Alma Bridge Road Newt Passage Project Alternatives Evaluation / Basis of Design (Phase I, Task 3)

Alma Bridge Road
Newt Passage Project
WILDLIFE CONNECTIVITY IMPROVEMENTS

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
AB	aggregate base
AC	asphalt concrete
BMP	best management practices
BOD	Basis of Design
CAD	computer-aided design
CALFIRE	California Department of Forestry and Fire Protection
Caltrans	California Department of Transportation
CBIs	cost-benefit indices
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
County	Santa Clara County
Feasibility Analysis	Alma Bridge Road Newt Passage Project Feasibility Analysis
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
ft	feet
HDM	Highway Design Manual
HEC-14	Hydraulic Engineering Circular No. 14
HUC	Hydrologic Unit Code
ITP	Incidental Take Permit
km	kilometer
LSAA	Lake and Streambed Alteration Agreement
MGS	Midwest Guardrail System
Midpen	Midpeninsula Regional Open Space District
mph	miles per hour
MUTCD	California Manual on Uniform Traffic Control Devices
NAVD	North American Vertical Datum
NEPA	National Environmental Policy Act
Mitigated Negative	Initial Study with Negative
OSP	Open Space Preserve
Phase I	Feasibility and Conceptual Design
Phase II	Environmental Review and Preliminary Design
project	Alma Bridge Road Newt Passage Project
PVA	Population Viability Assessment

ramp-down	single gradually ramped end-point
ramp-up	single gradually ramped approach
Ridge Trail	Bay Area Ridge Trail
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SERP	Statutory Exemption for Restoration Projects
SFHA	Special Flood Hazard Area
SHC	Streets & Highways Code
SSD	stopping-sight distance
Technical Review	Alma Bridge Road Newt Passage Project Technical Review
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
USGS	U.S. Geological Survey
Valley Water	Santa Clara Valley Water
VC	Vehicle Code

Executive Summary

One of the largest recorded wildlife roadkill events in California takes place every year on Alma Bridge Road , adjacent to Lexington Reservoir, in Santa Clara County (UC Davis 2021). Between 2017 and 2023, a total of approximately 34,000 California newts were recorded dead on the road as the result of vehicle traffic along Alma Bridge Road (Parsons 2021, Newt Patrol 2023). At an estimated localized road mortality rate for migratory newts of 39.2%, the population may be under threat of extirpation (H.T. Harvey & Associates 2021, Wilkinson and Romansic 2022). Midpeninsula Regional Open Space District (Midpen) and Santa Clara County (County) are looking to provide safe road passage for California newts and other herpetofauna species across Alma Bridge Road. This effort is collectively referred to as the Alma Bridge Road Newt Passage Project (project).

AECOM has prepared this Alternatives Evaluation/Basis of Design technical memorandum, the third and final task within Phase I of the project, that further refines two preliminary project alternatives identified in the Alma Bridge Road Newt Passage Project Feasibility Analysis (Feasibility Analysis) completed in April 2023 (AECOM 2023). The Basis of Design presented herein is the conceptual design level of the project (preliminary design) which will be expanded upon in Phase II.

Task 2 identified four preliminary alternatives, all of which were modeled to achieve the project goals of increased population persistence (no net loss in population size) and improved habitat permeability. One of the primary goals of Task 2 was to select two of these preliminary alternatives for further analysis. Of the four preliminary alternatives identified, two were eliminated from further consideration due to effectiveness (i.e., ability to achieve the overall goal of measurably decreasing newt mortality and increasing habitat permeability) and cost-effectiveness (i.e., achieving a balance between cost and effectiveness) of implementation, and two were retained for further consideration as part of this Alternatives Evaluation/Basis of Design.

The two preliminary project alternatives are Alternative 3 and Alternative 4, both of which include different combinations of Corrective Actions (i.e., wildlife crossing structure "types") in each of the four Priority Zones (Zone 1, 2, 2a, and 3) that were mapped as part of Task1 to encompass areas of significant wildlife road mortality hotspots. Four primary Corrective Actions were identified in Tasks 1 and 2 that comprise the make-up of recommended wildlife crossing structure types: Type 4 purpose-built crossing structures, Type 5 micro-passages, Type 6 elevated road segments, and modified cattle grates. The same Corrective Actions (and conceptual placement) were recommended in Zones 1 and 2 for Alternative 3 and Alternative 4. However, two different Corrective Action recommendations were proposed in Zones 2a and 3 for Alternative 3 and Alternative 4. The differences in Zone 2a were proposed primarily to account for uncertainties in traffic pattern changes associated with the future development of the former Beatty Trust property parking lot. The differences in Zone 3 were proposed to provide two different options that involve elevated road segment throughout most of Zone 3, or approximately half of Zone 3. In order of importance, the recommended order of priority for implementing the project in phases is as follows: Zone 1, Zone 3, Zone 2, and Zone 2a.

Beginning with Task 1 and extending into Task 3, several constraints have influenced the selection of Corrective Actions and the recommendation of preferred Alternatives. These constraints include those associated with limiting the placement of Type 5 micro-passages along narrow road shoulders; with limiting the placement of Type 4 crossing structures without elevated road segments; with the permeability and quantity of Type 4 vs Type 5 passage structures; with limiting opportunities to modify existing drainage culverts; and with road/shoulder width and safety concerns.

Under each of these Alternatives, a suite of traffic control and calming options and other considerations are also recommended to decrease newt mortality throughout the Alma Bridge Road Project Area (project area). None of the proposed Alternatives can treat the entire road, so these measures are critical to protect newts in the Secondary Zone where there would be no formal wildlife passage systems installed. These include traffic control and calming options such as improved signage, islands and medians, and transverse rumble

strips/perceptual treatments, as well as additional considerations like reconfiguring Ridge Trail trailhead designations to redirect/reduce automotive traffic on sensitive portions of Alma Bridge Road, and educational/interpretive signage and brochures to educate the public at parking areas and trailheads/kiosks.

While both alternatives contain similar elements and both meet the project goals, they differ in the length and location of Corrective Actions, which in turn determines their effectiveness and impacts the cost, complexity, and schedule. To evaluate Alternatives 3 and 4 based on the relative merits and potential impacts, a project-specific comparison was developed and applied to the alternatives based on five criteria: cost estimates and cost effectiveness; constructability and complexity; environmental impacts and environmental benefits (based on Effectiveness Modeling performed in Task 2); environmental clearance, permits, and approvals; and recreational use/access (safety, multimodal uses).

In general, Alternative 3 is ranked as either a "predominantly equivalent/undistinguishable" or "most desirable" outcome across these criteria, while Alternative 4 offers a "predominantly equivalent/undistinguishable" or "least preferable" outcome across these criteria. However, Project Partners may consider a hybrid approach consisting of selecting a combination of Corrective Actions drawn from both alternatives to achieve the most beneficial combination of these criteria. While both alternatives evaluated will provide population-level benefits to the population of California newts currently experiencing high mortality rates on Alma Bridge Road, the extent to which the newt population is to be protected must be considered carefully with respect to cost and safety.

This Alternatives Evaluation/Basis of Design concludes work performed for Phase I of the project. The project is anticipated to move into Phase II in Fall 2023. Phase II encompasses the environmental assessment and associated technical studies, preparation of environmental permit applications, and engineering design. The Project Partners have identified County Roads as the proposed Lead Agency for the environmental assessment and permitting process because the improvements would be to a County facility, the County has discretionary authority over the project, and the County would own, operate, and maintain the improvements. Phase II will continue to advance the engineering design of the project (preliminary design plans and 65% design) that includes detailed design drawings of a typical Type 4 purpose-built passage structure, Type 5 micro-passages, Type 6 elevated road segments, modified cattle grates, retaining walls, direction barriers (guide walls and fencing), guardrails or concrete safety carriers, unofficial turnouts/shoulders, and project-wide design plans that further refine the placement locations of individual crossing structures.

Future phases of the project (if approved) are anticipated to bring the effort through to final (100%) design, and will include final construction permits, implementation, and monitoring of the Corrective Actions.

1. Introduction

According to the University of California Davis Road Ecology Center, one of the largest recorded wildlife roadkill events in California takes place every year on Alma Bridge Road,[1] adjacent to Lexington Reservoir, in Santa Clara County (UC Davis 2021). California newts (*Taricha torosa*) disperse in winter when the first rains begin, moving from forests on the east side of the reservoir across the road to reproduce, and returning with the young of the year from the spring onwards. Between 2017 and 2023, a total of approximately 34,000 California newts were recorded dead on the road as the result of vehicle traffic along Alma Bridge Road (, Parsons 2021, Newt Patrol 2023). At an estimated localized road mortality rate for migratory newts of 39.2%, the population may be under threat of extirpation (H.T. Harvey & Associates 2021, Wilkinson and Romansic 2022).

Midpeninsula Regional Open Space District (Midpen) and Santa Clara County (County), along with stakeholders including Santa Clara Valley Water (Valley Water), Peninsula Open Space Trust, and others supportive of this project, are looking to provide safe road passage for California newts and other herpetofauna species across Alma Bridge Road. This effort is collectively referred to as the Alma Bridge Road Newt Passage Project (project).

The project is one of the first wildlife connectivity improvement projects in California to apply modelling of estimated variables to inform project design. It considers the effectiveness of various project-wide Corrective Actions with a consideration of non-environmental constraints such as engineering, design, cost, schedule, and recreation use. Specifically, this project is taking advantage of expected permeability modeling early in the conceptual design phase based on passage size and passage structure characteristics paired with what is known about migrating amphibians from existing road ecology literature (e.g., turn-around distances) to plan for population persistence.

AECOM has prepared this Alternatives Evaluation/Basis of Design technical memorandum that further refines two preliminary project alternatives identified in the Feasibility Analysis completed in April 2023 (AECOM 2023). The Basis of Design presented herein is the conceptual design level of the project (conceptual design) which will be expanded upon in Phase II.

The project is split into two Phases: Phase I (Feasibility and Conceptual Design) and Phase II (Environmental Review and Preliminary Design). This Alternatives Evaluation/Basis of Design is the third and final task within Phase I of the project (see Section 1.5 for Project History). Phase II will continue to advance the project with an environmental assessment and associated technical studies, environmental permitting, and engineering design (preliminary design plans to 65%). Throughout Phase II, continued coordination between Midpen, the County, and other stakeholders (e.g., Valley Water) will occur, which may include permit application review and encroachment permits. Future phase(s) of the project, beyond Phase II, will go through final (100%) design and will include construction permitting, landowner coordination, encroachment permits, licenses, possible land rights acquisitions, and ultimately construction implementation.

1.1 Project Goals

Project goals were developed to address the threat to California newts and other migratory herpetofauna in a manner that is feasible, evidence-based, cost effective, does not impede non-target wildlife movement, and maintains recreational and other human uses of Alma Bridge Road and surrounding open space areas. These

[1] Based on a database of over 44,000 traffic incidents involving wildlife that were recorded by the California Highway Patrol and over 65,000 carcass observations reported to the California Roadkill Observation System between 2016 and 2020 (UC Davis 2021).

goals were developed in collaboration between project partners and interested parties and reflect Midpen's commitment to an inclusive process.

The project goals are to:

- Reduce roadkill and provide habitat connectivity to sustain the local newt population
- Be correctly scaled—can be designed, environmentally cleared, permitted, and implemented
- Be cost effective
- Be maintainable
- Not impede road safety, hydrology, or public use
- Facilitate existing and future use of Alma Bridge Road and the surrounding areas and facilities
    - Continued vehicle use of the roadway and parking areas
    - Continued and future recreational access to existing facilities and trails, as well as future parking and trails (such as the former Beatty Trust property Parking Area and Trails Project)
- Have support from interested parties composed of both government and non-government agencies and organizations (Midpen; County; California Department of Fish and Wildlife (CDFW); Peninsula Open Space Trust; San Jose Water, and Valley Water); neighborhood representatives including the local quarry and nearby residents advocacy group representatives (Audubon Society, Center for Biological Diversity, and Sierra Club); and recreational user group representatives (Bay Area Ridge Trail, Los Gatos Rowing Club and Santa Cruz Mountain Trail Stewards)

1.2 Project Area

The project area is defined as an approximately 4.64-mile-long stretch of Alma Bridge Road as it passes along the northern and eastern slopes of Lexington Reservoir (Figure 1). It is located in Santa Clara County, California, in the foothills of the Santa Cruz Mountains south of the incorporated town of Los Gatos and north of the unincorporated area of Lexington Hills (Los Gatos 7.5-minute U.S. Geological Survey (USGS) topographic quadrangle). The land surrounding the project area can be characterized as a combination of primarily open space intermixed with intermittent rural, rural residential, and limited commercial.

The topography of the project area is relatively steep, ranging from Lexington Reservoir at 625 feet elevation, to Alma Bridge Road roadway (roughly 640 to 750 feet elevation) and continuing to increase in elevation up to 2,999 feet at the summit of Mount El Sombroso, located 4 miles to the east in the Sierra Azul Open Space Preserve. The upslope embankment east of Alma Bridge Road varies between gentle (<15% slope) (infrequent) to steep (30% to 60% slope) (typical) and includes areas with sheer embankments (≥100%) ranging in height from an estimated 2 to 8 feet to greater than 8 feet in areas where the road parallels especially steep terrain. Downslope, the embankment west of Alma Bridge Road terminates at the Lexington Reservoir shoreline and can be characterized similar to the upslope terrain. At some locations, an intermediary berm bordering the road shoulder separates the roadway and areas downslope. These artificial berms vary in height from an estimated 0 to 7 feet from the road deck.

Watercourses present within the project area include Limekiln Creek and Soda Springs Creek, which feed into Lexington Reservoir and are within the Guadalupe River-Frontal San Francisco Bay Estuaries (Hydrologic Unit Code [HUC] 10 1805000303) Watershed and the Los Gatos Creek (HUC 12 180500030303) Watershed. Several culverts and other drainage facilities built and maintained by Santa Clara County occur throughout the project area along Alma Bridge Road, with diameters ranging from 12 to 60 inches. More details on existing conditions can be found in the *Alma Bridge Road Newt Passage Project Technical Review* (AECOM 2022).

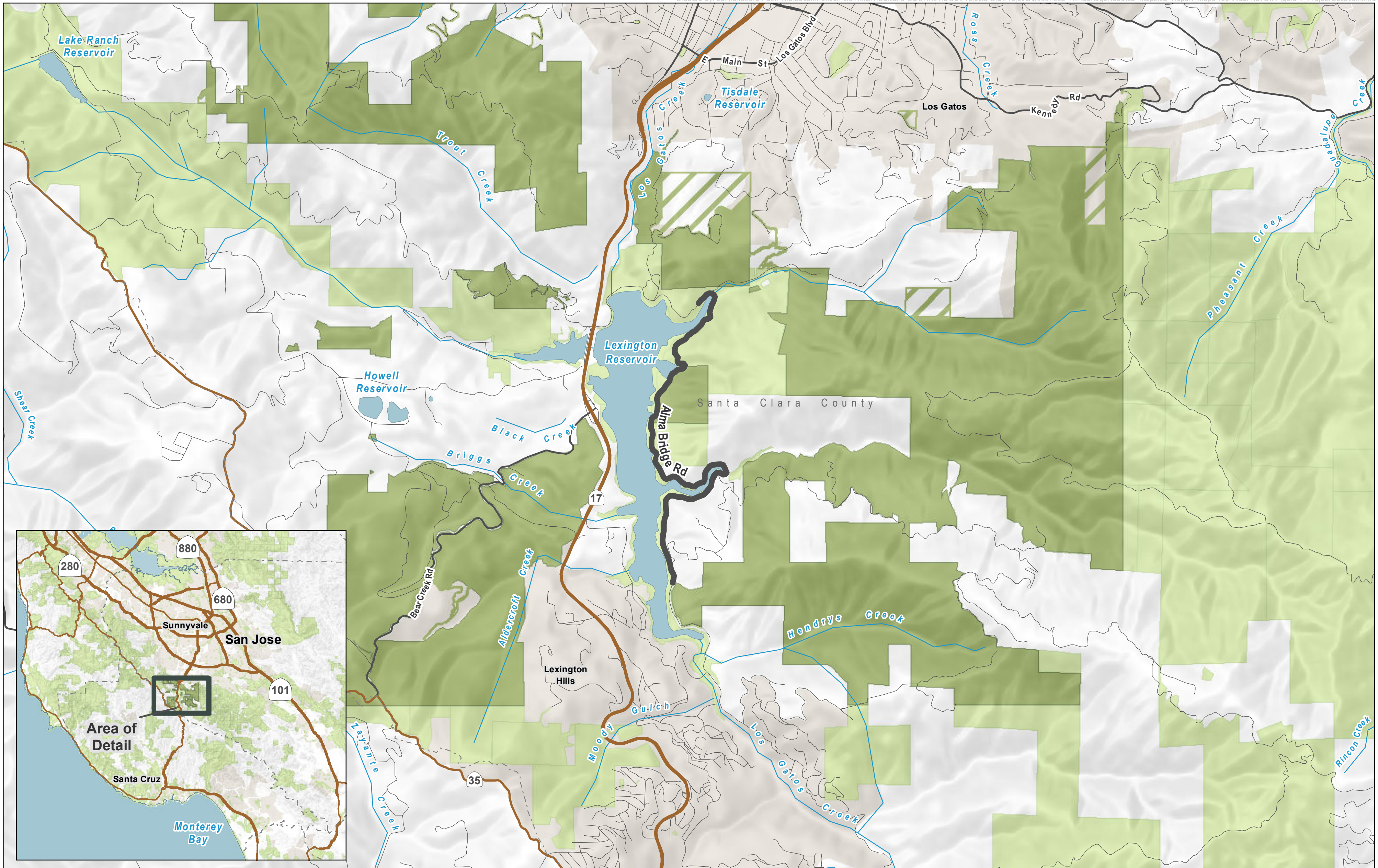

Figure 1: Project Location

Study Area (along Alma Bridge Rd)

Midpen Open Access

Other Protected Land

Midpeninsula Regional Open Space District (Midpen) 8/15/2022

Miles 0 0.5 1

MIDPENINSULA REGIONAL OPEN SPACE

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While the District strives to use the best available digital data, these data do not represent a legal survey and are merely a graphic illustration of geographic features.

1.3 Alma Bridge Road

Alma Bridge Road is a two-lane (one lane in each direction) County road that extends 4.64 miles between Aldercroft Heights Road and Highway 17. Based on a review of historical topographic maps, Alma Bridge Road north of Soda Springs was constructed immediately after the construction of the Lexington Reservoir around 1952. The section south of Soda Springs Road appears to follow near to the path of the South Pacific Coast Railroad that ran adjacent to Los Gatos Creek in the late 1800s and early 1900s. By 1953, most of the northern section of roadway along the eastern shore of the reservoir between Limekiln Creek and Hendry's Creek had been paved; the remaining roadway across the dam connecting Highway 17 and Alma Bridge Road at Limekiln Creek was constructed shortly thereafter. Road construction appears to have been a combination of cut-and-fill and benched roadway.

Each lane on Alma Bridge Road ranges from 10 to 11 feet wide, with double yellow striping separating the lanes. Just north of Soda Spring Canyon, a small segment of roadway (225 feet long) narrows to a single lane that is shared by both directions of traffic, with stop signs on both ends and a concrete barrier along the west side of the road. This single-lane segment appears to be a temporary fix to the west edge of the road to prevent collapsing.

The shoulders are mostly narrow extensions of the asphalt pavement road surface that vary from 0 to several feet wide where unofficial turnouts/shoulders exist. Short sections of dirt and gravel along the roadway also serve as shoulders and vehicle turnouts. Alma Bridge Road is maintained by Santa Clara County Roads and Airports Department. The asphalt pavement was repaved twice in 2021 and is in good condition, though there are some sections of the roads adjacent to steep slopes where the pavement is crumbling. The 1996 as-builts from culvert reconstruction projects near Limekiln Creek and Soda Springs Creek indicate 250 and 200 foot long roadway pavement structural sections of 4 inch asphalt over 6 inches of Class 3 aggregate base, respectively, above the culverts. Alma Bridge Road is designated as a primary evacuation route during emergencies (such as a wildfire) in the surrounding area.

The speed limit along Alma Bridge Road is 25 miles per hour (mph). There are no speed bumps, rumble strips, or other physical speed control features. Yellow advisory warning signs indicating lower speed limit recommendations are present in advance of sharp turns and winding sections of road, as well as newt crossing warning signs placed every mile.

Alma Bridge Road provides access to three primary County roads east of the Reservoir. Limekiln Canyon Road is a private drive that provides access to the Lexington Quarry. Soda Springs Road provides access to scattered rural residences east of the project and is designated as a secondary evacuation route during emergencies (such as a wildfire) in the surrounding area. Aldercroft Heights Road provides access to the Lupin Lodge and the rural residential neighborhood of Lexington Hills southeast of the project and is also designated as a primary evacuation route during emergencies.

Considered together, there are a total of 10 key intersections that connect this network of roads to Alma Bridge Road:

- Highway 17 (northbound)/Alma Bridge Road (#1)
- Alma Bridge Road/Limekiln Canyon Road (#2)
- Alma Bridge Road/Soda Springs Road (#3)
- Alma Bridge Road/Aldercroft Heights Road (#4)
- Highway 17 (southbound)/Bear Creek Road-Gillian Cichowski Memorial Overcrossing (#5)
- Bear Creek Road/Old Santa Cruz Highway (#6)
- Old Santa Cruz Highway/Aldercroft Heights Road (#7)
- Wright Drive (north)/Old Santa Cruz Highway (#8)

- Wright Drive (south)/Old Santa Cruz Highway (#9)
- Old Santa Cruz Highway/Idylwild Drive (#10)

1.3.1 Current Condition of Alma Bridge Road

In March 2023, a portion of Aldercroft Heights Road failed immediately upslope from the Alma Bridge Road/Aldercroft Heights Road intersection during a storm event. During execution of Phase I, and through the engagement of additional engineers during the scoping of future work anticipated under Phase II, road conditions observations on Alma Bridge Road were noted to include existing slope failures, head-cuts, undercut pavement, and landslides prevalent throughout the project area.

The wildlife passage design recommendations currently under consideration may change depending on whether Alma Bridge Road will continue to be maintained as-is, or if it will be repaired for increased road safety. For example, given the existing conditions observed onsite, Corrective Action placement could be significantly constrained by the existing road and ground conditions where slope failures, head-cuts, undercut pavement, and landslides exist or have a high probability of future occurrence. Conditions such as these would either impair the ability to successfully install and maintain wildlife passage structures, associated directional barriers (guide walls/fencing)—or would limit where such wildlife passage structures could be placed to ensure they remain functional. However, if sections of Alma Bridge Road were identified for road repairs, the options for Corrective Action placement may increase significantly and the overall design parameters of certain Corrective Actions will likely need to be tailored to integrate retaining walls.

From a cost-, planning-, and permitting-efficiency perspective, wildlife passage design recommendations should be developed that account for the future roadway, rather than recommendations that only account for current conditions. This Alternatives Evaluation/Basis of Design proposes Corrective Actions that take both wildlife passage designs and road safety improvements into consideration for overall project design.

1.4 Project History

To date, the project has been implemented in three tasks. Task 1 consisted of a technical review of the project history, existing site conditions, and wildlife crossing design guidance. Task 2 consisted of a feasibility analysis examining environmental and engineering constraints and opportunities. An overview of these prior tasks and an overview of the Alternatives Evaluation/Basis of Design described herein under Task 3, are provided below.

