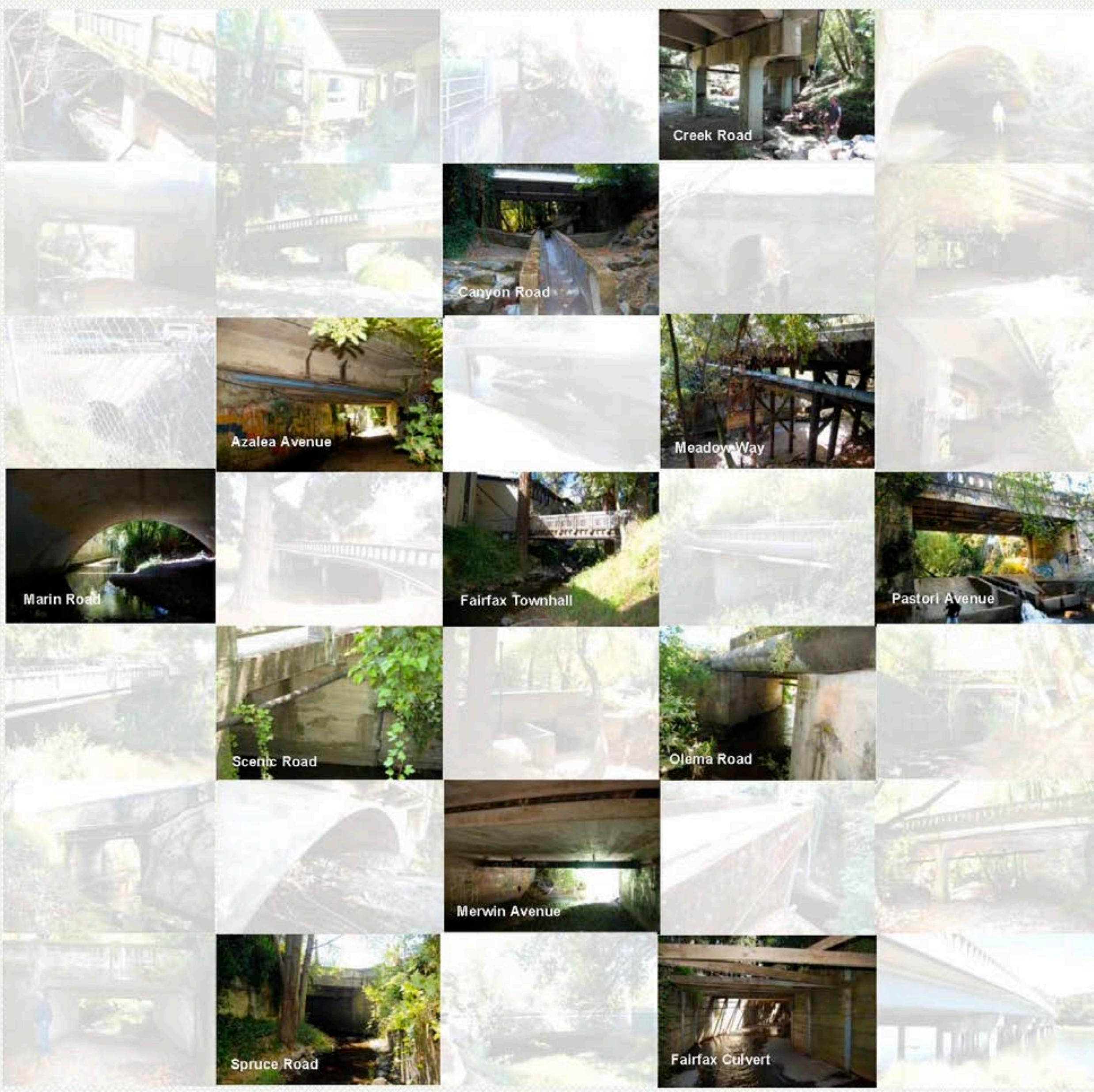
Seismic Retrofit Report for Creek Road Bridge over San Anselmo Creek (Bridge No. 27C-0144)



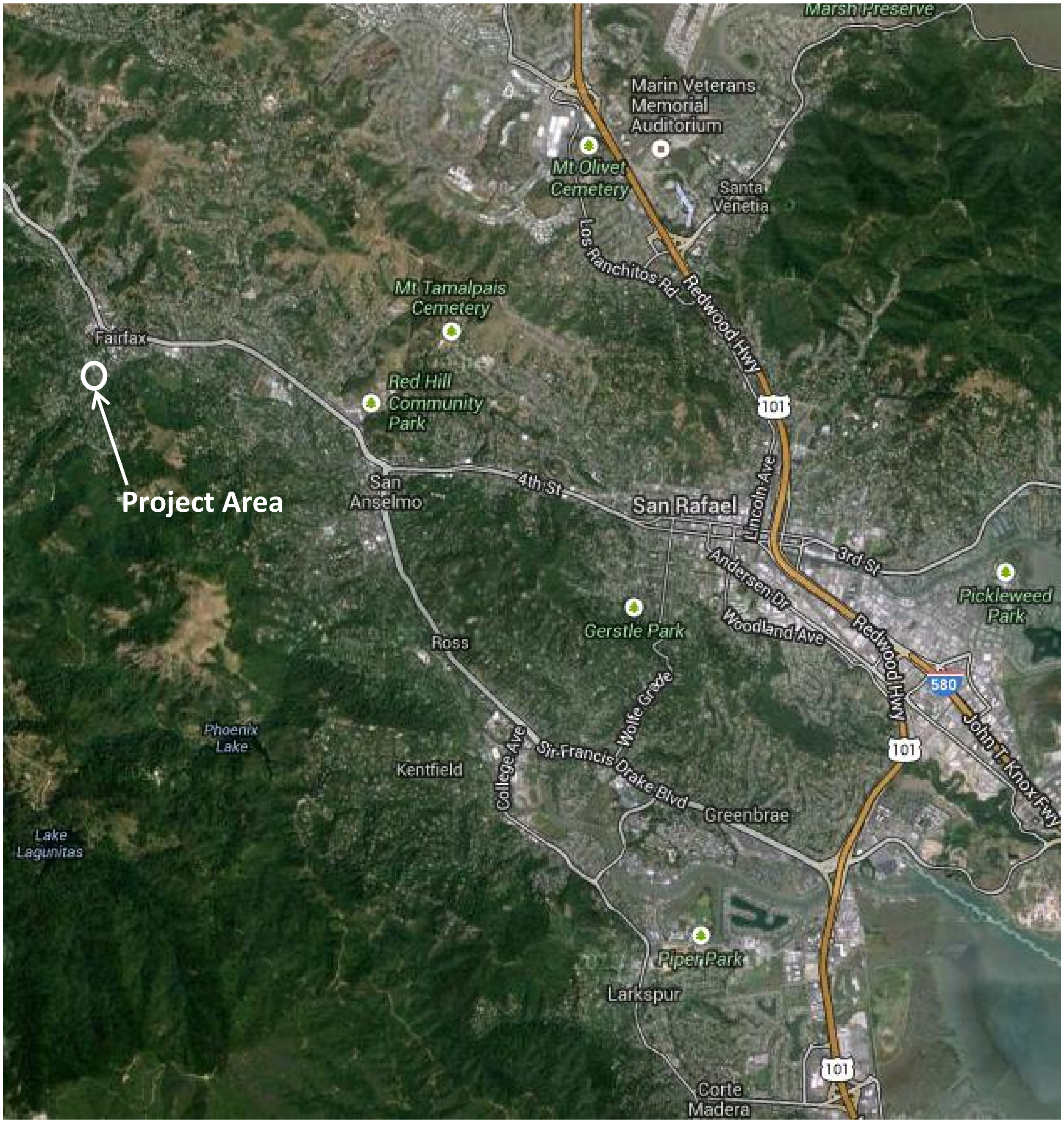
California Infrastructure Consultancy
MGE Engineering, Inc.
A Joint Venture

Submitted to the Town of Fairfax

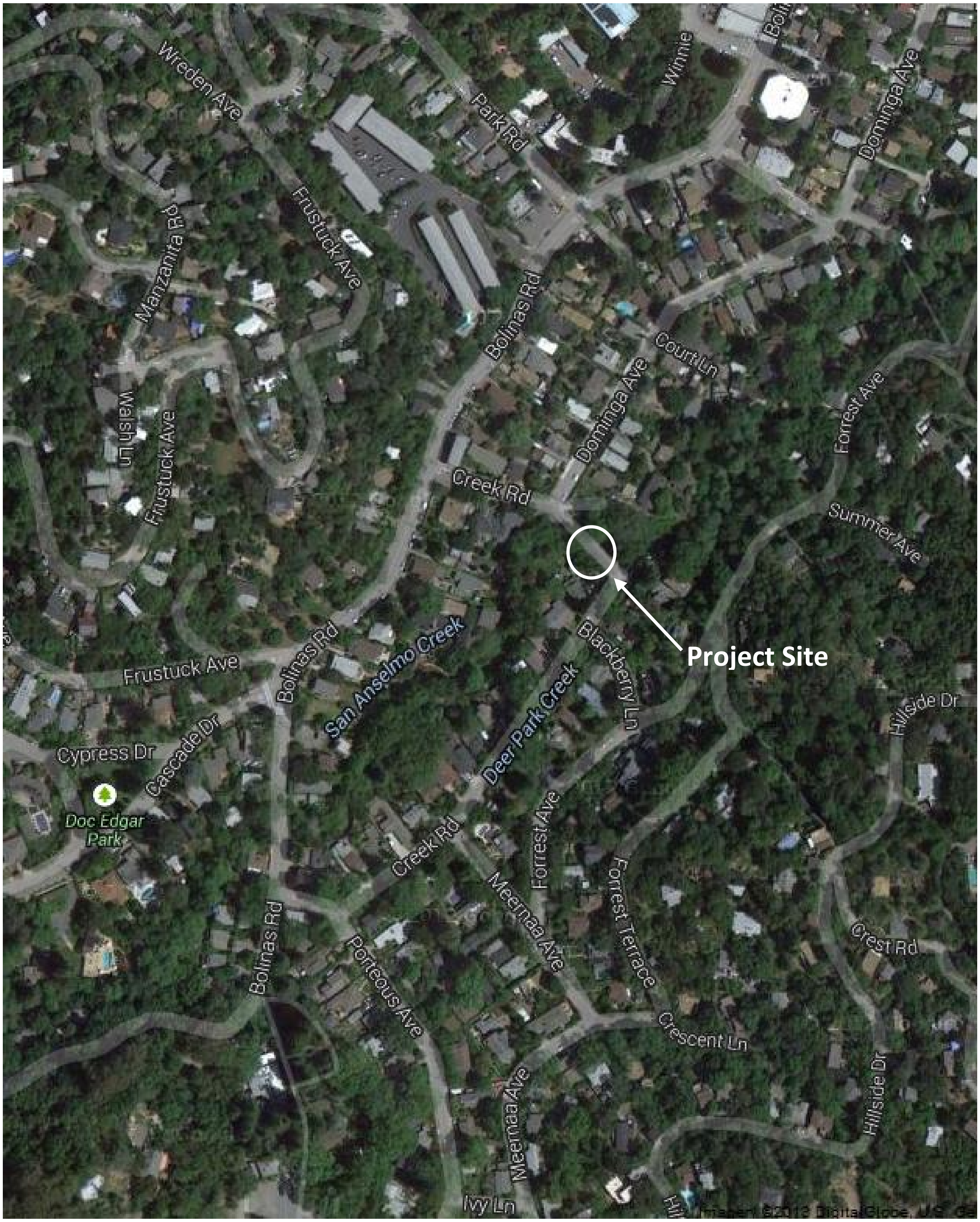
Department of Public Works

January 21, 2014

TABLE OF CONTENTS

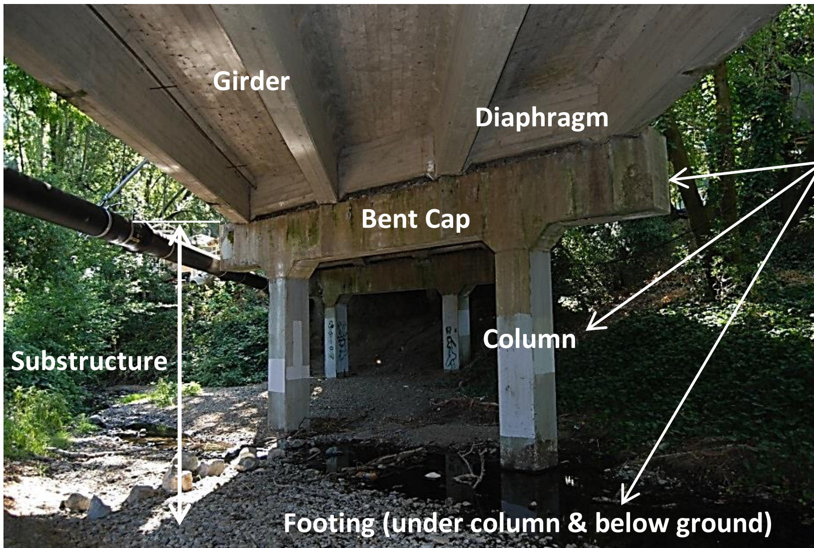


Regional Map



Location Map

Commonly Used Bridge Terminology in This Report



Note: the combination of columns, bent cap and footings is called a "Bent."

Substructure Area

Substructure Area

Overhang Area at the edge of deck

Superstructure Area

Executive Summary

Creek Road Bridge is a four-span, simply supported concrete T-beam structure on sets of 2-column bents and abutments, constructed over San Anselmo Creek in 1929. The 85-year old bridge has been known to be seismically vulnerable to forces from the maximum credible event (MCE) for this site since mid-1990s. This report was prepared as part of the federally funded Highway Bridge Program (HBP) for such local agency bridges administered by Caltrans, for which the Town of Fairfax is the lead agency. Several federal and state agencies have budgetary and/or permit approval and funding authority on this project.

