Los Alamos National Laboratory Los Alamos, New Mexico. *DOE/EA-1736*. Los Alamos, New Mexico: U.S. Department of Energy National Nuclear Security Administration.

Table B-2. Alternatives considered but not evaluated

Location	Technology	Effectiveness	Maturity	Relative Cost	Implementability	Reason Eliminated from Further Analysis
Sandia Canyon	Sediment/soil excavation	+	+	-	-	Excavation is technically feasible but cost prohibitive. Further, the status as a protected wetland prevents excavation of the area.
	DPT injection with ISCR/ISBR agents	-	-	-	-	Not needed. Data from geochemical studies presented in the Phase I IR (LANL, 2009) and Sandia wetland performance reports indicate that chromium in wetland sediments is predominantly geochemically stable as Cr(III) and is not likely to become a future source of chromium contamination in groundwater, especially if saturated conditions are maintained within the wetland.
	Sediment/soil mixing with ISCR/ISBR agents	+	+	-	-	
	Infiltration with ISCR/ISBR agents	-	-	-	-	
	Phytoremediation	-	-	+	-	Insoluble Cr(III) is not conducive to plant uptake, and some species can increase dissolved oxygen near their roots, which may not be favorable for maintenance of Cr(III).
	Containment	+	+	-	-	Containment barriers such as capping, grout walls are not needed to limit human or ecological exposure. Also not needed because chromium in wetland sediments is predominantly geochemically stable as Cr(III) and is not likely to become a future source of chromium contamination in groundwater, especially if saturated conditions are maintained within the wetland.
	Electrokinetic treatment	-	-	-	-	Innovative but has only been tested at pilot scale. Requires soluble Cr(VI), not insoluble Cr(VI). Expensive to install and operate.
Sandia Canyon Shallow/Vadose Zone Groundwater	Extraction with wells	+	+	-	-	Alluvium is too thin with low transmissivity for extraction wells.
	Extraction using a recovery trench	+	+	+	+	If extraction is used, a recovery trench spanning the width of the alluvium would be needed.

Table B-2. Alternatives considered but not evaluated

Location	Technology	Effectiveness	Maturity	Relative Cost	Implementability	Reason Eliminated from Further Analysis
	Extraction + ex situ groundwater treatment	+	+	+	+	Groundwater extraction would be feasible, if the occasional exceedances of Sandia Canyon alluvial groundwater (50–75 g/L range) indicate the need. Two of the proven industry-standard, full-scale treatment technologies are coagulation (or flocculation) and ion exchange. Others are not widely used for Cr in groundwater.
	Ion exchange for Cr(VI)	+	+	-	+	
	Reduction, precipitation and coagulation for Cr(VI)	+	+	-	+	
	Electrochemical precipitation for Cr(VI)	-	-	-	+	
	Reverse Osmosis/nanofiltration for Cr(VI)	-	-	-	+	
	Biochemical reactor/fluidized bed for Cr(VI)	-	-	-	+	
	Adsorption (activated carbon, Fe/Mn greensand) for Cr(VI)	-	-	-	+	
	Treated groundwater for municipal supply	+	-	-	-	Unlikely to attain public support, though currently used at several Cr contaminated drinking water aquifers in the U.S.
	Treated groundwater to POTW NPDES	+	+	-	-	The POTW for Los Alamos does not discharge to Sandia Canyon, and piping the discharge from a Sandia Canyon system would be impractical. The permitted Sandia Canyon outfall serves as the discharge for LANL treated sewage, and inclusion in the NPDES outfall permit may be possible for low flow rates.
	PRB	+	+	-	+	A PRB was included to potentially treat the occasional exceedance of the Cr standard in Sandia Canyon groundwater, but these exceedances are likely due to mobilized Cr(III) precipitates, which could be filtered but are non-reactive.

Table B-2. Alternatives considered but not evaluated

Location	Technology	Effectiveness	Maturity	Relative Cost	Implementability	Reason Eliminated from Further Analysis
	ZVI for Cr(VI)	+	+	-	+	Often used in a PRB setting (see PRB explanation).
	Adsorptive amendment for Cr(III)	-	-	-	+	As currently conceptualized, mobile Cr(III) colloids or nano precipitates are not adsorbed.
	Containment: slurry wall/sheet pile/grout curtain + extraction + treatment	+	+	-	-	If groundwater extraction in the alluvium were implemented, a groundwater extraction trench rather than these types of barriers would be used.
Intermediate and Regional Groundwater	Extraction + ex situ groundwater treatment	+	+	-	+	Two of the proven industry-standard, full-scale treatment technologies are coagulation (or flocculation) and ion exchange. Others are not widely used for Cr in groundwater.
	Electrochemical precipitation for Cr(VI)	-	-	-	+	
	Reverse Osmosis/nanofiltration for Cr(VI)	+	-	-	+	
	Biochemical reactor/fluidized bed for Cr(VI)	+	-	-	+	
	Adsorption (activated carbon, Fe/Mn greensand) for Cr(VI)	+	-	-	+	
	Constructed wetland (passive treatment) for Cr(VI)	+	-	+	-	
	Treated groundwater for municipal supply	+	-	-	-	Unlikely to attain public support, though currently used at several Cr contaminated drinking water aquifers in the U.S.
	Containment - fracture grouting	-	-	-	-	Involves sealing the fractured infiltration in intermediate groundwater, but fracture sealing the tuff would be difficult and sealing the brecciated Cerro del Rio all but impossible.

Key: Cr = chromium; DPT = direct push technology; Fe/Mn = iron/manganese; g/L = grams per liter; IR =Investigation Report; ISBR = in-situ biological reduction; ISCR = in-situ chemical reduction; LANL = Los Alamos National Laboratory; NPDES = National Pollutant Discharge Elimination System; PRB = Permeable Reactive Barrier; POTW = Publicly Owned Treatment Works; U.S. = United States

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Appendix C
Environmental Resources Supporting Information

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ENVIRONMENTAL RESOURCES SUPPORTING INFORMATION

C.1 WATER RESOURCES

This section presents figures illustrating groundwater components, contours of CR(VI), water table maps, and deep screen hydraulic head maps.

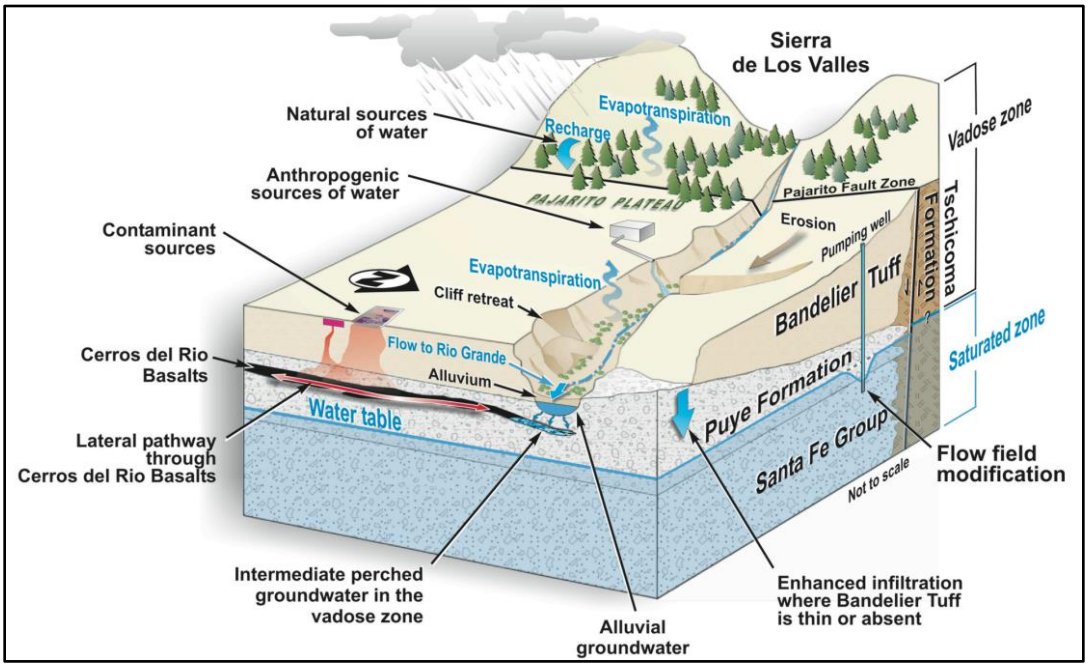


Figure C-1. Groundwater components at Los Alamos National Laboratory (Figure 1-2 from LANL, 2005)

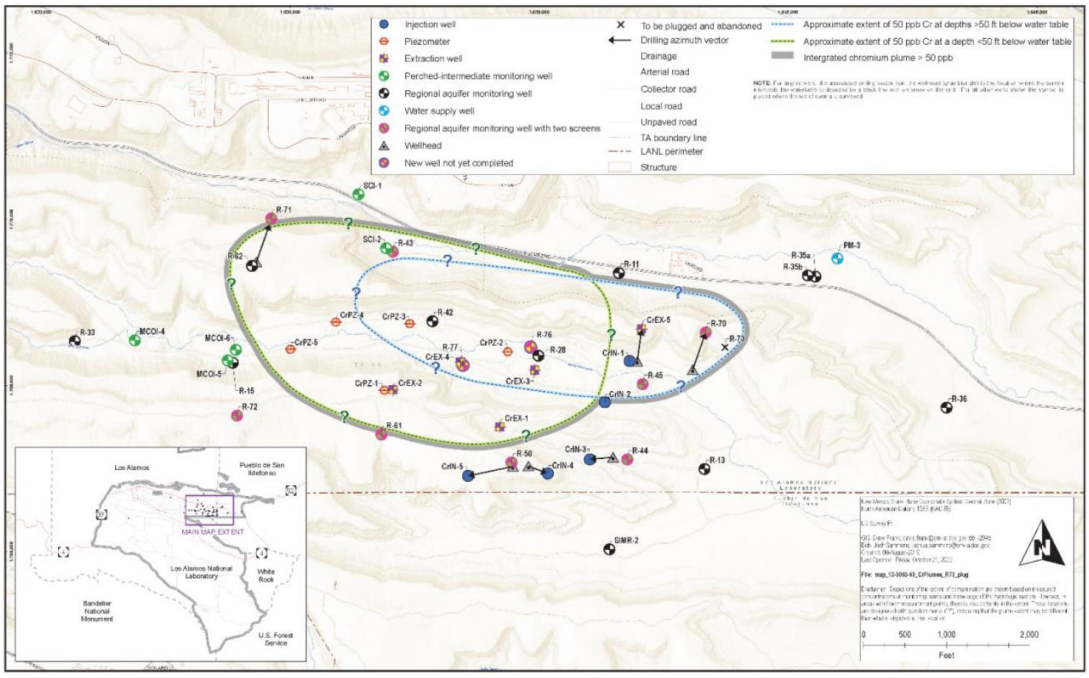


Figure C-2. Approximate iso-concentration contours of Cr(VI) in the regional aquifer with the locations of monitoring, injection, extraction, and water supply wells, and piezometers

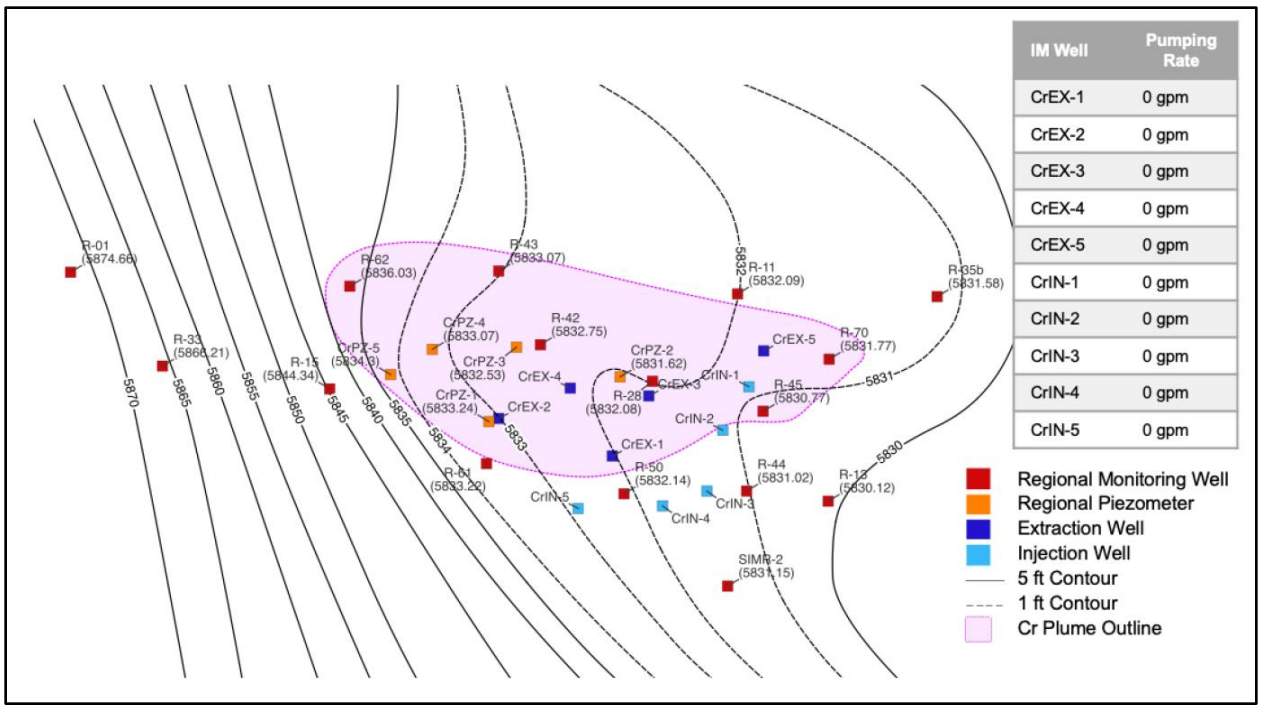


Figure C-3. Water table map for May 1, 2020, 1:00 a.m., which represents ambient ("baseline") conditions (Figure 8 from Neptune, 2023)