1.4.1 Task 1—Technical Review

AECOM prepared the *Alma Bridge Road Newt Passage Project Technical Review* (Technical Review) in October 2022 (AECOM 2022). This Technical Review details the project history, the natural history of the California newt, existing site conditions as they relate to Alma Bridge Road as a dispersal and migration impediment between upland habitat and aquatic breeding habitat at Lexington Reservoir, road crossing best management practices (BMPs), crossing design guidance, and Corrective Action opportunities. The Technical Review also provides background information on the environmental and physical setting, along with land ownership, land use, and recreation uses.

Collectively, this information was prepared to better understand the constraints and opportunities posed by the current conditions at Alma Bridge Road, inform the understanding of existing newt natural history at the site, and help identify measures to anticipate future public access, including parking and trail connections on the former Beatty Trust property. The Technical Review also established the background which any recommended or novel-built or non-built Corrective Actions may be applied to decrease newt mortality and increase habitat permeability under subsequent project tasks.

In particular, the Technical Review established two possible thresholds to determine whether Corrective Actions measurably decrease newt mortality and increase habitat permeability between aquatic and land habitats based on the previously prepared Population Growth Model estimate (H.T. Harvey & Associates 2021).

Specifically, reducing estimated road-based mortality to between 18% and 20% might allow the population to persist beyond 200 years, but the population would slowly decline. However, reducing the mortality rate to 18% or less (an estimated approximately 45% reduction from current levels) might sustain the population at its current size beyond 200 years (H.T. Harvey & Associates 2021).

The Technical Review also provides a high-level review of past studies, road crossing BMPs, and crossing design guidance pertaining to this project.

1.4.2 Task 2—Feasibility Analysis

AECOM prepared the Feasibility Analysis in April 2023 (AECOM 2023). This Feasibility Analysis was the product of collaboration between AECOM, Midpen, the County, technical experts, and interested parties and a site visit to examine environmental and engineering constraints and opportunities. AECOM, advised by technical experts from the team developed a suite of novel-built and non-built Corrective Action combinations (Options) to mitigate the road mortality recorded within a particular Priority Zone (Figure 2). The Corrective Actions identified were informed by the Task 1 Technical Review (AECOM 2022). Options were combined across Priority Zones into “Scenarios” which, in concert with each other, will potentially achieve the project goals of decreased California newt mortality and increased habitat permeability. These Scenarios were then analyzed by the USGS team for their predicted effects on newt population viability, mortality, and permeability. Those Scenarios that achieved the project objectives of no further decline and increased permeability were analyzed further and combined into a final suite of four “Alternatives.” Each Alternative was then evaluated for its environmental and engineering feasibility. The findings of this process are synthesized in the final Feasibility Analysis.

Although environmental considerations were used as the basis for establishing Zones, Corrective Action placement, and preliminary Alternatives, this Feasibility Analysis considered other, equally crucial factors such as engineering, permitting, public safety, cost, and schedule that could be triggered by the implementation of any Alternative. All such considerations were given equal weight in the final Feasibility Analysis.

Preliminary feedback from County Roads and Airports Department during Task 2 suggested that certain aspects of Corrective Actions discussed may not be feasible due to safety concerns. Further refinement between AECOM, Midpen, and County Roads and Airports Department helped the Project Partners to better understand constraints and opportunities associated with each Corrective Action, Option, and Alternative to inform which Alternatives advanced into Task 3 for more detailed evaluation.

1.4.3 Task 3—Alternatives Evaluation / Basis of Design

AECOM prepared this *Alma Bridge Road Wildlife Connectivity Improvements Project Alternatives Evaluation/Basis of Design* to further refine the preliminary project alternatives based on input provided by Agency stakeholders during Task 2. This Alternatives Evaluation includes a more thorough review of potential environmental impacts, impacts to existing facilities, hydraulics and hydrology, maintenance needs, constructability, and high-level cost effectiveness and cost estimates for two of the Alternatives.

As part of this task, the AECOM team also developed a Basis of Design (BOD) that includes the proposed Corrective Actions as alternatives, the design criteria, the decision-making process, draft schedule, preliminary construction cost estimates, and project phasing. The BOD and construction cost estimates are based on a preliminary, early-stage design.

The findings of the Alternatives Evaluation and the BOD were used to prepare the technical memorandum that provides a comparison of two Alternatives selected from the menu of proposed or novel Corrective Actions identified in the Feasibility Analysis. This evaluation addresses the following considerations:

- Cost estimates and cost effectiveness modeling
- Rationale (decision making process, constructability)

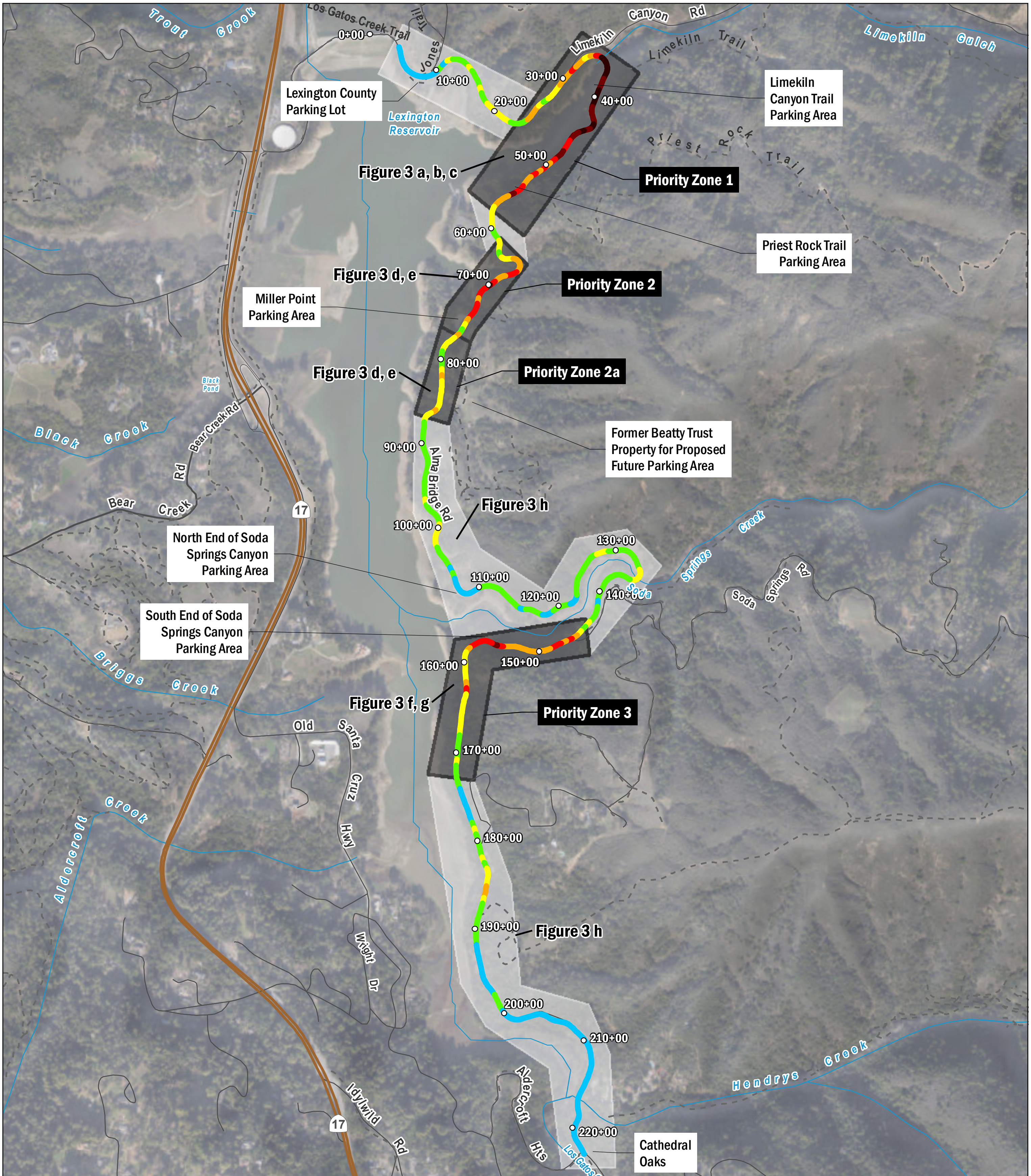

Figure 2: Priority and Secondary Zones

- - - - Existing Trail
Priority Zone
Secondary Zone

Newt Mortality (USGS)
Extremely High
Very High
High
Medium High
Medium
Low
Very Low

Midpeninsula Regional Open Space District
(Midpen)
3/29/2023

Feet
0 1,000 2,000

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While the District strives to use the best available digital data, these data do not represent a legal survey and are merely a graphic illustration of geographic features.

- Type(s) of structures
- Placement location(s)
- Extent (number/frequency)
- Dimensions
- Design criteria
- Preliminary hydraulics/hydrology considerations
- Tentative schedule
- Project phasing recommendations

This Alternatives Evaluation/Basis of Design technical memorandum presents a comparative analysis of two Alternatives for the Project Partners to consider while moving the project into Phase II.

During Phase II, additional consideration will include:

- Identification of (a) scale, (b) equipment, and (c) timing needed to perform ongoing maintenance of Corrective Action(s) (if needed)
- Completing California Environmental Quality Act (CEQA) and preparing regulatory permit applications
- Preparation of pre-construction, construction, and post-construction mitigation and monitoring requirements (if any)
- Continued coordination between Midpen and the County with stakeholders

These components require greater design and additional technical studies than is available at the current preliminary Phase I conceptual design level.

1.5 Corrective Action Constraints

Beginning with Task 1 and extending into Task 3, several constraints have influenced the selection of Corrective Actions and the recommendation of preferred Alternatives. One of those constraints is the prevailing condition of Alma Bridge Road, which consists of narrow road shoulders as well as existing slope failures, head-cuts, undercut pavement, and landslides described above. While many of these constraints are described in greater detail in the Technical Review (AECOM 2022) and Feasibility Analysis (AECOM 2023), an overview of the key constraints that were integral in the final suite of Corrective Actions and preferred Alternatives is provided below for context.

1.5.1 Constraints Limiting the Placement of Type 5 Micro-passages

Throughout the project footprint, a limiting factor that influences where Type 5 micro-passages can be placed is the narrow road shoulders, especially on the uphill (east) side of Alma Bridge Road. For Type 5 micro-passages to function optimally, ample space is required to install directional fencing angled suitably to redirect wildlife away from the active roadway and toward the micro-passages. To adequately place micro passages and directional fencing at these locations where the road shoulders are narrow or nonexistent, additional earthmoving activity would be required to expand the road shoulder on one or both sides of the road prior to constructing and placing each Type 5 micro-passage. This work would involve additional cutslope and earthmoving, retaining walls, land acquisition, engineering design, permits, natural habitat impact and mitigation, land easements, etc. In contrast, through the use of Type 4 crossing structures along sections of elevated road segments, the raised roadway with built-in guide walls and climbing barriers would double as the wildlife barrier and would not require extensive earth work on the uphill slope to install. Due to Alma Bridge Road 's prevailing conditions of narrow road shoulders, the predominant Corrective Action recommended consists of elevated road segments paired with Type 4 passage structures.

At this early stage in the preliminary design, County Roads and Airport Department has reviewed and expressed their support for including elevated road segments paired with Type 4 passage structures as a viable Corrective Action in the two alternatives considered in this Alternatives Evaluation/Basis of Design.

1.5.2 Constraints Limiting the Placement of Type 4 Crossing Structures Without Elevated Road Segments

The placement of Type 4 crossing structures in at-grade sections of roadway (rather than along sections of "raised" elevated road segments) was considered but deemed infeasible due to the prevailing road conditions described above. In at-grade sections of road, as is currently the case, Type 4 crossing structures, especially the opening on the uphill side, would have to be installed entirely underground to accommodate a purpose-built crossing structure that may be as large as 7 feet wide and 5 feet high (outer dimensions See; see "Key Assumptions" in Section 2.1.1 to explain how these dimensions are determined). To accommodate wildlife approaching from the uphill side, a ramped approach would have to be incorporated into the shoulder or drainage system at each uphill opening to guide newts into the crossing structure. This would result in a low point along the uphill side that could interrupt the intended design of adjoining drainage facilities by collecting runoff and debris, diverting flows through wildlife crossing structures rather than drainage facilities, and requiring additional maintenance. Wildlife approaching from the downhill side could be discouraged from entering the crossing structure if the opening on the uphill side is undergrounded or placed too close to the uphill embankment, which would obstruct any ambient light that might otherwise illuminate the crossing structure.

1.5.3 Permeability and Quantity of Type 4 vs Type 5 Passage Structures

In general, Corrective Actions with a larger opening (Type 4 passage structure) provide greater permeability than smaller openings (Type 5 micro-passage). As such, a greater number of Type 5 micro-passages would be required to achieve the same permeability as a Type 4 passage structure. In general, the smaller size of Type 5 micro-passages requires additional maintenance when they become occluded with debris. Each Type 5 micro-passage would also require at-grade directional fencing along both sides of the existing road shoulder that may constrict the travel path and reduce the width of road shoulders for bicyclists and pedestrians, and could be subject to damage from vehicle strikes, leading to additional maintenance costs. Due the greater number of Type 5 micro-passages, there was also concern from County Roads that the roadway lip adjacent to each of the micro passages may be subject to additional wear and tear resulting in compromised pavement across treated sections that would be undermine the integrity of the roadway long-term.

1.5.4 Constraints Limiting Opportunities to Modify Existing Drainage Culverts

Existing culvert modifications were considered as part of the Task 1 and Task 2 analyses and feasibility studies but were not identified as an optimal solution. To optimize any existing culverts to serve the double purpose as a drainage culvert and a wildlife crossing would require directional fencing that may impair the culvert's primary drainage functions on the uphill side. During high-flow events, the drainage culvert would become inaccessible to wildlife movement in both directions. The drainage culverts in the project area that terminate on the down-hill side via an overhanging culvert would need to be shortened and flush with the embankment, which would require energy dissipation measures such as rip-rap or an apron to reduce erosive conditions that could impair wildlife movement approaching the culverts from the Lexington Reservoir side (heading east) and could require earthmoving, additional permitting, and maintenance, as well as landowner coordination, encroachment permits, licenses, and land rights acquisitions. At these locations, the steep downhill embankments could also make the placement and regular inspection, maintenance, and/or repair of directional fencing (meant to guide wildlife toward the culvert opening) inaccessible, if not altogether infeasible.

1.5.5 Road/Shoulder Width and Safety Concerns

Among the project stated goals are to not impede road safety/public use, and to facilitate existing and future use of Alma Bridge Road and the surrounding areas and facilities through continued vehicle use of the roadway and parking areas, continued and future recreational (e.g. hiking, bicycling, angling) access to existing facilities and trails, and future parking and trails (such as the former Beatty Trust property Parking Area and Trails Project). One metric of site use and accessibility along the roadway is parking access at unofficial turnouts and shoulders along Alma Bridge Road. At other locations, road and road shoulder widths may require widening at locations where Corrective Actions are placed to meet County safety standards. Where road widening is not permissible, sufficient room may not be available to successfully implement Corrective Actions. Although road widening by 2 to 6 feet at certain locations to preserve unofficial turnouts and shoulders for parking or to improve safety will increase the length of any crossing structure, and thereby the distance that migratory newts would have to travel to pass underneath Alma Bridge Road, this may be a necessary compromise to address mortality areas overall and mitigate a larger, uninterrupted section of roadway.

1.5.6 Road Closures

Due to the current traffic/usage level of the road, including Alma Bridge Road's emergency access designation, road closures and/or permit only use of the road is not considered feasible. Furthermore, these options would divert road traffic onto other local roadways, preclude and limit recreational use of the area, and be challenging to effectively implement and enforce. Permanent closure of Alma Bridge Road is not feasible because California law sets forth limitations on permanently closing roads. Alma Bridge Road is under the jurisdiction of the County of Santa Clara, whereby Streets & Highways Code ("SHC") Section 942.5 states that a county may only permanently close a county highway when the closing is necessary for protection of the public, protection of the highway during storms, or during construction/improvement/maintenance operations. Vehicle Code ("VC") Section 21101 only allows for permanent road closure when the road is no longer needed for vehicular traffic.

1.6 Alternatives Development

Task 2 identified four preliminary alternatives, all of which were modeled to achieve the project goals of increased population persistence (no net loss in population size) and improved habitat permeability. Each preliminary alternative was identified based on the results of the Effectiveness Modeling completed in Task 2 to create a selection of Option combinations consisting of different levels of Corrective Action that represent a range of cost and effort.

One of the primary goals of Task 2 was to select two of these preliminary alternatives for further analysis. Of the four preliminary alternatives identified, two were eliminated from further consideration due to effectiveness (i.e., ability to achieve the overall goal of measurably decreasing newt mortality and increasing habitat permeability) and cost-effectiveness (i.e., achieving a balance between cost and effectiveness) of implementation, and two were retained for further consideration as part of this Alternatives Evaluation/Basis of Design.

Although an alternative's effectiveness is an important measure of the estimated success of Corrective Actions, it should not be the sole basis for the selection or rejection of any one alternative. Cost-, planning-, and permitting-efficiencies, among other factors, are equally important in determining the estimated success of a Corrective Action as long as project goals are met. Such factors have cost and schedule consequences (such as identifying funding sources and project schedule delays) that also influence an alternative's success. However, alternatives that result in population viability model scenarios of continued population decline would not be considered. Altogether, these factors inform the cost-effectiveness of an alternative.

Each alternative and the rationale for elimination or retention is described below.

1.6.1 Alternative 1

Preliminary Alternative 1 consists of the following Corrective Actions (Figure 3):

- **Zone 1:** construction of a 1,000-foot-long steel beam or precast concrete girder bridge supported by 125-foot-tall piers spanning the Limekiln Canyon inlet (approximately 850 to 900 feet long) and the partial road closure of a section of Alma Bridge Road between the northern and southern bridge touchdowns.
- **Zone 2:** elevated road segment (approximately 1,030 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate at either end of the approach.
- **Zone 2a:** elevated road segment (approximately 900 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate on either end of the approach.
- **Zone 3:** elevated road segment (approximately 2660 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate on either end of the approach.

Based on the Effectiveness Modeling (Task 2), Alternative 1 provides the most effective combination of Corrective Actions to address newt mortality and persistence of the local newt population.

Rationale for Elimination

The anticipated construction costs of Alternative 1 determined during Task 2 ($21M to $40M), the estimated overall project construction and support costs of Alternative 1 determined as part of this Task 3 BOD ($65.2M), and the schedule (5 to 8 years) are associated with the design, permitting, and construction of Corrective Actions that include a 1,000-foot-long bridge. The bridge will involve an inordinate level of costs (and associated fundraising) disproportionate to the effectiveness of similar solutions. The schedule is 5 to 8 years compared to 3 to 6 years for the other Alternatives proposed, which will result in an additional two or more years where the newt population will continue to experience mortality and further population decline as opposed to the other Alternatives.

For these reasons, Alternative 1 was not considered a viable alternative, and is not considered further.

1.6.2 Alternative 2

Preliminary Alternative 2 consists of the following Corrective Actions (Figure 4):

- **Zone 1:** elevated road segment (approximately 2,660 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate at either end of the approach
- **Zone 2:** elevated road segment (approximately 1,030 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate at either end of the approach
- **Zone 2a:** elevated road segment (approximately 900 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate on either end of the approach
- **Zone 3:** elevated road segment (approximately 2,660 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate on either end of the approach

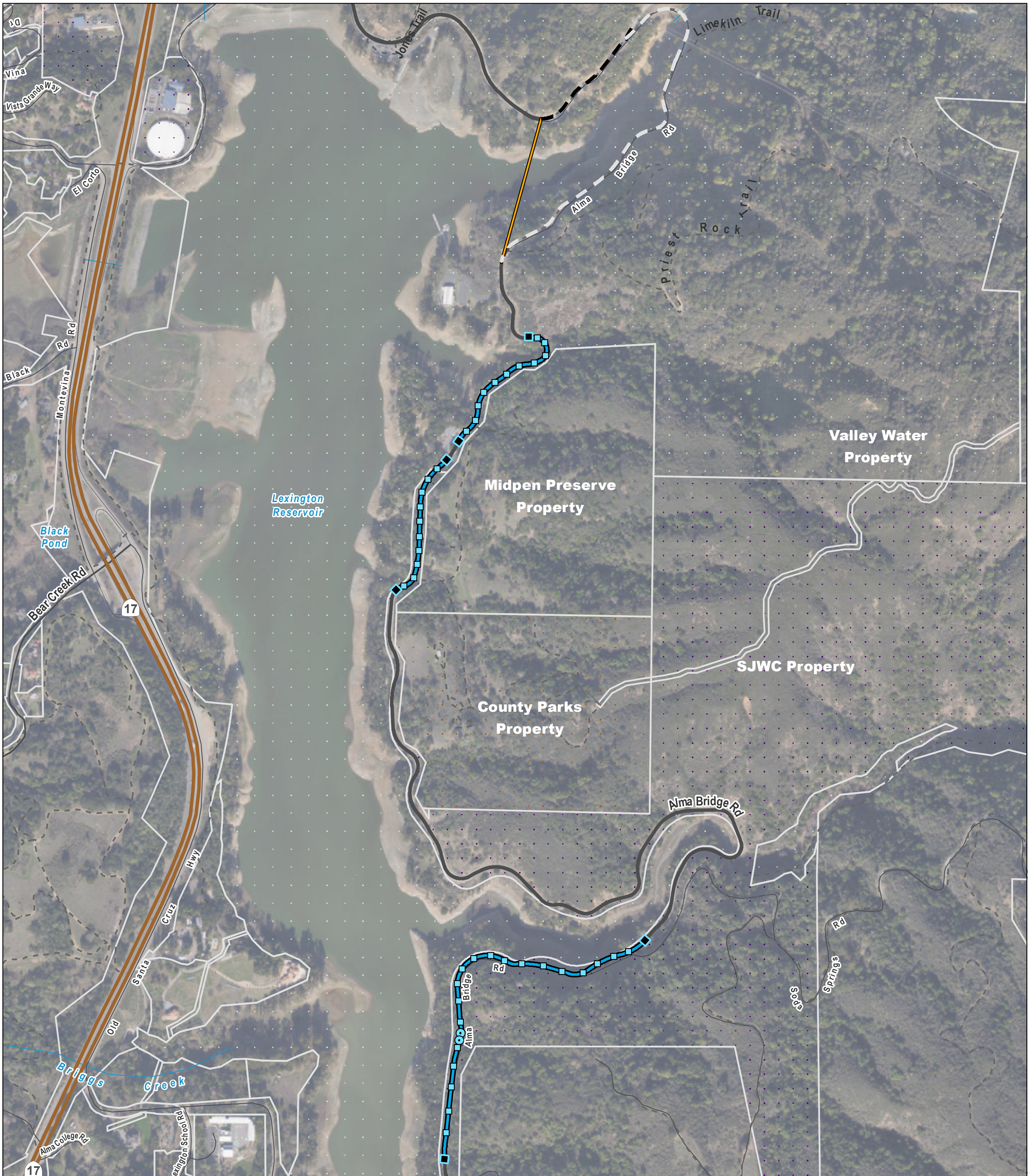

Figure 3: Alternative 1 (Option 1 + 5 + 7)

Alma Bridge Rd
Existing Trail

Land Ownership

Midpen Preserve
Valley Water
SJWC
County Parks

Alternative 1

Type 4 Purpose-Built Passage Structure
Type 5 Micro-Passage
Modified Cattle Grate
Multi-Span Bridge
Full Road Closure (No Vehicle Access)
Partial Road Closure (Non-Quarry Traffic)
Type 6 Elevated Road Segment

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N

Feet
0 500 1,000

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While the District strives to use the best available digital data, these data do not represent a legal survey and are merely a graphic illustration of geographic features.