With any record plans absent for the bridge, field measurements of its components were made to create an as-built Bridge General Plan, and for use in the computer analysis models. Tests on cores taken from the bridge showed that the concrete is sound and has hardened to 5,200 psi on the average. Ground penetrating radar (GPR) revealed the reinforcement patterns in the columns and bent cap and their sizes were determined from concrete spalls exposing rusty rebars. These investigations confirmed sparsely and seismically inadequate reinforcement patterns typical of the bridge's vintage. The site was drilled at two locations by the geotechnical engineer to explore the subsurface properties of the soils for the analysis models and future design. Locations and sizes of the footings were determined by poking long bars through the cover soil, but the footing thicknesses could not be determined.

The analysis included computer models of the bridge for dynamic (seismic) displacement demands on the bridge. Loads and displacements from up to 50 modes of seismic oscillations along the two orthogonal axes of the bridge captured the expected seismic demands on the bridge. Pushover analysis captured the ultimate capacity of the bridge to sway longitudinally and laterally before collapsing under the seismic loads. The following seismic response has been observed:

1. The girders and substructure are not tied together and there are no longitudinal or transverse shear keys on the bent caps to stop the girders from unseating, leading to collapse of the bridge.
2. Due to the small size of the columns, lack of adequate main vertical reinforcement and little steel rebar ties to confine the column cores, they are incapable of sustaining the seismic displacement or "plastic" shear demands and fail in both the transverse and longitudinal directions. The term plastic refers to seismic loads beyond the column's elastic capacity to bounce back.
3. All bent caps have inadequate capacity to take the column plastic bending moments transversely.
4. The footings are too small to resist the overturning moments and vertical loads, and will rotate excessively even if the columns were made to hold up. They are also likely inadequate for bending moments and shear, but this could not be confirmed due to the unknown footing thicknesses.

Each of the above mechanisms will potentially lead to a catastrophic seismic collapse of the bridge, which would result in the loss of life. As defined by Federal Highway Administration, this is a Category 1 bridge and its retrofit has been deemed mandatory. The bridge is not a lifeline structure and, as such, retrofitting will focus on preventing its collapse only, even though considerable damage may result.

Three seismic retrofit concepts, retrofit through widening and total bridge replacement options were considered. Initial construction, lifecycle and future capital expenditures cost estimates ranged from $3.18 million for retrofit to $3.79 million for replacement and $4.21 million for widening. Design and environmental phase are expected to take through the end of 2015 for any of the options considered. If construction begins in April 2016, it could finish in one season for retrofit and in two for replacement.

Considering the cumulative retrofitted bridge's lifecycle costs being borne by the Town, the design team recommends bridge replacement with a quality, low-maintenance concrete bridge that will have nearly a century of new life. The final decision will be that of the community and the Town of Fairfax.

Summary of Analyses, Findings, Issues, Retrofit Alternates and Recommendations

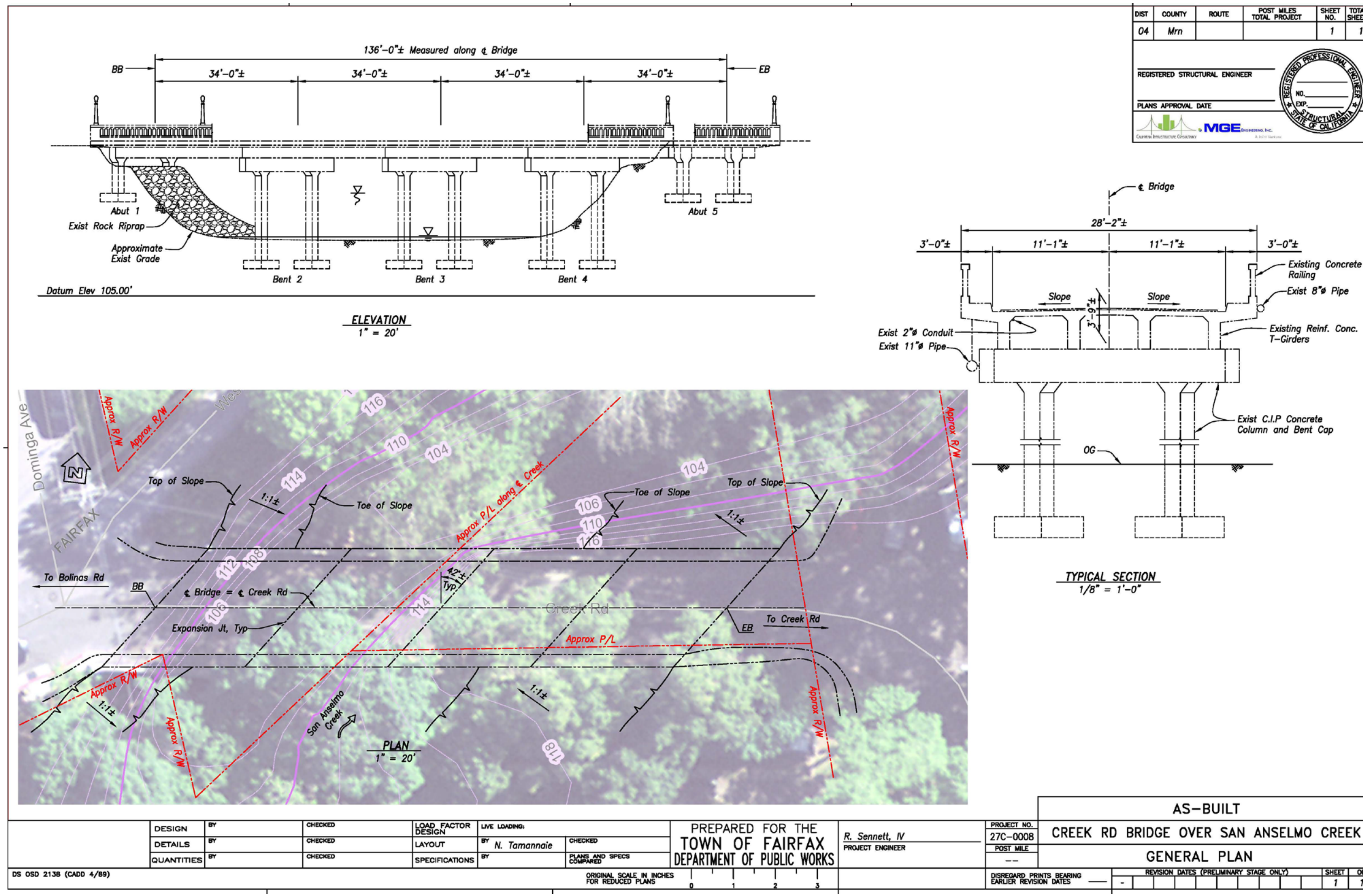
Introduction and Background - This bridge over San Anselmo Creek is reported to have been constructed in 1929. The four-span reinforced concrete structure is made up of four sets of reinforced concrete T-girders, simply supported on three sets of two-column bents in the creek and on an abutment at each river bank. The abutments are somewhat unusual in the way that, instead of being solid continuous walls, they are built similar to the bents on columns and, presumably, footings and buried in the embankment. The bridge is approximately 136 feet long and 28.2 feet wide. It supports two narrow, 10-foot-wide lanes and narrow non-ADA compliant sidewalks on each side. The bridge has a Sufficiency Rating (SR) of 57.9 (from 100) and an average daily traffic (ADT) of less than 300. The SR is further explained in this report. Caltrans has listed the bridge as ineligible for National Register of Historic Places (NRHP), which totally eases the cultural resources requirements on the bridge when being worked on. There are no as-built plans available for the bridge, but a typical Caltrans type as-built bridge General Plan has been prepared by this engineering team and included in this report.

In 1997, while Caltrans led the bulk of the Local Agency Seismic Safety Program, the bridge was found to be seismically vulnerable and a set of seismic retrofit plans was prepared for it. The work lacked environmental and hydraulic studies and did not have proper bridge foundation investigation done, and was not completed. The project did not go beyond the preliminary set of plans stage and funding for it was ultimately de-obligated, perhaps because environmental studies were not conducted to obtain the necessary permits. Since then, Caltrans' seismic retrofit and ground motion criteria have evolved considerably. The Seismic Safety Program now runs with the local agency in the lead and is supported by funds from federal Highway Bridge Program (HBP), as well as Caltrans and other State funds.

This bridge is located on a wide section of San Anselmo Creek. It experienced a significant washout and undermining of its west abutment during the floods of New Year's eve, 2005, although the water never exceeded a 7-8 feet height above the creek bed nor did it impinge on the girders. The washout may be attributed to not only the forces of the flow and soil conditions, but the unusual abutment configuration described earlier. The bridge was closed to vehicular traffic due to its gaping abutment exposure while the Town obtained funds and implemented repairs for it. During that time, motorists used a detour around the bridge via other streets. The abutment was underpinned and protected with a substantial course of rock riprap in 2008 and the bridge reopened after the repairs.

Bridge abutment washout & exposure of New Year's Eve 2005

Subsequently, a September 2010 bridge scour Plan of Action (POA) report by CIC team members found no signs of new significant bridge foundation scour. None of the bridge footings were exposed during the field investigations. The riprap has, however, had the effect of reducing scour potential at the bent adjacent to this abutment (Bent 2) and slightly increasing scour potential at Bent 3 near the creek center. From field visits and probings it is surmised that each bridge column sits on 6' x 6' spread footings approximately 5 feet below the creek bed. The thickness of the footings cannot be determined without extensive excavations.



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Dominga Ave
FAIRFAX
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Top of Slope
Toe of Slope
1:1±
Approx P/L along ℄ Creek
To Bolinas Rd
℄ Bridge = ℄ Creek Rd
47°± Typ
Creek Rd
Expansion Jt, Typ
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EB
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San Anselmo Creek
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R. Sennett, IV
PROJECT ENGINEER
PROJECT NO. 27C-0008
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0 1 2 3
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REVISION DATES (PRELIMINARY STAGE ONLY)
SHEET 1 OF 1

Public Right-of-Way and Private Land Ownership at the Project Area – The exhibit on the previous page shows an aerial photo of the project area and public right-of-way (ROW) and private land ownership. At the first look, the parcel lines look unconventional, but property records have been researched and it is believed the boundary lines are correct. However, extended research of the title reports and actual field monumentation to determine the parcel lines with 100% accuracy will be performed in the second phase of the project. As shown on the aerial, at two locations along the south edge of the bridge, the structure may be encroaching on private parcel lines, the easements for which will be identified.

It is not anticipated that any new property takes will be needed for the final design. As part of the federal and State processes, all easements and right-of-way descriptions will be established through legal agreements, including ones with the adjacent land owners, when necessary, in order for the ROW phase of the project to be certified by Caltrans.

Seismic Condition of the Existing Bridge - In these seismic evaluations the bridge was analyzed for its seismic performance according to the Caltrans “No Collapse” criteria and the latest bridge seismic engineering. The criteria assure a no-collapse scenario during the Maximum Credible Event (MCE) for non-lifeline bridges, where no loss of life or catastrophic collapse is allowed to occur, although the bridge may sustain substantial damage. Creek Road Bridge is not considered to be a lifeline bridge. Lifeline facilities, such as the Golden Gate Bridge, are on major roadways where the shutting down of the facilities after a large-scale disaster cannot be afforded, and are designed or retrofitted to sustain only minor damage during the MCE.

The initial Preliminary Engineering (PE) phase of this project was to determine the seismic retrofit strategy for the bridge. Since there are no as-built plans available for the bridge, field measurements of all relevant bridge parts were taken and the actual depth and size of the bridge foundations were field-verified. The design team’s materials testing subconsultant, WJE, obtained several cores from the bridge concrete at various critical locations and the concrete’s compressive strength was determined through specific tests. WJE also used ground penetrating radar (GPR) to look through the concrete beyond its surface and revealed the reinforcement details in critical bridge components. After drilling two borings and conducting site investigations, a preliminary Bridge Foundation Report has been prepared by the geotechnical engineer and used in the analysis. All data were input in the global computer models of the bridge and its critical elements, such as the columns and bent caps. Analyses were performed to ascertain if a collapse mechanism would develop as a result of the MCE.

Due to the bridge construction details, typical vulnerabilities in the substructure and foundation, common to the vintage of such construction, became evident in the analyses, as follows:

- Being a series of simple spans, the bridge superstructure is not rigidly connected to the substructure to participate in its seismic resistance, and instead sits on the bent caps and columns as dead weight.
- The lack of connectivity between the super- and substructure, and

Lack of connection between girders and bent cap is evident lack of shear keys acting as stoppers, pose a real danger of the bridge superstructure unseating from the bent caps during a large seismic event and resulting in collapse. The edge of deck is currently offset on each side of the expansion joints, pointing to differential movements of the spans relative to each other due to past seismic events, extreme creek flows, or both. Other distress caused by these movements, such as a cracked bent cap beam corner caused by grinding from the superstructure, is also evident as shown below.

- If the superstructure doesn't unseat itself during a large seismic event, its dead inertia will sway back and forth and laterally and puts extreme bending and compressive loads on the base of the columns and on the footings. The concrete columns cores in the bridge lack adequate steel rebar to confine them and will collapse under the extreme cyclic seismic loads predicted.
- The bent caps are poorly reinforced. The analysis showed them failing in bending, caused by the columns' ultimate plastic moments under the seismic loads plus the structure's dead weight.
- The bridge is founded on relatively small spread footings, which are also seismically inadequate. The footings fail due to bearing and overturning plastic moments from the columns. Additionally, they are expected to break up due to their thin depth and typically sparse reinforcement before even reaching bearing thresholds.

Overall, it has been determined that this is a Category 1 bridge, meaning that in its current condition it is subject to catastrophic collapse that can result in loss of life. These conditions necessitate bridge seismic retrofit or replacement if the latter is more feasible. Retrofitting will include columns and foundations, tying the super- and substructure together with restrainer cables, constructing shear keys atop the bent caps and the use of seismic approach slabs at each bridge end. Several options to implement these measures have been presented in this report. The purpose of investigating the various options to address the seismic deficiencies, including bridge widening and replacement, is to identify feasibility, environmental impacts and cost and provide information for the public and the Town of Fairfax to make an informed decision and choice for the future of the bridge.