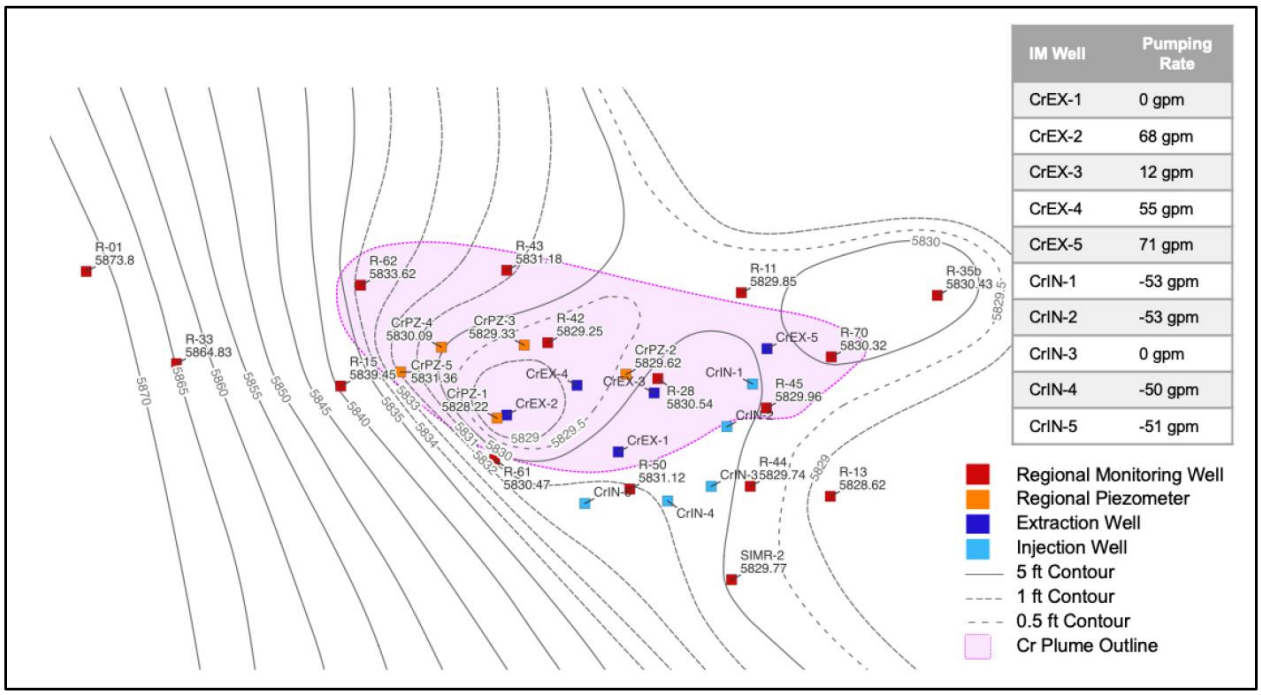
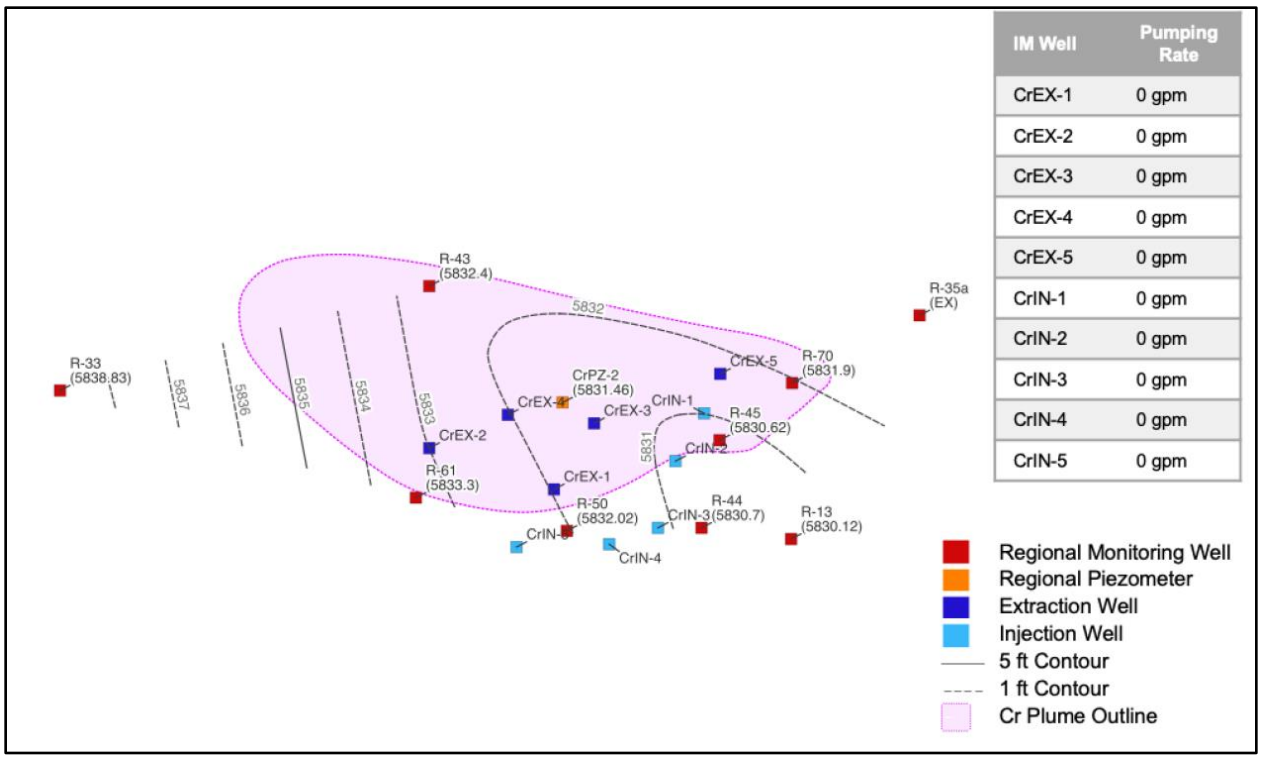
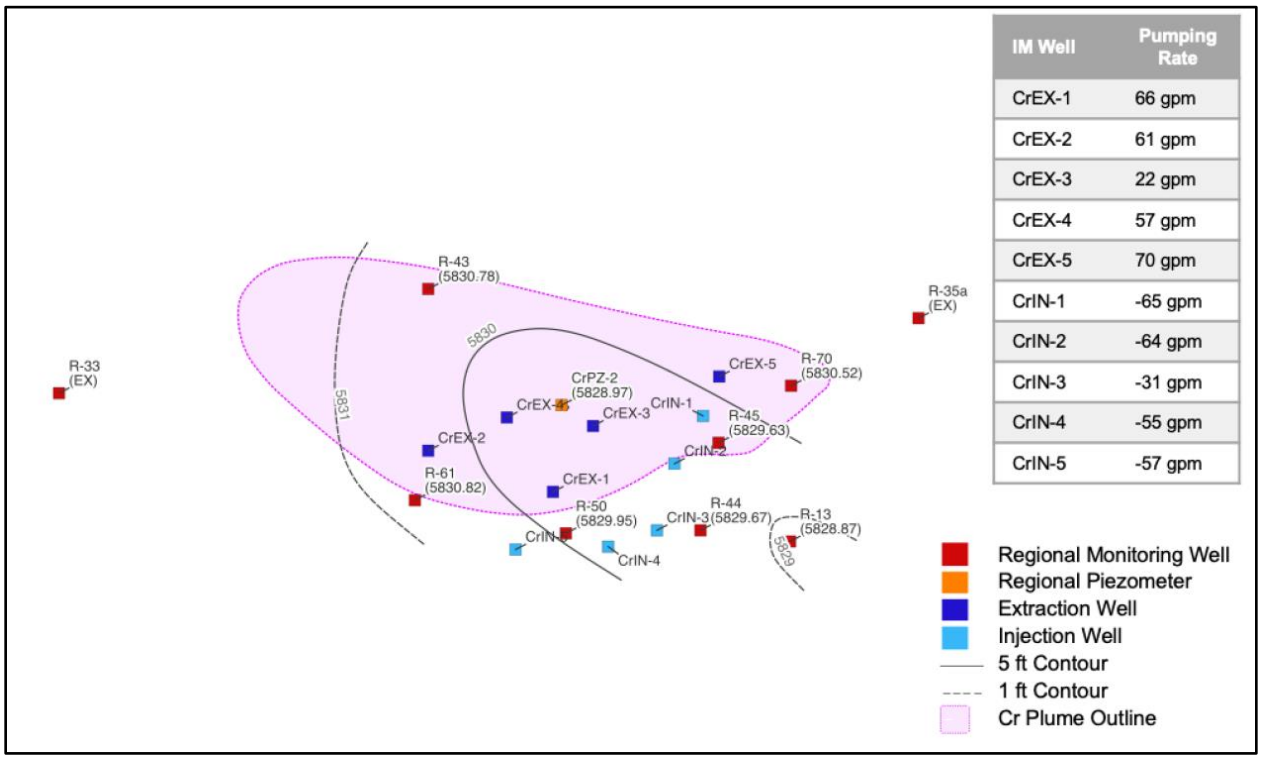


Figure C-4. Water table map for November 1, 2021, 1:00 a.m., which includes nearly full interim measure operation (with the exception of CrEX-1 and CrIN-3) (Figure 6 from Neptune, 2023)



IM Well	Pumping Rate
CrEX-1	0 gpm
CrEX-2	0 gpm
CrEX-3	0 gpm
CrEX-4	0 gpm
CrEX-5	0 gpm
CrIN-1	0 gpm
CrIN-2	0 gpm
CrIN-3	0 gpm
CrIN-4	0 gpm
CrIN-5	0 gpm

Figure C-5. Deep screen hydraulic head map for May 1, 2020, 1:00 a.m., which represents ambient ("baseline") conditions (Figure 9 from Neptune, 2023)



IM Well	Pumping Rate
CrEX-1	66 gpm
CrEX-2	61 gpm
CrEX-3	22 gpm
CrEX-4	57 gpm
CrEX-5	70 gpm
CrIN-1	-65 gpm
CrIN-2	-64 gpm
CrIN-3	-31 gpm
CrIN-4	-55 gpm
CrIN-5	-57 gpm

Figure C-6. Deep screen hydraulic head map for June 15, 2021, 1:00 a.m., which includes full interim measure operation (pumping and injection at all CrIN/CrEX wells) (Figure 10 from Neptune, 2023)

Water Resources Supporting Information References

LANL. (2005). *Los Alamos National Laboratory's Hydrogeologic Studies of the Pajarito Plateau: A Synthesis of Hydrogeologic Workplan Activities (1998-2004)*. LA-14263-MS.

Neptune and Company, Inc. (2023). Chromium Interim Measure Capture Zone Analysis, 16 June 2023.

C.2 AIR QUALITY

This section presents a figure illustrating the wind rose for Technical Area (TA)-5 Mortandad Canyon (MDCN).