Figure 4: Alternative 2 (Option 2b + 5 + 7)

Alma Bridge Rd
Existing Trail

Land Ownership
- Midpen Preserve
- Valley Water
- Private
- SJWC
- County Parks

Alternative 2
- Type 4 Purpose-Built Passage Structure
- Type 5 Micro-Passage
- Modified Cattle Grate
- Type 6 Elevated Road Segment

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Feet 0 500 1,000

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Based on the Effectiveness Modeling, Alternative 2 provides the second most effective combination of Corrective Action Options, along with Alternative 4, to address newt mortality and persistence of the local newt population.

Rationale for Elimination

The anticipated construction costs of Alternative 2 determined during Task 2 ($10M to $20M), the estimated overall project construction and support costs of Alternative 2 determined as part of this Task 3 BOD ($33.5M), and the schedule (3 to 6 years) associated with the design, permitting, and construction of a mixture of sections of elevated road segment with repeating Type 4 purpose-built passage structures across portions of the Priority Zones will be cost effective and involve a more proportionate level of funding consistent with the effectiveness of similar solutions. Despite these advantages, when compared to similar solutions (e.g., Alternative 3 and Alternative 4), the main differentiator that distinguishes Alternative 2 is its reliance on elevated road segment with repeating Type 4 purpose-built passage structures alone.

Additionally, under Alternative 2, the placement of elevated road segments in Priority Zone 1 along the "extended straightaway" section only addresses a portion of the known mortality area at that location, which leaves the known mortality area between the Limekiln Quarry driveway and Limekiln Trail unofficial turnout that can be remedied in a cost-effective manner through the placement of alternating Type 5 micro-passage structures with directional barriers (guide walls/fencing) and modified cattle grates, as recommended under Alternative 3 and Alternative 4) untreated. In comparison, both Alternative 3 and Alternative 4 address the entire known mortality area in Priority Zone equally (while providing differing levels of Corrective Action to address known mortality areas in Zones 2a and 3).

For these reasons, Alternative 2 was not considered a viable alternative and is not considered further.

1.6.3 Alternative 3

Preliminary Alternative 3 consists of the following Corrective Action Options (Figure 5):

- **Zone 1:** a combination of alternating Type 5 micro-passage structures with directional barriers (guide walls/fencing) and modified cattle grates between the Limekiln Quarry driveway and Limekiln Trail unofficial turnouts and shoulders, followed by section of elevated road segment (approximately 1,800 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate at either end of the approach
- **Zone 2:** elevated road segment (approximately 1,030 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate at either end of the approach
- **Zone 2a:** three Type 5 micro-passage structures with directional barriers (guide walls/fencing) placed adjacent to three unnamed tributaries in the areas of highest newt mortality within the Priority Zone.
- **Zone 3:** elevated road segment (approximately 1,370 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate on either end of the approach, along with Type 5 micro-passage structures with directional barriers (guide walls/fencing), and a modified cattle grate placed on each side of an existing culvert (unnamed tributary)

Based on the Effectiveness Modeling, Alternative 3 provides the least effective combination of Corrective Action Options to address newt mortality and persistence of the local newt population.

Rationale for Retention

The anticipated construction costs of Alternative 3 determined during Task 2 ($4M to $10M), the estimated overall project construction and support costs of Alternative 3 determined as part of this Task 3 BOD ($28.46M), and the schedule (3 to 5 years) associated with the design, permitting, and construction of a mixture of alternating Type 5 micro-passage structures—together with sections of elevated road segment with

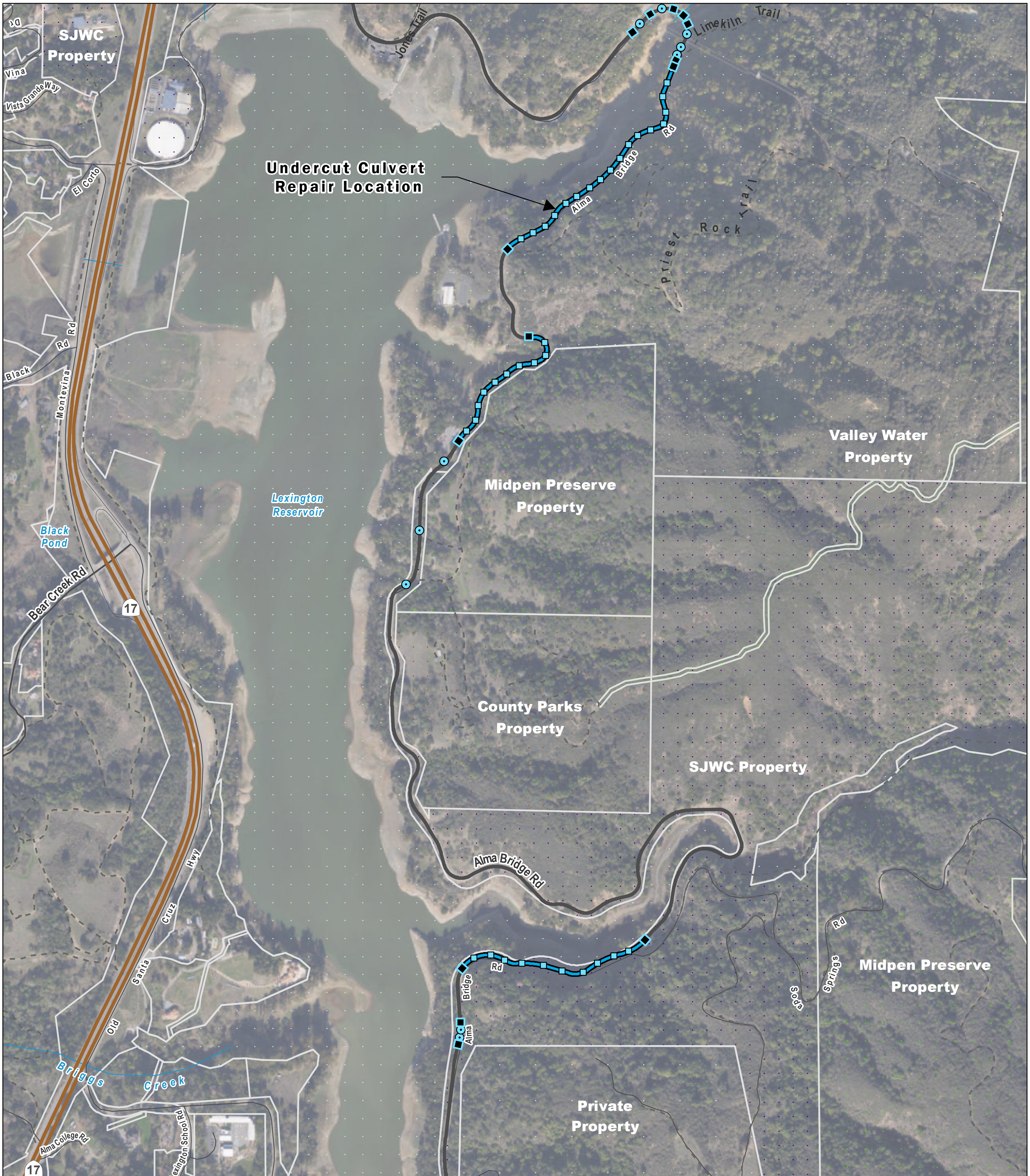

Figure 5: Alternative 3 (Option 2 + 2a + 4 + 6)

Alma Bridge Rd
Existing Trail

Land Ownership

Midpen Preserve
Valley Water
Private
SJWC
County Parks

Alternative 3

Type 4 Purpose-Built Passage Structure
Type 5 Micro-Passage
Modified Cattle Grate
Type 6 Elevated Road Segment

Feet
0 500 1,000

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repeating Type 4 purpose-built passage structures across a *smaller* proportion of the Priority Zones (approximately 4,195 linear feet) compared to Alternative 4—will be more cost-effective, involving a more proportionate level of funding consistent with the effectiveness of similar solutions. Furthermore, Alternative 3 will facilitate the timely implementation of any Corrective Action without exposing the local newt population to additional mortality and further population decline.

For these reasons, Alternative 3 was considered a viable alternative and is considered further as part of this Alternatives Evaluation/Basis of Design.

1.6.4 Alternative 4

Preliminary Alternative 4 consists of the following Corrective Action Options (Figure 6):

- **Zone 1:** a combination of alternating Type 5 micro-passage structures with directional barriers (guide walls/fencing) and modified cattle grates between the Limekiln Quarry driveway and Limekiln Trail unofficial parking lot, followed by section of elevated road segment (approximately 1,800 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate at either end of the approach
- **Zone 2:** elevated road segment (approximately 1,030 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate at either end of the approach
- **Zone 2a:** elevated road segment (approximately 900 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate on either end of the approach
- **Zone 3:** elevated road segment (approximately 2,660 feet long) with repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, with a modified cattle grate on either end of the approach

Based on the Effectiveness Modeling, Alternative 4 provides the second most effective combination of Corrective Action Options, along with Alternative 2, to address newt mortality and persistence of the local newt population.

Rationale for Retention

The anticipated construction costs of Alternative 4 determined during Task 2 ($4M to $10M), the estimated overall project construction and support costs of Alternative 4 determined as part of this Task 3 BOD ($33.76M), and the schedule (1 to 3 years) associated with the design, permitting, and construction of a mixture of alternating Type 5 micro-passage structures—together with sections of elevated road segment with repeating Type 4 purpose-built passage structures across a *greater* proportion of the Priority Zones (approximately 6,395 linear feet) compared to Alternative 3—will be more cost-effective, involving a more proportionate level of funding consistent with the effectiveness of similar solutions. Furthermore, Alternative 4 will facilitate the timely implementation of any corrective action without exposing the local newt population to additional mortality and further population decline.

For these reasons, Alternative 4 was considered a viable alternative and is considered further as part of this Alternatives Evaluation/Basis of Design.

1.6.5 Secondary Zone

Under each of the Alternatives analyzed above, a suite of traffic control and calming options and other considerations are recommended to decrease newt mortality throughout the Project Area (Figure 7). A no-build decision in the Secondary Zone would result in no additional wildlife crossing structures or traffic calming options and would not help mitigate the current observed newt mortality rate. None of the proposed

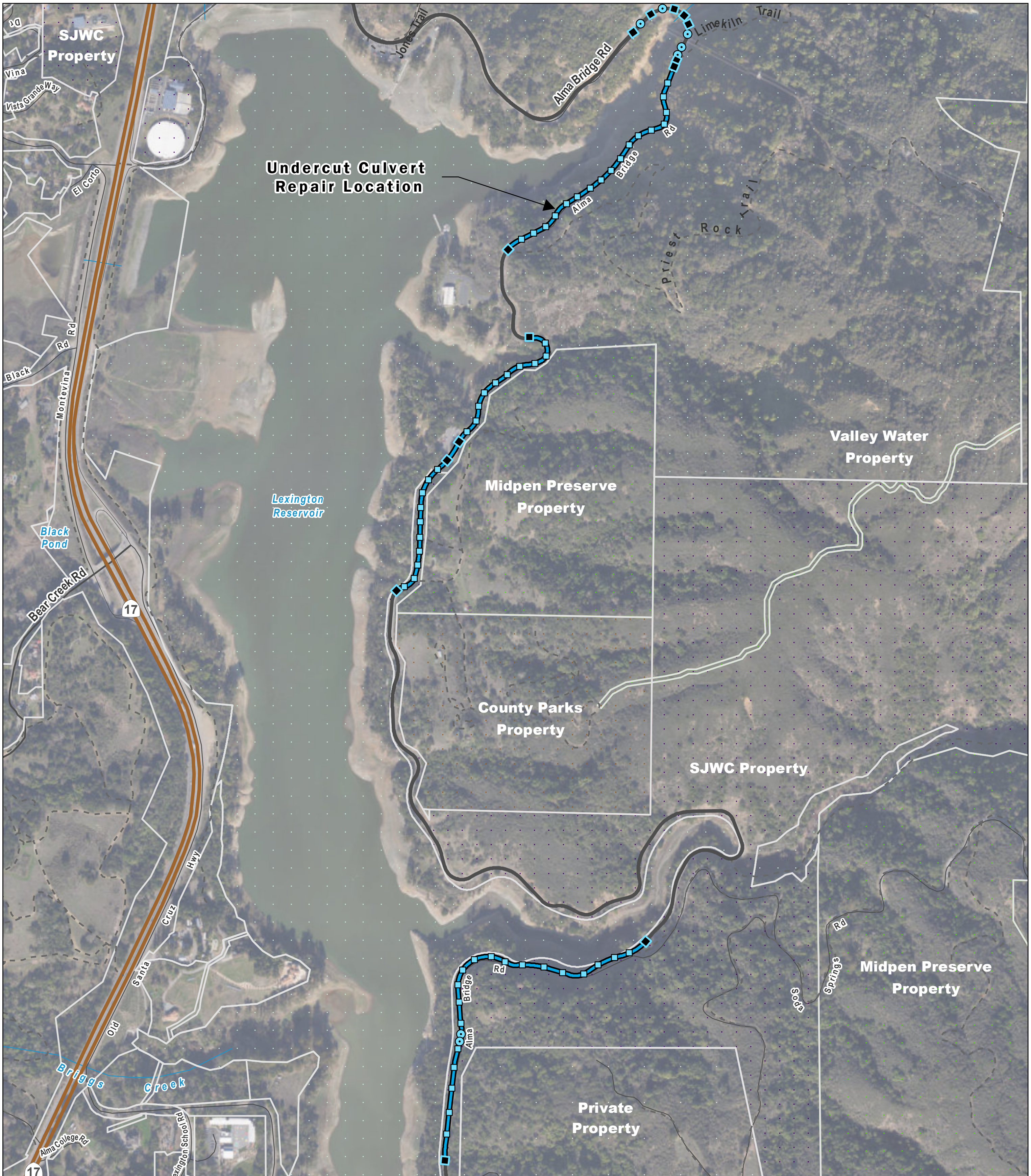

Figure 6: Alternative 4 (Option 2 + 2a + 4 + 5 + 7)

Alma Bridge Rd
Existing Trail

Land Ownership
Midpen Preserve
Valley Water
Private
SJWC
County Parks

Alternative 4
Type 4 Purpose-Built Passage Structure
Type 5 Micro-Passage
Modified Cattle Grate
Type 6 Elevated Road Segment

Feet
0 500 1,000

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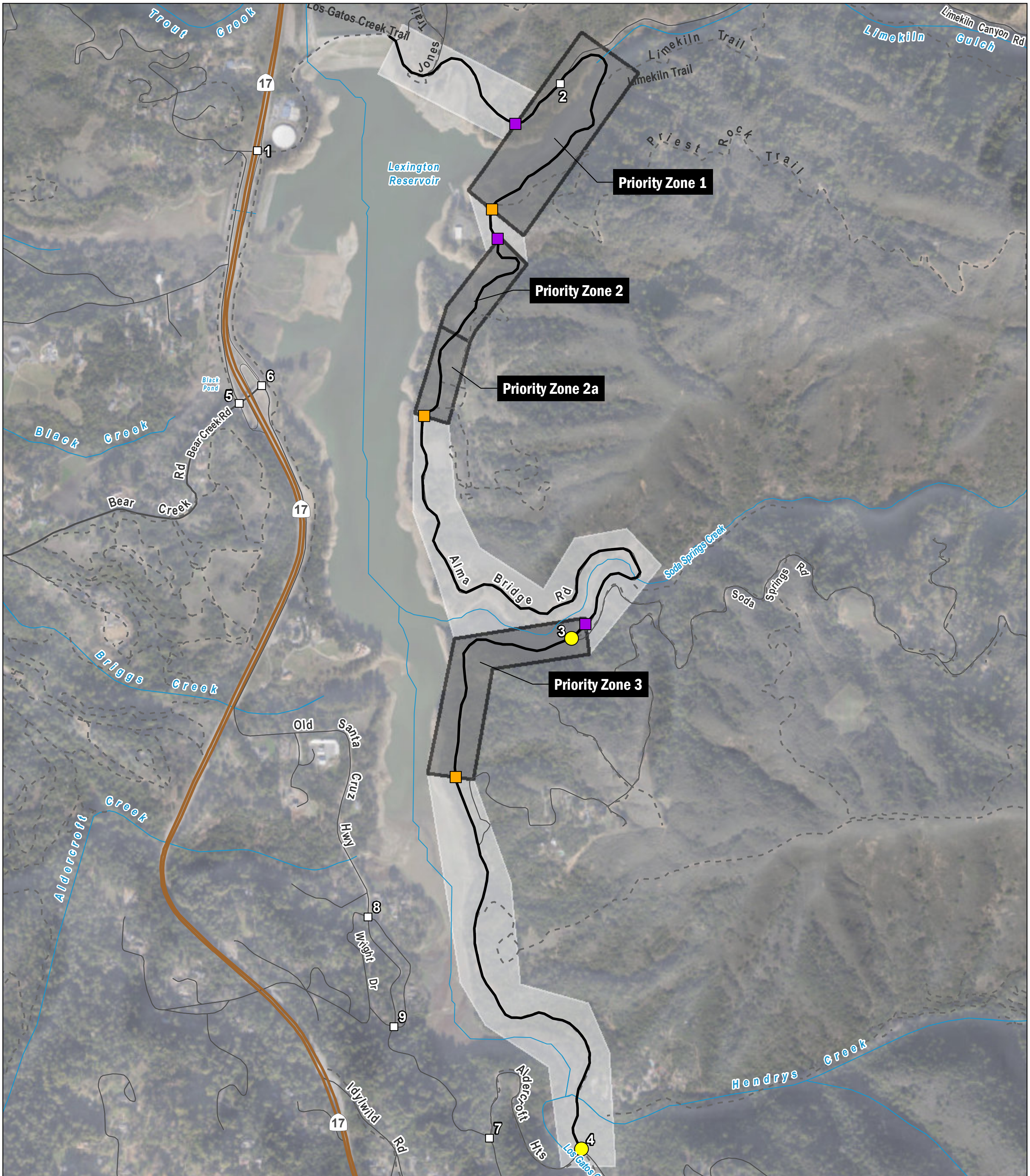

Figure 7: Secondary Zone

- Existing Trail
- Priority Zone
- Secondary Zone
- Major Intersection

1. Highway 17 (northbound)/Alma Bridge Rd
2. Alma Bridge Rd/Limekiln Canyon Rd
3. Alma Bridge Rd/Soda Springs Rd
4. Alma Bridge Rd/Aldercroft Heights Rd
5. Hwy 17 (southbound)/Bear Creek Rd Overcrossing
6. Bear Creek Rd/Old Santa Cruz Hwy
7. Old Santa Cruz Hwy/Aldercroft Heights Rd
8. Wright Dr (north)/Old Santa Cruz Hwy
9. Wright Dr (south)/Old Santa Cruz Hwy

Secondary Zone

- Island/Median Placement
- Start of Rumble Strip/Perceptual Treatment Zone (northbound)
- Start of Rumble Strip/Perceptual Treatment Zone (southbound)

Feet 0 1,000 2,000

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Alternatives can treat the entire road, so the following measures are critical to protect newts in the Secondary Zone where there would be no formal wildlife passage systems installed.

Traffic Control and Calming

Signage: To shorten route(s) and minimize travel time and distance, improved signage is recommended at the following key intersections (see Figure 7):

- Highway 17 (northbound)/Alma Bridge Road (#1)
- Alma Bridge Road/Limekiln Canyon Road (#2)
- Alma Bridge Road/Soda Springs Road (#3)
- Alma Bridge Road/Aldercroft Heights Road (#4)
- Highway 17 (southbound)/Bear Creek Road-Gillian Cichowski Memorial Overcrossing (#5)
- Bear Creek Road/Old Santa Cruz Highway (#6)
- Old Santa Cruz Highway/Aldercroft Heights Road (#7)
- Wright Drive (north)/Old Santa Cruz Highway (#8)
- Wright Drive (south)/Old Santa Cruz Highway (#9)
- Old Santa Cruz Highway/Idylwild Drive (#10)

At each of these locations, a study should be performed that includes: (a) a least cost path analysis to determine how new or improved destination, distance, street name, and advance street name signage might influence travel time and distance to key attractions along Alma Bridge Road (e.g., trailheads, Lupin Lodge, residential neighborhoods, recreational amenities), (b) visibility of existing signs, with recommendations on the need to relocate, replace, or remove obstructions (e.g., overgrown vegetation, tree limbs) or increase visibility (e.g., reflectivity) during day- and night-time conditions, (c) alternative route signage to redirect thru-traffic around Alma Bridge Road in response to road-closures or peak traffic along Highway 17.

Islands and Medians: To discourage additional traffic to the area related to street racing and sideshows, islands/medians are recommended at two primary intersections:

- intersection of Alma Bridge Road and Soda Springs Road
- intersection of Alma Bridge Road and Aldercroft Heights Road

Because raised channelizing islands and medians may function similarly to a barrier wall to migratory newts; jump-outs or other considerations for newt movement would be a necessary component of the island design, although newts are expected to traverse small impediments like curbs or islands easily.

Transverse Rumble Strips/Perceptual Treatments: To heighten driver awareness to speed reduction zones and newt crossing areas, and to improve driver safety, transverse rumble strips or perceptual treatments are recommended at the approach to all elevated road segments.

Other Considerations

Bay Area Ridge Trail: At present, the Priest Rock Trail in Sierra Azul Open Space Preserve (OSP) is part of the Bay Area Ridge Trail (Ridge Trail). As such, the trailhead for the Priest Rock Trail and the nearby Banjo Point parking area on Alma Bridge Road may attract additional visitors and recreational access to portions of the road in Priority Zone 1 that currently experience a heightened newt mortality rate.

Midpen's Highway 17 Wildlife and Regional Trail Crossings and Trail Connections Project includes potential trail improvements in this area. Two Options are proposed to help close east-west gaps between Ridge Trail segments to the east and west of SR 17. Only one of the two options would be constructed.

The first option is the Jones Trail to Priest Rock Trail (Trail #6), which would improve trail access along Alma Bridge Road between the two existing trailheads. The western end of this trail option would be at the Jones Trailhead along Alma Bridge Road, directly across from the Lexington Reservoir County Park parking lot near Lenihan Dam. The Lexington Reservoir County Park parking lot supports 32 official parking spaces (4 mini spaces, 1 handicap, and 27 regular spaces) appears to have sufficient space to accommodate additional recreational traffic in an area outside of any known newt mortality hotspots. The eastern end of this trail option would be the trailhead for Priest Rock Trail. This trail option could help to reduce automotive traffic on Alma Bridge Road associated with the Ridge Trail, especially with implementation of a public information campaign encouraging Ridge Trail users to park at the lot near Lenihan Dam. Although trail users would still cross through Priority Zone 1 on foot or bicycles, this option could reduce newt mortality compared to the existing condition.