Other Deficiencies of the Existing Bridge– As noted earlier, the bridge has a sufficiency rating of 54.1 out of 100 possible points. This number represents a weighted evaluation of several bridge attributes through a formula devised by the Federal Highway Administration (FHWA). This algorithm is used by Caltrans after its biennial inspections of the local agency bridges that are in the National Bridge Inventory (NBI), in which Creek Road Bridge and several other Fairfax bridges belong. It's an overall score for the bridge's functionality, composed of ratings (0 to 9) for its various components and attributes. Every two years the results are published by Caltrans in a Bridge Inspection Report (BIR), which is shared with the local agency, in this case the Town of Fairfax Public Works Department.

The latest BIR from 2010 (included in the appendix) shows the Structural Evaluation of the bridge and its Deck Geometry both receiving scores of 4 out of 9. The condition of the Deck and Superstructure received a score of 7 and Substructure received a 6. In terms of Traffic Safety, which in this case the bridge rails are cited, the score is a series of zeroes, pointing to substandard railings. The sidewalks are also substandard and not ADA-compliant. It must be noted that the biennial ratings of the bridge elements do not take into consideration the seismic attributes of the bridge and only deal with the everyday functioning of the bridge, hence this report.

The BIR notes numerous concrete spalls (flaking and chipping), exposing the reinforcement and resulting in its rusting. These preventive maintenance needs must be addressed during the construction of any of the four retrofit options presented, and will naturally go away if the bridge is replaced. Funding for these corrections will be included by this federal/State program

Seismic Retrofit Options - In total, four seismic retrofit options were studied and costs associated with each alternate estimated. (A 25% contingency was applied to all costs.) Other cost items considered in the estimate are water diversion, traffic control, vegetation restoration and lifecycle (maintenance, repairs, replacement) costs. Where applicable, existing utilities will be maintained in place, but retrofit Options 4 and 5, as described below, will require relocations. Access to and construction work in San Anselmo Creek, likely by ramping locally to the creek area, will be necessary.

These options and costs are described below:

Option 1 – Seismically retrofit the existing bridge by:

a. Enlarging its bent foundation footings and strengthening the columns by casting concrete infill walls between each pair. To do this, each of the six bridge footings in the creek will need to be exposed and made larger. The infill wall, dowelled into the insides of the columns and the underside of the bent cap, closes the huge rectangular space between the sets of columns at each bent. The columns and caps will no longer be separate entities but act together as a huge diaphragm that will be hard to tip over sideways. Having enlarged the footings, the structure will also resist any longitudinal seismic movements. With this approach, the deficiencies of the concrete cap beams over the columns, potentially leading to their brittle failure, are addressed as well.

b. Placement of cable restrainers to tie the superstructure together over the cap beams and a transverse and longitudinal shear key system at each bent to keep the superstructure seated on the bent caps and engage the rest of the substructure.

c. Construction of seismic approach slabs at the existing bridge abutments. Repairs requiring joint seal replacements at the abutments and the three bent locations on the bridge are also included.

These retrofit measures are shown on the Bridge General Plan on page 12.

The bridge will need to continue having its regular biennial inspections after retrofit construction. Maintenance work resulting from these inspections over the remaining life of the bridge is expected. The cost of this retrofit scheme, without lifecycle costs and construction management, is estimated to be $1,050,000.

Option 2 - This retrofit is shown on page 13 and includes:

a. Placing the same infill wall between the columns, transverse shear keys, cable restrainers at bent caps and joint seal repairs, as in Option 1.

b. To avoid excessive disturbance of the creek, instead of excavating and enlarging the existing footings, the bridge's longitudinal seismic movements at abutments will be kept in check with seismic "waffle" slabs. A waffle slab is a structural system involving a concrete approach slab connecting to the back of the abutment and sitting atop a cellular structure, supported on small diameter cast-in-drilled-hole (CIDH) piles. The system creates a resisting drag resistance in the back of the abutment, preventing the bridge from swaying longitudinally.

As with Option 1, regularly scheduled post-construction inspections and maintenance of the bridge are expected. The cost of Option 2 retrofit scheme, without lifecycle costs and construction management, is estimated to be $1,057,000.

Option 3 - This retrofit is shown on page 14. Seismic retrofit is the same as in Option 2 above, except:

a. Instead of seismic waffle slabs, two large-diameter (6') CIDH piles behind each abutment will be installed. These piles require large rigs, multiple cranes and multiple trucks to carry away the drilling byproducts. However, they are suited well for use in neighborhood settings where the percussive nature of the noise from driving dozens of small piles for similar seismic performance will be far more disturbing. The large piles, once installed, will be structurally connected to the back of the abutments to prevent the bridge from swaying in the longitudinal direction.

Regularly scheduled post-construction inspections and maintenance of the bridge are expected. The cost of this retrofit concept, without lifecycle costs, is estimated to be $1,050,000 as well.

Option 4 – This approach is shown on page 15 and includes:

a. Widening the bridge on the north side (where right-of-way is readily available) as both a seismic retrofit measure and to gain 4'-wide shoulders (doubling as Class II bike lanes) standard and ADA-compliant 5'-wide sidewalks on both sides of the bridge. The new total width will increase from 28'-2" to 44 feet. Bridge widening will involve adding an independent, precast double T-beam superstructure with a depth of 3'-2", supported on three sets of double-column bents on 4' diameter pile shafts in line with the existing bents. By tying the new and existing bridges together, the lateral seismic movements of the latter will be kept in check. This is partial retrofit.

b. Complete the retrofit with large diameter CIDH piles or waffle slabs at the abutments, as described in Options 2 and 3 above. Although a one-sided widening in this fashion is not ideal, this option satisfies the seismic concerns of the bridge as well as improves its every service by providing safer non-motorized travel for the neighborhood.

c. Repairs requiring joint seal replacement at five locations on the existing bridge are also included.

Work for this alternative also includes utility relocations and modifying the approach roadways at both ends of the bridge, as well as Dominga Avenue and Wessen Lane, for the widened bridge. The final approach layout will actually be improved and traffic calming measures can be implemented. The cost of this concept, without lifecycle costs and construction management, is estimated to be $2,243,000.

Detailed cost estimates, including lifecycle and construction management costs are shown in Appendix A and summarized on page 18 in this report. A discussion of the costs of the alternatives in the context of their advantages/disadvantages and has been provided on page 20.

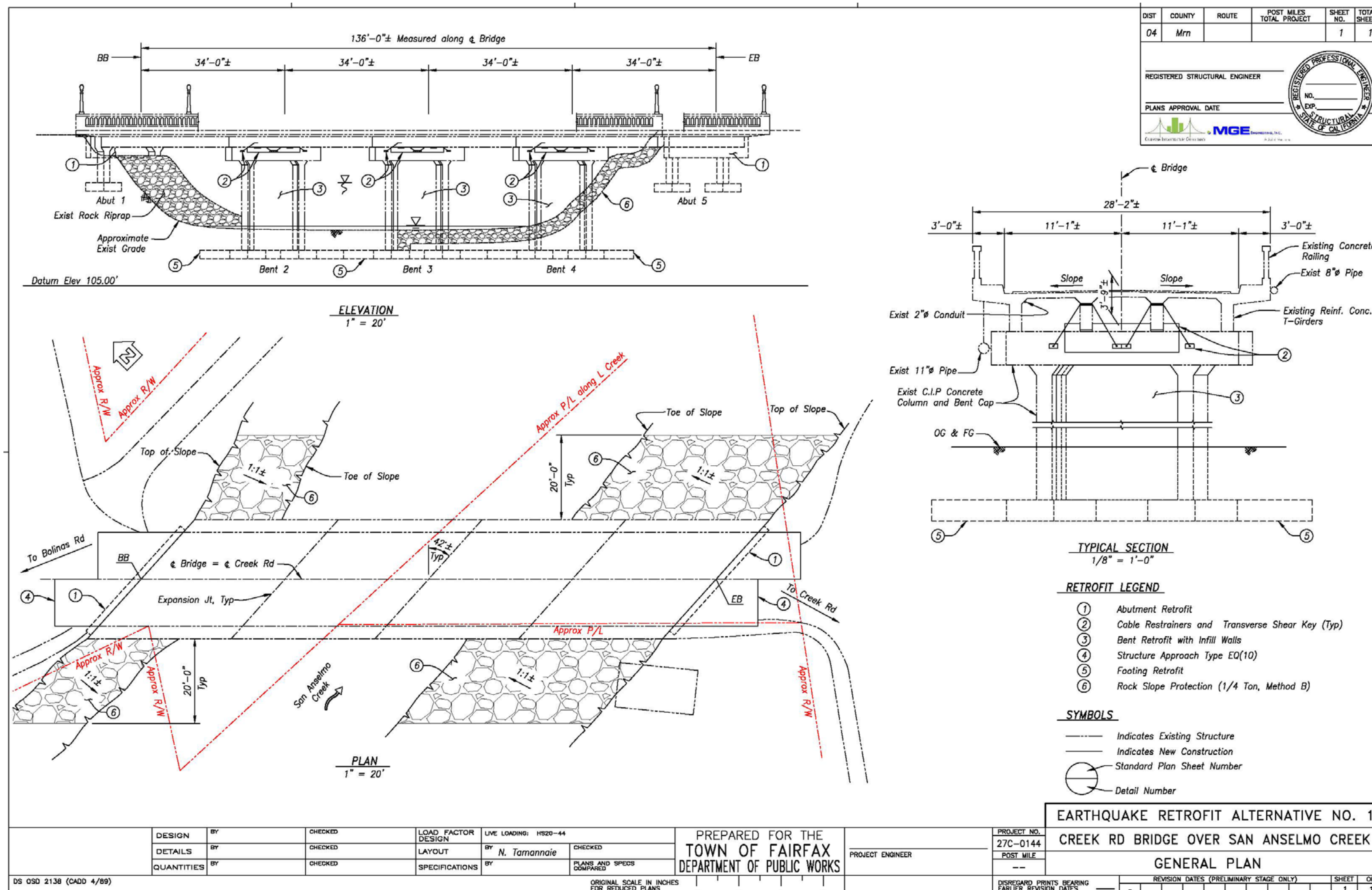
Each season of construction work in the creek is limited to the period from mid-April to mid-October. Outside of this time window, work at the bridge topside and street level can go on unimpededly. It is anticipated the bridge construction for any of the retrofit options will take one season and widening will likely need two seasons for construction. For each of the above four options the bridge can be closed off and the local traffic detoured during construction. This detour is shown on page 17. Alternatively, the work can be performed with occasional partial closures while allowing the traffic through, albeit more slowly. Total closure and detouring of the traffic will generally result in higher contractor efficiency, faster completion and certain economies of construction bid price.

Bridge Replacement – Seismic retrofit strategy requires that bridge replacement also be considered as a retrofit option. A new bridge would have two standard 12' lanes, two 4' shoulders (or bike lanes) and standard sidewalks and a total width the same as the widening option (Alternate 4 above), or 44 feet. A new bridge would be shifted north slightly to free up the right-of-way easement along its south edge.

The bridge considered would have a two-span cast-in-place concrete box girder superstructure with a depth of 3'-9", supported on a single two-column bent composed of 4'-diameter CIDH pile shafts, shown on page 16. A new bridge would have a structural concrete approach slab at each end and rock slope protection at both abutments. The abutments would be supported on 24" cast-in-drilled-hole concrete piles. Slight street intersection modifications at the junctions with Dominga Avenue and Wessen Lane would be implemented and traffic calming measures could be implemented.

Overall, the bridge would help vehicular and non-vehicular traffic considerably and guarantee a long service life for the creek crossing with minimal maintenance efforts. Having fewer supports in the creek and improved abutments, lack of bridge scour and better conveyance of debris and drift through the bridge opening would also be positive results. All utilities would be housed inside the bridge, either in the boxed cells if they are large pipes, or in the sidewalks and railings if they are smaller conduits. Street lighting, if deemed necessary, could be another added amenity. The bridge shown in this report is fairly generic and a concept only. A detailed process with the public and others to consider and incorporate design ideas, including bridge types and aesthetics, would be implemented for bridge replacement.