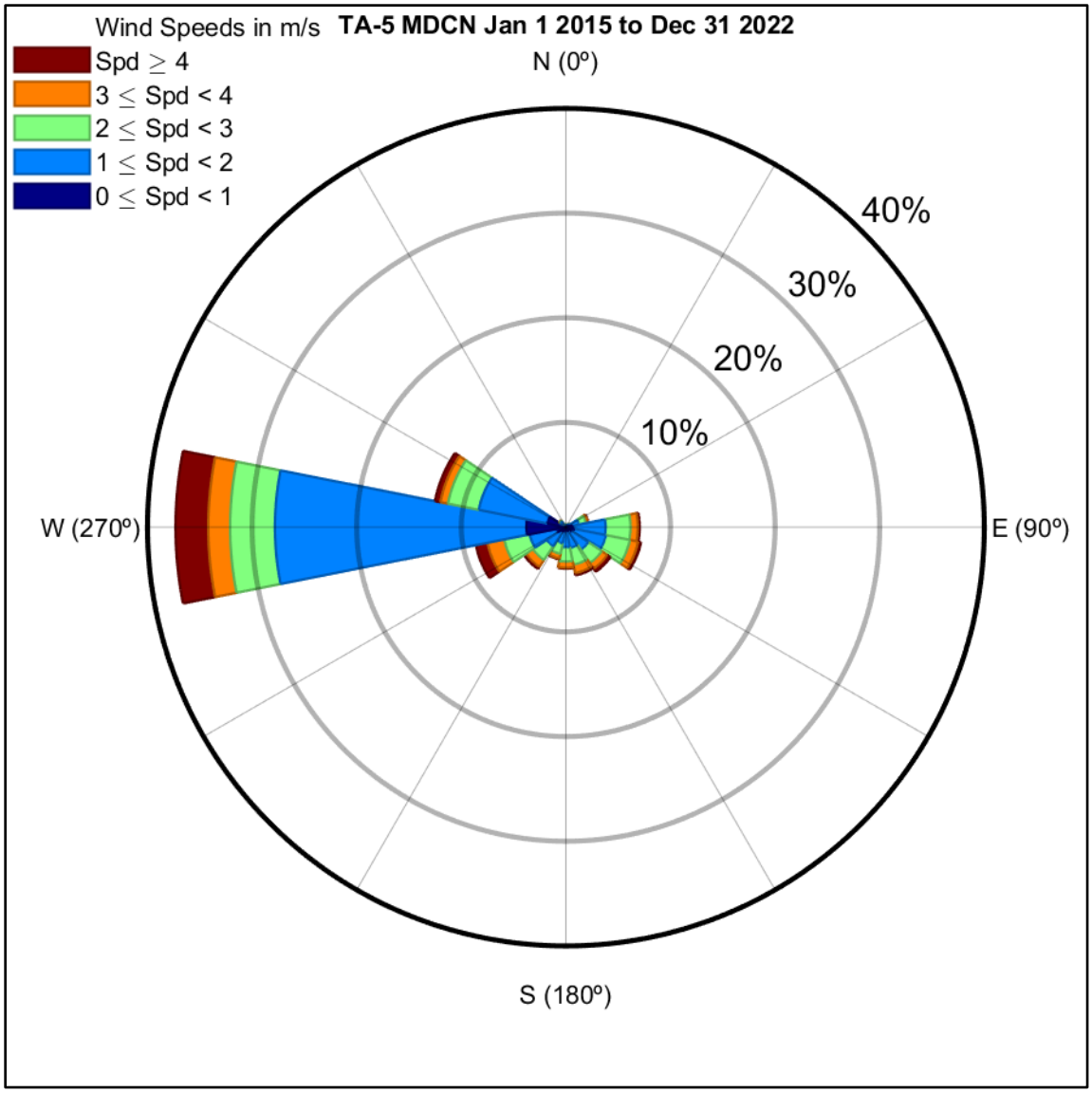


Figure C-7. Wind rose with speeds in meters per second (TA-5 MDCN)

The U.S. Department of Energy (DOE) Office of Environment Management (EM) would implement the following best management practices to minimize fugitive dust emissions during the proposed installation activities:

- During conditions of dry soil, use water spray/mists to minimize dust emissions generated from the operation of equipment on bare soils and the movement of vehicles on unpaved surfaces. When necessary due to dry conditions, apply water at the end of the workday to areas of soils disturbed during the day.
- Limit haul truck speeds to 15 miles per hour on any unpaved surface and 20 miles per hour on any paved surface. Post signs throughout the site to remind equipment operators and truck drivers of the speed limits.
- Consider covering unpaved roads with a low-silt-content material such as recycled road base or gravel to a minimum of 4 inches.
- Load and unload materials carefully to minimize the potential for spills or dust creation. Minimize drop height from loader bucket.
- To prevent soil haul trucks from tracking soil onto paved roads, use at least one of the following measures at each vehicle egress from on-site unpaved surfaces to on-site paved roads or public roads:
    - Install a pad consisting of washed gravel (minimum size of 1 inch) that is maintained in a clean condition to a depth of at least 6 inches and extending at least 30 feet wide and at least 50 feet long.
    - Pave the surface at least 100 feet long and at least 20 feet wide.
    - Use a wheel shaker/wheel spreading device, also known as a rumble grate, consisting of raised dividers (rails, pipe, or grates) at least 24 feet long and at a sufficient width to allow all wheels of vehicle traffic to travel over grate to remove bulk material from tires and vehicle undercarriages before vehicles exit unpaved surfaces.
    - Install and use a wheel-washing system to remove bulk material from tires and vehicle undercarriages before vehicles exit unpaved surfaces.
    - Any other control measure or device that prevents track-out onto paved roads.
- Use properly secured tarps that cover the entire surface area of truck loads. Maintain a minimum of 6 inches of freeboard or water, or otherwise treat the bulk material to minimize loss of material to wind or spillage.
- Soil Storage Piles: Implement at least one of the following measures:
    - Apply water at a sufficient quantity and frequency to prevent wind-driven dust.
    - Apply a non-toxic dust suppressant that complies with air and water quality agency standards at a sufficient quantity and frequency to prevent wind-driven dust.
    - Install and anchor tarps or plastic over the material.
    - Use surface crusting agents on inactive storage piles.
- Use a street sweeper at least twice per day to remove silt from on-site, paved roads traveled by haul trucks. Remove all track-out at the conclusion of each workday.
- To avoid fugitive dust during high wind conditions, cease soil disturbance activities if on-site wind speeds exceed 25 miles per hour for at least 5 minutes in an hour.

- Designate personnel to monitor the dust control program and increase control measures, as necessary, to minimize the generation of dust. This responsibility would extend to after-work hours.

C.3 ECOLOGICAL RESOURCES

This section presents figures and tables depicting vegetation types and special status species in the project area.

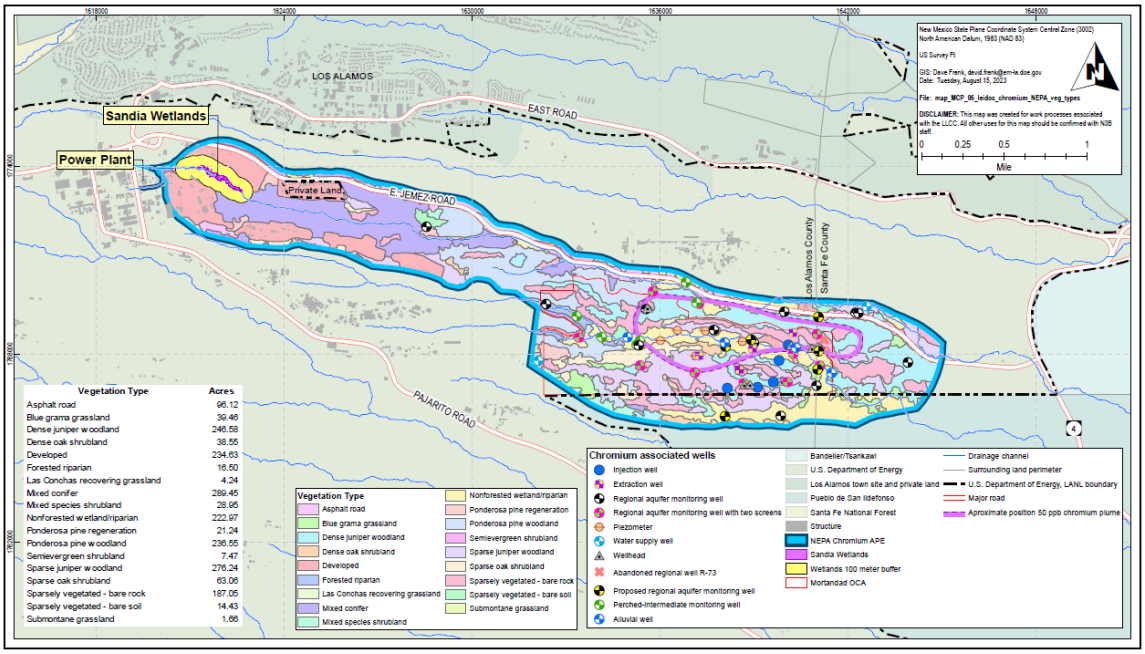


Figure C-8. Vegetation types in the project area

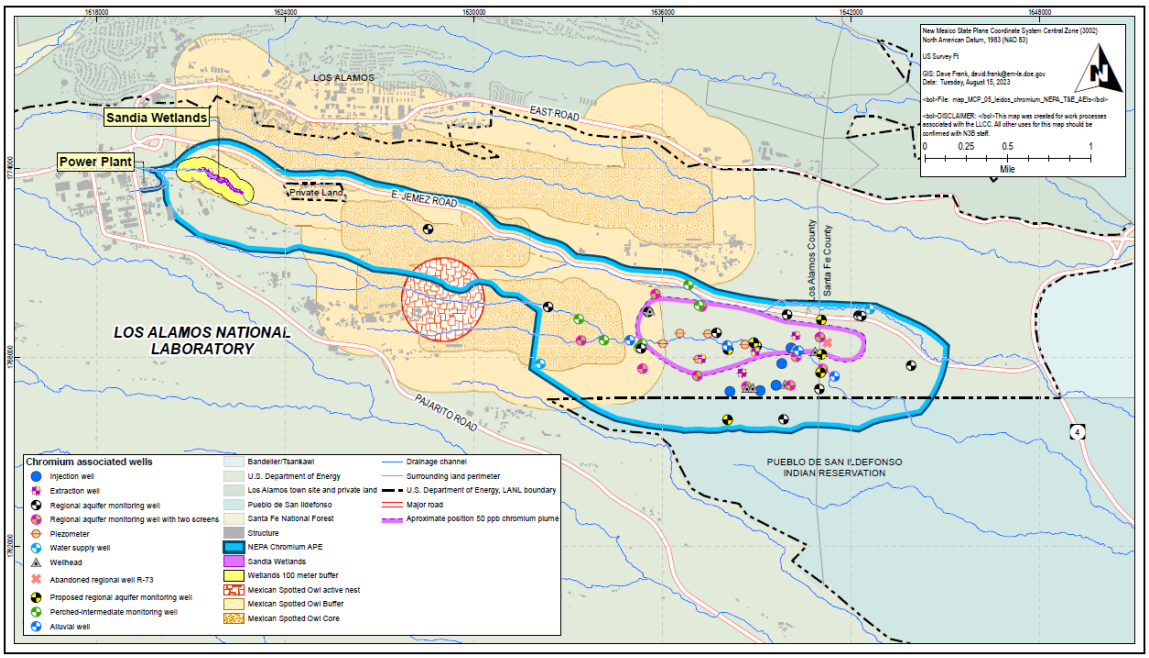


Figure C-9. Threatened, endangered, and sensitive species in the project area

1 **Table C-1. Sensitive species at Los Alamos National Laboratory**

Common name	Scientific name	New Mexico State Status	SWAP Category	NHNM [a]	Other [b]
Mammals					
Pale Townsend's Big-eared Bat	*Corynorhinus townsendii pallescens*		Susceptible	S3	
Spotted Bat	*Euderma maculatum*	Threatened	Susceptible	S3	
Gunnison's prairie dog	*Cynomys gunnisoni*		Immediate priority	S2	
Birds					
Bald Eagle	*Haliaeetus leucocephalus*	Threatened		S1	
Peregrine Falcon	*Falco peregrinus*	Threatened		S3	
Northern Goshawk	*Accipiter gentilis*			S2, S3	
Flammulated Owl	*Psiloscops flammeolus*		Immediate priority	S3	PIFWL
Lewis's Woodpecker	*Melanerpes lewis*		Immediate priority	S3	PIFWL
Gray Vireo	*Vireo vicinior*	Threatened	Immediate priority	S3	PIFWL
Pinyon Jay	*Gymnorhinus cyanocephalus*		Immediate priority	S2, S3	PIFWL
Juniper Titmouse	*Baeolophus ridgwayi*		Immediate priority		
Evening Grosbeak	*Coccothraustes vespertinus*		Susceptible		PIFWL
Cassin's Finch	*Haemorhous cassinii*		Susceptible	S3	PIFWL
Black-chinned Sparrow	*Spizella atrogularis*		Immediate priority	S3	PIFWL
Virginia's Warbler	*Leiothlypis virginiae*		Immediate priority	S3	PIFWL
Grace's Warbler	*Setophaga graciae*		Immediate priority	S3	PIFWL
Black-throated Gray Warbler	*Setophaga nigrescens*		Immediate priority	S3	
Amphibians and Reptiles					
Smooth Green Snake	*Opheodrys vernalis*			S3	
Plants					
Mountain wood lily	*Lilium philidelphicum*	Endangered		S3	
Springer's Blazingstar	*Mentzelia springeri*			S2	
Yellow Lady's Slipper	*Cypripedium parviflorum*	Endangered		S2	
Giant Helleborine Orchid	*Epipcactis gigantea*			S2	
Sapello canyon larkspur	*Delphinium sapellonis*			S3	
Invertebrates					
Monarch Butterfly	*Danaus plexippus*				Proposed

Sources: (LANL, 2020a)
Key: NHNM = Natural Heritage New Mexico; PIFWL = Partners in Flight watch list; Proposed; SWAP = New Mexico State Wildlife Action Plan
Notes:
[a] NHNM : Natural Heritage New Mexico state rankings of critically imperiled (S1), imperiled (S2), vulnerable (S3).New Mexico
[b] PIFWL: Partners in Flight watch list; Proposed: Proposed for Federal listing under the Endangered Species Act.