The second option is a combination of new and improved existing trail segments, the Manzanita Trail to Limekiln Trail (Trail #5) and the Alma Bridge Road to Manzanita Trail (Trail #7), which would provide a Ridge Trail connection through open space and private lands to the north of Alma Bridge Road. As with the first option, the western end of this trail option would be at the Jones Trailhead. The eastern end of this trail option would connect to the existing Limekiln Trail, which intersects with the Priest Rock Trail 2.2 miles east of the Limekiln Trailhead on Alma Bridge Road. This option would require public access rights to be secured and part of the Ridge Trail (and Juan Bautista de Anza National Historic Trail, or Anza Trail) to be redesignated from the Priest Rock Trail to the Limekiln Trail, Manzanita Trail, and Jones Trail. These requirements would require coordination with private landowners, Bay Area Ridge Trail Council, and the National Park Service, and would therefore involve additional time and cost. However, this trail option would have a greater potential to reduce newt mortality than the Trail #6 option because it would allow for all traffic related to the Ridge Trail to bypass Alma Bridge Road between the trailheads for the Jones Trail and the Priest Rock Trail, and thereby reduce travel through Priority Zone 1.

Educational/Interpretive Signage and Brochures: Educational and interpretive signage and brochures placed at parking areas and trailheads/kiosks, and other key attractions may be instrumental in helping to educate the public about the local population of newts and other herpetofauna, wildlife migration and dispersal, and the importance of wildlife crossings to provide safe passage for newts and other species across Alma Bridge Road.

1.6.6 Summary

Key differentiators that distinguish each alternative from other alternatives include:

- The disproportionate cost and schedule implications of the 1,000-foot-long steel beam or precast concrete girder bridge associated with Alternative 1;
- The limited treatment of a known key mortality area between Limekiln Quarry driveway and Limekiln Trail associated with Alternative 2;
- The two options proposed to account for a future no-change in the existing wildlife mortality hotspot in Zone 2a as a result of realigning the proposed former Beatty Trust property primary driveway in Alternative 3, or an estimated future expansion of the existing wildlife mortality hotspot in Zone 2a as a result of leaving the proposed former Beatty Trust property primary driveway in place in Alternative 4; and
- The placement of elevated road segment with repeating Type 4 purpose-built passage structures with built-in guide walls throughout approximately half (Alternative 3) or throughout the entirety (Alternative 4) of Zone 3.

The primary differences between Alternative 3 and Alternative 4 are the Corrective Action options proposed in Priority Zone 2a and 3 (Figure 8). Under Alternative 3, the realignment of the proposed former Beatty Trust property primary driveway in Zone 2a is included to prevent the estimated expansion of the existing wildlife mortality hotspot that could take place if the primary driveway remained in place which, as currently proposed, encourages vehicles to travel from Zone 2 into Zone 2a . This realignment may also require a reconfiguration of

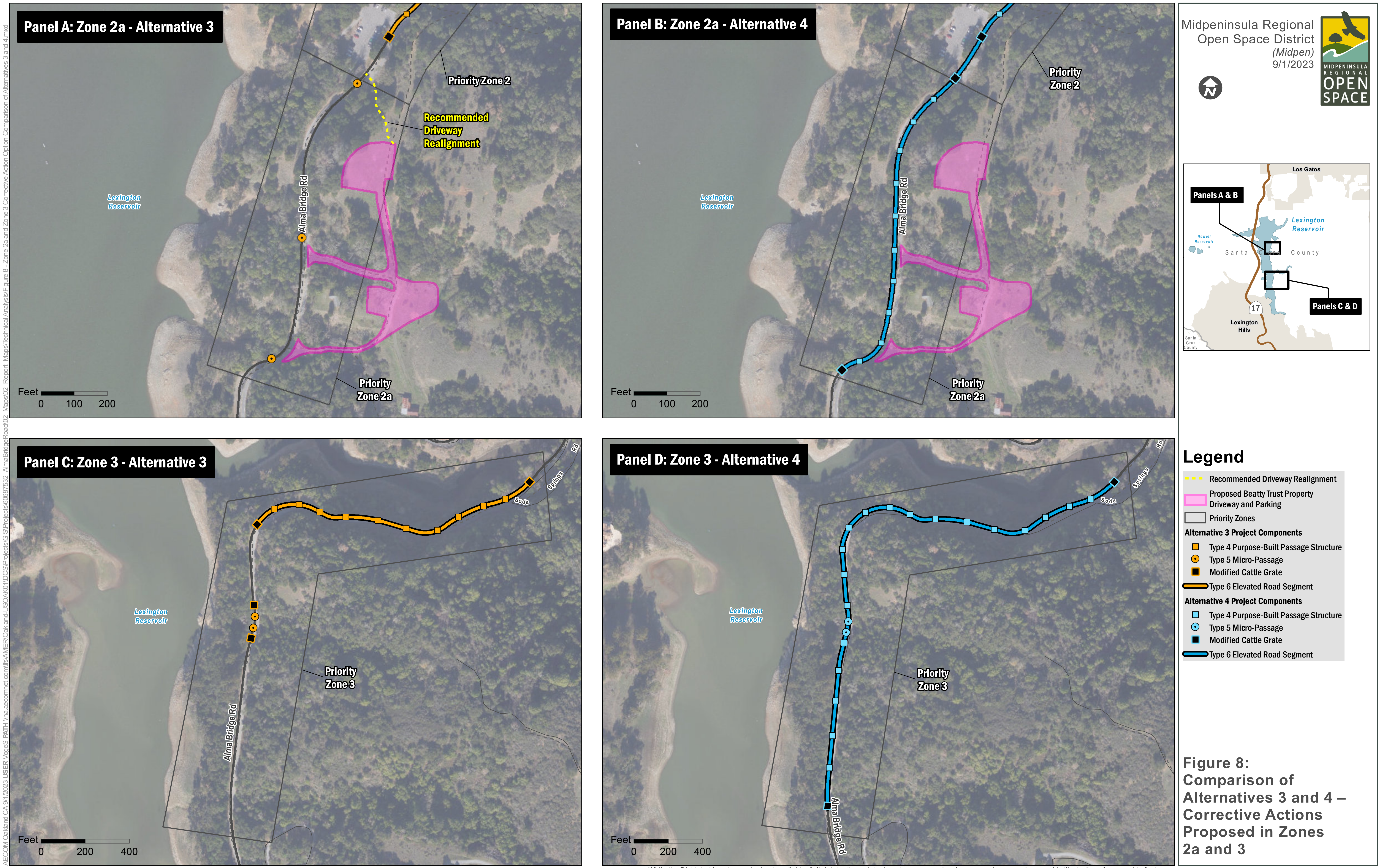


Figure 8: Comparison of Alternatives 3 and 4 – Corrective Actions Proposed in Zones 2a and 3

While the District strives to use the best available digital data, these data do not represent a legal survey and are merely a graphic illustration of geographic features.

the Miller Point parking lot to relocate its existing driveway entrance/exit further south; at its current location, a 4-way intersection is infeasible due to limited line-of-sight and visual obstructions. By realigning the primary driveway to match the Miller Point parking lot intersection, any existing vehicle-related newt mortality in Zone 2a would be addressed through the placement of three Type 5 micro-passage structures with directional barriers (guide walls/fencing) placed adjacent to three unnamed tributaries and would involve approximately 4,195 linear feet of roadway improvements across all zones.

Under Alternative 4, retaining in place the current former Beatty Trust property primary driveway in Zone 2a is estimated to lead to an expansion of the existing wildlife mortality hotspot in Zone 2a that could take place as vehicles travel from Zone 2 into Zone 2a. Without realigning the primary driveway, any vehicle-related newt mortality in Zone 2a would be offset instead by the placement of additional elevated road segment throughout Zone 2a and would involve approximately 6,395 linear feet of roadway improvements across all zones.

Under both of the alternatives described above, the possible expansion of the existing wildlife mortality hotspot in Zone 2a was estimated based on a future scenario in which visitors to Miller Point have the option to access a new designated parking lot and associated facilities (i.e., the former Beatty Trust property) approximately 800 feet south of the existing Miller Point parking lot. Considering this new access point, the possible expansion of the existing wildlife mortality hotspot in Zone 2a is based on a portion of the existing Miller Point vehicle traffic traveling an additional 800 feet south along Alma Springs Road but does not assume that traffic to the area would increase measurably. Likewise, it is unknown whether the existing wildlife mortality hotspot would increase in number of newts killed, be redistributed across an additional length of road, or whether there would be no change whatsoever.

In Zone 3, the east-west portion of Alma Bridge Road would consist entirely of elevated road segment with repeating Type 4 purpose-built passage structures with built-in guide walls under both alternatives. However, under Alternative 3, the subsequent north-south portion of Alma Bridge Road would consist of Type 5 micro-passage structures with directional barriers (guide walls/fencing), and a modified cattle grate placed on each side of an existing culvert, while under Alternative 4 that same portion of road would consist of a continuation of the elevated road segment with repeating Type 4 purpose-built passage structures with built-in guide walls.

Selecting both Alternatives 3 and 4 provides a spectrum of treatment options ranging from shorter sections of elevated road segments (Alternative 3) to longer sections of elevated road segments (Alternative 4) across Priority Zones 2a and 3, allowing for a more meaningful comparison and analysis of options and a range of unique, disparate options to consider. At their discretion, however, in Phase II the Project Partners may consider a hybrid approach consisting of selecting a combination of Corrective Actions drawn from both alternatives to achieve the most beneficial combination of cost estimates and cost effectiveness; constructability and complexity; environmental impacts and benefits; environmental clearances, permits; and approvals, and recreational uses and access.

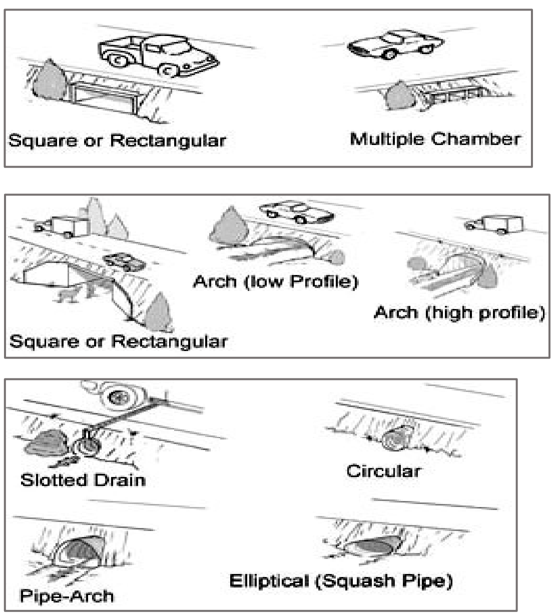
2. Basis of Design

The Task 2 Feasibility Analysis provided initial design information for several crossing structure types (described below) to identify the approximate dimensions, placement, and quantity of each crossing structure type (AECOM 2023). As described in Section 1.4.2, these Corrective Actions were then recommended at different Priority Zones to form Options, and finally grouped together into Alternatives (Section 1.5). This BOD expands on the design parameters identified in Task 2 and includes more detailed design criteria and assumptions, presented below as the conceptual, preliminary design.

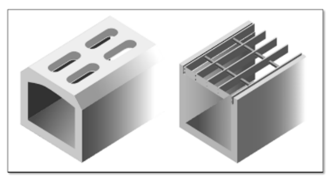
2.1 Corrective Action Design Criteria and Assumptions

Four primary Corrective Actions (Figure 9) are recommended together in different combinations and along different extents to form Alternatives 3 and 4 include:

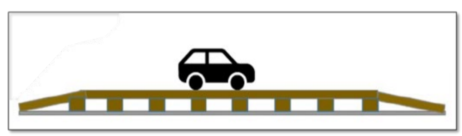
- Type 4 purpose-built passage structures,
- Type 5 micro-passage structures,
- Type 6 elevated road segments, and
- Modified cattle grates.



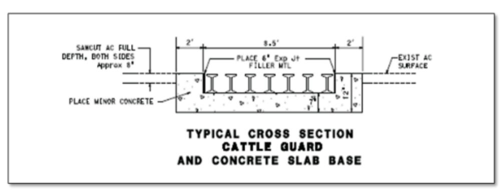
Examples of Type 4 Passage Structures (https://www.fs.usda.gov/wildlifecrossings/glossary/common-types2.php)



Examples of Type 5 Micro-passages (Langton and Clevenger 2021)



Example of a Type 6 Elevated Road Segment (Brehme et al. 2022)



Example of a Modified Cattle Grate (courtesy of Cheryl Brehme, USGS)

Figure 9. Examples of Type 4purpose-built passage structures, Type 5 micro-passage structures, Type 6 elevated road segments, and modified cattle grates.

Type 4 purpose built-passage structures are larger in dimensions, and are installed expressly with wildlife in mind, and are oftentimes designed and built to accommodate specific species, which can include amphibians, reptiles, and small- to medium-size mammals. By contrast, Type 5 micro-passages are smaller in dimensions and may serve the purpose of drainage or wildlife movement unless installed expressly with wildlife (typically amphibians and reptiles) in mind. Whether a structure (i.e., a Type 4 purpose-built passage structure vs a Type

5 micro-passage) is considered at-grade or below-grade depends on whether any portion of the structure, in this case grated tops, is flush with the road surface (at-grade) or not (below-grade).

Additional supporting design features are included for each of the four Corrective Actions to direct newt movements, provide safety enhancements for vehicular and multimodal users on Alma Bridge Road, and maintain or improve drainage features. These additional supporting design features include:

- Retaining walls,
- Directional barriers (guide walls and fencing),
- Guardrail or concrete safety barriers, and
- Unofficial turnouts / shoulders.

Of the four Corrective Actions considered, two of the structures would also accommodate non-target species in addition to amphibians and reptiles. Both Type 4 purpose-built passage structures and Type 6 elevated road segments paired with Type 4 purpose-built passage structures could accommodate wildlife passage for small- to medium-sized mammals. Similarly, the smaller-size Type 5 micro-passage structures could accommodate wildlife passage for small-mammals. Any recommended supporting design features such as retaining walls, directional barriers (guide walls and fencing), and guardrails or concrete safety barriers would be designed with consideration for wildlife movement to prevent impeding the movement of small-, medium-, and large-sized mammals.

2.1.1 Type 4 Purpose-built Passage Structures

General Overview

Type 4 purpose-built passage structures typically consist of small to medium sized (less than10 feet wide) box culverts or drainage culverts that may serve the primary purpose of drainage (i.e., any dry, ephemeral, intermittent, or annual drainage structure), or (as in this Project) may be instead repurposed or purpose-built to address wildlife movement. Type 4 purpose-built passage structures are typically repurposed culverts constructed from concrete, galvanized steel, or high-density polyethylene, and can be square, rectangular, arched, round, half, or three-quarters round (FHWA 2011, Langton and Clevenger 2021). Type 4 purpose-built passage structures require elevated road segments to a height of between 8 inches up to 2 feet above existing grade.

At Alma Bridge Road, several Type 4 purpose-built passage structures could be considered, including pre-cast box culverts, bridge culverts (i.e., a specific type of culvert whose design is technically similar in form and function to a formal bridge, but on a reduced scale), and/or culverts that will be designed with either a horizontal or drain-style metal grate on the road level. A grated top to the culvert provides access for routine maintenance and allow for ambient lighting necessary for migratory orientation and continuous ambient moisture to enhance permeability for migrating newts. A grated top may also require additional maintenance, upkeep, repair, and replacement, and may require additional design considerations for pedestrian and bicycle safety. Type 4 purpose-built passage structures will contain fill to mimic a natural soil bottom throughout the passage. Any grating in the active roadway will be bicycle-proof for road user safety.

Repeating Type 4 purpose-built passage structures will be placed at regularly spaced intervals (“repeating”) along/underneath elevated road segments that serve the primary purpose of wildlife movement and include built-in guide walls and climbing barrier. Type 4 purpose-built passage structures are also likely to convey runoff under the roadway when located in areas where rainfall or groundwater collects or is channeled. Use of Type 4 purpose-built passage structures may require the placement of energy dissipation measures such as an apron to lower stormwater runoff velocity and prevent surface scouring in newly formed concentrated outfall locations.

A preliminary analysis of the hydrologic and hydraulic conditions specific to the placement of a Type 4 purpose-built passage structure is included in Section 2.5.

Additional Design Criteria

For amphibians and/or reptiles as target species, the recommended minimum width and height for an open rectangular Type 4 purpose-built passage structures for a two-lane road is 3.25 feet wide and 2.5 feet high, and the recommended minimum diameter for circular passage along a two-lane road is 3.3 feet (Langton and Clevenger 2021). Purpose-built passage structures, however, may deviate from recommended dimensions to suit the specific needs or constraints of a project or at specific location(s) within a project.

Maintenance, durability, and safety considerations will be included in the design phase. The grated top and passage structure will need to be traffic rated and handle traffic loads and vehicle weights anticipated to travel along the Alma Bridge Road. In addition, the grated top will need to accommodate bicycle travel on a smooth but non-slippery surface. The grated top will be built and installed as two separate sections to allow maintenance personnel to perform maintenance activities on one half of the structure at a time to avoid full road closures. Structural and safety analyses will be conducted during Phase II to determine appropriate grating/top, passage dimensions, structural thickness, and material for anticipated loads, durability, maintainability, and safety. The design team will investigate appropriate mechanisms to keep the top from dislodging during Phase II.

In locations where at-grade Type 4 purpose-built passage structures terminate and guard railing is required along the side slope, the crossings will be located where the ends do not conflict with guard rail posts. Locations of guard railing will be determined during Phase II.

Type 4 purpose-built passage structures will be located, wherever possible, where they do not conflict with existing underground utilities or overhead utility poles that require relocation or adjustment of the utility.

Key Assumptions

The "Repeating Elevated Pre-Cast Box Culvert" Concept was assumed for a Type 4 purpose-built passage structure along the elevated road segments (Brehme et al. 2022) with spacing every 98 feet in Phase I. Modifications to the concept include a grated top supported by the culvert walls for structural integrity. See Figure 10 for an elevation view of Type 4 crossing on raised roadway. Inside dimensions of the box culvert are 3 feet high by 5 feet wide which meet the minimum recommended dimensions discussed above. The bottom of the passage will be comprised of native material to mimic natural conditions throughout the passage and allow for a 1 to 1.5 feet height of clearance inside the passageway. The thickness of the box culvert will be 12 inches (sides) and 12 inches (top and bottom) resulting in outside dimensions of 7 feet wide and 5 feet high. Final thickness of the box culvert will be determined, and the structure will be specially designed during Phase II as part of the structural analysis and design.

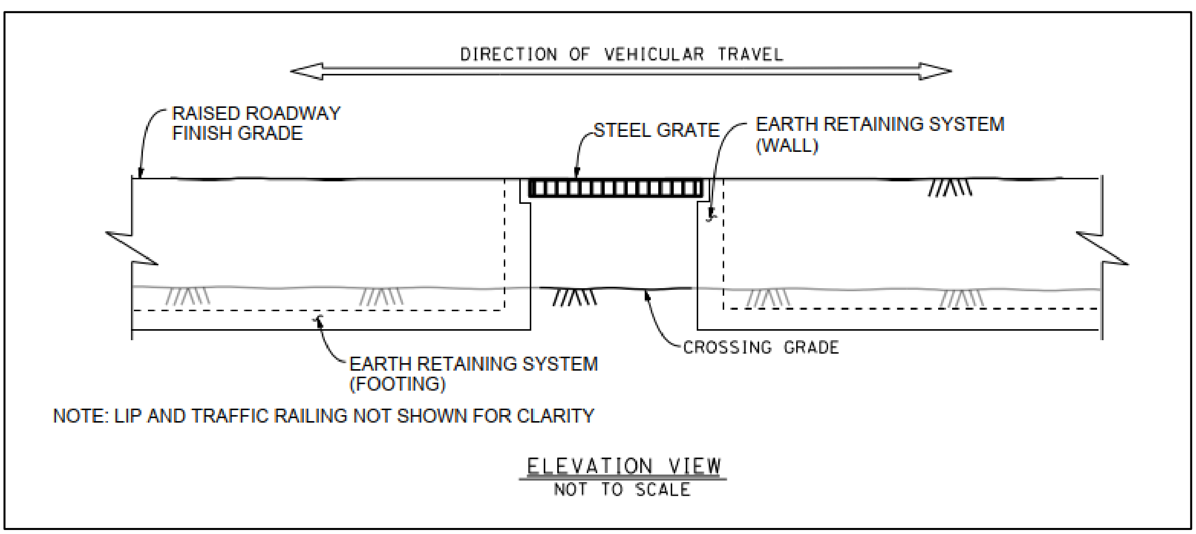


Figure 10. Elevation View of Type 4 Passage Structure on Raised Roadway (not to scale)

2.1.2 Type 5 Micro-passage Structures

General Overview

Type 5 micro-passage structures typically consist of smaller (less than 3 feet wide, 17 to 20 inches tall) below grade drainage culverts that may serve the primary purpose of drainage (i.e., any dry, ephemeral, or intermittent drainage structure), or in the case of this Project be purpose-built wildlife micro-passages designed for wildlife movement. Type 5 micro-passage structures are sometimes achieved through the construction of small cross-road drainage culverts constructed from concrete, galvanized steel, or high-density polyethylene. The installation of purpose-built commercial wildlife passage structures that include a grated top at-grade, often designed specifically for reptiles and amphibians is recommended (FHWA 2011, Langton and Clevenger 2021). Specific designs for water discharge are required because below-grade passages that inundate with water during rain events have been shown to be ineffective for amphibian movement (e.g., Hopkins et al. 2019, Schmidt et al. 2020).

At Alma Bridge Road, the recommended Type 5 micro-passage structures proposed for use throughout the project (where indicated) will consist of a commercial high-strength, slotted surface micro-passage that serve the primary purpose of wildlife movement.

Additional Design Criteria

Type 5 micro-passage structures will be placed so the slotted top is flush with the existing pavement (at-grade). If, however, installing the structures at-grade with the existing roadway requires excessive environmental or drainage impacts, raising the roadway up to 6 inches or eliminating the passage will be considered during Phase II.

Maintenance, durability, and safety considerations will be included in the design phase. The smaller size of Type 5 micro-passages requires additional maintenance when they become occluded with debris. The grated top of the micro-passage is traffic rated to handle loads and vehicle weights anticipated to travel along the road (Section 2.2). In addition, the grated top will accommodate bicycle traffic on a smooth but non-slippery surface. The grated top will be built and installed as two separate sections to allow maintenance personnel to perform maintenance activities on one half of the structure at a time to avoid full road closures. Structural and safety analyses will be conducted during Phase II to determine additional details for appropriate grating/top, passage dimensions, structural thickness, and material for anticipated loads, durability, maintainability, and safety.

In locations where at-grade Type 5 micro-passage structures terminate and guard railing (Section 2.1.6) is required along the side slope, the structures will be located where the ends do not conflict with guard rail posts.

At-grade Type 5 micro-passage structures will not be located where they conflict with existing underground utilities or overhead utility poles and require relocation or adjustment of the utility.

Key Assumptions

Type 5 micro-passage structures are assumed to be at-grade with the existing top of pavement elevation. See Figure 11 for typical views of Type 5 micro-passage structures.