Bridge replacement cost estimate, without lifecycle and construction management costs, is $2,653,000.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STRUCTURAL
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1:1±
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To Bolinas Rd
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42'± Typ
Expansion Jt, Typ
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TYPICAL SECTION
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RETROFIT LEGEND
1 Abutment Retrofit
2 Cable Restrainers and Transverse Shear Key (Typ)
3 Bent Retrofit with Infill Walls
4 Structure Approach Type EQ(10)
5 Footing Retrofit
6 Rock Slope Protection (1/4 Ton, Method B)
SYMBOLS
Indicates Existing Structure
Indicates New Construction
Standard Plan Sheet Number
Detail Number
EARTHQUAKE RETROFIT ALTERNATIVE NO. 1
CREEK RD BRIDGE OVER SAN ANSELMO CREEK
GENERAL PLAN
DESIGN
DETAILS
QUANTITIES
BY
CHECKED
LOAD FACTOR DESIGN
LIVE LOADING: HS20-44
LAYOUT
BY N. Tamannaie
SPECIFICATIONS
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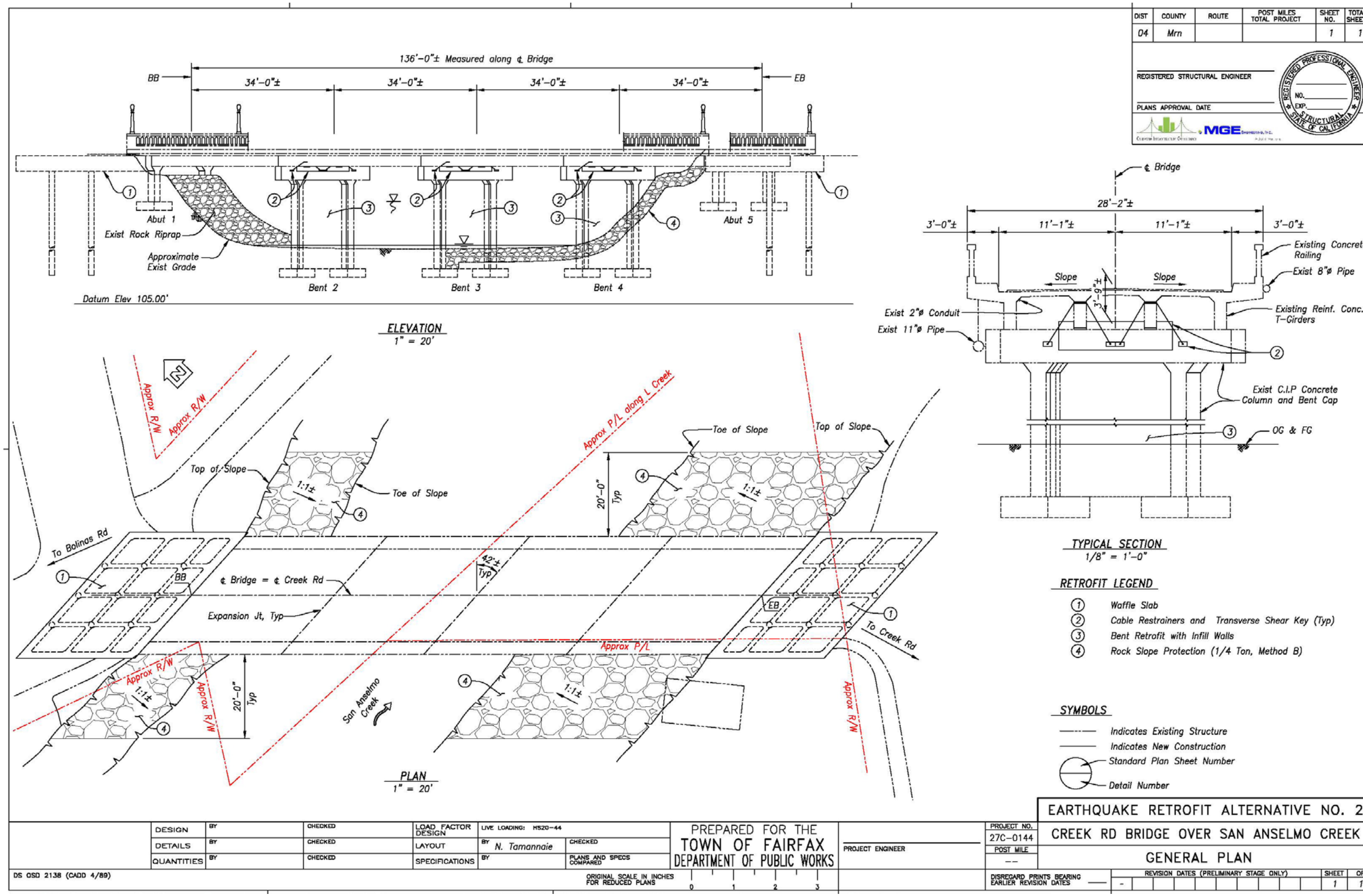

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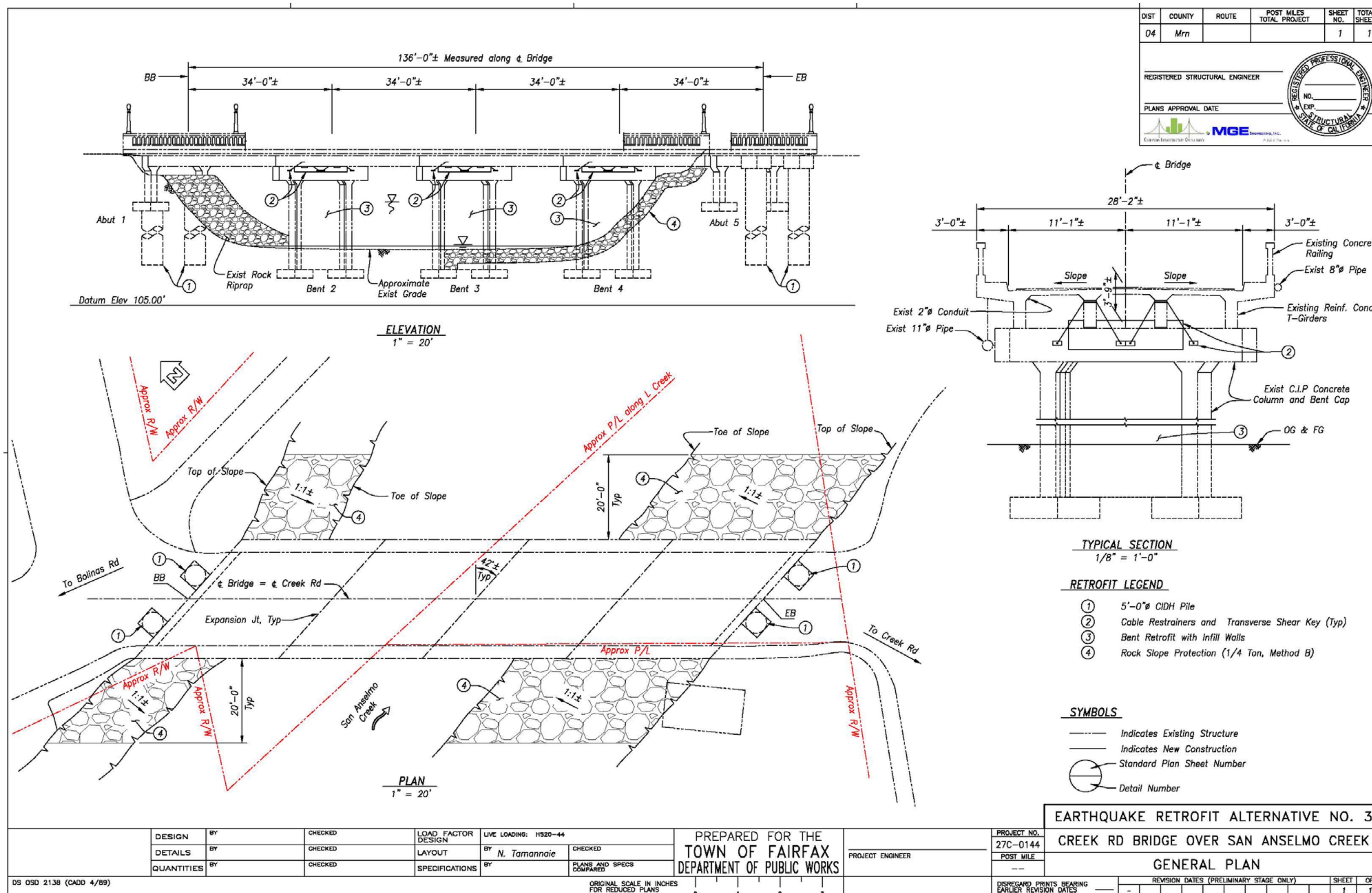
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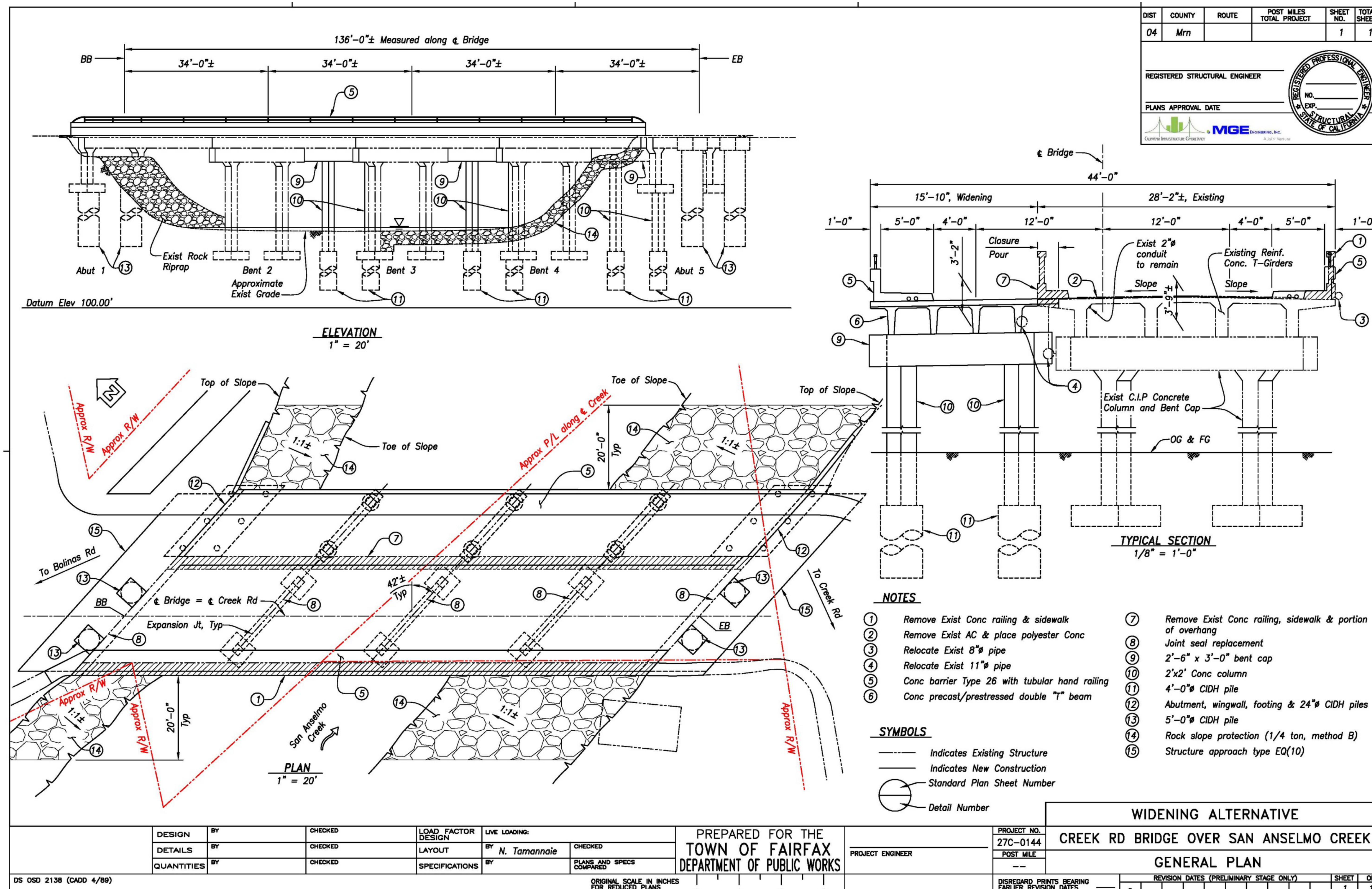
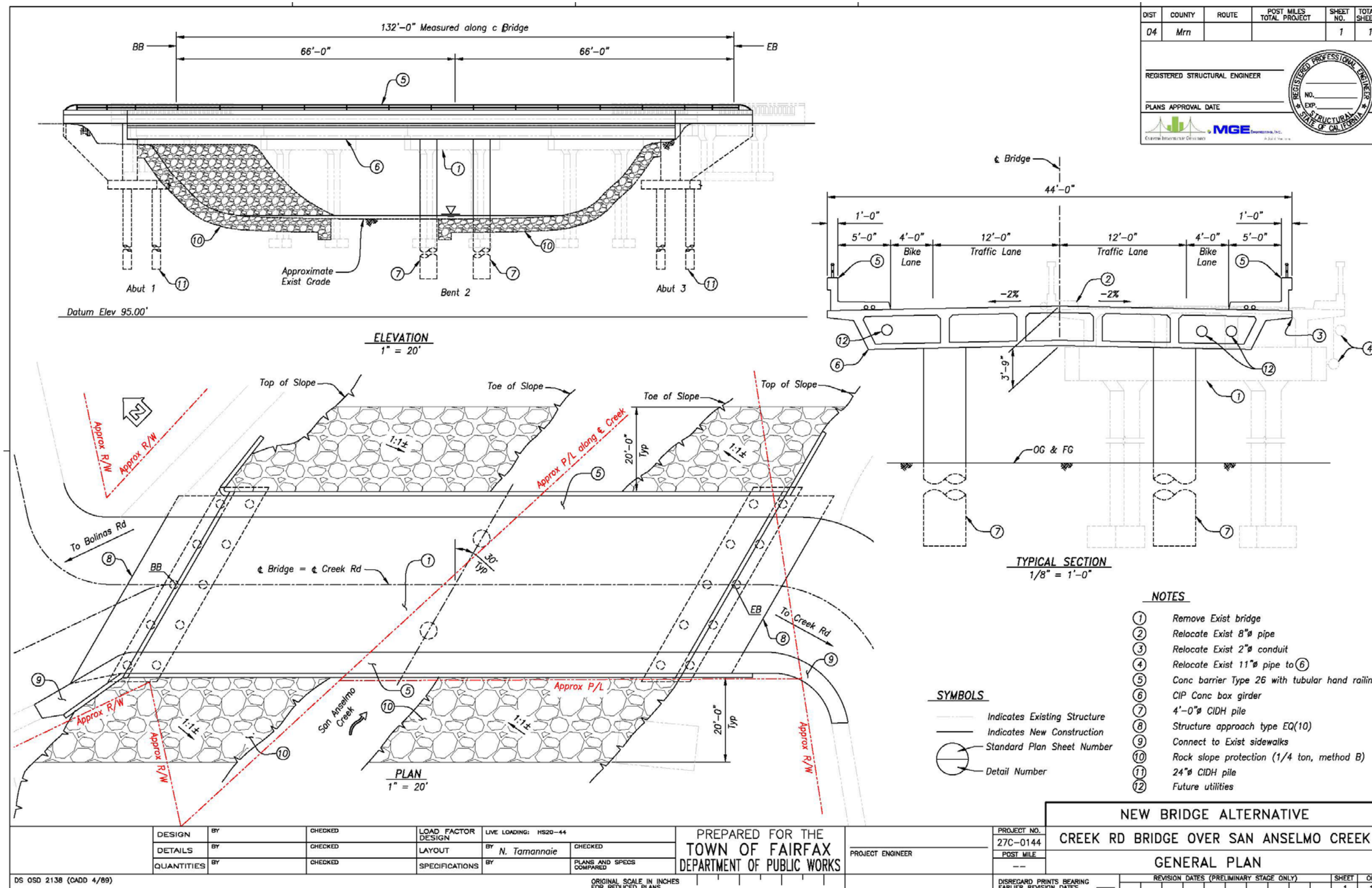
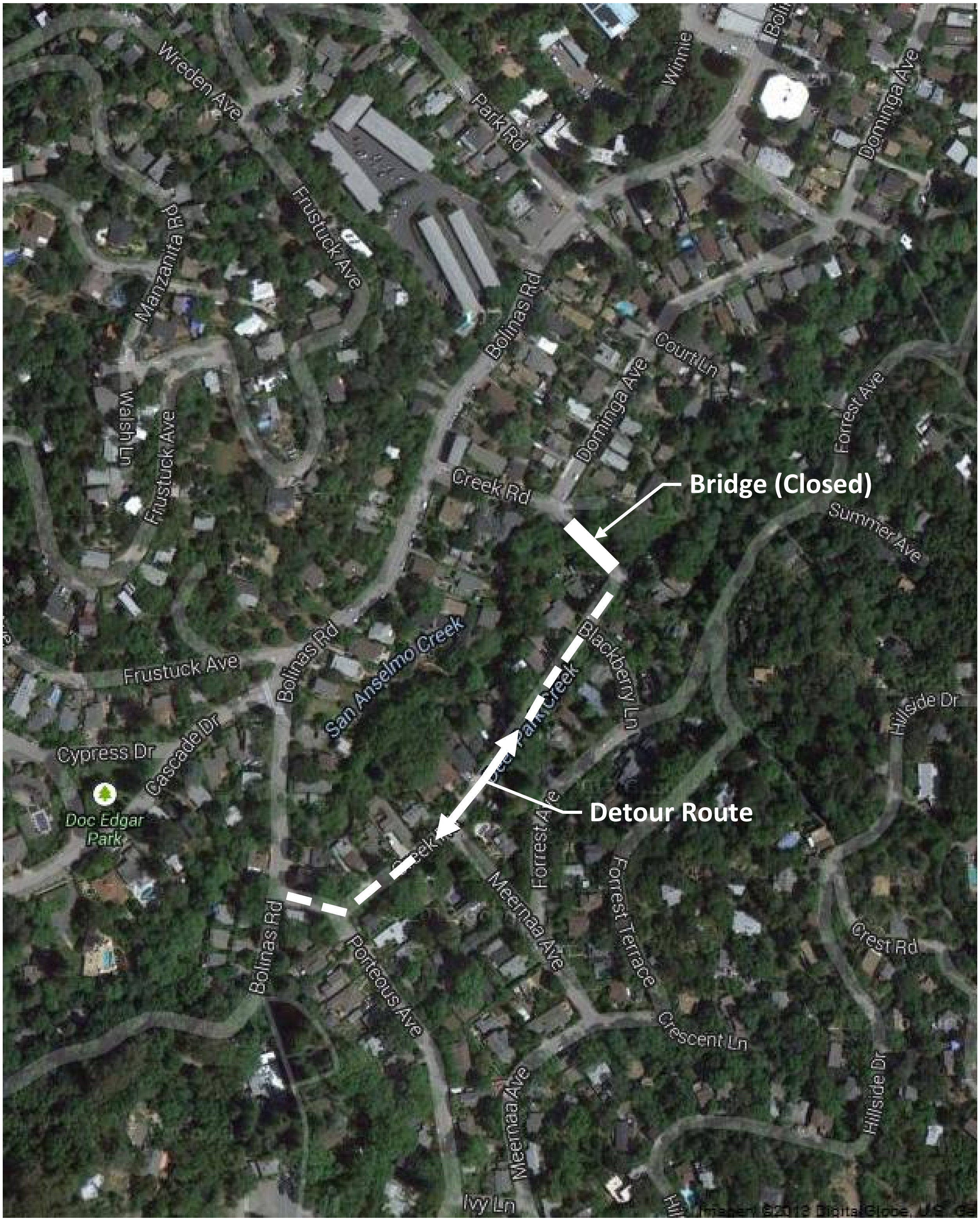
EB
34'-0"±
34'-0"±
34'-0"±
34'-0"±
Abut 1
Abut 5
Exist Rock Riprap
Bent 2
Approximate Exist Grade
Bent 3
Bent 4
Datum Elev 105.00'
ELEVATION
1" = 20'
℄ Bridge
28'-2"±
3'-0"±
11'-1"±
11'-1"±
3'-0"±
Existing Concrete Railing
Exist 8"ø Pipe
Slope
Slope
Exist 2"ø Conduit
Exist 11"ø Pipe
Existing Reinf. Conc. T-Girders
Exist C.I.P Concrete Column and Bent Cap
OG & FG
TYPICAL SECTION
1/8" = 1'-0"
RETROFIT LEGEND
① 5'-0"ø CIDH Pile
② Cable Restrainers and Transverse Shear Key (Typ)
③ Bent Retrofit with Infill Walls
④ Rock Slope Protection (1/4 Ton, Method B)
SYMBOLS
Indicates Existing Structure
Indicates New Construction
Standard Plan Sheet Number
Detail Number
Approx R/W
Approx R/W
Approx P/L along L Creek
Toe of Slope
Top of Slope
Top of Slope
Toe of Slope
1:1±
20'-0" Typ
To Bolinas Rd
BB
℄ Bridge = ℄ Creek Rd
42°± Typ
Expansion Jt, Typ
EB
To Creek Rd
Approx P/L
Approx R/W
Approx R/W
Approx R/W
San Anselmo Creek
PLAN
1" = 20'
EARTHQUAKE RETROFIT ALTERNATIVE NO. 3
CREEK RD BRIDGE OVER SAN ANSELMO CREEK
GENERAL PLAN
DESIGN
DETAILS
QUANTITIES
CHECKED
LOAD FACTOR DESIGN
LIVE LOADING: HS20-44
LAYOUT
N. Tamannaie
SPECIFICATIONS
PLANS AND SPECS COMPARED
PREPARED FOR THE
TOWN OF FAIRFAX
DEPARTMENT OF PUBLIC WORKS
PROJECT ENGINEER
PROJECT NO. 27C-0144
POST MILE
DS OSD 2138 (CADD 4/89)
ORIGINAL SCALE IN INCHES FOR REDUCED PLANS
DISREGARD PRINTS BEARING EARLIER REVISION DATES
REVISION DATES (PRELIMINARY STAGE ONLY)
SHEET 1 OF 1