Table C-2. Summary of best management practices for threatened, endangered, sensitive species, pollinators, migratory birds and non-native invasive plants on Los Alamos National Laboratory

Common name Scientific name	Best Management Practices
Mammals	
Pale Townsend's Big-eared Bat *Corynorhinus townsendii pallescens*	Do not disturb active bat roosts, including on buildings. Avoid removing standing dead trees in the summer months. Buildings and outside structures slated for demolition should be inspected by biologists before work is conducted.
Spotted Bat *Euderma maculatum*	Do not disturb active bat roosts, including on buildings. Avoid removing standing dead trees in the summer months. Buildings and outside structures slated for demolition should be inspected by biologists before work is conducted. Because this species is so rare and not well understood, any sightings should be reported to biologists.
Gunnison's prairie dog *Cynomys gunnisoni*	Survey known locations before development.
Birds	
Bald Eagle *Haliaeetus leucocephalus*	In Bald Eagle habitat on LANL's eastern boundary along the Rio Grande, new power lines should comply with the suggested practices adopted by the electrical industry.
Peregrine Falcon *Falco peregrinus*	Avoid disturbing cliff structure in the canyons between March 1 and May 15 without having a Biological Resources SME survey the cliffs for peregrine nests. Limit human activity within 400 m of a nest site.
Northern Goshawk *Accipiter gentilis*	Avoid large tree removal in mixed conifer habitat from April through June. If tree removals are necessary during this time, contact a Biological Resources SME to survey trees before removal. No logging within 800 m of active nests or within established post-fledging areas (Reynolds et al. 1992).
Flammulated Owl *Psiloscops flammeolus*	Avoid tree and snag removal in mixed conifer habitat from April through June. If tree or snag removals are necessary during this time, contact a Biological Resources SME to survey the trees before removal.
Lewis's Woodpecker *Melanerpes lewis*	During vegetation-removal operations, active nests with eggs or nestlings could get destroyed. The BMP to protect these nests is to schedule tree and shrub removal outside of the peak bird-nesting season, May 15–July 15. During this time, EPC-ES biologists can survey trees and shrubs immediately before removal. If active nests are discovered outside of the breeding season, then work will be paused, and EPC-ES biologists must be notified. Active nests built within structures or equipment are also protected.
Gray Vireo *Vireo vicinior*	During vegetation-removal operations, active nests with eggs or nestlings could get destroyed. The BMP to protect these nests is to schedule tree and shrub removal outside of the peak bird-nesting season, May 15–July 15. During this time, EPC-ES biologists can survey trees and shrubs immediately before removal. If active nests are discovered outside of the breeding season, then work will be paused, and EPC-ES biologists must be notified. Active nests built within structures or equipment are also protected.
Pinyon Jay *Gymnorhinus cyanocephalus*	During vegetation-removal operations, active nests with eggs or nestlings could get destroyed. The BMP to protect these nests is to schedule tree and shrub removal outside of the peak bird-nesting season, May 15–July 15. During this time, EPC-ES biologists can survey trees and shrubs immediately before removal. If active nests are discovered outside of the breeding season, then work will be paused, and EPC-ES biologists must be notified. Active nests built within structures or equipment are also protected.
Juniper Titmouse *Baeolophus ridgwayi*	During vegetation-removal operations, active nests with eggs or nestlings could get destroyed. The BMP to protect these nests is to schedule tree and shrub removal outside of the peak bird-nesting season, May 15–July 15. During this time, EPC-ES biologists can survey trees and shrubs immediately before removal. If active nests are discovered outside of the breeding season, then work will be

Table C-2. Summary of best management practices for threatened, endangered, sensitive species, pollinators, migratory birds and non-native invasive plants on Los Alamos National Laboratory

Common name Scientific name	Best Management Practices
	paused, and EPC-ES biologists must be notified. Active nests built within structures or equipment are also protected.
Evening Grosbeak *Coccothraustes vespertinus*	During vegetation-removal operations, active nests with eggs or nestlings could get destroyed. The BMP to protect these nests is to schedule tree and shrub removal outside of the peak bird-nesting season, May 15–July 15. During this time, EPC-ES biologists can survey trees and shrubs immediately before removal. If active nests are discovered outside of the breeding season, then work will be paused, and EPC-ES biologists must be notified. Active nests built within structures or equipment are also protected.
Cassin's Finch *Haemorhous cassinii*	During vegetation-removal operations, active nests with eggs or nestlings could get destroyed. The BMP to protect these nests is to schedule tree and shrub removal outside of the peak bird-nesting season, May 15–July 15. During this time, EPC-ES biologists can survey trees and shrubs immediately before removal. If active nests are discovered outside of the breeding season, then work will be paused, and EPC-ES biologists must be notified. Active nests built within structures or equipment are also protected.
Black-chinned Sparrow *Spizella atrogularis*	During vegetation-removal operations, active nests with eggs or nestlings could get destroyed. The BMP to protect these nests is to schedule tree and shrub removal outside of the peak bird-nesting season, May 15–July 15. During this time, EPC-ES biologists can survey trees and shrubs immediately before removal. If active nests are discovered outside of the breeding season, then work will be paused, and EPC-ES biologists must be notified. Active nests built within structures or equipment are also protected.
Virginia's Warbler *Leiothlypis virginiae*	During vegetation-removal operations, active nests with eggs or nestlings could get destroyed. The BMP to protect these nests is to schedule tree and shrub removal outside of the peak bird-nesting season, May 15–July 15. During this time, EPC-ES biologists can survey trees and shrubs immediately before removal. If active nests are discovered outside of the breeding season, then work will be paused, and EPC-ES biologists must be notified. Active nests built within structures or equipment are also protected.
Grace's Warbler *Setophaga graciae*	During vegetation-removal operations, active nests with eggs or nestlings could get destroyed. The BMP to protect these nests is to schedule tree and shrub removal outside of the peak bird-nesting season, May 15–July 15. During this time, EPC-ES biologists can survey trees and shrubs immediately before removal. If active nests are discovered outside of the breeding season, then work will be paused, and EPC-ES biologists must be notified. Active nests built within structures or equipment are also protected.
Black-throated Gray Warbler *Setophaga nigrescens*	During vegetation-removal operations, active nests with eggs or nestlings could get destroyed. The BMP to protect these nests is to schedule tree and shrub removal outside of the peak bird-nesting season, May 15–July 15. During this time, EPC-ES biologists can survey trees and shrubs immediately before removal. If active nests are discovered outside of the breeding season, then work will be paused, and EPC-ES biologists must be notified. Active nests built within structures or equipment are also protected.
Mexican Spotted Owl *Strix occidentalis lucida*	Restriction of activities in undeveloped occupied Mexican spotted owl AEI. In Core habitat, people, vehicles, other light production and noise production is restricted from March 1–August 31. In AEIs Timing of projects must take into account that projects in core areas or projects that violate restrictions for occupied buffer areas must stop on February 28 of each year until occupancy status of the AEI is determined. Make every reasonable effort to reduce the noise from explosives testing within 800 m (2,624 ft) of occupied habitat. Methods to reduce noise could include contained shots, noise shields in the direction of AEI cores, etc. For night shots, every reasonable effort should be made to limit the amount of light directed into AEI core areas. Install signs on dirt roads and trails that lead into AEIs, posting them as restricted access areas and providing a contact number for access restrictions. Keep disturbance and noise to a minimum. Avoid unnecessary disturbance to vegetation (e.g., excessive parking areas or equipment storage areas, off-road travel, materials storage areas, crossing of streams or washes). Avoid removal of vegetation along drainage systems and stream channels.

Table C-2. Summary of best management practices for threatened, endangered, sensitive species, pollinators, migratory birds and non-native invasive plants on Los Alamos National Laboratory

Common name Scientific name	Best Management Practices
	Avoid all vegetation removals not absolutely necessary. Employ appropriate erosion and runoff controls to reduce soil loss. The controls must be put in place and periodically checked throughout the life of projects. Revegetate all exposed soils as soon as feasible after construction to minimize erosion. Focus development away from undeveloped areas on the western end of the Los Alamos Canyon AEI. Any development in buffer of Sandia-Mortandad AEI would require consultation.
Southwestern Willow Flycatcher *Empidonax traillii extimus*	Restriction of activities in undeveloped occupied Southwestern Willow Flycatcher AEI. In Core habitat, people, vehicles, other light production and noise production is restricted from May 15–September 15. No wetland vegetation will be removed outside of developed areas. Employ appropriate erosion and runoff controls to reduce soil loss. Avoid unnecessary disturbance to vegetation (e.g., excessive parking areas or equipment storage areas, off-road travel, materials storage areas, crossing of streams or washes). Avoid removal of vegetation along drainage systems and stream channels. Avoid all vegetation removals not absolutely necessary. Appropriate erosion controls must be put in place and periodically checked throughout the life of any projects. Revegetate all exposed soils as soon as feasible after disturbance to minimize erosion.
Amphibians and Reptiles	
Smooth Green Snake *Opheodrys vernalis*	Survey sites with suitable habitat before development.
Jemez Mountain Salamander *Plethodon neomexicanus*	Habitat alterations other than the fuels management practices and utility corridor maintenance are not allowed in undeveloped core areas. If a project or activity is planned that would alter habitat in an undeveloped core area, it must be individually evaluated for Endangered Species Act compliance. Habitat alterations in buffer areas must be reviewed by LANL biologists to ensure that there are no impacts to core habitat.
Plants	
Mountain wood lily *Lilium philidelphicum*	Survey sites with suitable habitat before development.
Springer's Blazingstar *Mentzelia springeri*	Survey sites with suitable habitat before development.
Yellow Lady's Slipper *Cypripedium parviflorum*	Survey sites with suitable habitat before development.
Giant Helleborine Orchid *Epipcactis gigantea*	Survey sites with suitable habitat before development.
Sapello canyon larkspur *Delphinium sapellonis*	Survey sites with suitable habitat before development.
Invertebrates	
Monarch Butterfly *Danaus plexippus*	Prioritize mowing before July 1. Do not mow from July 1–October 15. If mowing is necessary during that period, biologists should check the milkweed patches for eggs, caterpillars, and pupae before mowing. During the early breeding season (May–June), perform light mowing at a minimum height of 30–40 cm and/or mow milkweed in patches. Preserve some milkweed patches during the breeding season.