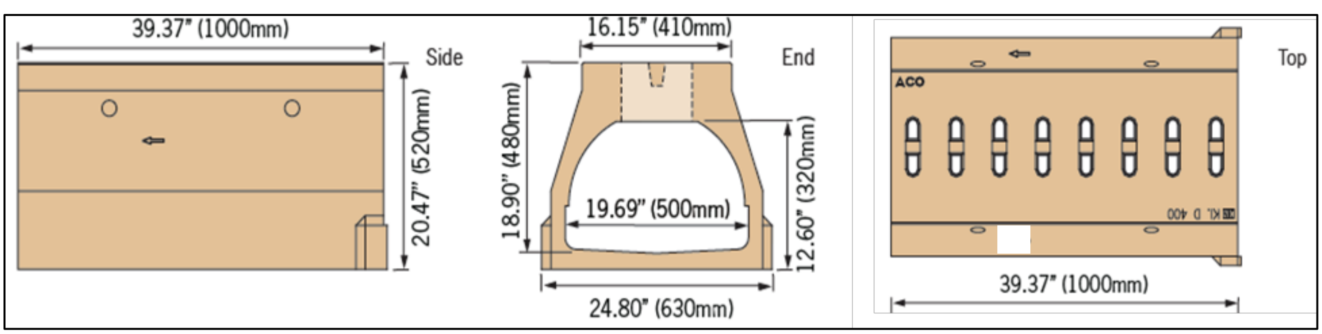


Figure 11. View of Type 5 Micro-passage Structure

2.1.3 Type 6 Elevated Road Segments

General Overview

Type 6 structures typically consist of microbridges and continuous elevated road segments, raising the road between 8 inches up to several feet above an existing roadway, forming a low viaduct. These are typically designed to span and preserve existing wildlife movement corridors (Langton and Clevenger 2021, Brehme and Fisher 2021, Brehme et al. 2022). Elevated road segment designs with grated-topped passages offer increased permeability to migrating amphibians by allowing the passage to be wetted during rainfall events when amphibians are most likely to be crossing the road (Brehme et al. 2023). This design also reduces the probability of inundating passages which can further reduce passage use (Hopkins et al. 2019, Schmidt et al. 2020, Langton and Clevenger 2021).

At Alma Bridge Road, the recommended elevated road segment proposed for use throughout the project (where indicated) will require raising the roadway up to 2 feet from existing roadway elevation for anywhere from 4,195 feet to 6,395 feet across the four separate zones to accommodate Type 4 purpose-built passage structures (Section 2.1.1) with built-in guide walls and climbing barrier (Section 2.1.6), placed at regularly spaced intervals along this portion of road. Built-in guide walls function to redirect wildlife movement to each Type 4 purpose-built passage structure and climbing barriers prevent wildlife from over-topping the guide wall to access the roadway.

Anywhere from three sections of elevated road segment in Alternative 3 to as many as four sections in Alternative 4 are recommended. In each Zone where a section of elevated road segment is proposed, it will consist of a single gradually ramped approach (ramp-up) ranging anywhere from 50 to 155 feet with approach grades ranging anywhere from 1.40% to 10.0%, with a single gradually ramped end-point (ramp-down) at the end of the section. No more than one continuous section of elevated road segment will be placed in any one Zone. The shortest distance between sections of elevated road segment is approximately 250 feet between Zone 2 and 2a; however, elsewhere throughout the project, the estimated distance between elevated road segments will be 750 feet (0.14 mile) between Zone 1 and Zone 2, and 5,560 feet (1.05 miles) between Zone 2a and Zone 3. Throughout each continuous elevated road segment, repeating Type 4 purpose-built passage structures will be installed at-grade with the new road surface. Wherever possible, the gradually ramped approaches and endpoints of elevated road segment will be placed strategically in line with the existing natural change in elevation of the roadway to ensure that drivers traveling along Alma Bridge Road do not experience a noticeable grade change. Fill depths range from 2 to 4 feet.

Any elevated roadway structures will be permanent (non-timber type structures), confined to the existing road prism and available shoulder (e.g., will not require additional widening), and accommodate bicyclists consistent with existing conditions onsite, and are subject to further design; however, due to the possibility that such structures may require additional maintenance if the underlying Type 4 purpose-built passage structures cannot be feasibly designed with grated tops due to structural concerns, elevated road segments may not ultimately be supported by the County.

Additional Design Criteria

Because elevated road segments are to be used with Type 4 purpose-built passage structures, much of the same design criteria apply as described in Section 2.1.1. Additional design criteria are in Section 2.2 (Roadway Design Standards and Assumptions).

Key Assumptions

It is assumed that spacing for the Type 4 purpose-built passage structures is approximately 98 feet along the proposed elevated road segments. Additional analysis will be conducted before the 65% design to determine impacts of alternative spacing at approximately 60 feet, as recommended by Langton and Clevenger (2021).

It is also assumed that below-grade Type 4 or Type 5 structures would not be feasible in stretches of road with steep up-slopes abutting the road with little to no road shoulders, due to instability of existing slopes and increased probability of erosion and slope failures. Therefore, elevated road segments with repeating Type 4 purpose-built passage structures with built-in guide walls were considered the only viable alternative. This assumption will be further evaluated in Phase II after geotechnical and engineering assessments. See Figure 12 for a typical view of Type 6 elevated road segment with Type 4 passage structures.

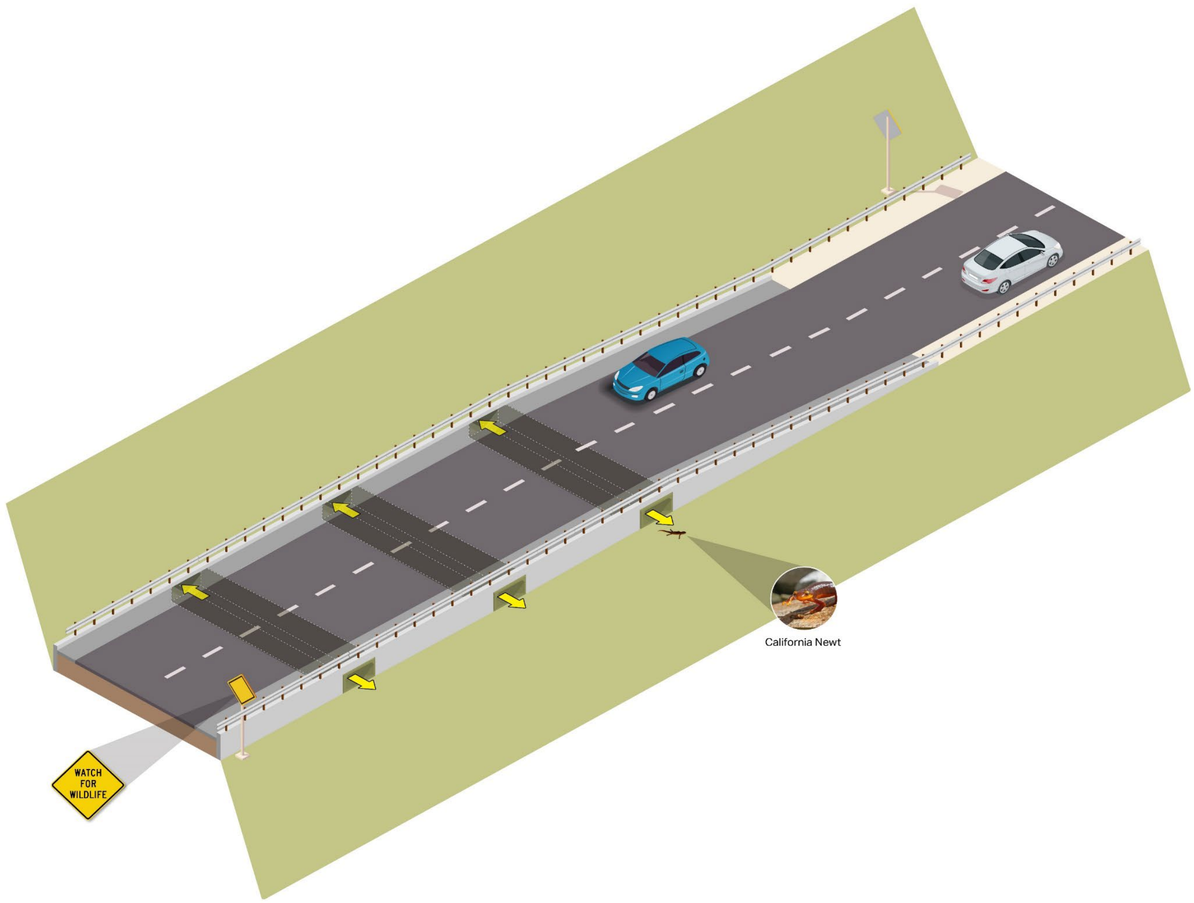


Figure 12. View of Type 6 Elevated Road Segment (with Type 4 Passage Structure; not to scale)

2.1.4 Modified Cattle Grates

General Overview

Modified cattle grates are typically 8.5 feet wide with an approximately 5-inch-deep open passage below that facilitates herpetofauna movement but could be modified to accommodate a project's specific needs. The cattle grate extends across the full width of the roadway and can be constructed with round-top steel pipe, flat-top steel pipe, or steel structural H- and I-beams placed at-grade in the roadway.

Modified cattle grates can function in two ways. When paired with directional fencing alone, modified cattle grates can function as a wildlife passage structure (similar to a Type 4 purpose-built passage structure or a Type 5 micro-passage structure) by directing wildlife underneath an active roadway. When paired with directional fencing and placed at either end of an elevated road segment, modified cattle grates will redirect newts that encounter the grate. When the newt encounters the open grate, they should fall safely through the openings into the protected passage below, where they can complete their migratory movement without further risk of a vehicle strike. Modified cattle grates require an open end at each side of the road to allow species passage. Installation of modified cattle grates will ensure that newts do not find their way onto an elevated road segment from either end of the paved roadway.

At Alma Bridge Road, cattle grates are recommended at either end of elevated road segments and the other crossing structures to redirect newts traveling along the road instead of across it. Cattle grates will be outfitted with grating or smooth surface on top to safely accommodate bicycle traffic.

Modified cattle grates and the open passage below the grates can quickly fill up with debris. Periodic maintenance to clear the debris will be required.

Additional Design Criteria

The top of the cattle grate structures will be traffic rated and handle loads and vehicle weights anticipated to travel along the road (Section 2,2). Similar to the Type 5 micro-passage structures, the top will need to be bicycle-safe that provides smooth but non-slippery surface. Structural and safety analysis will be conducted during Phase II to determine the appropriate top and cattle guard size for the anticipated loads, durability, maintainability, and facilitate use by bicycles.

Slow speeds are an integral part of cattle grates as suction forces from vehicles may potentially lift and kill small animals. Depth of these structures and spacing of grid bars will be an important consideration during Phase II. In addition, posting advisory speed limit signs of 15 mph will be considered where cattle guards are proposed.

The risk of newts or other herpetofauna coming in contact with the surface of the steel grate bars, which could become hot during the summer months, will be mitigated by allowing a gap at either approach-end of the structure between the outer frame and the steel grate bars to allow safe passage as newts and other small wildlife drop from the road surface into the passage below.

In locations where cattle grates terminate and guard railing is required along the edge of roadway side slope, cattle grates will be located where the ends do not conflict with guardrail posts. Guard railing placement will be determined during Phase II based on a safety analysis. As part of the safety analysis, the design team will evaluate whether a vehicle hitting a guard rail will be more or less severe than going over an embankment slope.

Cattle grates will be located where they do not conflict with existing underground utilities or overhead utility poles and require relocation or adjustment of the utility.

Key Assumptions

The top of the cattle grate is assumed to be at-grade with the existing top of pavement elevation.

2.1.5 Retaining Walls

General Overview

Retaining walls are anticipated at many locations to support the elevated road segments and/or improve slope stability. A continuous retaining wall will be constructed to support the elevated road segment, which will have a grade offset between the elevated road, the finished grade below the elevated road, and the side slope towards the reservoir. The distance between the wall and edge of road may vary, and will be determined during preliminary design plans and 65% design.

Shorter segments of retaining wall may also be needed at locations where slopes are determined to be potentially unstable due to changes in roadway alignment and profile or geologic conditions.

Different types of retaining walls are designed to address distinct functions and site conditions. Cast-in-place concrete cantilever walls are versatile in meeting geometric and aesthetic requirements. They will accommodate the small radius curvature while providing a smooth concrete exterior finish (and architectural treatment if preferred). Back-to-back mechanically stabilized earth retaining walls can also be cost effective for the new elevated road segment. However, due to steep slopes at some locations, mechanically stabilized earth walls may not be feasible. For locations with potentially unstable slopes, soldier pile and lagging walls (with or without tiebacks) may be considered—this approach is advantageous because it is relatively inexpensive, and fast and easy to construct.

The selection of specific wall types will be finalized in Phase II. Geologic reconnaissance and geotechnical explorations will be conducted prior to final design of the retaining walls to understand the site conditions and develop recommendations for the wall and foundation system design. Retaining walls will likely be needed for any design, including those with below-grade passages to insure stability of slopes and stability of any passage system.

Additional Design Criteria

Additional design criteria for retaining walls will be determined during Phase II following geotechnical investigations and reports.

Key Assumptions

Cast-in-place concrete retaining walls are assumed for the elevated road segment and will be confirmed during type selection in Phase II.

Retaining walls that require soldier piles, drilled shafts, and/or tieback anchors will be designed for one scenario only—their need will be determined during Phase II.

Retaining walls will be designed in combination with guardrails (Section 2.1.7) at the edge of the road shoulder and/or concrete barriers (Section 2.1.7).

2.1.6 Directional Barriers (Guide Walls/Fencing)

General Overview

For channeling the movement of smaller species such as amphibians, directional fencing generally ranges from 12 to 28 inches high above ground and are buried up to 12 inches underground. Additional features of the directional fencing that help ensure smaller species do not burrow underneath or climb over include offsetting the buried fence at 90 degrees and including built-in overhangs or shaped and angled in the ground to reduce or prevent over-climbing (Langton and Clevenger 2021) (Figure 13). The minimum barrier height for newts is 15 inches and an overhang is needed (Langton and Clevenger 2021).

Figure 13. Two examples of directional barriers; Left: showing built-in overhang; Right: showing angled to ground (Langton and Clevenger 2021)

Galvanized steel mesh, plastic mesh, and plastic-coated steel mesh fences that allow the natural movement of air, water, and some windblown soil are not recommended because wildlife may interpret these materials as passable (rather than as a barrier), leaving them vulnerable to predation, exposing them to detrimental hot or cold conditions, or causing an unnecessary expenditure of energy while they delay movement or attempt to pass through the material (Langton and Clevenger 2021, Brehme et. al. 2022)—such materials should be avoided. Guide wall barriers should be made from solid, more permanent, and durable material such as concrete, zinc-coated (galvanized) steel or other metal alloy sheeting, or with purpose-made polymer concrete units.

Additional Design Criteria
Additional design criteria such as type, materials, and alignment will be identified and developed as part of Phase II with drainage considerations. Maintenance needs will be dependent on the type and extent of directional fencing/guide wall barriers recommended and will be determined during Phase II.

Key Assumptions
No key assumptions have been identified in Phase I. Additional key assumptions may be identified and developed as part of Phase II.

2.1.7 Guardrail or Concrete Barriers

General Overview
Guardrails for vehicle and bicycle safety will be provided along elevated road segments using the Midwest Guardrail System (MGS) in areas where retaining walls (Section 2.1.5) are proposed; the MGS will meet Caltrans standards, which are typically adopted by County Roads. Proposed placement of MGS along non-elevated areas will be evaluated whether a vehicle hitting a guardrail is more or less severe than going over an embankment slope during Phase II. Placement of concrete barrier instead of MGS along fill retaining walls will also be evaluated whether a vehicle hitting a concrete barrier is more or less severe than hitting MGS or going over an embankment slope. A safety analysis will be conducted during Phase II to evaluate applicability for installation of concrete barriers, and other roadside safety features such as crash cushions. Installation of the MGS or concrete barrier has the potential to reduce sight distance for motorists and bicyclists; thus, installation locations will be evaluated to identify locations that contribute to stopping-sight distance (SSD) reduction, particularly along horizontal curves that will result in a nonstandard design feature. Please see Section 2.2 for discussion on nonstandard design features.

Additional Design Criteria
Additional design criteria may be identified and developed as part of Phase II.

Key Assumptions
No key assumptions have been identified in Phase I. Additional key assumptions may be identified and developed as part of Phase II.

2.1.8 Unofficial Turnouts / Shoulders

General Overview
In general, Alma Bridge Road has 1 to 2 foot wide shoulders, although some areas have little to no shoulder; however, there are several locations in the project area and in the Priority Zones with unofficial turnouts for emergency parking, passing, recreational parking, and maintenance purposes (Figure 14). Existing unofficial turnouts and shoulders along the elevated road segments will be reconstructed and regraded to maintain existing usage and match the elevation of the raised roadway.

Additional Design Criteria
Where existing unofficial turnouts and shoulders are reconstructed and regraded, the minimum recommended turnout width is 10 feet.

Key Assumptions
Along the elevated road segments, roadside treatments such as guard railing (Section 2.1.7) will be paired with fill retaining walls (Section 2.1.5) and will likely be required along the edge of the unofficial turnouts/shoulders on the reservoir side slope. See Section 3.5 Recreational Use/Access (Safety, Multimodal Uses) for additional information.

Figure 14. Examples of road shoulders and unofficial turnouts on Alma Bridge Road. Top Left: Example of 0-1 foot shoulder; Bottom Left: Example of 1-2 foot shoulder; Right Top and Bottom: Examples of unofficial turnouts (Source: Google Maps)

2.2 Roadway Design Standards and Assumptions

General Overview

The roadway geometric design criteria presented below is based on the following guidelines and will apply to the Alma Bridge Road improvements, including elevated roadway segments:

- *A Policy on Geometric Design of Highways and Streets*, American Association of State Highway and Transportation Officials (AASHTO 2018)
- *Highway Design Manual (HDM)*, California Department of Transportation (Caltrans 2022)
- *Traffic Safety Systems Guidance,* California Department of Transportation (Caltrans 2019)
- *California Manual on Uniform Traffic Control Devices (MUTCD)* (Caltrans 2023)
- *County of Santa Clara Roads and Airports – Standard Details, Specifications and Documents* (County of Santa Clara 2014)

Along the elevated road segments, the existing horizontal alignment will be maintained; but the vertical profile will need to be raised up to 2 feet along 1,000 to 2,600 foot long segments. Given the environmental sensitivity and geographical constraints of the area, realignment of the existing roadway was not considered. In the Feasibility Analysis, Alternative 1 included a realignment where a bridge option is included for Zone 1, but this

Alternative was not considered further in this Alternatives Evaluation/Basis of Design based on cost and construction timeline (Section 1.5).

Additional Design Criteria

Additional design criteria specific to roadway geometrics, pavement structural section, profile grade, crest vertical curves, design vehicle, permanent and temporary signing, and pavement delineation are described in further detail below.

Roadway Geometrics

Roadway geometrics include the roadway elements related to dimensions, slope, and speed. A summary of the roadway design elements and requirements in relation to roadway improvements along Alma Bridge Road, including the elevated road segments, is provided in Table 1.

Nonstandard Design Features

For the purpose of this study and cost estimating, nonstandard design features such as lane and shoulder widths are proposed along elevated roadway segments in order to minimize impacts and match existing roadway width. For example, 11 foot wide lanes and 1 foot wide shoulders are proposed instead of the standard 12 foot wide lane and 4 foot wide outside shoulders. Further discussions with County of Santa Clara Roads and Airports will determine if non-standard design features require approval of design exceptions/variance from the County and mitigation for the nonstandard feature or if the Project will need to comply with standard lane and shoulder widths.

In addition, for the 25 mph design speed, the minimum stopping sight distance is 150 feet (Caltrans 2022). Stopping sight distance is defined as the distance needed for drivers to see an object on the roadway ahead and bring their vehicles to a safe stop before colliding with the object. The distances are derived for various design speeds based on assumptions for driver reaction time, the braking ability of most vehicles under wet pavement conditions, and the friction provided by most pavement surfaces, assuming good tires. Based on the minimum radii and cross section dimensions noted below, retaining walls in cut situations, placement of concrete barriers, or guardrails may result in stopping sight distance of less than 150 feet. If less-than-standard stopping sight distance has been determined for a specific location during Phase II, the design team will evaluate options to either seek approval for design exceptions/variance, determine mitigations for the nonstandard features or change the design to make it standard. Providing standard geometric roadway elements has potential for significant cost and environmental impacts that will be investigated during Phase II.

Pavement Structural Section

Figure 15 through Figure 19 provide typical cross sections of an elevated roadway segment as well as various crossing types. Pavement structural section are the various pavement layers (depth and material type) along a roadway.

Profile Grade

The maximum profile grade of the roadway will be 10%, which is consistent with American Association of State Highway and Transportation Officials (AASHTO's) guidelines for low-speed roadways in rolling terrain. The minimum profile grade of the roadway (along a vertical tangent) will be 0.5% to accommodate drainage.

Crest Vertical Curves

Crest vertical curves will be designed based on the design speed (V = 25 mph) and sight distance (S = 150 feet) described above. A driver's eye height of 3.5 feet and an object height of 6 inches will be used (AASHTO 2018 and Caltrans 2022).