DIST 04 COUNTY Mrn ROUTE POST MILES TOTAL PROJECT SHEET NO. 1 TOTAL SHEETS 1
REGISTERED STRUCTURAL ENGINEER
PLANS APPROVAL DATE
136'-0"± Measured along ℄ Bridge
34'-0"± 34'-0"± 34'-0"± 34'-0"±
BB
EB
Abut 1
Exist Rock Riprap
Bent 2
Approximate Exist Grade
Bent 3
Bent 4
Abut 5
Datum Elev 100.00'
ELEVATION
1" = 20'
℄ Bridge
44'-0"
15'-10", Widening
28'-2"±, Existing
1'-0" 5'-0" 4'-0" 12'-0" 12'-0" 4'-0" 5'-0" 1'-0"
Closure Pour
Exist 2"ø conduit to remain
Existing Reinf. Conc. T-Girders
Slope
Exist C.I.P Concrete Column and Bent Cap
OG & FG
TYPICAL SECTION
1/8" = 1'-0"
Top of Slope
Toe of Slope
Approx R/W
Approx P/L along ℄ Creek
To Bolinas Rd
℄ Bridge = ℄ Creek Rd
Expansion Jt, Typ
42°± Typ
20'-0" Typ
San Anselmo Creek
To Creek Rd
PLAN
1" = 20'
NOTES
1 Remove Exist Conc railing & sidewalk
2 Remove Exist AC & place polyester Conc
3 Relocate Exist 8"ø pipe
4 Relocate Exist 11"ø pipe
5 Conc barrier Type 26 with tubular hand railing
6 Conc precast/prestressed double "T" beam
7 Remove Exist Conc railing, sidewalk & portion of overhang
8 Joint seal replacement
9 2'-6" x 3'-0" bent cap
10 2'x2' Conc column
11 4'-0"ø CIDH pile
12 Abutment, wingwall, footing & 24"ø CIDH piles
13 5'-0"ø CIDH pile
14 Rock slope protection (1/4 ton, method B)
15 Structure approach type EQ(10)
SYMBOLS
Indicates Existing Structure
Indicates New Construction
Standard Plan Sheet Number
Detail Number
WIDENING ALTERNATIVE
CREEK RD BRIDGE OVER SAN ANSELMO CREEK
GENERAL PLAN
DESIGN BY CHECKED
DETAILS BY CHECKED
QUANTITIES BY CHECKED
LOAD FACTOR DESIGN
LAYOUT BY N. Tamannaie CHECKED
SPECIFICATIONS BY PLANS AND SPECS COMPARED
LIVE LOADING:
PREPARED FOR THE TOWN OF FAIRFAX DEPARTMENT OF PUBLIC WORKS
PROJECT ENGINEER
PROJECT NO. 27C-0144
POST MILE --
DISREGARD PRINTS BEARING EARLIER REVISION DATES
REVISION DATES (PRELIMINARY STAGE ONLY)
SHEET 1 OF 1
DS OSD 2138 (CADD 4/89)
ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3


DIST 04
COUNTY Mrn
ROUTE
POST MILES TOTAL PROJECT
SHEET NO. 1
TOTAL SHEETS 1
REGISTERED STRUCTURAL ENGINEER
PLANS APPROVAL DATE
REGISTERED PROFESSIONAL ENGINEER
NO.
EXP.
STRUCTURAL
STATE OF CALIFORNIA
132'–0" Measured along ℄ Bridge
66'–0"
66'–0"
BB
EB
Abut 1
Bent 2
Abut 3
Approximate Exist Grade
Datum Elev 95.00'
ELEVATION
1" = 20'
℄ Bridge
44'–0"
1'–0"
5'–0"
4'–0"
Bike Lane
12'–0"
Traffic Lane
–2%
3'–9"
OG & FG
TYPICAL SECTION
1/8" = 1'–0"
Top of Slope
Toe of Slope
Approx R/W
Approx P/L along ℄ Creek
Approx P/L
20'–0" Typ
1:1±
To Bolinas Rd
To Creek Rd
℄ Bridge = ℄ Creek Rd
30° Typ
San Anselmo Creek
PLAN
1" = 20'
SYMBOLS
Indicates Existing Structure
Indicates New Construction
Standard Plan Sheet Number
Detail Number
NOTES
1 Remove Exist bridge
2 Relocate Exist 8"ø pipe
3 Relocate Exist 2"ø conduit
4 Relocate Exist 11"ø pipe to 6
5 Conc barrier Type 26 with tubular hand railing
6 CIP Conc box girder
7 4'–0"ø CIDH pile
8 Structure approach type EQ(10)
9 Connect to Exist sidewalks
10 Rock slope protection (1/4 ton, method B)
11 24"ø CIDH pile
12 Future utilities
NEW BRIDGE ALTERNATIVE
CREEK RD BRIDGE OVER SAN ANSELMO CREEK
GENERAL PLAN
DESIGN
DETAILS
QUANTITIES
BY
CHECKED
LOAD FACTOR DESIGN
LIVE LOADING: HS20–44
LAYOUT
BY N. Tamannaie
SPECIFICATIONS
PLANS AND SPECS COMPARED
PREPARED FOR THE
TOWN OF FAIRFAX
DEPARTMENT OF PUBLIC WORKS
PROJECT ENGINEER
PROJECT NO.
27C–0144
POST MILE
DISREGARD PRINTS BEARING EARLIER REVISION DATES
REVISION DATES (PRELIMINARY STAGE ONLY)
SHEET 1 OF 1
DS OSD 2138 (CADD 4/89)
ORIGINAL SCALE IN INCHES FOR REDUCED PLANS
0 1 2 3



Creek Road Bridge Detour Map

Cost Summary – The table below shows a summary of the costs of the 5 options for the bridge, including replacement. Long-term lifecycle costs are also included for an 80-year design period.

Option	Type of Seismic Retrofit Work	Present Worth (2017) Cost Estimates				
		Initial Construction (CON)		Construction Engineering (CE - 15% of CON)	Lifecycle (Routine Maint.)	Total
		Retrofit, Widening or Replacement	Bridge Preventive Maintenance			
1	Infill walls; enlarged footings; restrainers and shear keys at bents; and 10' long approach slabs	$968,736	$81,000	$157,460	$1,975,500	$3,182,697 Say **$3.18 m**
2	Infill walls; waffle slabs at approach roadways; and restrainers and transverse shear keys at bents	$976,458	$81,000	$158,619	$1,975,500	$3,191,577 Say **$3.19 m**
3	Infill walls; two 5' diameter CIDH piles at abutments; & restrainers and transverse shear keys at bents	$969,069	$81,000	$157,510	$1,975,500	$ 3,183,080 Say **$3.18 m**
4	Widen bridge on one side to width of 44'; 5' dia. CIDH piles at each abutment and two 10' approach slabs	$2,089,630	$153,422	$336,458	$1,833,600	$4,213,110 Say **$4.21 m**
5	Replace bridge with a 2-span cast-in-pace concrete bridge with width of 44'	$2,653,365	$0	$398,005	$739,500	$3,790,869 Say **$3.79 m**

It must be noted that the lifecycle costs will be paid for by Town of Fairfax over the years. The assumptions made for lifecycle costs in the above table are shown in Appendix A on page 28. All other elements of the project, when approved by Caltrans as viable, including bridge replacement or widening, are currently planned to be 100% funded through various state and federal programs, as follows:

Project Phase	Fairfax Funds	State Funds	Federal Funds
Preliminary Engineering (PE), including design, environmental and other design related activities	0%	0%	88.53% (HBP) 11.47% (Toll Credit)
Right-of-way (ROW)	0%	0%	88.53% (HBP) 11.47% (Toll Credit)
Construction (CON), including construction management	0%	11.47% (State Proposition 1B)	88.53% (HBP)

It is important to note that the pool of Proposition 1B funds for seismic retrofit is a limited sum ($120 million), managed and allocated by Caltrans and includes replacement or widening resulting as part of seismic retrofit. The funds are assigned on a first-come-first-served basis and once they run out Caltrans participation of 11.47% will not be guaranteed. For this reason, it is imperative that the Preliminary Engineering (PE) and ROW phases of the project be finished as soon as possible.