Table C-2. Summary of best management practices for threatened, endangered, sensitive species, pollinators, migratory birds and non-native invasive plants on Los Alamos National Laboratory

Common name Scientific name	Best Management Practices
	Plant native milkweed and wildflower seeds where possible for mitigation, restoration, and/or to enhance existing habitat. No mowing recommended July1–October 15, Light Mowing May 1–June 30, Priority mowing October 16–April 30.
Pollinators	If a high-quality site is identified in a project area, recommended site-specific prescriptions can be used to lessen the effects of the project and ensure that this valuable resource is protected. Site-specific prescriptions could include administrative controls, such as roadside vegetation management timing considerations, and physical controls, such as flushing bars on mowers to allow pollinators to escape mowing.
Native Bees	• Use seed from native forbs, grasses, and other plant species beneficial to local pollinators, and prioritize plant species that will provide continuous blooms from early spring to late fall for use in restoration and mitigation projects. • Avoid disturbing high-quality habitat areas that contain a variety of native flowering plants. • Remove invasive species opportunistically. Invasive non-flower species—particularly invasive Eurasian grasses—do not provide food for pollinators and restrict native bee-nesting areas. When possible, integrate roadside vegetation management, including mow during non-blooming seasons (late October through April). • When summer mowing is necessary, stagger mowing and/or mow in patches to ensure that some nectar flowers are always available and/or cut vegetation high (minimum 12–16 in). Allow pollinators and other wildlife to escape mower blades by using a flushing bar on the mower. Use herbicides efficiently and effectively. Avoid damage to non-target plants by using selective herbicides when feasible.
Migratory Birds	
	• Schedule tree and shrub removal outside of the peak bird-nesting season: May 15–July 15. During this time, EPC-ES biologists can survey trees and shrubs immediately before removal. If active nests are discovered outside of the breeding season, then work will be paused, and EPC-ES biologists must be notified. • Do not remove standing dead trees unless there is a hazard to workers. • Any active bird nests encountered regardless of the time of year are protected, including nests built within structures or equipment. Contact a LANL biological resources subject matter expert if an active nest is encountered during work activities. Do not disturb active nests. An active nest is a nest with eggs and/or nestling birds. • For new or remodeled buildings, designers can use features such as overhangs, shutters, louvers, mesh, and awnings to reduce glass reflections or reduce visibility into transparent areas. Another option is to install windows at an angle so that the pane reflects the ground instead of the surrounding sky and habitat. Reduce the exterior reflectivity of windows by applying the window film CollidEscape (http://www.collidescape.org/) or installing a permanent sunscreen over the window. For buildings higher than two stories tall, turn off or dim lights near windows at night. Program building lighting systems to achieve a measurable reduction in nightlighting from 9 p.m. to 6 a.m., or, ideally, ensure that all lights are switched off during that period. • Extinguish all exterior vanity lighting (roof-top floods, perimeter spots, etc.) during migration periods (February 15–May 15 and August 15–November 30). When lights must be left on at night, examine and adopt alternatives to bright, all-night, floor-wide lighting. Options include installing motion-sensitive lighting, using desk lamps and task lighting, re-programming timers, adopting

Table C-2. Summary of best management practices for threatened, endangered, sensitive species, pollinators, migratory birds and non-native invasive plants on Los Alamos National Laboratory

Common name Scientific name	Best Management Practices
	lower-intensity lighting, reducing perimeter lighting, re-scheduling work and night cleaning, establishing interior working areas, and using blinds and curtains. • Report all observed bird mortalities and injuries to a LANL biological resources subject matter expert. If the event is a collision with a building or window, identify the location so that problem areas can be identified and rectified.
Non-Native Invasive Plants	
	• Use native species in landscaping, restoration, and forest management; consult with Forest Health and Biological Resources SMEs in the Environmental Stewardship Group to assess for existing invasive species and for planning restoration. • Projects that are subject to a CGP, must adhere to all measures for stabilization, sediment and erosion control, and storm water management. Projects not covered by a CGP must follow project-specific comments provided by EPC-CP personnel in the IRT. • Remove mud from boots, gear, and vehicles before entering and leaving the work site. This action is especially important when changing fieldwork locations. Mud can harbor high densities of seeds, including those of invasive species. • Field personnel should take care not to get seeds on clothing. Burs, cockleburs, burdock found attached to personal articles of clothing or other items should be removed close to the source or disposed of in an appropriate municipal waste receptacle if in an open area. • Contact Environmental Stewardship personnel to participate in documenting new populations of invasives with the Survey 123 invasive species mobile application. Promote the use of locally native species in landscaping, restoration, and forest management.
Floodplain and Wetlands	
	The following best management practices will be used to mitigate impacts: • Disturbed areas will be revegetated using an appropriate native seed mix. • Erosion and sediment control measures will be installed during construction. • Heavy equipment will not be used within the wetland. • Permanent equipment staging areas will not be located within the floodplains or wetland. • All equipment will be refueled at least 100 feet from the floodplains and wetland. • Hazardous materials, chemicals, fuels, and oils will not be stored within the floodplains or wetland. • If any spillage occurs, all contaminated soil will immediately be containerized and relocated. • Portable generators, compressors, and other fuel-driven equipment will be staged on bermed plastic sheeting as a form of secondary containment. Construction equipment (e.g., graders, dozers, excavators, etc.) and light vehicles will not be subject to this restriction. • Support structures, such as the treatment facility, personnel trailers, storage tanks, or permanent laydown yards will not be installed within the floodplains or wetland. • Project will remove all trash and debris (e.g., construction material) from the floodplains and wetland after completion. • Well pads and roads will be reinforced to minimize erosion and/or flooding following project completion. • Any excavation within the source area (i.e., Sandia Wetland) will require an additional Wetland Assessment to determine the potential impacts of that proposed action on the Sandia Wetland.

Table C-2. Summary of best management practices for threatened, endangered, sensitive species, pollinators, migratory birds and non-native invasive plants on Los Alamos National Laboratory

Common name Scientific name	Best Management Practices
	• The land application of treated water within portions of the 100-year floodplain within Mortandad Canyon is anticipated to have a long-term positive impact by enhancing native plant growth and stabilizing soils.

Sources: (LANL, 2020a; 2020b; 2021a; 2022; 2023)
Key: AEI = Area of Environmental Interest; BMP = best management practice; CGP = Construction General Permit; cm = centimeter; EPC-CP = Environmental Protection and Compliance Division – Compliance Program; EPC-ES = Environmental Protection and Compliance Division – Environmental Science; ft = feet; in = inches; IRT = Integrated Review Tool; LANL = Los Alamos National Laboratory; m = mile; SME = subject matter expert

Biological Resources Supporting Information References

LANL. (2020a). *Sensitive Species Best Management Practices Source Document, Revision 5.* Jesse T. Berryhill, Jenna E. Stanek, Elisa J. Abeyta, and Charles D. Hathcock Environmental Protection and Compliance Division Environmental Stewardship Group.

LANL. (2020b). *Migratory Bird Best Management Practices Source Document for Los Alamos National Laboratory, Revised June 2020.* Biological Resources Program Environmental Protection and Compliance Division, Environmental Regulatory Document.

LANL. (2021). *Pollinator Protection Plan for Los Alamos National Laboratory.* Prepared by Environmental Protection and Compliance Division Environmental Stewardship Group, Resources Management Team Los Alamos National Laboratory.

LANL. (2022). *Threatened and Endangered Species Habitat Management Plan for Los Alamos National Laboratory.* Prepared for Environmental Protection and Compliance Division Resources Management Team Los Alamos National Laboratory.

LANL (2023). Floodplain and Wetland Assessment for Chromium Remediation in Sandia and Mortandad Canyons, Los Alamos National Laboratory. Prepared by N3B.

C.4 CULTURAL RESOURCES

C.4.1 RESOURCE DEFINITION

Cultural resources are physical manifestations of culture, specifically archaeological sites, architectural properties, ethnographic resources, and other historical resources relating to human activities, society, and cultural institutions that define communities and link them to their surroundings. They include expressions of human culture and history in the physical environment, such as prehistoric and historic archaeological sites, buildings, structures, objects, and districts, which are considered important to a culture, subculture, or community. Cultural resources can also include locations of important historic events and aspects of the natural environment, such as natural features of the land or biota, which are part of traditional lifeways and practices.

The National Register of Historic Places (NRHP) is a listing maintained by the Federal government of prehistoric, historic, and ethnographic buildings, structures, sites, districts, and objects that are considered significant at a national, state, or local level. Listed resources can have significance in the areas of history, archaeology, architecture, engineering, or culture.

Cultural resources listed on the NRHP, or determined eligible for listing, have been documented and evaluated according to uniform standards and have been found to meet criteria of significance and integrity. Cultural resources that meet the criteria for listing on the NRHP, regardless of age, are called historic properties. Resources that have undetermined eligibility are treated as historic properties until a determination otherwise is made.

C.4.2 REGULATORY FRAMEWORK

A number of Federal laws and Executive Orders (EOs) address cultural resources and Federal responsibilities regarding them. Foremost among these statutory provisions, and most relevant to the current analysis, is the National Historic Preservation Act (NHPA) (54 U.S.C. 300101 et seq.). Section 106 of the NHPA requires Federal agencies to take into account the effect of their

undertakings on historic properties. The Advisory Council on Historic Preservation regulations that implement Section 106 (36 Code of Federal Regulations [CFR] 800) describe the process for identifying and evaluating resources; assessing effects of Federal actions on historic properties; and consulting to avoid, minimize, or mitigate those adverse effects. The NHPA does not mandate preservation of historic properties, but it does ensure that Federal agency decisions concerning the treatment of these properties result from meaningful consideration of cultural and historical values and identification of options available to protect the properties.

DOE has multiple policies, orders, plans, agreements, and protocols that stipulate how it manages the cultural resources on lands under its jurisdiction and provides guidance on implementing actions in accordance with Federal laws and regulations. Specific to DOE's responsibilities at the Los Alamos National Laboratory (LANL), DOE has executed a Programmatic Agreement (DOE, 2006) with the Advisory Council on Historic Preservation and the New Mexico State Historic Preservation Officer that outlines how DOE will administer its activities that have the potential to affect historic properties to satisfy the agency's responsibilities under Section 106 of the NHPA. The LANL Cultural Resources Management Plan (CRMP) is a comprehensive plan that defines the responsibilities, requirements, and methods for managing cultural resources located on DOE-administered lands at LANL, focusing on effective management of those cultural resources that warrant long-term protection (LANL, 2006).

As a Federal agency, DOE has a trust responsibility to American Indian Tribes (Tribes) to protect Tribal cultural resources and to consult with Tribes on a government-to-government basis regarding those resources. Section 101(d)(6) of the NHPA mandates that Federal agencies consult with Tribes and other Native American groups who either historically occupied the project area or may attach religious or cultural significance to historic properties in the region.

The National Environmental Policy Act (NEPA) implementing regulations link to the NHPA, as well as to the American Indian Religious Freedom Act (AIRFA) (42 U.S.C. 1996), EO 13007 Indian Sacred Sites (61 Federal Register [FR] 26771), EO 13175 Consultation and Coordination with Indian Tribal Governments (65 FR 67249), and the Executive Memorandum on Government-to-Government Relations with Native American Tribal Governments (59 FR 22951). These requirements call on agencies to consult with American Indian Tribal leaders and others knowledgeable about cultural resources important to them. DOE Order 144.1, American Indian and Alaska Natives Tribal Government Policy, outlines the principles to be followed by the department in its interactions with Tribes.

Both the Programmatic Agreement and LANL CRMP address consultation to be undertaken by DOE with Tribes in furtherance of compliance with environmental and cultural resource laws.

C.4.3 CULTURAL RESOURCE INVESTIGATIONS

Cultural resource investigations have been undertaken to develop the information needed to assess the potential impacts of the proposed project on cultural resources and to meet compliance requirements under Section 106 of the NHPA. These investigations included archaeological survey, testing, and Tribal consultation and were conducted in accordance with the CRMP, state, and Federal requirements.

Archaeological Survey and Testing

Previous archaeological investigations have been conducted in Mortandad Canyon and surrounding areas. These investigations, dating to as early as 1967, included site recording, surveying, and

periodic monitoring. Most recently, an intensive investigation was conducted following the Cerro Grande fire in 2000 (LANL, 2002). The report of this work provides information regarding fire effects on archaeological sites located within and adjacent to Mortandad Canyon. The report recommends annual monitoring, and archaeological sites are periodically revisited by archaeologists and updated as part of ongoing cultural resources site monitoring. For the 2015 Interim Measure Environmental Assessment (EA), all previously identified cultural resources were revisited for the purpose of updating the site recording forms and obtaining additional data for NRHP eligibility determinations.

Intensive pedestrian surveys of the portions of the 2015 Interim Measures EA (DOE, 2015) area of potential effect (APE) that were not previously surveyed were conducted to identify archaeological sites that meet the criteria for eligibility for listing on the NRHP (DOE, 2015). The areas surveyed in 2015 included the upper portion of Mortandad Canyon and the north-facing cliff face and slope. The pedestrian survey was conducted using evenly spaced 33-foot (10-meter) transects and transects that followed slope topography. Newly identified resources were recorded in the field; this effort included in-field analyses of artifacts and features, creation of sketch maps, collection of geographic information system data, and photographs of the site, features, and artifacts. Boundaries at some revisited sites were expanded to include additional associated features that had not been previously identified.

DOE evaluated all identified archaeological sites for NRHP eligibility, determined the potential for effects to eligible properties from the proposed project, and will submit a report of its findings and determinations to the New Mexico State Historic Preservation Officer for review and concurrence.

Tribal Consultation

The purposes of consultation are to elicit from Tribal representatives concerns for potential impacts from the proposed project on the Tribe or resources that are important to the Tribe and to identify possible measures to avoid, minimize, or mitigate potential impacts.