Table 1. Roadway Elements and Requirements for Proposed Project

Design Element	Existing	Requirement	Reference
Road Classification	Minor Collector	Minor Collector Rural	Santa Clara County Roads Standards
Posted Speed Limit	25 mph (between SR-17 and Limekiln Canyon only)	25 mph	Current Posted Speed (between SR-17 and Limekiln Canyon Only)
Design Speed	25 mph	25 mph	Current Posted Speed
Stopping Sight Distance	Not available	150 ft (25 mph design speed)	Caltrans Highway Design Manual or AASHTO Local Roads and Streets
Lane Width[1]	10-11 ft	12 ft	Santa Clara County Roads Standards
Outside Shoulder Width[2]	0 to 1 ft	4 ft	Santa Clara County Roads Standards
Cross Slope	2.00% and Varies	2.50%	Santa Clara County Roads Standards
Side Slope[3]	Approximately 1:1 to 2:1 fill Approximately 1:1 Cut	Fill: 2:1 Cut: As recommended by geotechnical engineer	AASHTO Local Roads and Streets
Minimum Horizontal Clearances to Obstructions inside Clear Recovery Zone	3-10 ft	4 ft (where shoulder width is less than 4 feet)	Caltrans Highway Design Manual or Caltrans Traffic Safety Systems Guidance
Edge of Shoulder to Hinge Point (for side slopes)	0-1 ft	1 ft (both sides)	N/A

Notes
[1] Lane widths less than 12 feet wide may require approval from County of Santa Clara Roads and Airports Department.
[2] Shoulder widths less than 2 feet require approval from County of Santa Clara Roads and Airports Department.
[3] Slopes steeper than 1.5:1 to be verified by geotechnical recommendations during Phase II.
AASTHO = American Association of State Highway and Transportation Officials
ft = foot/feet
mph = miles per hour
N/A = not applicable
SR = State Route

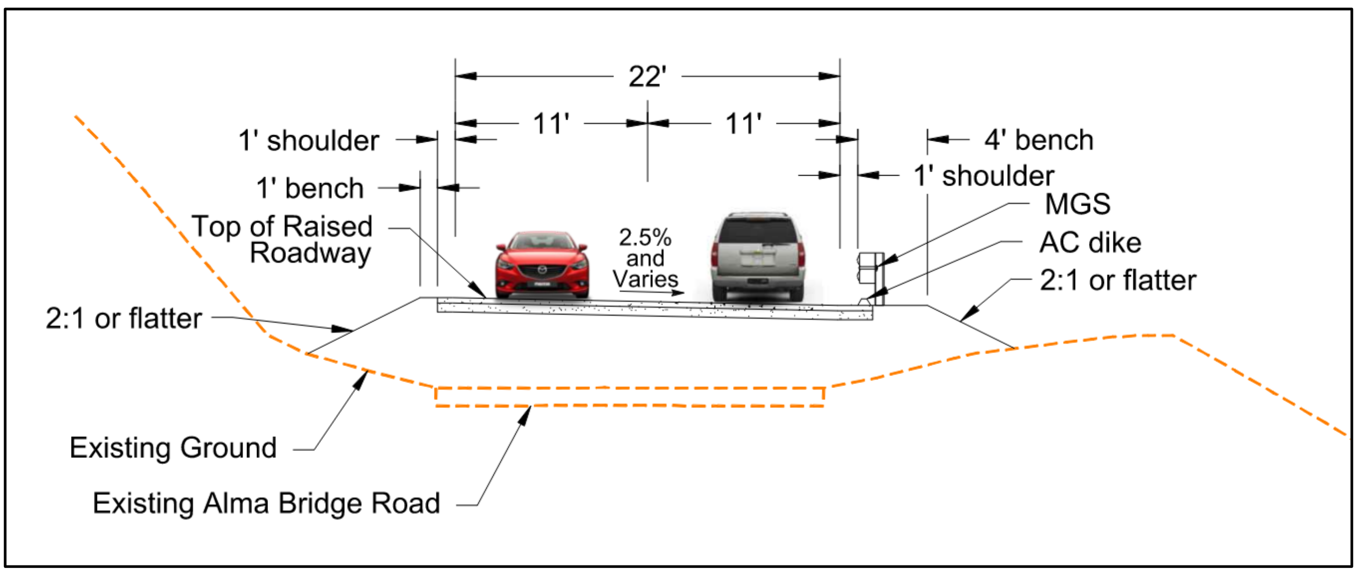


Figure 15. Typical Section #1 - Raised Roadway on Fill (not to scale)

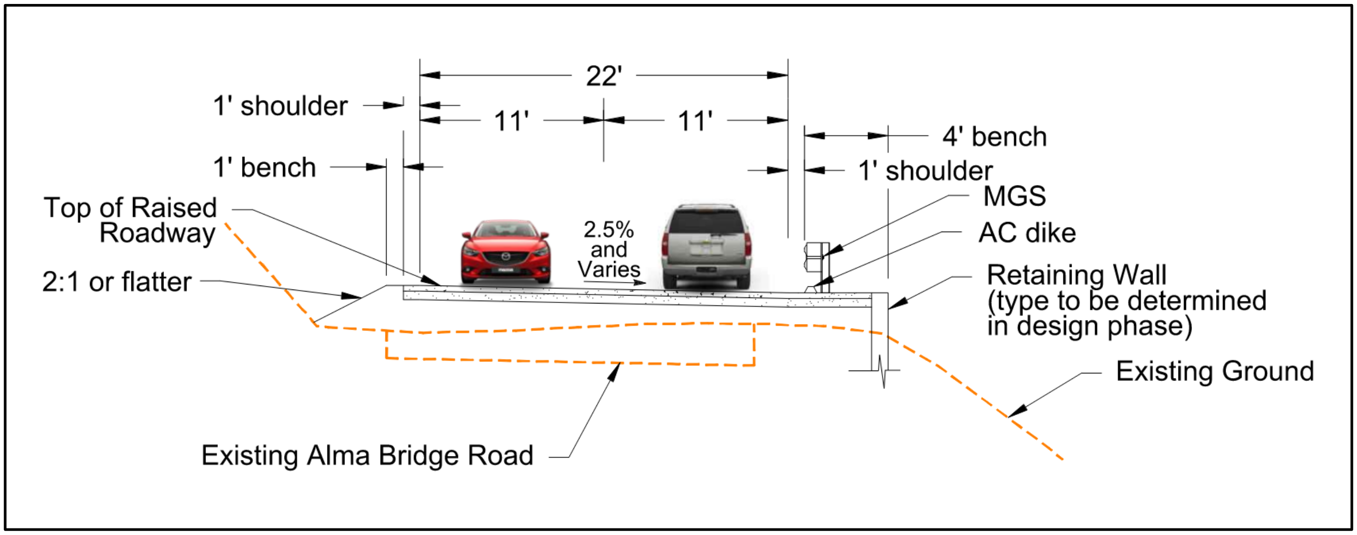


Figure 16. Typical Section #2 – Raised Roadway with Retaining Wall (not to scale)

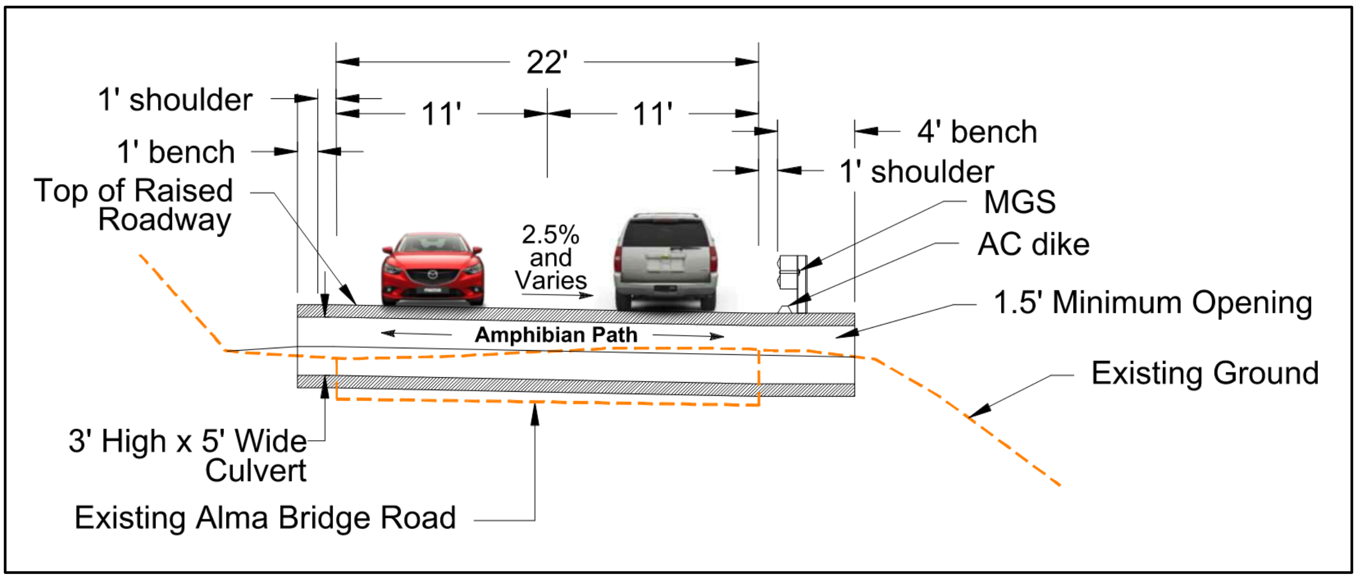


Figure 17. Typical Section #3 –Type 4 Purpose-built Passage Structure on Type 6 Elevated Road Segment (not to scale)

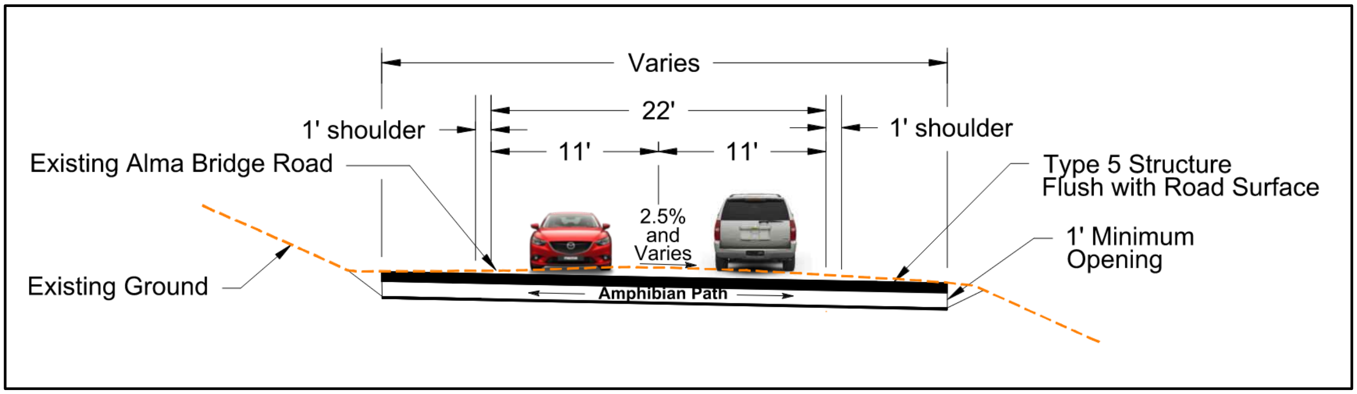


Figure 18. Typical Section #4 –Type 5 Micro-passage Structure (not to scale)

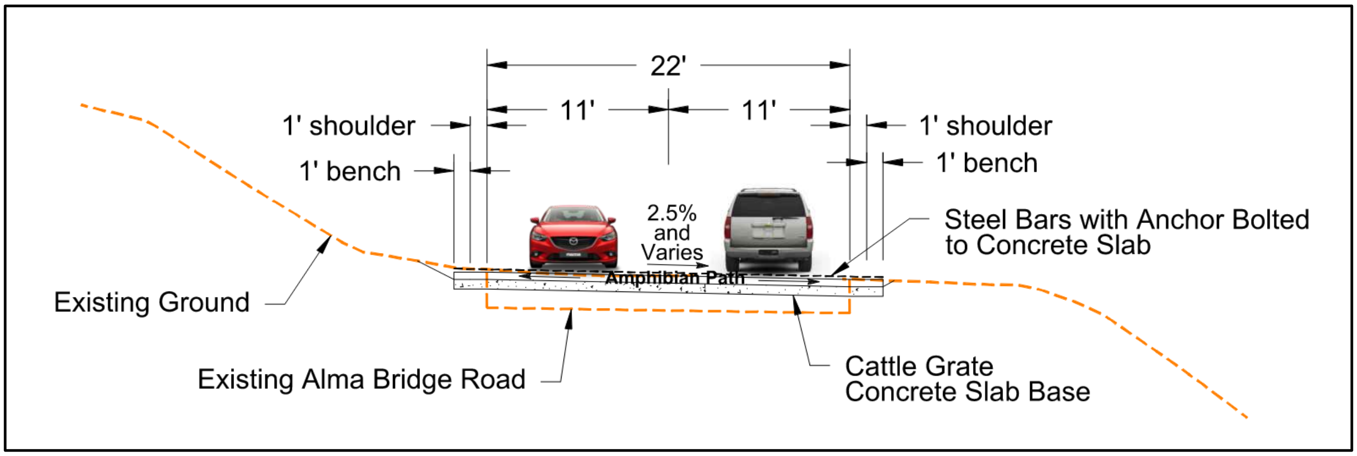


Figure 19. Typical Section #5 – Modified Cattle Grate (not to scale)

Sag Vertical Curves

Sag vertical curves will be designed for passenger comfort and drainage considerations. A design speed of V = 25 mph will be used for the sag vertical curve.

Design Vehicles

For the proposed project, Alma Bridge Road will be designed to provide safe maneuvers of either (a) Motor Homes and Boat Trailers or (b) Fire Trucks (Figure 20 and Figure 21). The fire truck size will be confirmed with County Fire/California Department of Forestry and Fire Protection (CALFIRE) during Phase II.

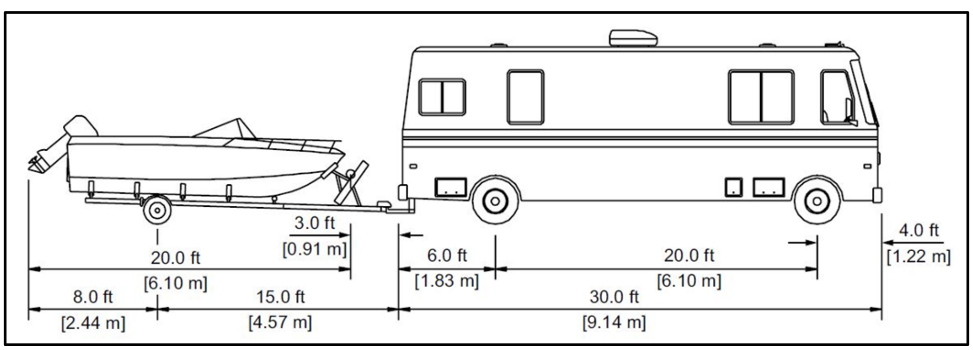


Figure 20. Motor Home and Boat Trailer

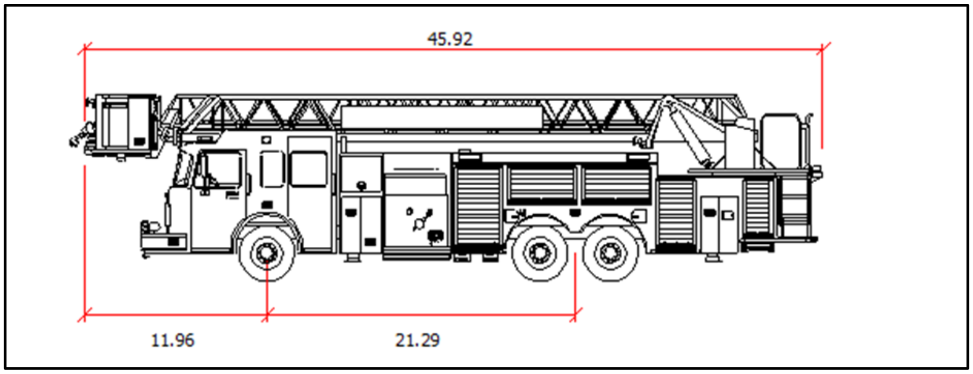


Figure 21. Fire Truck

Permanent and Temporary Signing and Pavement Delineation

Signing, pavement delineation, and temporary traffic control devices will be designed in accordance with the MUTCD (Caltrans 2022).

Key Assumptions

For the purpose of this study and cost estimating, nonstandard design features such as lane and shoulder widths are proposed along elevated roadway segments in order to minimize impacts and match existing roadway width. For example, 11 foot wide lanes and 1 foot wide shoulders are proposed instead of the standard 12 foot wide lane and 4 foot wide outside shoulders. The project will attempt to provide 12 foot wide-lane and 4-foot wide shoulder where feasible and reasonable and does not create significant environmental and right of way impacts. However, due to the existing narrow roadway width, mountainous terrain and environmentally sensitive areas adjacent to the roadway, nonstandard roadway design features may be proposed. Nonstandard design features will be discussed with County of Santa Clara Roads and Airports to request approval of nonstandard design features.

In addition, for 25 mph design speed, the minimum stopping-sight distance is 150 feet (Caltrans 2022). Based on the minimum radii and cross section dimensions noted below, retaining walls in cut situations, placement of concrete barriers, or guardrails may result in stopping-sight distance of less than 150 feet. If less-than-standard stopping-sight distance has been determined in a specific location during Phase II, the design team will evaluate options to either seek approval for design exceptions/variance, determine mitigations for the nonstandard features or change the design to make it standard. Providing standard geometric roadway elements has potential for significant cost and environmental impacts that will be investigated during Phase II.

For the purpose of this study and cost estimating, the assumed pavement structural section is based on available as-builts (4 inch asphalt concrete (AC) and 6 inch Class III aggregate base (AB)). These values may be revised based on geotechnical materials recommendations to be prepared during Phase II.

In addition, preliminary vertical alignment of an elevated road segment within the project limits consists of a ramp-up ranging anywhere from 50 to 200 feet with approach grades ranging anywhere from 1% to 10%, with a ramp-down at the end of the section. In between the transition (ramp-up and ramp-down) areas and on the fully elevated section, the profile grades will follow the existing profile, but approximately 2 feet higher than existing roadway elevations. No more than one continuous section of elevated road segment will be placed in any one Zone. The shortest distance between sections of elevated road segment is approximately 250 feet between Zone 2 and 2a; however, elsewhere throughout the project, the estimated distance between elevated road segments will be 750 feet (0.14 mile) between Zone 1 and Zone 2, and 5,560 feet (1.05 miles) between Zone 2a and Zone 3. Wherever possible, the gradually ramped approaches and endpoints of elevated road segment will be placed strategically in line with the existing natural change in elevation of the roadway to ensure that drivers traveling along Alma Bridge Road do not experience a noticeable grade change.

To minimize impacts to existing facilities, minimization measures such as phased construction and reversible traffic control during temporary road closures would be developed through the preparation of a traffic management plan and implemented to avoid full road closures.

2.3 Multimodal and Safety Considerations

General Overview

Preliminary feedback from County Roads and Airports Department suggests identified elevated road segments paired with Type 4 micro-passages as a possible safety concern. Specifically, the multimodal nature of Alma Bridge Road requires that the roadway remain accessible to multiple users, including vehicles, bicyclists, and pedestrians. Depending on site conditions and final design, elevated road segments could constrict the travel path and reduce the width of road shoulders for bicyclists and pedestrians, putting these users at risk, if such multimodal and safety considerations are not taken into account. However, if the existing roadway is replaced with elevated road segments that are designed to include safety measures (such as enhanced shoulder widths, guardrails, and other features), road conditions may instead improve along Alma Bridge Road at locations where the existing condition is narrow, where road shoulders are absent, or where the shoulders immediately abut steep slopes. The proposed improvements will also address crumbling and undercut culverts where they occur at proposed improvement areas that pose a safety hazard for both vehicles and multimodal recreational users.

Additional Design Criteria

Additional design criteria directly associated with Type 4 purpose-built passage structures, Type 5 micro-passages, Type 6 elevated road segments, cattle grates, retaining walls, directional fencing/guide wall barriers, guardrail or concrete barriers, unofficial turnouts/ shoulders, and/or general roadway design standards may be identified and developed as part of Phase II.

Key Assumptions

Alma Bridge Road is expected to support not only motor vehicles, but also bicyclists, pedestrians, and other traffic. At the preliminary Phase I design level, a key assumption for multimodal/safety considerations is that at a bare minimum, the existing road width will be maintained, such that any proposed modifications to Alma Bridge Road will only serve to improve multimodal use and safety concerns and improve conditions for all road users.

2.4 Phasing

General Overview

Special consideration should be taken regarding the ability to phase the implementation of a recommended Alternative in parts, sequentially, to allow time to sufficiently fund, implement, and monitor the success of each Corrective Action. For example, by phasing project implementation by Priority Zone (Year 1: Zone 1, Year 3: Zone 3, Year 5: Zone 2+2a2a), ample time could be built-in to the project to allow for an intermediate study of a given Corrective Action's ability to achieve the expected performance and success criteria and allow time to integrate adaptive management into subsequent design plans. Funding, permitting, and scheduling limitations may determine whether adaptive management is feasible, efficient, and/or cost-effective.

Priority Zones 1, 2, 2a, and 3 were identified and delineated during the Task 2 Wildlife Crossing Conceptual Design Workshop from north to south in the project Area. Any future recommendations for phased implementation and order of importance (i.e., Zone 1, Zone 3, Zone 2, and Zone 2a) are based on the newt mortality observed and are independent of each Zone's designation number in the project Area (i.e., Zone 1, Zone 2, Zone 2a, and Zone 3) (Figure 2). In other words, the nomenclature used to designate each Zone should not be confused with future recommendations of phased implementation order as proposed in Table 2.

Additional Design Criteria

Under Task 2, the Alternatives Analysis helped determine the highest Priority Zones for mitigation (Table 2). In particular, the analysis determined that Zone 1 is the highest priority for mitigation because it contains the hotspots with the greatest newt mortality and highest newt carrying capacity. Zone 3 is the second highest Priority Zone, followed by Zone 2.

Table 2. Priority Ranking of Priority Zones Based on Species Persistence

Priority Zone Ranking
Priority Zone 1
Priority Zone 3
Priority Zone 2
Priority Zone 2a

Key Assumptions

At this time, it is anticipated that all Priority Zones will undergo design and permitting through 65% design. Thereafter, this Priority Zone priority ranking order will be used to guide any phasing deemed necessary for project permitting, funding, implementation, and monitoring to maximize the effectiveness of Corrective Action implementation.

Factors that may influence the need for project phasing include funding availability, site access and constructability (i.e. road closures), seasonal work windows, and success criteria monitoring of initial Priority Zones to inform design/placement of Corrective Actions in later Priority Zones.

2.5 Preliminary Hydraulics / Hydrology

General Overview

Within the project area, Limekiln Creek and Soda Springs Creek are tributaries which feed into Lexington Reservoir, which is the receiving waterbody for the project. Lexington Reservoir is owned and operated by Valley Water to provide storage for groundwater re-charge. Lexington Reservoir has a spillway elevation of 653 feet (ft,) North American Vertical Datum (NAVD) 88, according to the *Seismic Stability Evaluations of Chesbro, Lenihan, Stevens Creek, and Uvas Dams Compilation Report* prepared for Valley Water (Terra/GeoPentech 2012). The project is within the Guadalupe River-Frontal San Francisco Bay Estuaries (HUC 10 1805000303) Watershed and the Los Gatos Creek (HUC 12 180500030303) Watershed in the Santa Clara Hydrologic Unit.

The Project site is located within Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panels 06085C0390H and 06085C0380H, both with an effective date of May 18, 2009. Lexington Reservoir and a portion of the roadway crossing Limekiln Creek are located within FEMA Special Flood Hazard Area (SFHA) Zone A. Zone A is identified as areas with a 1% annual chance of flooding. The surrounding areas, including the remaining portion of the roadway along the perimeter of Lexington Reservoir, are located within SFHA Zone D. Zone D is identified as areas with possible but undetermined flood hazards.

The project area is characterized by steep slopes on both sides of Alma Bridge Road. Runoff from the upper hillside is generally captured in existing inlets and roadside ditches then conveyed under Alma Bridge Road through cross culverts and discharges into Lexington Reservoir. Flows that are not captured in roadside drainage structures sheet flow across the roadway and are typically discharged through downdrains or overside drains.

Slope failures, erosion, and landslides were observed at several locations within the existing conditions onsite on the downhill side of the roadway. At some locations, culverts on the downhill side were observed to extend significantly beyond the existing grade. This is likely due to erosive conditions over time at the culvert point discharge locations.

The proposed Corrective Actions include passage structures, micro-passages, elevated road segments, and cattle grates. The proposed Alternatives will mostly maintain existing flow patterns, but they do have the potential to create new point source discharge locations. These sites would need to be analyzed for discharge velocities and may require energy dissipation to reduce erosive conditions. Proposed drainage infrastructure improvements would also need to be analyzed for their potential to increase the conveyance at existing crossings such as passage structures which may have a higher flow capacity than the existing drainage infrastructure.