Design and Construction Schedules - The design process is greatly driven by the environmental studies and permits. Generally, since each alternative presented requires access to, and excavation and construction in the creek, the nature of environmental studies and permits remains similar. These studies and agency permits will require approximately 18 months to complete. Since the process is federally funded, both National Environmental Protection Act (NEPA) and California Environmental Quality Act (CEQA) requirements must be satisfied for the permits to be granted so that the project can move forward to construction.

The goal is to have the design and permits package ready for bidding by the first quarter of 2016 so that by April 15 of the same year a construction contract is awarded and a contractor can be in the creek working. Without unforeseen complications, such as those arising from environmental or funding issues, it is anticipated that the above elements of schedule are achievable and we propose the following overall general schedule:

Public approval of the design option:	January 29, 2014
Caltrans funding of the PE phase (design and environmental studies):	April 1, 2014
Clear NEPA/CEQA, obtain agency permits and finish final design:	April 2014 – December 2015
Certify right-of-way:	June 2015 - December 2015
Bid and award period:	January 2016 - March 2016
Begin Construction:	April 15, 2016
Complete Construction	February 2017 – July 2017

The above completion date is variable, depending on the alternate selected. The front end of the schedule (timing of Caltrans funding of PE phase by April 2014) may be somewhat aggressive. Barring delays, such as those caused by funding or environmental issues during design or construction, finishing by mid-2017 will be still entirely possible.

Recommended Alternative – To summarize the various attributes of the five options discussed, each alternate's advantages, disadvantages and total cost are compared below:

Alternative	Costs (Construction + Routine & Preventive Maintenance)	Advantages	Disadvantages
1 (Retrofit only)	Construction + CM[*] Costs: $1.21 m Lifecycle & Future Capital Costs: $1.97 m Total: $3.18 million	• No falsework required • Short one-season project • Least expensive	• Largest excavation and backfill and creek disturbance • Limited bridge life (30-40 years) • Bridge and sidewalks remain narrow, no bike lanes • Regular maintenance needed • Aesthetically neutral • Lifecycle and future capital costs ($1.97 m) paid by Fairfax
2 (Retrofit only)	Construction + CM Costs: $1.22 m Lifecycle & Future Capital Costs: $1.97 m Total: $3.19 million	• Less disturbance in creek than Alt 1 • Short, one-season project • No falsework required • Comparable cost	• Limited bridge life (30-40 years) • Bridge and sidewalks remain narrow, no bike lanes • Regular maintenance needed • Aesthetically neutral • Lifecycle and future capital costs ($1.97 m) paid by Fairfax
3 (Retrofit only)	Construction + CM Costs: $1.21 m Lifecycle & Future Capital Costs: $1.97 m Total: $3.18 million	• Less disturbance in creek than Alt 1 • Short one-season project • No falsework required • Least expensive alternate	• Limited bridge life, 30-40 years • Bridge and sidewalks remain narrow, no bike lanes • Regular maintenance needed • Aesthetically neutral • Large CIDH pile installation messy for a couple of weeks • Lifecycle and future capital costs ($1.97 m) paid by Fairfax
4 (Retrofit with Widening)	Construction + CM Costs: $2.58 m Lifecycle & Future Capital Costs: $1.63 m Total: $4.21 million	• Added bike lanes and standard sidewalks • A full one-season project • No falsework required	• Existing bridge portion will have limited life (30-40 year) and will need to be replaced in the future • Moderate Maintenance needed • Aesthetically neutral • Most expensive alternate • Lifecycle and future capital costs ($1.63 m) paid by Fairfax
5 (Replace Bridge)	Construction + CM Costs: $3.05 m Lifecycle Costs: $0.74 m Total: $3.79 million	• Added bike lanes and standard sidewalks • 75 -100 years of life • Low maintenance • Aesthetically pleasing • Lowest lifecycle cost ($740 k) • Bridge no longer encroaching on privately owned parcel	• Bridge foundation work in creek • May require falsework in creek • Total cost roughly 20% more expensive than retrofit, but 11% less than widening • Likely two-season construction

[*]Note: CM = Construction Management (cost factor = 15% of Construction)

CIC-MGE recommends Option 5, bridge replacement. This recommendation is based on the fact that the overall costs of the different alternates, including long-term costs, are close and there is an opportunity to upgrade to modern multimodal standards with a low-maintenance and aesthetically pleasing bridge with nearly a century of service life. Additionally, for retrofit option, the long-term lifecycle and future capital improvements costs will be borne by the Town, which can be avoided.

The final decision will be that of the community and the Town of Fairfax. To facilitate the process, this report and a shorter version of it will be posted on the project's web site and discussed with the community during the workshop scheduled for January 29, 2014. The Fairfax Town Council will be considering the subject after this meeting. Any option ultimately adopted by the Town of Fairfax will also need to be accepted and approved by Caltrans.

Summary of the Technical Analysis

Modeling of the Bridge and its Components - This type of bridge is not considered as a "lifeline" structure and the Caltrans policy is to prevent its collapse during the MCE without loss of life. Damage, even heavy damage, but not collapse would be expected. The goal of this analysis was to determine the adequacy of various structural elements subjected to seismic loading short of collapsing.

Several specialty type programs were used for the analysis of this project. The bridge was modeled in Visual Analysis, a multipurpose structural analysis and design software. Visual Analysis provides mode shapes, displacements, moments, shears and axial loads through multimodal excitation of the structure under seismic loadings. The output for these analyses represents the global seismic demands on the bridge. The modeling of the bridge in Visual Analysis was checked for static loads using long-hand methods. The fundamental period of the bridge under seismic loads was also manually checked for accuracy. Cracked concrete section properties are used in the global demand model.

The columns capacities, such as plastic moments, moment curvature and cracked section properties were analyzed using xSECTION. This software provided nonlinear, post yield (plastic) properties of the columns under compressive loads, bending moments or both. Generally, demands on the structure are analyzed along with capacities of the bridge components and compared. If a demand exceeds capacity in a key component, such as a column, cap or footing, that component fails and contributes to or directly leads to the collapse of the bridge. For the analysis, the provisions of Section 20 of the Caltrans Bridge Memo to Designers (MTD) and Seismic Design Criteria (SDC), version 1.7, were utilized.

Material Properties - Expected material properties were used, as follows:

- Samples of the existing concrete were cored and tested by the testing subconsultant, WJE, Inc., and yielded compressive strength of 5,250 psi. Strength of 5,000 psi was used in the models.
- Grade 40 rebar was assigned an expected yield of 44,000 psi and an ultimate stress of 66,000 psi.

Project Approach to Demand Analysis - Part of the general approach to this analysis was to create a global model of the structure with all the elements playing a role in its behavior under the maximum credible event (MCE) seismic loads. Because there were no as-built plans available for the bridge and due to the hidden connection of the girders to the bent caps, the interconnection of the girders to the bents for the four spans were concluded to be fixed-sliding-pin-sliding-pin-sliding-sliding fixed, from field observations, as shown below:

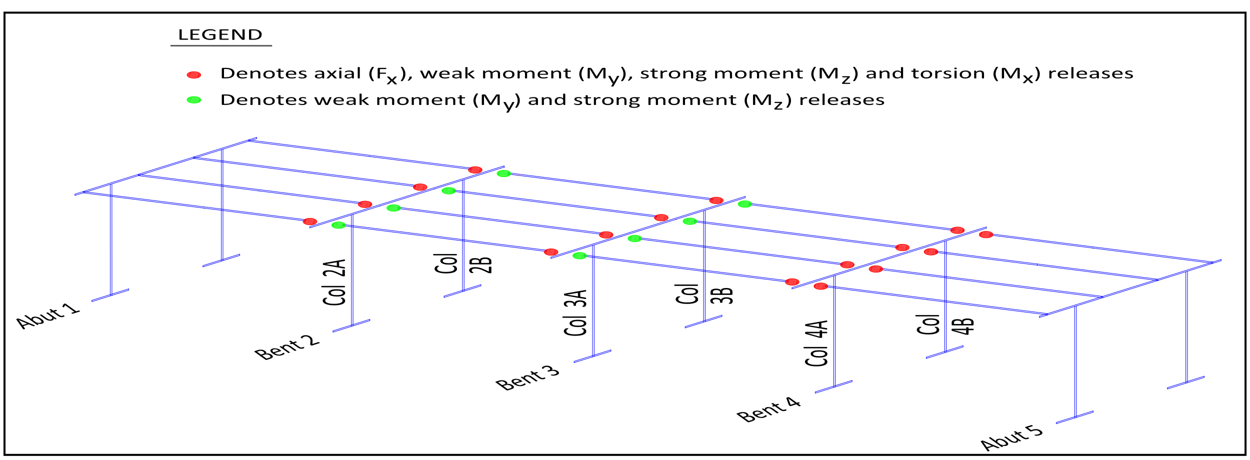


Figure 1 - Visual Analysis Model of Bridge with Girder End Releases

The global model would yield the seismic demands on the components of the structure, such as the columns, bent caps and footings. There are no seismic effects on the superstructure since it does not engage the substructure and is isolated. A total of 50 modes were analyzed, during which the structure would move longitudinally, transversely and at various other angles because of its geometry and stiffness. The program adds the modal demands on the structure based on Complete Quadratic Combination **(**CQC) method.

The model was first developed for the static (dead) loads, using "uncracked" section properties. The vertical reactions at the footings were computed, and a hand calculation was done to check the reactions at the footings. After reasonable agreements were concluded for the reactions from both the model and hand calculations, the global model's fundamental period in each direction was also hand checked. Reasonable agreements were obtained in each direction between the global model and the single frame models after several iterations and corrections of input.

From capacity analyses (the next discussion topic), the values of cracked moment of inertia (I_{CR}) were input in the global model along with the boundary conditions and seismic acceleration response spectrum (ARS) values to obtain the demand displacements. The process of determining the demand and capacity is nonlinear and iterative. For example, the global demand model would start with uncracked stiffness values for the columns. These would yield a certain set of compressive forces in the columns, which would then result in cracked section properties for these elements in xSECTION, to be re-input in the global model until convergence is achieved, usually after few iterations.

In order to ascertain the properties of the foundation soils, the geotechnical engineer drilled a 50'-long boring at each bridge abutment. A third boring in the creek is scheduled for when environmental permits for drilling in the creek are issued by the resource agencies and a full Geotechnical report will be completed then. For now, the more limited information about the bearing capacity of the ground at the bent footings has been used in the analysis and this report. The Acceleration Response Spectrum (ARS) curve below was developed by the geotechnical engineer as the bridge seismic loading.

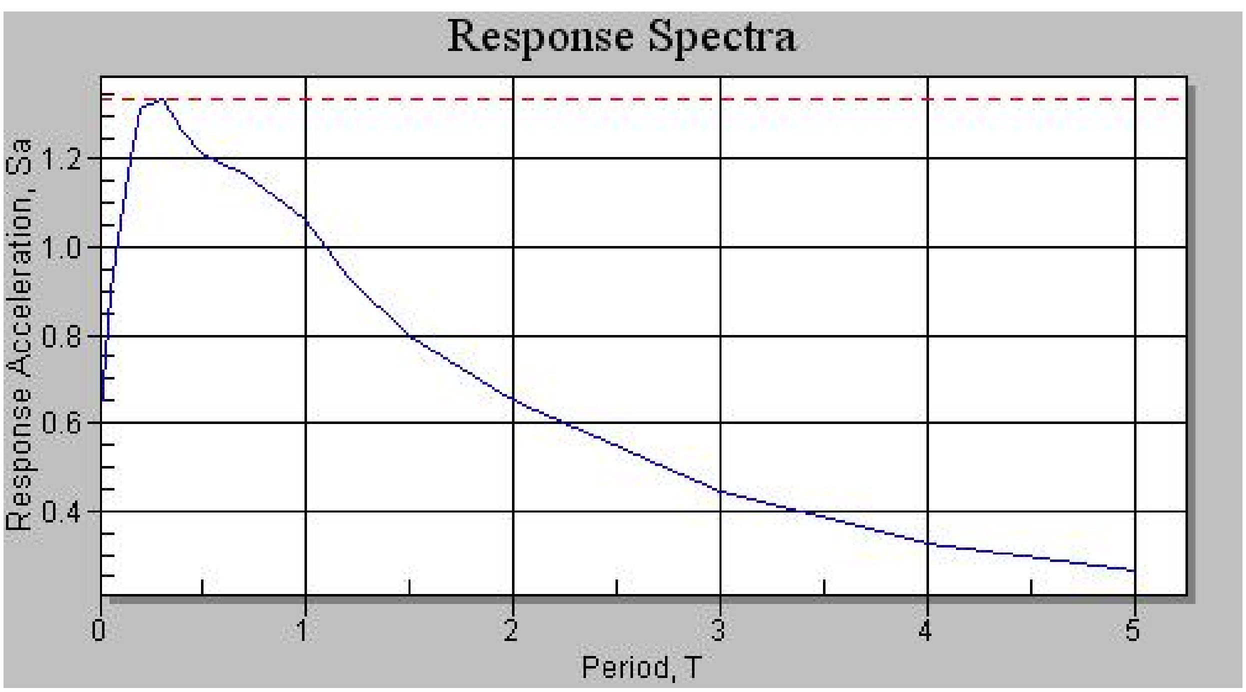


Figure 2 – ARS Curve for Seismic Loading

This ARS curve represents values of ground acceleration in "g"s on the structure for the structure's periods of vibration and reaches acceleration levels up to 1.35 g.

The Visual Analysis model was next prepared for dynamic analysis by specifying 50 mode shapes and input of an ARS. Two seismic loadings on the structure considered were:

1. Dead Load + 1.0 x Longitudinal EQ + 0.3 x Transverse EQ
2. Dead Load + 0.3 x Longitudinal EQ + 1.0 x Transverse EQ

The global model's superstructure boundaries consist of abutments and the interconnection between the girders and the bent caps. These interconnection points were modeled allowing the superstructure to move along its long direction axis when not pinned or fixed. When the structure moves toward the abutments, it will see no soil resistance since the frame making up the abutments is only 3 feet deep. For this reason, the abutments in the model could not contribute much to resisting the longitudinal seismic movements of the structure. For the longitudinal direction, all columns have a fixed bottom and the superstructure will depend on its connections to the bent caps (pin or sliding) to transfer load to the bent frames. In the transverse direction, all the columns are fixed at the bottom to the footings and to the bent caps at the top.