Tribes that have shown an interest in, or claimed affiliation to, cultural resources located on LANL property include Pueblo de San Ildefonso, Santa Clara Pueblo, Pueblo de Cochiti, Jemez Pueblo, Acoma Pueblo, Mescalero Apache Tribe, Hopi Tribe, and Jicarilla Apache Tribe (LANL, 2006). Acoma Pueblo, Mescalero Apache Tribe, and the Hopi Tribe have all indicated to DOE that they do not need to be active participants in cultural resource consultations for activities at LANL. Jicarilla Apache Tribe, Jemez Pueblo, Pueblo de Cochiti, and Santa Clara Pueblo all claim cultural affiliation to resources that are located in portions of LANL property, outside of the project area. Representatives from the Pueblo de San Ildefonso view the entire project area to be within their ancestral land use areas and claim cultural affiliation to the Ancestral Pueblo cultural remains within it (LANL, 2006). DOE recognizes the affiliation for all of these Pueblos; however, in this area of LANL property the Pueblo de San Ildefonso is the recognized affiliated Pueblo. For this reason, DOE has focused its Tribal consultation for this project on Pueblo de San Ildefonso.

Consultation with federally recognized Tribes for the Proposed Action commenced during the Public Scoping period, beginning with a courtesy phone call to the environment department of each of the Accord Pueblos (Pueblo de Cochiti, Pueblo de San Ildefonso, Pueblo of Jemez, Santa Clara Pueblo) ahead of the Public Scoping meeting, followed by letters regarding the scoping with an offer for in-person consultation.

Consultation for this proposal is ongoing, and cultural resources in the APE within Pueblo de San Ildefonso Reservation, as well as the Tribal cultural resources concerns for the chromium plume area have yet to be identified.

C.4.4 EVALUATION OF ARCHAEOLOGICAL SITE SIGNIFICANCE

DOE evaluated the sites identified during archaeological surveys and testing efforts to determine their eligibility for listing on the NRHP. Evaluation was conducted to determine those resources that have status as historic properties, which is needed to determine the effect of the project on historic properties under Section 106 of the NHPA and 36 CFR 800. Properties eligible for the NRHP must have significance in American history, archaeology, architecture, engineering, or culture. The guidelines for evaluation of significance can be found in 36 CFR 60.4. For a cultural resource to be considered significant, the resource must meet at least one of four significance criteria:

A. Association with events that have made a significant contribution to the broad patterns of our history.

B. Association with the lives of persons significant in our past.

C. Embody the distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction.

D. Have yielded, or may be likely to yield, information important in prehistory or history.

The property must also possess integrity or the ability to convey its significance. The NRHP recognizes seven aspects or qualities that, in varying combinations, define integrity. These are as follows: location, design, setting, materials, workmanship, feeling, and association. In the case of properties that possess traditional cultural significance, it is also important to consider the integrity of relationship and condition.

C.4.5 CULTURAL RESOURCES IN THE APE

As a result of the archaeological survey, testing, and Tribal consultation, DOE identified archaeological sites and Tribal cultural resources that were considered when assessing the potential impact of the project. These resources are described in this section.

Archaeological Sites

Based on previous archaeological surveys and testing investigations, 114 archaeological sites are located within the APE. The majority of the sites consist of two site types: cavate sites and pueblo or roomblock sites. The 32 cavate sites identified in the APE are predominantly located along the south-facing wall of Mortandad Canyon, although some cavates are located along the north-facing canyon wall. Cavate sites include plastered walls, sooted ceilings, vent holes, niches, rock art, viga holes, evidence of talus rooms (located out front of the cavate entrances), and stairways of hand and foot holds in the bedrock near the cavate entrances. Few artifacts are usually present, and none of the cavate sites have identified middens (trash mounds).

The 27 Pueblos or roomblock sites, which are all located on the mesa tops north and south of Mortandad Canyon, generally range in size from 1 to 10 rooms, to 10 to 20 rooms. One site has 20 to 40 rooms surrounding a plaza, and another has 100-plus rooms surrounding a plaza with an identifiable kiva (subterranean ceremonial room). These sites have surface artifact scatters containing many artifacts and sometimes large, distinct middens. Shaped tuff blocks are present at

most of the sites, and one site contains adobe blocks; sometimes these are seen in their original wall alignments.

The remaining 54 sites in the APE include 10 fieldhouses, 14 prehistoric artifact scatters with no evidence of architecture, 2 game traps carved into bedrock, 10 prehistoric trails and stairways of hand and foot holds carved into bedrock, 2 rock art sites, 3 rock features, 3 rock rings, 1 rockshelter, 1 thermal feature, 2 water control features, 4 Homestead period structures, 2 Homestead period wagon roads, and a Homestead period trash scatter.

Artifacts found at the sites include ceramic sherds of multiple types; flaked stone tools and manufacturing debris comprised of obsidian, chert, chalcedony, basalt, quartzite, and petrified wood; and ground stone tools of sandstone, quartzite, basalt, and granite that include manos (hand-held grinding tools), metates (surface on which grinding occurred), and bedrock grinding slicks. Other than the 7 Homestead period sites and 6 of the artifact scatters deposited during the Archaic (5500 B.C. to A.D. 600) and Late Archaic (800 B.C. to A.D. 600), these sites represent occupations occurring during the Coalition (A.D. 1150 to 1325) and Classic (A.D. 1325 to 1600) cultural periods, which is consistent with the ages of cultural resources found throughout LANL.

The condition of the sites is generally quite good, in part because of the restricted access at LANL. Almost all the sites have experienced some level of impact from water runoff, although this has occurred mainly as sheet wash and not in the development of drainage cuts. Other impacts to the sites include damage from construction of dirt roads on the mesa tops that were developed historically, vandalism or limited pot hunting at two of the sites, and modern graffiti at one site.

Shovel testing and geomorphological analysis previously conducted in areas where proposed interim project infrastructure would occur close to known sites revealed that no intact sediments or cultural deposits exist within those areas (DOE, 2015), which may be an indication of the potential for subsurface deposits at other sites in the expanded APE.

Of the 114 sites in the APE, DOE determined 80 sites eligible, 18 sites not eligible, and 16 sites either potentially eligible for listing in the NRHP or unevaluated. The sites determined eligible have significance for their potential to yield important information about settlement and subsistence patterns on the Pajarito Plateau during the Coalition and Classic periods and the sites retain their integrity. The sites determined not eligible are either (a) in poor condition because of erosion and existing road impacts and do not retain enough integrity to demonstrate their historical significance or (b) are located directly on bedrock and thus lack the presence of subsurface cultural deposits that would give the sites significance for their information potential. Shovel testing and geomorphological analysis were conducted in areas where proposed project infrastructure would occur close to known sites because of a concern for possible impacts to buried cultural deposits. The testing and analysis revealed that no intact sediments or cultural deposits exist within those areas. Although some artifacts were observed during testing, the limited number and fragmentary nature of the artifacts indicate they are present in secondary colluvial deposits derived from sediment and artifacts eroding downslope from nearby roomblocks. Results of the previous testing may be an indication of the potential for subsurface deposits at other sites in the expanded APE.

Historic Buildings

There are 12 historical buildings within the APE, all of which were built during the Cold War between 1959 and 1986 (Table C-3). Five of them have been determined eligible for listing in the NRHP (two under Criterion A, and three under Criterion A and C). The other seven

buildings are not evaluated or are currently undergoing assessment for significance and NRHP eligibility, and are managed as NRHP-eligible until a final determination is made.

There are no buildings or sites within the legislative boundary of the Manhattan Project National Historical Park within the APE.

Table C-3. Los Alamos National Laboratory historic buildings in the area of potential effects

Building Number	Building Name	Construction Date	Historic Use	NRHP Status
03-0066	Sigma Building	1959	Central laboratory and administration building for the Sigma Complex. Constructed to fabricate a variety of structural materials, including steel, brass, lead, and uranium, in support of the weapons program.	Eligible - Criterion A
03-0141	Beryllium Technology Facility	1959	Fabrication of graphite-enriched uranium dioxide fuel components in support of the Rover rocket program. Other activities include power metallurgy, filament welding, ceramics research, and fabrication using beryllium and uranium.	Eligible - Criterion A
03-0223	Utilities Control Center	1966	Utilities control center for TA-3 and surrounding technical areas.	Under Assessment
03-0317	Graphite Flour Storage	1967	Storage of graphite used in the processing, characterizing, and fabrication of metallic, ceramic, and depleted-uranium items.	Under Assessment
53-0056	Storage Building	1970	Support facility housing industrial equipment for the abrasive cleaning of ion pumps.	Not Evaluated
60-0001	Mobile Equipment Repair Shop	1977	Vehicle and heavy equipment repair shop.	Under Assessment
60-0002	JCI Warehouse	1978	Maintenance warehouse for Johnson Controls, Inc.	Under Assessment
60-0017	Test Fabrication Facility (Assembly Building)	1986	Assembly of experimental racks used in underground nuclear testing activities at the Nevada Test Site.	Eligible - Criteria A, C
60-0019	Test Fabrication Facility (Rack Tower)	1986	Testing of experimental racks used in underground nuclear testing activities at the Nevada Test Site.	Eligible - Criteria A, C
60-0045	High Frequency Radio Facility	1966	Emergency and civil defense radio communications center.	Under Assessment
72-0008	Office Building (Former Guard Station TA-20-47 / TA-00-271)	1952	Public security checkpoint/guard station for East Jemez Road.	Eligible - Criteria A, C
72-0013	Storage Building	1966	General storage building.	Under Assessment

Key: NRHP = National Register of Historic Places; TA = Technical Area

Tribal Cultural Resources

Consultation for this proposal is ongoing, and cultural resources in the APE within the Pueblo de San Ildefonso Reservation, as well as the Tribal cultural resources concerns for the chromium plume area have yet to be identified.

During their meeting with DOE for the 2015 Interim Measure EA, Pueblo de San Ildefonso representatives described the cultural resources and activities within and surrounding the project area in the following way (DOE, 2015): The Pueblo representatives consider the entire area on which LANL is located to be part of a larger Sacred Area that has been used and inhabited by their ancestors for over a thousand years. This Sacred Area is of great importance to the Pueblo and thus continues to be used by Pueblo members today. The resources located within the Sacred Area that contribute to its importance include naturally occurring water, animals, plants, springs, rocks, and soil as well as cultural-defined places such as archaeological sites and deposits; religious or ceremonial features and places; traditional areas used for gathering plants, clay, or other materials; hunting areas; and viewsheds. Important traditional activities conducted in the Sacred Area include hunting, gathering, collecting, and ceremonial practices. It should be noted that this list is likely not exhaustive.

According to the Pueblo representatives, the Sacred Area plays a very important role in the history, culture, and religious practices of the Pueblo, and this forms the basis for its importance. Because of this intrinsic significance, the Sacred Area is used only for traditional cultural and religious activities by Pueblo members. By conducting these activities in the Sacred Area, or by using resources collected from the Sacred Area, the importance of the Sacred Area is transferred to those activities and materials, instilling in them cultural "power" and ensuring their efficacy. In turn, the conduct of these activities within the Sacred Area and the use of these materials imbue the Sacred Area with even greater importance. This illustrates the circular relationship between the Sacred Area, the resources and activities located within it, and explains the Pueblo's consideration of the Sacred Area and its resources as important.

Pueblo representatives explained that, though varied in character, the resources in the Sacred Area are not distinguished into types such as natural, cultural, economic, secular, or sacred. Rather, the resources of the Sacred Area are regarded as comprising an integrated "whole," connected with one another through physical, functional, and spiritual relationships. This "whole" is regarded as essential to the continued survival of the Pueblo, and thus all the resources contained within it are considered cultural. The resources located within the project area and in the areas adjacent to it, both on and off LANL property, are considered to be a part of and connected to this whole (DOE, 2015).

C.4.6 ENVIRONMENTAL CONSEQUENCES ANALYSIS METHODOLOGY

The following analysis details the anticipated direct and indirect effects of the Proposed Action alternative and the No Action Alternative on cultural resources. Potential effects were identified through application of the NHPA Section 106 Criteria of Adverse Effects (36 CFR 800.5) to historic properties and through consultation with the Pueblo de San Ildefonso to learn about potential impacts to Tribal cultural resources and practices. Potential effects to historic properties were determined based on the proximity of the property to proposed project facilities or infrastructure; proximity to project infrastructure development, operations, or reclamation activities; and the presence of workers in the area. Because historic properties are a finite resource and cannot

be regenerated, all physical impacts to historic properties are considered to be permanent in duration.

Criteria of Adverse Effects

Section 106 of the NHPA requires Federal agencies to take into account the effects of their actions on any district, site, object, building, or structure included in, or eligible for inclusion in, the NRHP. An adverse effect occurs when an undertaking diminishes the integrity of those characteristics of an historic property that qualify it for inclusion in the NRHP. Implementing regulations for Section 106 (36 CFR 800) provide specific criteria for identifying effects on historic properties. The types of possible adverse effects include:

- Physical destruction of or damage to all or part of a property
- Physical alteration of a property
- Removal of a property from its historic location
- Change in the character of a property's use or of physical features within a property's setting that contribute to its historic significance
- Introduction of visual, atmospheric, or auditory elements that diminish the integrity of a property's significant historic features
- Neglect of a property, which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance
- Transfer, lease, or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of a property's historic significance (36 CFR 800.5[a][2])

DOE applied the criteria of adverse effects to the activities planned under the Proposed Action alternative and the No Action Alternative to identify potential effects to historic properties identified within the APE.