New passage structures and associated retaining walls and guide walls should be placed to maintain the existing drainage patterns to the extent feasible. Stormwater is likely to be partially conveyed through the passage structures and should be designed with cross slopes that allow for self-cleaning velocities through the passage structures to prevent clogging or regular maintenance requirements.

Additional Design Criteria

The hydraulic design criteria provided in Table 3 are based on the following guidelines and will apply to the Alma Bridge Road improvements:

- *County of Santa Clara Drainage Manual*, Santa Clara County (County of Santa Clara 2007) or Caltrans Highway Design Manual (7^{th} ed.)
- *C.3 Stormwater Handbook*, Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP 2016)
- *Hydraulic Engineering Circular No. 14 (HEC-14), Third Edition, Hydraulic Design of Energy Dissipators for Culverts and Channels,* Federal Highway Administration (FWHA 2006)
- *HDM*, California Department of Transportation (Caltrans 2022)

Table 3. Drainage Elements and Requirements for Proposed Project

Design Element	Requirement	Reference
Minimum allowable pipe diameter under roadbed	18-inch	As per the Caltrans Highway Design Manual
Pipe Cover	Minimum 24 inches from edge of travelway elevation to the top of outside surface of the pipe, or per HDM based on culvert material	As per the Caltrans Highway Design Manual
Design storm	10-yr, 25-yr, and 100-yr	As per the County of Santa Clara Drainage Manual
Hydrologic Method	Rational Method for watersheds < 200 acres; Unit Hydrograph Method for larger watersheds	As per the County of Santa Clara Drainage Manual
Crossover flow	Less than or equal to 0.1 cubic feet per sec (cfs)	As per the Highway Design Manual
Minimum pipe velocity	2.6 feet per sec (fps) for the 2-year return period	As per the County of Santa Clara Drainage Manual
On-site culvert hydraulics	10-year: Conveyed in the storm drainage system (HGL to the nearest gutter elevation) 100-year: Safely conveyed from the project site without creating or contributing to downstream or upstream flooding	As per the County of Santa Clara Drainage Manual
Cross culvert hydraulics (25-year storm)	Culverts shall be sized to pass the 25-year design flow under free outfall conditions, without an inlet head in excess of the top of culvert	As per the County of Santa Clara Drainage Manual

Key Assumptions

The existing drainage facilities are assumed to be currently functional and to meet current drainage criteria. As design progresses, the existing drainage facilities should be analyzed for their conveyance capacity to determine if improvements or modifications to the existing drainage facilities are warranted or required. Any changes made to the drainage to Lexington Reservoir will be reviewed by Valley Water.

The proposed features will be designed to maintain existing drainage patterns and minimize adverse impacts from proposed improvements including an increase in conveyance across the roadway or the creation of a new point source discharge location.

Energy dissipation measures such as a riprap aprons may be required to prevent erosive conditions due to increased velocities at newly formed concentrated outfall locations. There may also be a need for energy dissipation at existing outfall locations.

The Corrective Actions, including culverts and other wildlife passages, are not expected to significantly increase the amount of impervious area existing onsite or have a significant permanent impact on water quality, but may have the potential for temporary impacts on water quality through construction. The drainage design will be designed to minimize impacts to water quality and provide water quality treatment per the Municipal Region Permit if impervious areas are increased over a 1-acre threshold.

3. Opportunities and Constraints

Alternatives 3 and 4 were prioritized for analysis based on the characteristics that make them different from the other two alternatives identified in the Feasibility Analysis (AECOM 2023). While both alternatives contain similar elements and both meet the project goals, they differ on the length and location of Corrective Actions, which in turn determines their effectiveness and impacts the cost, complexity, and schedule. To evaluate Alternatives 3 and 4 based on the relative merits and potential impacts, a project-specific comparison was developed and applied to the alternatives.

The comparison was based on five criteria:

- Cost estimates and cost effectiveness;
- Constructability and complexity;
- Environmental impacts and environmental benefits (based on Effectiveness Modeling performed in Task 2);
- Environmental clearance, permits, and approvals; and
- Recreational use/access (safety, multimodal uses).

3.1 Cost and Cost Effectiveness

3.1.1 Cost

General Overview

The construction cost estimates generally include pavement, earthwork including imported fill, drainage, structures, wildlife crossing systems, utility relocations/adjustments, contingencies, and mobilization. The estimates are based on preliminary design. Unit costs were developed based on bid results, other project experience, and professional engineering judgment. During conceptual engineering stage, a 30% to 50% contingency is typically included in the cost estimate due to level of design detail. In addition, current market trends of high inflation rate have affected material unit costs. A 40% contingency (adjusted to account for inflation and market price of material costs) on the construction costs is included in the cost estimates to account for uncertainty in design assumptions, stage construction, traffic handling and unit costs.

The cost estimates include:

- Site preparation (mobilization and demobilization, including wildlife exclusion fencing and monitoring);
- Clearing and grubbing;
- Demolition;
- Roadway earthwork and fill, pavement, drainage, guard railing, and structures (retaining walls);
- Utility relocations/adjustments;
- Erosion and sediment control, structures, replacement planting;
- Corrective Actions and additional supporting design features as applicable.

Assumptions made in the cost estimates are as follows.

- Support costs include engineering design, environmental documentation and permitting, and construction management.

- Most quantities are based on rough estimates of the area or linear distance of anticipated features. Areas and linear distances are calculated from conceptual computer-aided design (CAD) drawings separate of this estimate.
- Excavated material will be reused as fill material where possible.
- Additional costs for material testing and sorting are included in the contingency.
- Type 4 crossings are spaced every 98 feet at elevated road segments sections.

Construction capital and support cost estimate summary for the conceptual design of Alternatives 3 and 4 are provided in Table 4.

A cost estimate summary for the preparation of Secondary Zone improvement studies are also provided as a separate line item in Table 4. These studies would make recommendations on where signage, islands and medians, and transverse rumble strips/perceptual treatments may be beneficial in traffic control and calming. Construction and support costs to implement these secondary measures, which are not included in this cost estimate summary, would be based on these study's recommendations, which may include improvements or modifications that would take place in- or outside of the project footprint.

Table 4. Construction Capital, Support, and Secondary Zone Improvement Studies Cost Summary

Zone	Alternative 3	Alternative 4
Phase II Support Costs to 65%, Environmental Review and Permitting [1]		
Zone 1	$1,100,000	$1,100,000
Zone 2/2a	$850,000	$850,000
Zone 3	$950,000	$950,000
Sub-total:	$2,900,000	$2,900,000
Secondary Zone Improvement Studies 1		
Secondary Zone	$60,000	$60,000
Sub-total:	*$60,000*	*$60,000*
Phase III Support Costs to 95%, Final Design, Construction Permitting 1		
Zone 1	$1,600,000	$1,600,000
Zone 2/2a	$900,000	$1,200,000
Zone 3	$1,000,000	$1,400,000
Sub-total:	*$3,500,000*	*$4,200,000*
Phase IV Construction Capital 1		
Zone 1	$9,900,000	$9,900,000
Zone 2/2a	$5,700,000	$7,800,000
Zone 3	$6,400,000	$8,900,000
Sub-total:	$22,000,000	$26,600,000
TOTAL:	**$28,460,000.00**	**$33,760,000.00**

[1] Cost summaries are high level estimates based on order of magnitude costs, and each phase's subtotal is subject to change contingent on the results of the prior phase.

Alternative 3

By zone, the capital cost estimates for Alternative 3 in comparison to Alternative 4 are equivalent in Zone 1, and proportionally equivalent between in Zones 2, 2a, and 3. Overall, the capital costs between alternatives, estimated at $21,868,000 for Alternative 3, are proportionally equivalent (Table 4). The differences in costs can be attributed to the lower construction costs involved in installing at-grade Type 5 micro-passages rather than elevated road segments.

Alternative 4

By zone, the capital cost estimates for Alternative 4 in comparison to Alternative 3 are equivalent in Zone 1, and proportionally equivalent between in Zones 2, 2a, and 3. Overall, the capital costs between alternatives, estimated at $26,520,000 for Alternative 4, are proportionally equivalent (Table 4). The difference in costs can be attributed to the higher construction costs involved in installing elevated road segments rather than at-grade Type 5 micro-passages.

3.1.2 Cost Effectiveness

General Overview

Balancing costs and benefits, usually by interpreting the cost-benefit ratio, is a common tool in conservation planning. However, cost-benefit analyses are rarely done in road mitigation design (Sijtsma et al. 2020, Helldin 2022), despite the value they represent. Most often these are applied in human-ungulate conflict scenarios, where cost-efficiency is directly linked to reducing wildlife vehicle collisions and resulting insurance claims. In studies where benefit is related to biological outcomes, rather than reduced human-conflict, determining benefit is more difficult as it requires valuation of species populations (Huijser et al. 2022).

For the initial cost-benefit analysis of California newts between Alternatives 3 and 4, two cost-benefit indices (CBIs) were considered. The indices are associated with overall estimates of population persistence (Standardized Cost for Population Persistence), and reduced mortality, the latter of which was also evaluated by Zone. Future cost-benefit analyses for these alternatives, and potential modifications of these alternatives, may incorporate additional conservation value and help discriminate the cost of road improvements (slope stabilization, etc.) required for road safety vs. the specific crossing system design (passages and barrier system). These cost-benefit indices can be described as follows:

1) CBI-1: The "Standardized Cost for Population Persistence" is the [Cost/Probability of no further population decline]. Probability of no further population decline is the proportion of model simulations that predicted a population size of 37,844 (current estimate) or greater in 100 years (AECOM 2023). The lower number would have the greatest cost benefit.

$$\frac{total\ cost\ \$}{probability\ of\ no\ further\ decline}$$

2) CBI-2: The Reduced Mortality" index represents the projected model sum of all newts saved over the 100 years of PVA simulation, following mitigation, divided by the total cost. Reduced Mortality was calculated as the number of newts that are predicted to successfully cross the road to breed and return (Ncross2) multiplied by probability of round-trip road mortality (1-(1-r)^2) in the absence of mitigation summed over 100 years. The lower number would have the greatest cost benefit.

$$\frac{total\ cost\ \$}{\Sigma_i^{100} Ncross2x_i * (1-(1-r)^2)}$$

This index relies on the assumption that road mortality remains at levels estimated by Wilkinson and Romansic (2022) in the absence of mitigation. If human use of the road increases, following the development of new park space, future development, or other demographic changes, the reduced mortality cost would decrease.

Results

The results of the cost-benefit analyses show that while both alternatives fully meet the objectives of CBI 1 The "Standardized Cost for Population Persistence", Alternative 3 is the most cost-effective alternative when considering the effectiveness of each alternative's Corrective Actions (Table 5). The CBI-2 "Reduced Mortality" analysis also shows an overall cost-benefit of Alternative 3 over Alternative 4 when considering the benefit of each alternative's Corrective Actions.

However, zone specific results show equal benefit to cost ratios for Zones 1 and 2/2a for both alternatives, with Zone 3 being more cost effective for Alternative 3. Among zones, Zone 1 is the most cost effective, followed by Zones 2 and 3 which were not significantly different according to the modeling scenarios. A substantial proportion of costs are associated with slope stabilization, road safety, and longevity improvements; therefore, the direct costs associated with newt population persistence and reduced mortality would be further reduced if these costs were eliminated from the modeling scenarios.

Table 5. Cost-Benefit Analyses Results

Zone	Total Cost	Probability of Population Persist	CBI-1: Pop. Persist $	Estimated Benefit	CBI-2: $ Reduced Mortality	CBI-2: 95% CI
Alternative 3						
Overall	$21,868,000	0.999	$21,868,000	954,747	$22.73	$21.28 - $25.00
Zone 1	$9,863,000			585,384	$16.94	$15.63 - $18.18
Zone 2/2a	$5,660,000			183,041	$31.25	$28.57 - $33.33
Zone 3	$6,345,000			186,321	$34.48	$32.26 - $37.04
Alternative 4						
Overall	$26,520,000	0.999	$26,520,000	1,091,455	$24.39	$22.73 - $26.32
Zone 1	$9,863,000			583,452	$16.95	$15.87 - $18.18
Zone 2/2a	$7,805,000			246,016	$31.25	$29.41 - $33.33
Zone 3	$8,852,000			261,986	$33.33	$32.26 - $35.71

Note:
CBI = cost-benefit indices

3.2 Constructability and Complexity

General Overview

Constructability/complexity is defined as the engineering and construction management effort associated with constructing the project. Constructability/complexity considers the number of processes and independent components associated with the unique design elements under each alternative as well as the degree of technical difficulty involved in engineering and building the various design components of each alternative. With each alternative, possible engineering considerations will include the installation of guardrails; staging areas; the need for uphill cutslope and downhill retaining walls along all or portions of the treatment areas; speed reduction signage at select areas (due to reduced stopping sight distance along sharp horizontal curves); overhead utility pole relocation/raise; underground utility investigation/survey; the redesign (raise and reconstruct) of turnout areas along sections of raised roadway; and phased construction to maintain reversible traffic control during construction. Any unofficial turnouts or road shoulders adjacent to elevated road segments will need to be raised and include design elements that minimize newt mortality and permit or enhance newt movement, including directional fencing and/or guide walls.

The anticipated construction timeline is included in this category, which considers phasing and other considerations for comparing the two alternatives.

Alternative 3

Extent of Corrective Actions

The primary difference between Alternatives 3 and 4 is that Alternative 3 proposes a shorter length of roadway improvements with fewer Type 4 crossing structures (see Figure 8 for a more detailed and comparison view of the alternatives). Alternative 3 contains approximately 2,200 fewer linear feet of roadway improvements, 20 fewer Type 4 structures, and 3 more Type 5 micro-passage structures than Alternative 4. The number of modified cattle grates is relatively the same. Alternative 3 also has 200 fewer linear feet of retaining wall and 200 fewer linear feet of guardrails than Alternative 4. The total estimated borrowed fill for Alternative 3 is approximately 4,600 cubic yards less than for Alternative 4.

Construction Staging and Duration

Construction of the elevated road segments will require temporary road closure of Alma Bridge Road between Limekiln Canyon Road and Soda Springs Road. Detour routes will be required. The approximate construction durations[2] for each zone under Alternative 3 are:

- **Zone 1:** 7 months—Construct Type 5 micro-passage structures, modified cattle grates, elevated road segment (approximately 1,800 feet long) with Type 4 purpose-built passage structures.
- **Zone 2:** 4 months—Construct elevated road segment (approximately 1,030 feet long) with Type 4 purpose-built passage structures, modified cattle grates.
- **Zone 2a:** 1.5 months—Construct Type 5 micro-passage structures placed adjacent to three unnamed tributaries.
- **Zone 3:** 6 months—Construct elevated road segment (approximately 1,370 feet long) with Type 4 purpose-built passage structures, modified cattle grates, and Type 5 micro-passage structures.

If the zones are constructed one at a time (i.e., phased), the total construction duration is approximately 19 months. Zones can be constructed concurrently with multiple work crews to potentially reduce construction time if Alma Bridge Road can be temporarily closed between Limekiln Canyon Road and Soda Springs Road.

Utilities

Utility relocations/adjustments are anticipated in all Priority Zones where elevated road segments are proposed. The utility coordination process for relocations/adjustments may take up to 2 years, including completion of the utility agreements, depending on the number of utilities affected. Detailed utility verification, ownership, and liability will be determined during Phase II. The approximate number of utilities requiring relocations for each zone are:

- **Zone 1:** 7 Overhead poles
- **Zone 2:** 6 Overhead poles
- **Zone 2a:** None anticipated
- **Zone 3:** 9 Overhead poles, 1 underground maintenance hole
- **Total:** The approximate total number of utility relocations/adjustments under Alternative 3 is 22 overhead poles and 1 underground maintenance hole.

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[2] Construction durations include the Corrective Actions notes in the text and the following additional design features: guide walls, climbing barriers, MGS, retaining walls, reconstruct unofficial turnouts/shoulders, and construct/reconstruct drainage culvert systems.

Maintenance

Depending on the final design specifications, the level of maintenance required by at-grade structures like Type 4 purpose-built passage structures and Type 5 micro-passage structures could be more extensive than standard road maintenance/inspections.

Alternative 4

Extent of Corrective Actions

Compared to Alternative 3, Alternative 4 contains approximately 2,200 more linear feet of roadway improvements, 20 more Type 4 purpose-built passage structures, and 3 fewer Type 5 micro-passage structures than Alternative 3. The number of modified cattle grates is relatively the same. Alternative 4 also has 200 more linear feet retaining wall and 200 more linear feet of guardrails than Alternative 3. The total estimated borrowed fill for Alternative 4 is approximately 4,600 cubic yards more than for Alternative 3.

Construction Staging and Duration

Construction of the elevated road segments will require temporary road closure of Alma Bridge Road between Limekiln Canyon Road and Soda Springs Road. Detour routes will be required. Approximate construction duration[3] for each zone under Alternative 4 are longer than Alternative 3 based on the following:

- **Zone 1:** 7 months—Construct Type 5 micro-passage structure, modified cattle grates, elevated road segment (approximately 1,800 feet long) with Type 4 passage-built structures, and modified cattle grates.
- **Zone 2:** 4 months—Construct elevated road segment (approximately 1,030 feet long) with Type 4 passage-built structures, and modified cattle grates.
- **Zone 2a:** 6 months—Construct elevated road segment (approximately 900 feet long) Type 4 passage-built structures, and modified cattle grates.
- **Zone 3:** 11 months—Construct elevated road segment (approximately 2,660 feet long) with Type 4 passage-built structures, modified cattle grates.

If the zones are constructed one at a time (i.e., phased), the total construction duration will be approximately 28 months. As with Alternative 3, zone can be constructed concurrently with multiple work crews to potentially reduce construction time if Alma Bridge Road can be temporarily closed between Limekiln Canyon Road and Soda Springs Road.

Utilities

Utility relocations/adjustments are anticipated in all Priority Zones where elevated road segments are proposed. The utility coordination process for relocations/adjustments may take up to 2 years, including completion of the utility agreements, depending on the number of utilities affected. An existing 36” diameter San Jose Water pipeline runs along Alma Bridge Road at the south end of Zone 3. Potential conflicts or relocation of this line with the proposed project will be determined during Phase II when the line can be positively located horizontally and vertically. Detailed utility mapping and verification will be performed during Phase II in order to determine ownership and liability. The approximate number of utilities requiring relocations for each zone are:

- **Zone 1:** 7 Overhead poles
- **Zone 2:** 6 Overhead poles

[3] Construction durations include the Corrective Actions noted in the text and the following additional design features: guide walls, climbing barriers, MGS, retaining walls, reconstruct unofficial turnouts/shoulders, and construct/reconstruct drainage culvert systems.

- **Zone 2a:** 2 Overhead poles
- **Zone 3:** 14 Overhead poles, 2 underground maintenance holes
- **Total:** The approximate total number of utility relocations/adjustments under Alternative 4 is 29 overhead poles and 2 underground maintenance which is greater than Alternative 3.

Maintenance
Depending on the final design specifications, the level of maintenance required by at-grade structures like Type 4 purpose-built passage structures and Type 5 micro-passage structures could be more extensive than standard road maintenance/inspections.

3.3 Environment

The environmental category describes the anticipated gains and losses of specific environmental resources of interest in the project area including potential sensitive natural communities, potential special-status plant and animal species, potentially jurisdictional wetlands and other waters, wildlife connectivity, trees, and cultural resources potentially present. While the project is intended to provide long-term, ecosystem-wide and climate resiliency benefits particularly for herpetofauna species, there are anticipated short-term direct and indirect temporary and permanent impacts related to construction.

Though certain aspects of the road will be changed, the project is not anticipated to have long-term impacts to traffic, visual or aesthetics, noise, or air quality, although temporary impacts from construction will occur. The potential for noise effects from vehicles traversing the cattle grates is not expected to be significant and will be evaluated as part of the environmental review process in Phase II. Traffic, visual, noise, and air quality were not included below for comparison of the two Alternatives because detailed analyses of these elements are not proposed in Phase II.

3.3.1 Environmental Impact

General Overview

Potential impacts to environmental resources, including sensitive natural communities, special-status plant and animal species, potentially jurisdictional wetlands and other waters, wildlife connectivity, trees, and cultural resources will be predominantly direct and comparatively short-term at any one location, especially if the project is phased. Any direct, short-term effects will be offset by the project's overall benefit to the ecosystem as a whole, which includes enhanced wildlife movement, improved habitat connectivity, and improved gene flow for California newts and other amphibians/reptile species. In addition, implementation of the project provides improved climate resiliency for herpetofauna species by providing protected wildlife movement and improved habitat connectivity across an elevational gradient. According to California's Fourth Climate Change Assessment (Bedsworth et al. 2018), the changing climate in California specifically related to precipitation is expected to result in more drought-like conditions as well as more extreme precipitation events. The project allows these species to move up and down to adapt to changing lake levels, moisture availability, and vegetation composition that could result from a changing climate, making this a climate-wise corridor for providing enhanced range dynamics (Keeley et al. 2018). Upon completion, this project will be the first of its kind for California newts and could serve as a model for similar projects.

Ideally, this will be a self-mitigating project such that any impacts to terrestrial or aquatic habitats will be either insignificant in size, temporary in duration, and/or mitigable through the successful implementation of this wildlife connectivity project (e.g., restoring/enhancing habitat connectivity and/or gene flow, reducing wildlife mortality). Both alternatives will also identify measures intended to avoid or minimize impacts to the environment during construction, such as limiting work to the road prism, seasonal work restrictions, and implementing standard construction avoidance and minimization measures (e.g., preconstruction nesting bird surveys and erosion control). If, however, impacts are identified that cannot be mitigated directly through wildlife connectivity or avoidance and minimization measures, both alternatives will identify appropriate mitigation to offset unavoidable impacts to sensitive resources.

Special-status plant and animal species with potential to occur in the project area as described in the Technical Review (AECOM 2022) totaled 24 species of special-status plants and 66 species of special-status animals. During Phase II, a Biological Resources Assessment Report will be prepared describing the known presence or likelihood to occur for special-status plant and wildlife resources, wetlands and other waters, and sensitive vegetation communities.

Impacts to potentially jurisdictional features such as wetlands and other waters under federal or state jurisdiction will be determined after a full Aquatic Resources Delineation Report is completed during Phase II of the project. This will inform further design refinement and be the basis for environmental permitting.

Regarding wildlife movement, implementation of this project will result in direct and indirect short-term effects to wildlife movement such as temporary and habitat loss and impairment of wildlife movement during construction. Such impacts will be offset in the short-term by implementing avoidance and minimization measures (including possible seasonal work restrictions) during construction, as well as achieving the long-term goal of improving wildlife movement and habitat connectivity post-construction. Fencing as described in Section 2.1.6 would be low enough not to impede movement of medium and large mammals such as deer, mountain lions, and bobcats. Depending on the final dimensions and placement, some wildlife may also be able to use the Type 4 purpose-built passage structures for movement under Alma Bridge Road.

Trees along Alma Bridge Road may be temporarily or permanently impacted by the project. A Tree Impact Memorandum will be prepared during Phase II to support the impact analysis and identification of tree protection measures for the environmental review.