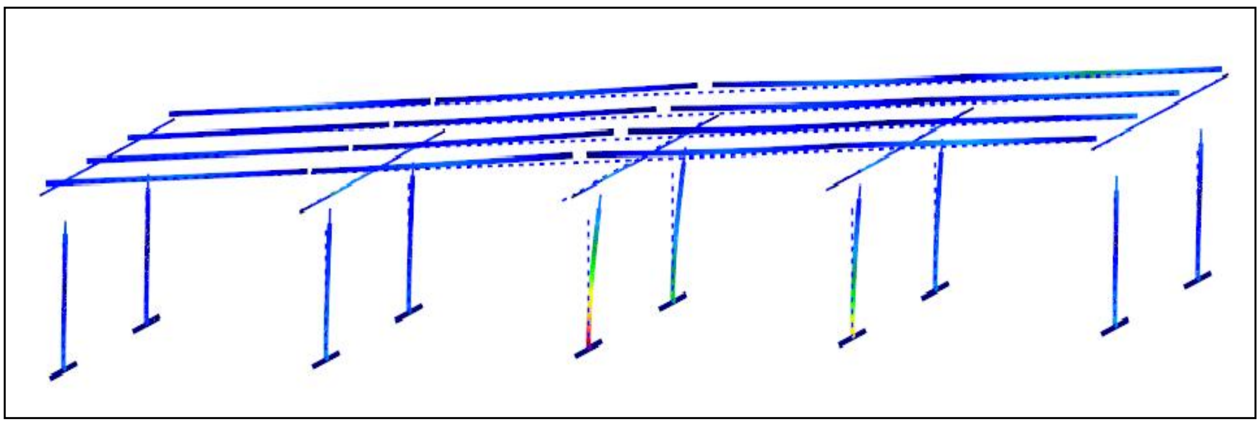


Figure 4 –Envelope of member displacements demands (exaggerated) for 50 modes of vibration

Project Approach for Capacity Analysis - For capacity analysis, the post-yield (plastic), non-linear moment displacements properties of all columns were analyzed using xSECTION. These yielded plastic moment (M_p), cracked moment of inertia (I_{CR}) and plastic curvature angle (ϕ_P) for:

a. Column with maximum compression force from dead load only during longitudinal movements
b. Column with maximum compression force from dead and seismic loads
c. Column with maximum tension force from seismic load

The three output parameters from xSECTION runs for the columns, M_p, I_{CR} and ϕ_P, a sample of which is shown in the following exhibit, were used in hand calculations to calculate the column displacement capacities. Once both the demands (D) and capacities (C) are computed, D/C ratios are calculated and as long as the D/Cs are 1.0 or less all would be fine.

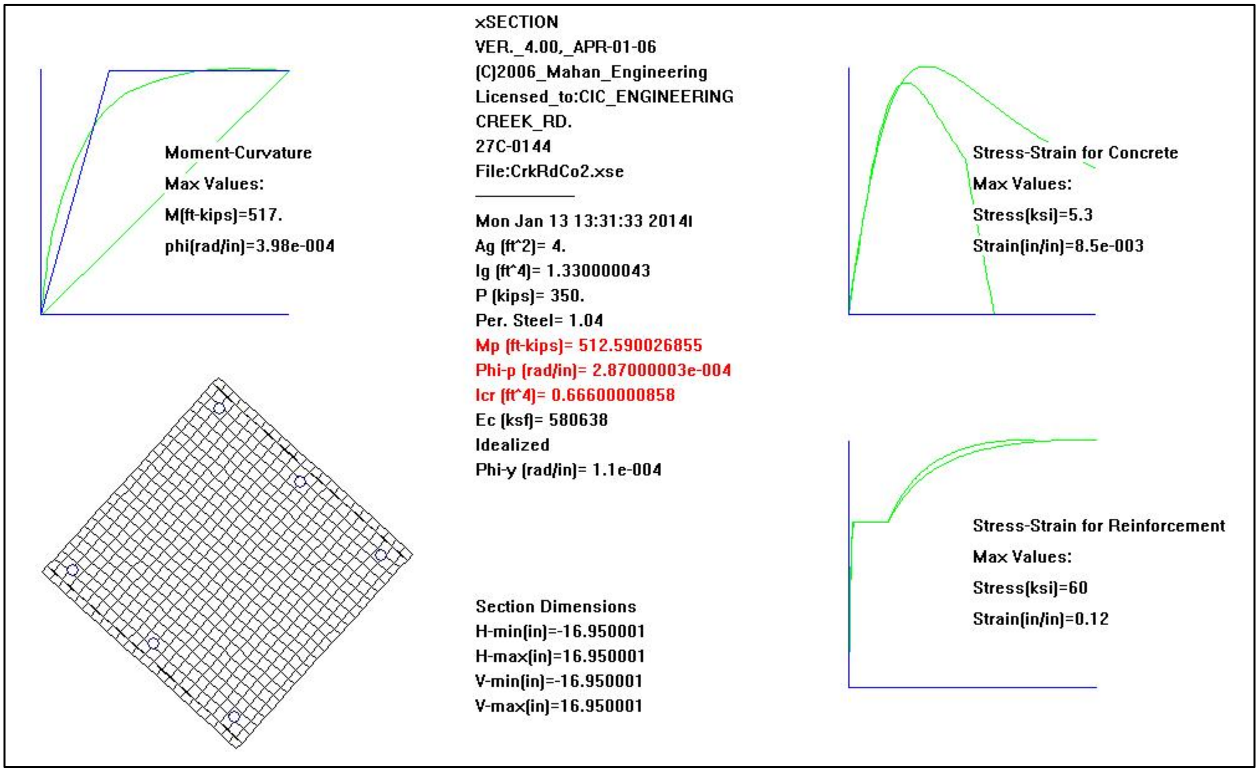


Figure 3 - xSECTION analysis of one column at Bent 2 in the longitudinal direction

Other critical capacity checks concerned bent caps, footings and shear in the columns. When a column exerts moments in a footing, the latter rotates and presses into the soil on one side and pulls up on the other side. If the soil doesn't have enough bearing pressure resistance, the column/footing combination may rotate excessively and the structure will fall over. Also, if the column or bent cap doesn't have enough concrete and rebar strength to resist the shear and bending moment demands, they will fail due to excessive demands. As with older bridges, the ties in columns and caps are not spaced tightly enough or hooked properly to comply with ductility demands properly.

To summarize, demands on and capacities of critical structural components evaluated, discussed in detail in the upcoming sections of this report, were:

1. The transverse and longitudinal displacement capacities of the bridge columns
2. Shear in columns
3. Shear and bending moment in bent caps
4. Bearing and structural capacities of footings

Longitudinal Column Displacement Capacities - Columns were modeled longitudinally as fixed at the footing and free the top to the bent cap. The plastic hinges in the columns developed at the bases of the columns in the longitudinal direction, and at the bases and tops in the transverse direction. The columns are relatively small in cross sectional area and developed yield displacement capacities of 1.82 inches and higher. When added to the column plastic displacements, total displacement capacity values, Δ_C, of over 3.56 inches were achieved for the columns, as shown in the table below.

For columns 3A and 3B, the D/C ratios are above 1.0 (see Table 1 below), one reason being that the ties in the columns are not per today's standards. The spacing of the ties is relatively large, and they do not terminate with 135-degree seismic hooks. Therefore, they don't meet the confinement requirements set forth in today's code, and are not useful as confining reinforcement for the column cores. This holds true for the columns in the transverse direction as well (Table 2).

Table 1 – Longitudinal Column Displacement Demand to Capacity Ratios

Bent No. & Column	Displacement Capacity, Δ_C, in.	Deal Load (DL) Displacement, in.	Seismic Cases 3 & Case 4 Displacement Envelope, in.	Total Demand, (DL+Seismic), Δ_D, in.	Demand to Capacity, D/C, Ratio	Status
2A	3.491	0.012	2.832	2.844	0.81	<1.0 OK
2B	3.480	0.019	2.758	2.777	0.79	<1.0 OK
3A	3.560	0.005	4.299	4.304	1.21	>1.0 NG
3B	3.549	0.002	4.011	4.013	1.13	>1.0 NG
4A	3.612	0.038	2.271	2.309	0.63	<1.0 OK
4B	3.585	0.006	2.108	2.114	0.59	<1.0 OK

Transverse Column Displacement Capacities - Transverse columns were modeled as fixed at the bottom and top and plastic hinges in the columns developed mainly at the top of the columns. The columns along bents 2, 3 and 4 were checked and all were found to have D/C ratios over 1.0 except for column 2A (see Table 2 below).

Table 2 – Transverse Column Displacement Demand to Capacity Ratios

Bent No. & Column	Displacement Capacity, Δ_C, in.	Deal Load (DL) Displacement, in.	Seismic Cases 3 & Case 4 Displacement Envelope, in.	Total Demand, (DL+Seismic), Δ_D, in.	Demand to Capacity, D/C, Ratio	Status
2A	3.501	0.021	3.399	3.42	0.97	<1.0 OK
2B	3.491	0.031	3.566	3.597	1.02	>1.0 NG
3A	3.558	0.009	6.135	6.144	1.73	>1.0 NG
3B	3.549	0.007	5.929	5.936	1.67	>1.0 NG
4A	3.569	0.053	4.696	4.749	1.32	>1.0 NG
4B	3.549	0.004	3.889	3.893	1.10	>1.0 NG

Column Shear - Shear capacities of the columns were calculated with the influence of the member Ductility Demand ratio μ_d, and the column axial load accounted for. Concrete shear capacities were arrived at using the formulas of Section 3.6.1 of the SDC. Because the columns were not very large, and due to the reinforcement spacing, detail and yield strength, column shear capacities are low. In columns 3A and 3B, the concrete and shear steel capacities were less than the shear demands.

Table 3 – Column Shear Demand to Capacity Ratios

Bent No. & Column	Total Seismic + DL Longitudinal Shear, kips	Total Seismic + DL Transverse Shear, kips	Concrete & Steel Tie Capacity, kips	Demand to Capacity, D/C, Ratio	Status
2A	52.68	52.04	95.63	0.54	<1.0 OK
2B	53.01	53.01	93.46	0.57	<1.0 OK
3A	50.37	50.03	39.70	1.26	>1.0 NG
3B	50.72	50.72	44.95	1.13	>1.0 NG
4A	48.66	49.70	67.77	0.73	<1.0 NG
4B	49.35	50.72	84.93	0.60	<1.0 OK

Bent Cap Shears and Moments - The total shears and moments due to seismic and dead loads were obtained for all critical areas of the bent caps, namely at the junction of the columns and bent caps. The seismic shear is caused by the plastic column moments (M_p) cranked into the cap. A value of 2 x $(f_c')^{1/2}$ was used for concrete shear capacity of the cap. With the existing girder stirrups, shear reinforcement for seismic loads turns out to be adequate but the caps all failed on flexure (bending) by a factor of 3.

Footing Capacities - This structure doesn't have piles under the footings and the moments taken by the footings are relatively large. The footings are relatively small and only 6' x 6' in area. The eccentricities produced by the moments are less than one-third the footing widths. However, the bearing pressures resisted by the footings will exceed the allowable capacity of 6,500 psf. As a result, there isn't enough resistance in the footings to prevent the bridge from bearing pressure failure. Additionally, the footings are expected to be thin and lack a top mat of reinforcement, both typical design methods dating back to the time of construction, leading to the breakup of the footings even before they reach bearing failure. In conclusion, the structure will fail seismically due to inadequate footing sizes and reinforcement.

Table 4 - Footing Capacities

Bent No. & Footing	Total DL+Seismic Load at Bottom of Column, kips	Maximum Overturning Moment, ft-kips	Eccentricity of demand loads, feet	Eccentricity > Footing Width / 3?	Bearing Pressure on Footing, psf	Allowable Footing Bearing Pressure, psf	D/C Ratio
2A	329.4	500.5	1.52	No	23,053	6500	>1.0 NG
2B	333.1	503.57	1.51	No	23,241	6500	>1.0 NG
3A	295.4	478.52	1.62	No	21,498	6500	>1.0 NG
3B	298.8	481.81	1.61	No	21,684	6500	>1.0 NG
4A	285.2	472.11	1.66	No	21,036	6500	>1.0 NG
4B	300.7	481.81	1.60	No	21,736	6500	>1.0 NG

Appendix A – Bridge Retrofit, Widening and Replacement Cost Estimates and Construction Schedules

Calculation of lifecycle costs – It is anticipated the existing bridge will last another 30 to 40 years after retrofitting. For the purpose of economic analysis 40 years has been used for the remaining life of the bridge. This means that after 40 years the retrofitted bridge will need to be replaced. By the same token, if the bridge is widened, the current portion of the bridge will also need to be replaced after 40 years and the current widening will need to be widened after the removal of the current bridge. A new concrete bridge, when designed and constructed to today's standards will easily last twice that long and, therefore, an 80-year life had been assumed for a new bridge. In reality, a new bridge constructed today may last 100 years without trouble.

To calculate the lifecycle costs Caltrans construction cost index is used. If the cost index for year 2007 was 100, the data shows the Index for 1972 was 11.3 and for 2012 it was 79.2. Therefore, for the 40 years between 1972 and 2012 the prices increased by the ratio of 79.2/11.3, or 7-fold. This translates to an average annual cost escalation of roughly 5% per year.

The cost of bridge maintenance is traditionally assumed to be between 1% to 1 ½% of the cost of a new bridge. Given the existing bridge will be already over 87 years old by the time it is retrofitted, a value of 1 ½% should be justifiable, subject to construction cost escalation after the first year of consideration. In 2012 the cost of a reinforced concrete T-girder bridge, the existing bridge type, was approximately $218 per square foot (SQFT), resulting in a maintenance cost of roughly $3.27 / SQFT per year. Using $3/SQFT, The bridge deck area is 3,831 SQFT, making the first year maintenance cost $11,493 and the 40th year cost more than 7 times that amount, or $80,911 according to 5% construction cost index. The total of the expenditures for the 40 years will be $1,457,760 in future worth. The average U.S. inflation rate for the same 40-year period has been approximately 4.47%, which is, curiously, pretty close to the construction index. The present worth cost of the annual maintenance expenditures for this average inflation rate will, therefore, come to $487,757. This number was rounded to $488,000 for 40 years of bridge maintenance in the analysis.