Tribal Consultation

Consultation with federally recognized Tribes for the Proposed Action commenced during the Public Scoping period. Each of the Accord Pueblos (Pueblo de Cochiti, Pueblo de San Ildefonso, Pueblo of Jemez, Santa Clara Pueblo) received a courtesy phone call to the pueblo environment department ahead of the Public Scoping meeting, followed by letters regarding the scoping with an offer for in-person consultation. DOE Office of Environmental Management Los Alamos Field Office (EM-LA) also had an in-person meeting on the scoping with the Pueblo de San Ildefonso environment department. Additionally, EM-LA Corrective Measures Evaluations presented at the Accord Technical Exchange Meeting (ATEM) on July 11, 2023, regarding the NEPA for the Proposed Action. Representatives from each of the Accord Pueblos were in attendance for that occurrence of the ATEM. EM-LA will send another round of letters to each of the Accord Pueblos when the Draft EA is available, which will include an offer to consult, after which there will be another presentation to the ATEM on the Draft EA. Pueblo de San Ildefonso has responded that they plan to request consultation at that time.

Cultural Resources Supporting Information References

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C.5 SOCIOECONOMICS

In order to tailor the affected environment discussion to a level commensurate with the potential for impact, which is expected to be small given the small in-migrating workforce and population associated with the Proposed Action, the characterization of socioeconomic data in this EA focuses primarily on population, employment/unemployment, income and housing data, where the potential for adverse impact from an in-migrating population (workers and their families) would be greatest.

With respect to impacts on community services, it is assumed that the potential impacts from any in-migrating population on existing population levels in the region of influence (ROI) would serve as a surrogate for analyzing potential impacts on each of the community services that support that population currently. As such, this analysis does not include a discussion of community services within the ROI where the potential increase in population would be very small (e.g., generally less than 0.1 percent of the existing population). At such small levels, it is assumed that the level of community services currently available to the population would be sufficient to accommodate the small population influx resulting from the Proposed Action.

Summary data are provided for the ROI, which is defined for purposes of this analysis as a four-county region encompassing the Los Alamos County (host county for LANL) and immediately adjacent counties (Rio Arriba, Sandoval, Santa Fe Counties) in New Mexico, where the majority of workers for proposed chromium plume remediations would be expected to reside and spend most of their salary, and in which a significant portion of site purchase and non-payroll expenditures from the construction and operation of the Proposed Action and alternatives are expected to take place. Note that this is slightly smaller than the ROI identified in the most recent Supplemental Analysis to the 2008 LANL (DOE August 2020 SA-06) but considered appropriate given the limited geographic scope of the Proposed Action.

Table C-4 summarizes socioeconomic conditions for the ROI with respect to population, income, housing, and employment. Data are for 2021 unless otherwise indicated.

Table C-4. Region of influence summary data for select socioeconomic conditions

Parameter	Los Alamos	Rio Arriba	Sandoval	Santa Fe	Region of Influence	New Mexico
Population						
2022	19,187	40,048	153,501	155,644	368,400	2,113,344
2021	19,169	40,347	153,632	147,327	360,475	2,109,366
2020	19,419	40,363	148,834	154,823	363,439	2,117,522
2010	17,950	40,246	131,561	144,170	333,027	2,059,179
Housing						
Total units	8,593	19,585	57,857	75,798	161,833	937,397
Occupied	8,029 Owner: 5,963 Rental: 2,066	13,293 Owner: 10,342 Rental: 2,951	53,567 Owner: 42,549 Rental: 11,018	65,856 Owner: 46,974 Rental: 18,882	140,745 Owner: 105,828 Rental: 34,917	797,596 Owner: 543,834 Rental: 253,762
Vacant	564	6,292	4,290	9,942	21,088	139,801
Vacancy rate (# vacant units/ total units)	6.6%	32%	7.4%	13.5%	13%	14.9%
Vacancy rate for owner-occupied units/Rental vacancy rate	0.9 / 1.7	1.8 / 4.5	1.2 / 7.4	0.8 / 5.0	1.1% / 5.5%	1.5% / 7.3%
Median value	$343,100	$179,800	$222,200	$315,100		$184,800
Income						
Median Household income	$123,677	$46,994	$68,947	$64,423		$54,020
Per capita income	$64,521	$25,342	$32,246	$40,952		$29,624
Employment						
Civilian labor force	10,599	16,627	69,670	74,838	171,734	952,564
Employed	10,269	15,591	64,827	70,904	161,591	889,428
Unemployed	330	1,036	4,843	3,934	10,143	63,136
Unemployment rate	3.1%	6.2%	7.0%	5.0%	5.9%	6.6%
LANL employees (laboratory, contractor, guard force)*: 15,707 (as of 9/30/2022)	5,225 (37%) [5,187 (Triad + N3B CY 2021 from SWEIS 2021 Yearbook)]	2,175 (15.5%) 2,191 (2021)	580 (4.1%) Not broken out	3,460 (24.6%) 3,239 (2021)	Rio Arriba: 2,175 (15.5%)	Other NM: 1,558 Outside NM: 1,056

Sources: (LANL, 2023a; 2023b), (USCB, 2023a; 2023b; 2023c; 2023d)
Key: # = number; % = percent; CY = calendar year; LANL = Los Alamos National Laboratory; N3B = Newport News Nuclear BWXT-Los Alamos; NM = New Mexico; ROI = region of influence; SWEIS = Site-wide Environmental Impact Statement

Population levels fluctuated slightly in Los Alamos County, the ROI, and New Mexico between 2020 and 2022 (slight decreases between 2020 and 2021), but showed a small increase in 2022. The Pueblo of San Ildefonso is a minority-dominated community nearest LANL and the existing plume; it had a population of 2,261 in 2021.

In 2021, there were a total of 161,833 housing units in the four-county area, with 87 percent occupied and 13 percent vacant. The median value of owner-occupied homes in Los Alamos County ($343,100) is the greatest of the four counties and nearly twice the median value of owner-occupied homes in Rio Arriba County ($179,800). According to the most recent

Supplemental Analysis to the LANL Site-Wide Environmental Impact Statement (SWEIS) (DOE, 2020), Los Alamos County is experiencing a housing shortage that affects the quality of life for individuals who work in Los Alamos, including LANL, and reside elsewhere in the ROI. A 2019 housing study indicates that approximately 576 new units would be needed to accommodate new hires to the county, including LANL (LAC, 2019, pp. 44).

There are major differences in the income levels among the four counties, especially between Rio Arriba County, at the low end with a median household income in 2021 of $46,994 and a per capita income of $25,342, and Los Alamos County, at the upper end with a median household income of $123,677 and a per capita income of $64,521. The median household income in Los Alamos County is over twice that of the New Mexico State average ($54,020 in 2021).

The total population of the ROI is 368,400 with a total workforce population of 171,734 people. As of 2022, LANL full-time employees represented represent 87 percent of the total workforce within the ROI and 1.5 percent of the total workforce in New Mexico. The annual unemployment rate in the ROI is 5.9 percent, compared to New Mexico's annual unemployment rate of 6.6 percent.

LANL is a major economic force in the region; it has a positive economic impact on Northern New Mexico by creating jobs, generating income, and purchasing goods and services from local businesses. Local DOE activities directly and indirectly account for more than a third of employment, wage and salary income, and business activity in the region. Based on a 3-year study, LANL expended an average of $752.6 million on procurement of goods, services, and construction within the ROI, New Mexico, and out of state. Just over one-half of those purchases were from New Mexico-based businesses (UNM, 2019). Expenditures by LANL and its full-time employees generated $1.65 billion in sales for businesses within the ROI.

As of 2018, LANL had a total direct labor income of $1.34 billion. Indirectly, LANL supported 19,122 jobs and those jobs equal $1.57 billion in labor income to the State of New Mexico (UNM, 2019). An update to the 2019 Economic Report identified the annual salary at LANL at 1.53 billion ($689,636,978 in Los Alamos County) and the Laboratory spent $915,988,873 on procurement in New Mexico (LANL, 2023a).

Assumptions Regarding Workforce Requirements and Worker In-Migration to the Study Area

- No Action Alternative: The total peak workforce that could be on-site at one time for a short duration of the year is estimated at 75 workers; based on up to two wells being drilled at same time (four new wells would be drilled over the course of a year under the No Action Alternative), including 38 relating to construction (8 drillers and 30 admin/support staff) and 42 relating to operation (12 drillers and 30 admin/support staff).
- ASM Proposed Action options: Same breakout per well as No Action Alternative but more wells within a given year and peak workforce up to 120 on-site at one time.
- Regarding the well and pad construction and operation, a large number of the workers include T2S and Newport News Nuclear BWXT-Los Alamos, LLC (N3B) personnel (e.g., contractor management/admin staff, see Appendix B, *Description of Alternatives Supporting Information*, Table B-1), which would be pulled from existing contractor staff (e.g., transition from current positions associated with the ongoing measures to contain the plume boundary or transition over from other LANL activities) or would be local hires if new positions were created.

- Drilling crews would be subcontractors and hired per job. They would be unlikely to live in the Los Alamos area, as most contractors currently come on site from Albuquerque area, and would relocate to the site on a temporary, per job basis. The drilling crews would comprise the in-migrating workforce for purposes of this analysis.
- Regarding construction and operation of the new treatment facility, it is assumed that the same employees, counted in the well pad builds, also would construct the facility; and that operation of the facility would be conducted by existing contractor staff.
- A breakout of an in-migrating workforce associated with the drilling crew would include:
    - ASM options: 24 construction (8 x 3) and 36 (12 x 3) operations workers (assuming up to 3 wells drilled concurrently during a five-month period over course of year.
    - No Action Alternative: 16 construction (8 x 2 wells) and 24 (12 x 2 wells) operations workers, assuming two wells would be drilled concurrently during a 5-month period over the course of a year.
- It is unlikely that the drilling crews, based on the short-term nature of the work, would bring their families with them. However, the analysis assumes they would bring their families in order to provide a more conservative bounding scenario. In some cases, the same worker may stay on to drill subsequent wells on-site during the course of the project.
- In-migrating families would consist of 2.59 family members, including the worker, based on average household size in New Mexico in 2021.

The assumptions listed above would result in an in-migrating workforce and total population as follows:

- ASM options: 62 in-migrating population with construction and 93 with operations, including the workers.
- It is estimated that 50 to 75 (ASM options), or 81.1 percent, of these employees (and their families) would live within the ROI based on existing residence rates.
- No Action Alternative: 41 in-migrating population with construction and 62 with operation, including the workers.
- The existence of these direct jobs would be expected to result in the creation of up to another indirect 100 jobs (under ASM option operations), based on the LANL multiplier used in the 2008 SWEIS (1.06).

Socioeconomics Supporting Information References

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C.6 ENVIRONMENTAL JUSTICE

C.6.1 REGULATORY BACKGROUND

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, issued on February 16, 1994, focused attention on the environmental and human health effects of Federal actions on those populations with the goal of achieving environmental protection for all communities. The EO directs Federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations to the greatest extent practicable and permitted by law. The following discussion is consistent with the guidelines and procedures for compliance with the EO (12898) promulgated by the CEQ (CEQ, 1997).

The definitions of environmental justice, minority, low-income, and minority and low-income populations are presented below.

- **Environmental Justice** – The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (EPA, 2023).
- **Minority** – Individual(s) who have identified themselves as members of one or more of the following population groups as designated in the U.S. Census Bureau (USCB) data: Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, as well as Hispanic or Latino of any race (USCB now refers to these individuals as people of color).
- **Low income** – The USCB uses a set of money income thresholds that vary by family size and composition to determine who is in poverty (i.e., classified as "low income"). A family and each individual in the family is considered in poverty if the total family income is less than the family's threshold or the dollar amount calculated by the USCB to determine poverty status (USCB, 2023a).
- **Minority or low-income population** – A minority population is a population where either: (a) the minority population of the selected geographic units of analysis (block group) exceeds 50 percent, or (b) the minority population percentage of the block group is meaningfully greater (e.g., 10 or 20 percent greater) than the minority population percentage in a reference community (i.e., state). For low-income populations, the presence of the population is determined if the percentage of low-income individuals residing within the selected geographic units of analysis (block groups) is equal to or greater than the percentage of low-income individuals residing within the reference community (in this case the State of New Mexico). In identifying minority or low-income populations, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a geographically dispersed/transient set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect. The selection of the appropriate unit of geographic analysis may be a governing body's jurisdiction, a neighborhood, census tract, or other similar unit that is to be chosen so as to not artificially dilute or inflate the affected minority population.