Impacts to cultural resources will be analyzed in greater detail in Phase II. Existing information regarding known historical sites and areas with the potential to have sensitive resources will be gathered based on recent and nearby cultural resource surveys performed for the adjacent Highway 17 Wildlife and Regional Trail Crossings and Trail Connections Project.

Alternative 3

The total length of roadway improvements in Alternative 3 is approximately 4,195 linear feet. The proposed Corrective Actions consist of the construction of a mixture of alternating Type 5 micro-passage structures together with sections of elevated road segment with repeating Type 4 purpose-built passage structures across a *smaller* proportion of the Priority Zones (compared to Alternative 4). This will result in a smaller project footprint and consequently a corresponding smaller environmental impact footprint along Alma Bridge Road. Details on the acreage of impacts to sensitive resources such as wetlands, special status species, sensitive communities, and cultural resources will be available following the Phase II technical studies but can overall be expected to be less than Alternative 4 based on the linear feet of roadway improvements proposed relative to Alternative 4.

Under this alternative, the realignment of the proposed former Beatty Trust property primary driveway is included to prevent the *estimated* expansion of the wildlife mortality hotspot that could take place if the primary driveway remained in place (as currently proposed), which encourages vehicles to travel from Zone 2 into Zone 2a and could lead to an increase in vehicle-related newt mortality.

Alternative 4

The total length of roadway improvements in Alternative 4 is approximately 6,395 linear feet. The proposed Corrective Actions consist of the construction of a mixture of alternating Type 5 micro-passage structures together with sections of elevated road segment with repeating Type 4 purpose-built passage structures across a *larger* proportion of the Priority Zones (compared to Alternative 3).

This will result in a larger project footprint, and consequently a corresponding larger environmental impact footprint along Alma Bridge Road. Details on the amount of impacts to sensitive resources such as wetlands and other waters, special status species, sensitive communities, and cultural resources will be available following the Phase II technical studies but can overall be expected to be more than Alternative 3 based on the linear feet of roadway improvements proposed relative to Alternative 3.

Under this alternative, no realignment of the proposed former Beatty Trust property primary driveway takes place, and the *estimated* expansion of the wildlife mortality hotspot that could take place as vehicles travel from Zone 2 into Zone 2a is offset instead by the placement of additional elevated road segment.

3.3.2 Environmental Benefits (Effectiveness)

General Overview

In Task 2, to assess whether workshop-developed Corrective Actions meet the project goals of habitat connectivity and species persistence, the effectiveness of various Corrective Action Options was analyzed. To accomplish this, Dr. Phillip Gould (USGS) worked with Cheryl Brehme (USGS) to model spatially explicit newt population-level road permeability along Alma Bridge Road for each suite of Corrective Actions. Due to the lack of information on California newt, this was based on existing research on the responses of migratory amphibians (principally, salamanders and toads) to road passages and barriers (see AECOM 2023 for additional details on the Effectiveness Modeling performed for Task 2).

Alternative 3

Under Preliminary Alternative 3, Zone 2a includes the recommendation to modify the proposed former Beatty Trust property project by relocating the former Beatty Trust property parking area public access point to a single driveway in Zone 2 located immediately opposite the Miller Point parking lot (Gate SA40). This realignment may also require a reconfiguration of the Miller Point parking lot to relocate its existing driveway entrance/exit further south; at its current location, a 4-way intersection is infeasible due to limited line-of-sight and visual obstructions. This will create a new 4-way intersection to, and focus vehicle traffic in, Zone 2, preventing additional vehicles and vehicle-related newt mortality from encroaching from Zone 2 into Zone 2a. Under this recommendation, Zone 2a vehicle mortality will instead be mitigated through the placement of Type 5 micro-passages at key mortality hotspots rather than the more costly elevated road segment.

Preliminary Alternative 3 is estimated to protect an estimated 53% of the migrating California newt population in the project area against road mortality, may result in an estimated 56% increase in population size after 30 years, and is predicted to meet the goal of population persistence to Year 100 (subject to conditions remaining the same as at present) (AECOM 2023).

Alternative 4

Preliminary Alternative 4 is estimated to protect an estimated 61% of the migrating California newt population in the project area against road mortality, may result in an estimated 70% increase in population size after 30 years, and is predicted to meet the goal of population persistence to Year 100 (subject to conditions remaining the same as at present) (AECOM 2023).

3.4 Environmental Clearance, Permits, and Approvals

General Overview

The project's final environmental clearance, permits, and approval needs are uncertain at this early stage in the planning process, and will depend on future Stakeholder input, the Alternative(s) selected, the project footprint, and detailed design specifications. Probable project permits and approvals required may include a Statutory Exemption, Categorical Exemption, or Initial Study/Mitigated Negative Declaration under CEQA, a Categorical Exclusion under National Environmental Policy Act (NEPA), and a Regional Water Quality Control Board (RWQCB) 401 permit, US Army Corps of Engineers (USACE) 404 permit, CDFW Incidental Take Permit (ITP) and 1602 Lake and Streambed Alteration Agreement (LSAA), and US Fish and Wildlife Service (USFWS))Section 7 consultation). In addition, approvals such as landowner coordination (e.g., Valley Water), encroachment permits, licenses, and land rights acquisitions may be necessary.

The Project Partners have identified County Roads as the proposed lead agency because the improvements would be to a County facility, the County has discretionary authority over the project, and the County would own, operate, and maintain the improvements as part of the roadway they own and are responsible for maintaining Alma Bridge Road.

Alternative 3 and Alternative 4

Under both alternatives, the process for obtaining necessary environmental clearance, permits, and approvals will be equivalent. There are no differentiators between the two alternatives that will result in different requirements, such as exceeding minimum thresholds or impacting different types of resources. Alternatives 3 and 4 will differ only in the quantities of environmental impacts reported within the required permits and approvals.

3.5 Recreational Use/Access (Safety, Multimodal Uses)

General Overview

Among the project stated goals are to not impede road safety/public use, and to facilitate existing and future use of Alma Bridge Road and the surrounding areas and facilities through continued vehicle use of the roadway and parking areas, continued and future recreational access to existing facilities and trails, and future parking and trails (such as the former Beatty Trust property Parking Area and Trails Project). One metric of site use and accessibility along the roadway is parking access at unofficial turnouts and shoulders along Alma Bridge Road. Although wildlife crossing structure success might be optimized when placed where recreational access demands are low, wildlife mortality areas appear to be concentrated where recreational access (which includes both unofficial turnouts and shoulders as well as thru-traffic to reach these locations) demand is high. Eliminating unofficial turnouts and shoulders to decrease recreational access and maximize crossing structure success would conflict with the goals stated above.

Recreational use and access considerations include safety for vehicles and other multimodal users who rely on Alma Bridge Road to visit the area (typically by vehicle, bicycle, or on foot), stage their vehicles (e.g., parking along the unofficial turnouts and shoulders), and access the surrounding recreation areas. Several larger parking shoulders adjacent to designated trailheads provide dedicated access points to trails associated with the parking area, while unofficial turnouts and shoulders elsewhere along Alma Bridge Road are used as unofficial passing or recovery lanes for vehicles and bicycles, and parking and staging areas for recreational use such as fishing/angling or overflow parking areas when trailhead parking areas are full. Along Alma Bridge Road, the road shoulder widths vary considerably and there are several locations with steep slopes and minimal to no road shoulders. There are also areas where crumbling pavement, undercut culverts, and other safety hazards have been identified. Although the purpose of the project is not to improve Alma Bridge Road for vehicle safety and other recreational and multimodal uses, the current use of Alma Bridge Road for those purposes and the existing safety concerns warrants an analysis of the two alternatives from this perspective.

Alma Bridge Road also has road segments with existing safety features, such as k-rail or other barriers. Additional features such as unofficial turnouts and larger unpaved and unofficial parking areas will not be changed as part of implementation of the Corrective Actions.

At some locations, road and road shoulder widths may require widening at locations where Corrective Actions are placed to meet County safety standards. Although road widening will increase the length of any crossing structure, and thereby the distance, migratory newts would have to travel to pass underneath Alma Bridge Road, this may be a necessary compromise to address mortality areas overall.

Despite the differences in the length of Corrective Actions between Alternatives 3 and 4, they both propose improvements at the same 10 road segments where there is a steep slope paired with a minimal or no road shoulder. Under both alternatives, there is one location where an undercut culvert will be repaired and improved, providing safety benefits to vehicles and other multimodal users. The extent of roadway improvements for both alternatives also come very close to two additional locations where crumbling pavement poses a significant safety risk to multimodal traffic on Alma Bridge Road—depending on the final design, these locations may also be included for repair and enhanced safety. Proposed improvements for both Alternatives 3 and 4 will not change turnouts or parking areas associated with Limekiln or Priest Rock Trailheads, Douglas B. Miller Memorial Park, driveway to Los Gatos Rowing Club, or multiple County and private property access roads.

Alternative 3

In Zone 2 and 2a, the construction of an elevated road segment involving repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier will take place in between the upper end of Zone 2 (approximately station 64+00) and a location immediately north of the Miller Point parking lot, followed by Type 5 micro-passages placed adjacent to three existing culverts (unnamed tributaries) in Zone 2a where newt mortality is highest within the Priority Zone. The roadway along the Miller Point parking lot will be left at the current grade to avoid any need to raise the entire parking lot; in place of modifying the parking lot, guide walls could be placed along the west/water-facing side of the parking lot to redirect newt movement around the parking lot.

Under this Alternative, the lack of elevated road segment in Zone 2a will accompany the recommendation to modify the proposed former Beatty Trust property parking area by relocating the proposed parking lot public access point to a single primary driveway in Zone 2 located immediately opposite the Miller Point parking lot/driveway, creating a new 4-way intersection. Relocating the primary driveway will focus vehicle traffic in Zone 2, and prevent additional vehicles, and vehicle-related newt mortality, from encroaching from Zone 2 into Zone 2a.

Under the scenario outlined above, additional feasibility and design work will be required for the former Beatty Trust property to relocate the proposed primary driveway so that it provides access from the north (immediately opposite the Miller Point parking lot) rather than from the west. Furthermore, the project footprint of the revised driveway relocation could require grading and additional impacts to natural vegetation communities to repurpose the existing unimproved access road.

Alternative 4

In Zone 2 and 2a, the construction of an elevated road segment involving repeating Type 4 purpose-built passage structures with built-in guide walls and climbing barrier, and modified cattle grates at either end of a segment will take place in two discrete locations: in Zone 2 between the upper end of Zone 2 and a location immediately north of the Miller Point parking lot, and throughout Zone 2a. The portion of Alma Bridge Road along the Miller Point parking lot will be left at the current grade to avoid any need to raise the entire parking lot. In place of modifying the parking lot, guide walls could be placed along the west/water-facing side of this parking lot to redirect newt movement around the parking lot.

Under this Alternative, the proposed elevated road segment in Zone 2a will not involve the recommendation to modify the proposed former Beatty Trust property project primary driveway (as proposed under Alternative 3). This elevated road segment in Zone 2a is proposed to address the likely change in vehicle traffic patterns and associated newt mortality from the development of new recreational facilities.

Under the scenario outlined above, no modifications will be recommended for the former Beatty Trust property.

4. Alternatives Evaluation

4.1 Methods

To provide a useful comparison of the two alternatives, a color-coding scheme was used to indicate how each alternative performed when considering each of the criteria.

Least Preferable Outcome	The least preferable outcome related to performance of the alternative for each criterion.
Equivalent or Indistinguishable Outcomes	The outcome was equivalent or undistinguishable from the other alternative related to performance of the alternative for each criterion.
Most Desirable Outcome	The most desirable outcome related to performance of the alternative for each criterion.

4.2 Results

A high-level overview comparison of the two alternatives using the five criteria discussed in Section 4 (cost estimates and cost effectiveness; constructability and complexity; environmental impacts and benefits; environmental clearances, permits; and approvals, and recreational uses and access) is provided in Table 6 below. A descriptive summary of the analysis that generated the color-coded results for each alternative's relative performance is provided in Section 4.

Table 6. Alternatives Evaluation Summary Table

Category	Subcategory	Alternative 3	Alternative 4
Cost	Cost Estimates (Phase II + Secondary Zone Improvement Studies + Phase III + Phase IV)	**$28,460,000.00**	**$33,760,000.00**
	Cost Effectiveness	Most Cost-Effective (Population Persistence) Most Cost-Effective (Reduced Mortality)	Least Cost-Effective (Population Persistence) Least Cost-Effective (Reduced Mortality)
Constructability/ Complexity	Extent of Corrective Actions	4,195 linear feet of elevated road segments	6,395 linear feet of elevated road segments
	Construction Staging and Duration	19 months	28 months
	Utilities	22 overhead poles and 1 underground maintenance hole	29 overhead poles and 2 underground maintenance holes
	Maintenance	Higher than typical/ standard road maintenance/inspections for fewer structures	Higher than typical/ standard road maintenance/inspections for more structures
Environment	Impacts (sensitive natural communities, special-status species, potentially jurisdictional features, wildlife connectivity, trees, and cultural resources)	Short-term impacts to (a) aquatic/terrestrial habitat and (b) plant/wildlife species habitat Lower impact acreage limited to (a) marginal roadside habitat and (b) adjoining natural vegetation communities	Short-term impacts to (a) aquatic/terrestrial habitat and (b) plant/wildlife species habitat Higher impact acreage limited to (a) marginal roadside habitat and (b) adjoining natural vegetation communities

Category	Subcategory	Alternative 3	Alternative 4
	Benefits (Effectiveness)	Estimated lower decline in newt mortality Lower estimated protection of California newt population	Estimated higher decline in newt mortality Higher estimated protection of California newt population
Environmental Clearance, Permits and Approvals		Despite lower impact acreage, comparable approach and level of effort for environmental clearance, permits, approvals;	Despite higher impact acreage, comparable approach, and level of effort for environmental clearance, permits, approvals
Recreational Use/Access (Safety, Multimodal Uses)		No anticipated difference in level of recreational use/ access Additional design work to relocate the former Beatty Trust property primary driveway	No anticipated difference in level of recreational use/ access No modifications recommended for the former Beatty Trust property primary driveway

4.3 Hybrid Alternative Option by Zones

This Alternatives Evaluation/Basis of Design technical memorandum presents a comparative analysis of two alternatives for the Project Partners to consider while moving the project into Phase II. At their discretion, Project Partners may consider a hybrid approach consisting of selecting a combination of Corrective Actions drawn from both alternatives to achieve the most beneficial combination of cost estimates and cost effectiveness; constructability and complexity; environmental impacts and benefits; environmental clearances, permits; and approvals, and recreational uses and access.

4.4 Modeling and Corrective Action Recommendation Limitations

The best available data has been used to inform the parameters of the modeling and preliminary Corrective Action recommendations. Inherent in the exercise of modeling a natural system is the need to make certain assumptions to predict the system's response to change based on the best available evidence. As a non-listed species, research into the basic life history elements of the California newt's natural history is limited. This lack of a baseline understanding is reflected in the scientific literature and carries into the assumptions that are made if modeling is used to estimate this population's response to movement barriers and vehicle mortality, as well as their response to the Corrective Actions proposed to mitigate their effects.

The USGS's spatially explicit model of newt population-level road permeability along Alma Bridge Road (AECOM 2023) was based on existing research on the responses of migratory amphibians (principally, salamanders and toads) to road passages and barriers, the most recent four years of Newt Patrol road mortality data, the Newt Patrol carcass persistence study, and the study of newt road mortality versus successful road crossings by H.T. Harvey (H.T. Harvey & Associates 2021, Parsons 2021, Newt Patrol 2023).

The model developed for the H.T. Harvey study (H. T. Harvey & Associates 2021, Wilkinson and Romansic 2022) in particular was conditioned on Lexington Reservoir and inlet streams on the reservoir side of Alma Bridge Road being the only breeding source for this population and the adult newts in this population crossing Alma Bridge Road to breed. However, it is possible that there are adult newts in other upland areas around Lexington Reservoir that breed in the reservoir without crossing Alma Bridge Road. Also, there are likely other breeding sources for this population besides Lexington Reservoir. For example, newts breed in the upper reaches of Limekiln Creek (approximately 16 kilometer (km) of creek distance upstream of Alma Bridge Road) and Soda Springs Creek (approximately 19 km of creek distance upstream of Alma Bridge Road).

If newts are breeding in Lexington Reservoir without crossing Alma Bridge Road or are breeding in these other locations, annual recruitments from the reservoir or these other sources might be sustaining or supplementing the population, even though the high mortality rate of crossing Alma Bridge Road to breed would represent a population sink for the overall metapopulation.

The H.T. Harvey study also assumed that all adults in the California newt population attempt to breed (i.e., undergo the breeding migration) every year. In some salamander populations, males may attempt to breed every year while females skip at least some years between attempts, foregoing the breeding migration in some years to avoid unfavorable conditions or to acquire energy for use in later breeding attempts. Also, there may be a higher annual breeding potential of the females than their assumed 0.5%.

5. Conclusions

This Alternatives Evaluation/Basis of Design provides a critical foundation for the elimination of Alternatives 1 and 2 and retention of Alternatives 3 and 4. It also provides the basis for further refining the design for Alternatives 3 and 4 and weighing these two alternatives' merits and drawbacks. The BOD (Section 2) includes the preliminary design for four proposed Corrective Actions and additional supportive design features. Section 2 includes design criteria, key assumptions, construction cost estimates, schedule, and project phasing. The BOD will be used in Phase II to outline and develop the project through to 65% design (Section 6).

While both alternatives evaluated will provide population-level benefits to the population of California newts currently experiencing high mortality rates on Alma Bridge Road, the extent to which the newt population is to be protected must be considered carefully with respect to cost and safety. The Alternatives Evaluation provides the side-by-side comparison of the two Alternatives in descriptive narratives in Section 3 (Opportunities and Constraints) and in a color-coded summary table in Section 4 (Table 6). The comparison of the two Alternatives in the context of cost and cost effectiveness, constructability and complexity, environmental impacts and benefits, environmental clearance, permits, and approvals, and recreational uses will help inform and guide future Alternatives development in Phase II. If assumptions in presenting these designs are not valid based on future geotechnical, hydrological, and engineering evaluations, additional cost-effective alternatives and/or modification and refinement of conceptual designs may be presented in Phase II.

As described in Section 1.6.5, the key differentiators that distinguish the alternatives include: disproportionate cost and schedule implications of the 1,000-foot-long steel beam or precast concrete girder bridge under Alternative 1; the limited treatment of a known key mortality area between Limekiln Quarry driveway and Limekiln Trail under Alternative 2; the two alternative options proposed to account for a future no-change in the wildlife mortality hotspot in Zone 2a as a result of realigning the proposed former Beatty Trust property primary driveway under Alternative 3, or an estimated future expansion of the wildlife mortality hotspot in Zone 2a as a result of leaving the proposed former Beatty Trust property primary driveway in place under Alternative 4; and the placement of elevated road segment with repeating Type 4 purpose-built passage structures with built-in guide walls throughout approximately half (Alternative 3) or throughout the entirety (Alternative 4) of Zone 3.

The prevailing road conditions, County design standards, and recommendations from interested parties impose certain constraints and limitations that have guided the identification of suitable Corrective Actions and subsequent alternatives selection (Sections 1.4 and 1.5; AECOM 2022; AECOM 2023). The prevailing road conditions include narrow-to-non-existent road shoulders, steep up- and downhill embankments, and existing slope failures, head-cuts, undercut pavement, and landslides. Where these constraints limit the use of Type 5 micro-passages and associated directional barriers (guide walls/fencing), elevated road segments with repeating Type 4 purpose-built passage structures with built-in guide walls were preferred. The prevailing road and culvert conditions also imposed limitations on cost-saving measures that were explored and considered. County design standards and recommendations from interested parties dictated the need to consider and prioritize multimodal user safety, recreational access, and maintenance/repair costs, which necessitate meeting additional requirement on lane and shoulder width, stopping sight distances, and minimum lengths of elevated road segments to avoid an uncomfortable up-and-down driving surface for vehicles. The two alternatives in this Alternatives Evaluation/Basis of Design factored all these considerations for the selection of Alternatives 3 and 4.

6. Next Steps

This Alternatives Evaluation/Basis of Design concludes work performed for Phase I of the project. The project will move into Phase II in Fall 2023.

Phase II encompasses the environmental assessment and associated technical studies, preparation of environmental permit applications, and engineering design. Technical studies will be performed to identify potential impacts to special-status species, sensitive natural communities, wetlands and other waters of the US, waters of the state, and cultural resources. A tree impact memorandum will be prepared to inventory trees located within permanent impact footprints of the Build Alternative. Another component of Phase II will include a water quality and hydrology memorandum to identify and describe potential water quality and drainage impacts for the Build Alternative and possible minimization and mitigation measures to reduce adverse impacts to water quality.

Ideally, this will be a self-mitigating project such that any impacts to terrestrial or aquatic habitats will be either insignificant in size, temporary in duration, and/or mitigable through the successful implementation of this wildlife connectivity project (e.g., restoring/enhancing habitat connectivity and/or gene flow, reducing wildlife mortality) and/or avoidance and minimization measures before, during, and after construction. If, however, impacts are identified that cannot be mitigated directly through wildlife connectivity or avoidance and minimization measures, Phase II will also include a Mitigation Plan that will include a matrix of mitigation options to offset any unavoidable impacts to federal and state listed species, federal and state jurisdictional waters, and riparian resources for which regulatory agencies will require compensatory mitigation.

In addition, Phase II will include the CEQA environmental review and documentation process. Potential ways that CEQA will be addressed, and are currently being explored, include an Initial Study with Negative (or Mitigated Negative) Declaration, or potential use of the Statutory Exemption for Restoration Projects (SERP). Under California Public Resources Code, Senate Bill (SB) 155 (signed September 23, 2021), SERP provides CEQA statutory exemption until January 1, 2025, for fish and wildlife restoration projects that meet certain requirements.

The Project Partners have identified County Roads as the proposed Lead Agency because the improvements would be to a County facility, the County has discretionary authority over the project, and the County would own, operate, and maintain the improvements.

Pre-concurrence with the CEQA lead agency and CDFW will be necessary to determine whether the statutory exemption applies. Even if the statutory exemption applies, the project will remain subject to all other applicable federal, state, and local laws and regulations and will not weaken or violate any applicable environmental or public health standards.

Environmental permit applications prepared in Phase II may consist of CDFW ITP, USFWS Endangered Species Act Section 7 Consultation, USACE Section 404 Permitting, RWQCB Section 401 Certification, CDFW Section 1602 Lake and Streambed Alteration Agreement, and County of Santa Clara Tree Preservation and Removal permits.

The detailed design for the Build Alternative will also be prepared in Phase II which will include additional site visits and field surveys, utility coordination and right-of-way support, preliminary structural investigations, the draft drainage report and stormwater control plan, soils testing and reporting, and the geotechnical investigations.

Phase II will continue to advance the engineering design of the project (preliminary design plans and 65% design) that includes detailed design drawings of a typical Type 4 purpose-built passage structure, Type 5 micro-passages, Type 6 elevated road segments, modified cattle grates, retaining walls, direction barriers (guide walls and fencing), guardrails or concrete safety carriers, unofficial turnouts/shoulders, and project-wide design plans that further refine the placement locations of individual crossing structures.

Another future phase, beyond the Phase II 65% design, will bring the project through final (100%) design, and will include final permits, implementation, and monitoring of the Corrective Actions.

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