On January 27, 2021, President Biden issued EO 14008, *Tackling the Climate Crisis at Home and Abroad*, which further directs Federal agencies to take steps to address disproportionately high and adverse impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts. EO 14008 established the Justice40 Initiative. This initiative mandates 40 percent of the benefits of Federal climate and clean energy investments to be provided to disadvantaged communities.

EM-LA Justice40 Initiative

As a part of the Justice40 Initiative, DOE has conducted an analysis to identify disadvantaged communities in the United States, which DOE defines as underserved, overburdened, and front-line communities (DOE, 2022). The Justice40 Initiative focuses on Federal investments to disadvantaged communities in the following areas: clean energy and energy efficiency, clean transit, affordable and sustainable housing, training and workforce development, the remediation of legacy pollution, and the development of critical clean water infrastructure (EM-LA, 2021a).

In July 2021 EM-LA in New Mexico was selected as one of five DOE Justice40 Initiative Pilot Programs and it is the only Justice40 Pilot Program in EM. EM-LA's mission falls under the

covered program of "remediation and reduction of legacy pollution." The focus of EM's environmental cleanup work under Justice40 is soil and groundwater remediation.

EM-LA and its cleanup contractor N3B engage with numerous "disadvantaged communities" in the areas surrounding Los Alamos County. By way of example, these disadvantaged communities include Tribal jurisdictions and Northern New Mexico counties, as well as predominantly Hispanic communities in which there are low incomes and high levels of poverty (EM-LA, 2021b).

Tribal jurisdictions include the following Pueblos:

- Pueblo de San Ildefonso
- Pueblo of Jemez
- Santa Clara Pueblo
- Pueblo de Cochiti
- Pueblo of Pojoaque
- Taos Pueblo

The (proximate) Accord Tribes, which comprises four New Mexico Pueblo Governments (Santa Clara Pueblo, Pueblo de Cochiti, Pueblo of Jemez and Pueblo de San Ildefonso), have individual cooperative agreements to develop and maintain environmental monitoring programs through the Los Alamos Pueblos Project. These agreements and grants funded by EM-LA (e.g., EM funds the Santa Fe Indian School) enable the Los Alamos Pueblos Project Tribal program personnel to obtain the training to monitor and sample soil, air, groundwater, and other media, and facilitate development of Pueblo environmental programs to analyze and monitor the impact, if any, of DOE operations to Pueblo lands (EM-LA, 2021b). EM-LA also provides numerous educational and training briefings to Pueblo members to enhance awareness of ongoing efforts regarding remediation and reduction of legacy waste. EM-LA continues to pursue additional opportunities to inform, train, and educate these disadvantaged communities regarding ongoing cleanup projects in and around LANL. These opportunities would consist of both presentations and site visits (EM-LA, 2021a).

Each year, as part of its Community Commitment Program, N3B donates 5 percent of its anticipated annual fee to workforce development programs and nonprofit organizations that benefit Northern New Mexico communities. Since August 2019, N3B's workforce development programs have served 34 students—19 of which are from the neighboring Rio Arriba County, a predominantly Hispanic community in which 20 percent of the population lived below the poverty line in 2020. N3B covers tuition costs for participating students, who receive on-the-job training from N3B mentors while being compensated with competitive salaries and benefits.

N3B offers three workforce development programs: (1) the 2-year Nuclear Operator Apprenticeship Program in partnership with Northern New Mexico College; (2) the 12-week Waste Processing Operator Boot Camp; and (3) the Radiological Control Technician Boot Camp. Students in the Apprenticeship Program earn an associate degree, while students in the Boot Camps earn 10 college credits and a program certificate. All three programs put students in the educational pipeline to pursue advanced degrees in STEM-related fields.

In the past 2 years, N3B has also provided $48,000 in scholarships to six Northern New Mexico students in need of financial aid to pursue STEM-related degrees at regional colleges. Four of the six scholarship recipients are from economically disadvantaged communities.

Since N3B's start of contract in April 2018, N3B has donated $973,444 to workforce development programs and Northern New Mexico nonprofits (EM-LA, 2021b).

Recent Tribal outreach efforts specific to the Proposed Action include the following (Chandler, 2023):

- Each of the Accord Pueblos (Pueblo de Cochiti, Pueblo de San Ildefonso, Pueblo of Jemez, Santa Clara Pueblo) received a courtesy phone call to the pueblo environment department ahead of the Public Scoping meeting, followed by letters regarding the scoping and an offer for in-person consultation.
- An in-person meeting on the scoping with Pueblo de San Ildefonso environment department was conducted on July 11, 2023.
- EM-LA CMEs presented at the ATEM on July 11, 2023, regarding the NEPA analysis for chromium. Representatives from each of the Accord Pueblos were in attendance for that occurrence of the ATEM.

EM-LA anticipates sending out another round of letters related to publication of the Draft EA, with an accompanying offer to consult followed by a presentation to the ATEM on the draft. Pueblo de San Ildefonso has indicated that they plan to request consultation at that time.

C.6.2 AFFECTED ENVIRONMENT AND SUPPORTING DATA

The potentially affected area includes all of Los Alamos County, and parts of Sandoval, Santa Fe and Rio Arriba Counties in New Mexico.

The potentially affected area is located primarily in Los Alamos County, New Mexico. The demographics for Los Alamos County are as follows (2021 data): Non-Hispanic/Latino comprise 81.8 percent of residents. People of Hispanic or Latino ethnicity represent 18.2 percent of the residents; this percentage is much lower (2.8 times) than New Mexico, which is at 50.2 percent. Native Americans represent approximately 1.5 percent of residents, while Blacks and African Americans make up 1.4 percent of residents (USCB, 2023b). The total minority population in New Mexico in 2021 was 64.3 percent.

In addition to ongoing engagement efforts with the Pueblos in Northern New Mexico, EM-LA and N3B have programs for disadvantaged communities in neighboring counties, including Rio Arriba County (EM-LA, n.d.). In 2021, the demographics of the five largest ethnic groups in Rio Arriba County were 75.7 percent White (Hispanic), 71.0 percent Other (Hispanic), 20.2 percent American Indian and Alaska Native (Non-Hispanic), 12.9 percent White (Non-Hispanic), and 1.0 percent African American (USCB, 2023b).

The population and income levels of four additional nearby pueblos for 2021 were as follows (USCB, 2023c):

Pueblo	Population	Median Household income	% families living below poverty
San Ildefonso	2,261	$52,424	19.2%
Santa Clara	11,893	$45,313	16.5%
Cochiti	1,465	$44,732	13%
Jemez	2,042	$49,700	13.4%
Pojoaque	3,608	$57,277	11.4%

Region of Analysis

For purposes of the EM-LA Justice40 Pilot Program, EM-LA determined eight counties are included or partially included in the potentially affected legacy pollution area (Bernalillo, Los Alamos, Mora, Rio Arriba, Sandoval, San Miguel, Santa Fe and Taos), based on potential radiological risk from current missions performed at LANL, and as measured within a 50-mile radius from the emissions stack at the Los Alamos Neutron Science Center in Technical Area (TA)-534 (EM-LA, 2021a). These areas include the City of Santa Fe and Indian Reservations in North Central New Mexico; they also are consistent with the ROI defined in past LANL SWEISs and the currently in progress SWEIS. The majority of properties within a 50-mile radius of LANL consist of Federal property without full-time residents.

The proposed region of analysis for environmental justice in this EA is significantly smaller than 50-miles since no radiological air emissions would be expected from the proposed project. Rather, the project boundary is based on the existing area of (and potential movement of) the contaminated chromium groundwater plume that is better defined and more limited in size. Specifically, it is identified as a 5-mile radius of the plume boundary. This is consistent with the for the ROI for water resources (i.e., groundwater) and potential health effects analyzed in this EA; these resource areas are considered to be the primary drivers for determining potential adverse effects of most concern to any environmental justice populations identified. The ROI lies within a part of Los Alamos County (primarily within LANL site boundary), and very small portions of Rio Arriba, Santa Fe, and Sandoval Counties, New Mexico.

Methodology for Determining Minority and Low-Income Populations

The methodology used for the environmental justice analysis, is described in EPA's *Promising Practices for EJ Methodologies in NEPA Reviews* (EPA, 2016) and typically includes both the 50 percent and greater meaningful analysis as defined previously. This EA is using only the 50 percent analysis in identifying minority populations, consistent with the methodology used in the 2008 SWEIS. The analysis of minority and low-income populations focuses on USCB data for geographic units (i.e., block groups) that represent, as closely as possible, the potentially affected areas.

Minority Population in 2021

Minority populations were evaluated using the 50 percent for potentially affected block groups within 5 miles of the chromium groundwater plume. If a block group's percentage of minority individuals was greater than 50 percent, then the block group was identified as having a minority population. The total population of New Mexico is 2,109,366, of which 64.0 percent would be considered members of a minority population.

According to 2021 census data, approximately 8,030 minority individuals resided within the 5-mile radius of LANL. This represented 34 percent of the total population within the 5-mile radius. The largest minority group in the study area was the Hispanic population (51.9 percent), followed by American Indians (4.5 percent). Minorities are about 29.2 percent of Los Alamos County's population, with Hispanics being the largest minority group (18.3 percent). Hispanics reside throughout the 50-mile (80-kilometer) radius area, but most are located in the Española Valley and in the Santa Fe metropolitan area.

Based on 2021 census data, Table C-5 shows minority population for all block groups within the study area, including those where more than 50 percent of the block group population is minority.

Table C-5. Communities within 5 miles of the chromium plume – Los Alamos National Laboratory, New Mexico (block group by tract)

Block Group by Tract		Total Population	Minority	% Minority	Population for Whom Poverty is Calculated	Low-Income Population	% Low Income
Census Tract 1	Block Group 1	1,161	263	22.6	1,161	38	3.3
	Block Group 2	857	218	25.4	857	0	0
	Block Group 3	1,886	574	30.4	1,886	157	8.3
Census Tract 2	Block Group 1	1,271	390	30.7	1,271	83	6.5
	Block Group 2	1,016	254	25	1,016	52	5.1
	Block Group 3	1,640	421	25.7	1,640	0	0
	Block Group 4	1,644	603	36.7	1,644	0	0
Census Tract 4	Block Group 1	768	262	34.1	724	0	0
	Block Group 2	1,083	601	55.5	1,083	86	7.9
	Block Group 3	781	251	32.1	781	40	5.1
	Block Group 4	1,321	515	39%	1,288	197	15.3
Census Tract 5	Block Group 1	494	95	19.2	494	0	0
	Block Group 2	876	69	7.9	876	39	4.4
	Block Group 3	1,491	376	25.2	1,491	61	4.1
	Block Group 4	602	38	6.3	602	4	0.7
	Block Group 5	1,116	409	36.6	1,116	0	0
	Block Group 6	1,162	269	23.1	1,162	45	3.9
Census Tract 102.4	Block Group 2	903	151	16.7	903	159	17.6
Census Tract 109	Block Group 2	962	128	13.3	962	165	17.1
Census Tract 9403*	Block Group 1	822	743	90.4	812	165	20.3
Census Tract 9408	Block Group 3	1,427	1,400	98.1	1,422	219+92 311	21.9
ROI (5-mile radius): [%]		23,283	8,030	34	23,283	1,602	6.9

Sources: (USCB, 2023c; 2023d)
Key: % = percent
Note: *Found in Santa Fe County; note that no population is found in the portion of Sandoval County that contains part of Census Tract 9403.

Three block groups (of the 21 block groups within the ROI) have a percentage that would meet the 50 percent threshold for minority populations: one block group each in Los Alamos, Santa Fe, and Rio Arriba Counties. None of these block groups include any portion of the groundwater plume itself. While the plume does extend into a small corner of Sandoval County and the Pueblo San de Ildefonso Reservation, there is no population in the block group found within this portion of the reservation according to Census Bureau records.

Low-Income Population in 2021

According to 2021 census data, approximately 1,602 individuals residing within the 5-mile radius of LANL were identified as living below the Federal poverty threshold, which represents approximately 6.9 percent of the study area population. The median household income for New Mexico in 2022 was $54,020, while 18.3 percent of the population was determined to be living below the Federal poverty threshold.

Los Alamos County had the highest median income ($123,677) within the state, and the lowest percentage (4.2 percent) of individuals living below the poverty level when compared to other counties in the area.

Census block groups were considered low-income block groups if the percentage of the populations living below the Federal poverty threshold exceeded 18.3 percent. Table C-5 shows all low-income block groups within the study area, including where more than 18.3 percent of the block group population is living below the Federal poverty threshold. Based on Census data, 2 of the 21 block groups within the ROI have percentages that would meet the threshold for low-income populations and include population living below the Federal poverty threshold. However, it should be noted that two additional blocks (Census Tract 102.4, Block Group 2, and Census Tract 109, Block Group 2), have percentages that are just under the threshold, at 17.6 and 17.1 percent, respectively.

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