After 40 years the retrofitted bridge would be replaced with a similar bridge used in the replacement analysis. The replacement bridge is estimated to cost $2,653,365 if constructed today. This bridge will then cost $18,679,660 according to 5% annual construction cost escalation, the present worth value of which for inflation rate of 4.47% would be $2,975,100. Since these numbers will be compared with an 80-year life for new bridge, half of this amount will be used as capital investment for a replacement bridge after 40 years, or $1,487,500 to provide the same functionality.

For widening the bridge are increases to 5,984 SQFT, 3,831 SQFT of which will be maintained at $3 / SQFT and the rest at $2.18 / SQFT since this portion would be a new T-beam bridge. The first year's maintenance cost will be $16,186 and the total present worth maintenance expenditures $686,938, which was rounded to $687,000. The existing portion of the widening (28' width) will need to be replaced after 40 years since it will be over 125 years old by then. The proportionate cost of the 28' wide replacement after 40 years will be $1,487,500 x (28'/44') = $946,590 for capital investment.

For a new bridge the total deck area is 5,808 SQFT and at $3.00/SQFT the first year maintenance cost is $17,424, total accumulate expenses will be $2,210,056, and its present worth value will come to $739,466. This is conservative value. A rounded value of $739,500 was used for a new bridge's lifecycle cost.

Construction Cost Estimate for Creek Road Bridge Seismic Retrofit Alternate 1 Infill Walls and Enlarged Footings

Item	Quantity	Unit	Unit Price	Item Cost
Structure Concrete, Bridge	112	CY	$ 1,000.00	$ 112,000
Structure Concrete, Bridge Footing	196	CY	$ 350.00	$ 68,600
Bar Reinforcing Steel	64,000	LB	$ 2.00	$ 128,000
Drill & Bond Dowel	496	LF	$ 40.00	$ 19,840
Drill & Bond Dowel (Epoxy Cartridge)	60	EA	$ 80.00	$ 4,800
Miscellaneous Metal (Cable Restrainers)	1,200	LB	$ 10.00	$ 12,000
Structure Excavation	273	CY	$ 120.00	$ 32,760
Structure Excavation (Type D)	16	CY	$ 300.00	$ 4,800
Structure Backfill	66	CY	$ 200.00	$ 13,200
Joint Seal (Remove and Replace)	120	LF	$ 100.00	$ 12,000
Structural Concrete Approach Slab Type EQ (10)	25	CY	$ 1,200.00	$ 30,000
Rock Slope Protection (1/4 Ton, Method B)	1,010	CY	$ 150.00	$ 151,500
Water Diversion	1	LS	$ 30,000.00	$ 30,000
Traffic Control	1	LS	$ 63,000.00	$ 63,000
Vegetation Restoration	1	LS	$ 15,000.00	$ 15,000
Repair Spalls	1	LS	$ 15,000.00	$ 15,000
Grind and Remove Bridge Deck AC	3,831	SF	$ 5.00	$ 19,155
Furnish Bridge Deck Treatment Material	50	Gal	$ 100.00	$ 5,000
Treat Bridge Deck	3,831	SF	$ 5.00	$ 19,155
Subtotal 1				$ 755,810
Mobilization				$ 83,979
subtotal 2				$ 839,789
Contingency 25%				$ 209,947
Total Retrofit Option No 1				**$ 1,049,736**
Construction Management (15%)				$ 157,460
Lifecycle Cost: Maintenance for 40 years	1	LS	$ 488,000.00	$ 488,000
Capital Cost: 50% of Cost of Replacement after 40 years	1	LS	$1,487,500.00	$ 1,487,500

Grand Total with Lifecycle Costs and Construction Management: $ 3,182,697

Say: $3.18 million

Construction Schedule for Creek Road Bridge Seismic Retrofit Alternate 1 - Infill Walls and Enlarged Footings

Activity No.	Creek Road Bridge Seismic Retrofit Option 1	No. of Weeks in Construction																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Clear & Grubbing, Install CAS																								
2	Submit Review & approve Submittals																								
3	Water Diversion																								
4	Structure Excavation																								
5	Form, Rebar & Pour Footing Retrofit																								
6	Form, Rebar & Pour Infill Walls & Bent Cap Retrofit																								
7	Install Restraining System, Remove AC, Treat Br Deck																								
6	Remove Forms, Structure Backfill & Rock Slope Protection																								
7	Remove Water Diversion & Vegetation Restoration																								
8	Prepare punch list, conduct final walk through, Remove CAS																								

Note: Red cells indicate critical path.

Construction Cost Estimate for Creek Road Bridge Seismic Retrofit Alternate 2

Infill Walls and Waffle Slabs

Item	Quantity	Unit	Unit Price	Item Cost
Structure Concrete, Bridge	224	CY	$ 1,000.00	$ 224,000
Bar Reinforcing Steel	40,500	LB	$ 2.00	$ 81,000
Drill & Bond Dowel	396	LF	$ 40.00	$ 15,840
Drill & Bond Dowel (Epoxy Cartridge)	60	EA	$ 80.00	$ 4,800
Miscellaneous Metal (Cable Restrainers)	1,200	LB	$ 10.00	$ 12,000
16" CIDH Piling (from waffle slabs)	900	LF	$ 80.00	$ 72,000
Structure Excavation	126	CY	$ 120.00	$ 15,120
Structure Excavation (Type D)	16	CY	$ 300.00	$ 4,800
Structure Backfill	25	CY	$ 200.00	$ 5,000
Joint Seal (Remove and Replace)	120	LF	$ 100.00	$ 12,000
Rock Slope Protection (1/4 Ton, Method B)	1,010	CY	$ 150.00	$ 151,500
Water Diversion	1	LS	$ 30,000.00	$ 30,000
Traffic Control	1	LS	$ 60,000.00	$ 60,000
Vegetation Restoration	1	LS	$ 15,000.00	$ 15,000
Repair Spalls	1	LS	$ 15,000.00	$ 15,000
Grind and Remove Bridge Deck AC	3,831	SF	$ 5.00	$ 19,155
Furnish Bridge Treatment Material	50	Gal	$ 100.00	$ 5,000
Treat Bridge Deck	3,831	SF	$ 5.00	$ 19,155
Subtotal 1				$ 761,370
Mobilization				$ 84,597
subtotal 2				$ 845,967
Contingency 25%				$ 211,492
Total Retrofit Option No 2				**$ 1,057,458**
Construction Management (15%)				$ 158,619
Lifecycle Cost: Maintenance for 40 years	1	LS	$ 488,000.00	$ 488,000
Capital Cost: 50% of Cost of Replacement after 40 years	1	LS	$ 1,487,500.00	$ 1,487,500

Grand Total with Lifecycle Costs and Construction Management: $ 3,191,577

Say $3.19 million

Construction Schedule for Creek Road Bridge Seismic Retrofit Alternate 2 – Infill Walls and Waffle Slabs

Activity No.	**Creek Road Bridge Seismic Retrofit Option 2**	No. of Weeks in Construction																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	Clear & Grubbing, Install CAS																						
2	Submit Review & approve Submittals																						
3	Water Diversion																						
4	Structure Excavation																						
5	Form, Rebar & Pour Waffle Slab																						
6	Form, Rebar & Pour Infill Walls & Bent Cap Retrofit																						
7	Install Restraining System, Remove AC, Treat Br Deck																						
6	Remove Forms, Structure Backfill & Rock Slope Protection																						
7	Remove Water Diversion & Vegetation Restoration																						
8	Prepare punch list, conduct final walk through, Remove CAS																						

Note: Red cells indicate critical path.

Construction Cost Estimate for Creek Road Bridge Seismic Retrofit Alternate 3
Infill Walls and 60" CIDH Piling at Abutments

Item	Quantity	Unit	Unit Price	Item Cost
Structure Concrete, Bridge	83	CY	$ 1,100.00	$ 91,300
Bar Reinforcing Steel	17,000	LB	$ 3.00	$ 51,000
Drill & Bond Dowel	364	LF	$ 40.00	$ 14,560
Drill & Bond Dowel (Epoxy Cartridge)	60	EA	$ 80.00	$ 4,800
Miscellaneous Metal (Cable Restrainers)	1,200	LB	$ 10.00	$ 12,000
60" CIDH Piling	281	LF	$ 900.00	$ 252,900
Structure Excavation	19	CY	$ 120.00	$ 2,280
Structure Excavation (Type D)	16	CY	$ 300.00	$ 4,800
Structure Backfill	3	CY	$ 200.00	$ 600
Joint Seal (Remove and Replace)	120	LF	$ 100.00	$ 12,000
Rock Slope Protection (1/4 Ton, Method B)	1,010	CY	$ 150.00	$ 151,500
Water Diversion	1	LS	$ 30,000.00	$ 30,000
Traffic Control	1	LS	$ 55,000.00	$ 55,000
Vegetation Restoration	1	LS	$ 15,000.00	$ 15,000
Repair Spalls	1	LS	$ 15,000.00	$ 15,000
Grind and Remove Bridge Deck AC	3,831	SF	$ 5.00	$ 19,155
Furnish Bridge Treatment Material	50	Gal	$ 100.00	$ 5,000
Treat Bridge Deck	3,831	SF	$ 5.00	$ 19,155
Subtotal 1				$ 756,050
Mobilization				$ 84,006
subtotal 2				$ 840,056
Contingency 25%				$ 210,014
Total Retrofit Alternate No 3				**$ 1,050,069**
Construction Management (15%)				$ 157,510
Lifecycle Cost: Maintenance for 40 years	1	LS	$ 488,000.00	$ 488,000
Capital Cost: 50% of Cost of Replacement for years 40-80	1	LS	$ 1,487,500	$ 1,487,500

Grand Total with Lifecycle Costs and Construction Management: $ 3,183,080

Say: $3.18 million

Construction Schedule for Creek Road Bridge Seismic Retrofit Alternate No. 3 - Infill Walls and 60" CIDH Piling at Abutments

Activity No.	**Creek Road Bridge Seismic Retrofit Option 3**	No. of Weeks in Construction																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Clear & Grubbing, Install CAS																				
2	Submit Review & approve Submittals																				
3	Water Diversion																				
4	Structure Excavation																				
5	Form, Rebar & Pour CIDH																				
6	Form, Rebar & Pour Infill Walls & Bent Cap Retrofit																				
7	Install Restraining System, Remove AC, Treat Br Deck																				
6	Remove Forms, Structure Backfill & Rock Slope Protection																				
7	Remove Water Diversion & Vegetation Restoration																				
8	Prepare punch list, conduct final walk through, Remove CAS																				

Note: Red cells indicate critical path.

Construction Cost Estimate for Creek Road Bridge Seismic Retrofit Alternate 4

Widen with a 4-span Concrete Double T-Beam Bridge

Item	Quantity	Unit	Unit Price	Item Cost
Structure Concrete, Bridge	153	CY	$ 750.00	$ 114,750
Structure Concrete, Bridge Approach Slab	32	CY	$ 1,000.00	$ 32,000
Bar Reinforcing Steel	131,245	LB	$ 2.00	$ 262,491
Drill & Bond Dowel (Epoxy Cartridge)	60	EA	$ 80.00	$ 4,800
Furnish R/C Concrete Double T-Beam Girders (34')	8	EA	$ 10,000.00	$ 80,000
Erect R/C Concrete Double T-Beam Girders (34')	8	EA	$ 2,000.00	$ 16,000
60" CIDH Piling	280	LF	$ 900.00	$ 252,000
48" CIDH Piling	360	LF	$ 800.00	$ 288,000
24" CIDH Piling	480	LF	$ 280.00	$ 134,400
Structure Excavation	47	CY	$ 150.00	$ 7,117
Structure Backfill	19	CY	$ 200.00	$ 3,875
Joint Seal (Type B)	107	LF	$ 60.00	$ 6,420
Joint Seal (Remove and Replace)	120	LF	$ 100.00	$ 12,000
Rock Slope Protection (1/4 Ton, Method B)	800	CY	$ 150.00	$ 120,000
Water Diversion	1	LS	$ 30,000.00	$ 30,000
Traffic Control	1	LS	$ 55,000.00	$ 55,000
Approach Roadway	1	LS	$ 15,000.00	$ 15,000
Vegetation Restoration	1	LS	$ 15,000.00	$ 15,000
Repair Spalls	1	LS	$ 15,000.00	$ 15,000
Grind and Remove Bridge Deck AC	3,831	SF	$ 5.00	$ 19,155
Furnish Polyester Concrete	380	CF	$ 100.00	$ 38,000
Place Polyester Concrete Overlay	3,831	SF	$ 10.00	$ 38,310
Concrete Barrier (Type 26)	348	LF	$ 100.00	$ 34,800
Tubular hand railing	348	LF	$ 60.00	$ 20,880
Subtotal 1				$ 1,614,998
Mobilization				$ 179,444
subtotal 2				$ 1,794,442
Contingency 25%				$ 448,610
Total Retrofit Alternate No 4				**$ 2,243,052**
Construction Management (15%)				$ 336,458
Lifecycle Cost: Maintenance for 40 years	1	LS	$ 687,000.00	$ 687,000.00
Capital Cost: 50% of Cost of Replacement of existing half after 40 years	1	LS	$ 946,000.00	$ 946,000.00

Grand Total with Lifecycle Costs and Construction Management: $ 4,213,110

Say $4.21 million

Construction Schedule for Creek Road Bridge Seismic Retrofit Alternate 4 - Widen with a 4-span Concrete Double T-Beam Bridge

Activity No.	**Creek Road Bridge - Widening & Retrofit Existing Br (Alt 4)**	No. of Weeks in Construction																		
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38
1	Clear & Grubbing, Install CAS																			
2	Submit Review & approve Submittals																			
3	Water Diversion																			
4	Bridge Removal																			
5	Structure Excavation																			
6	CIDH Piling & Footing Construction																			
7	Erect F/W & Sub-Structure Construction																			
8	Erect Precast T Beams																			
9	Super Structure Construction																			
10	Remove F/W, Structure Backfill & Rock Slope Protection																			
11	Construct Structure Approach Slab & Relocate Utilities																			
12	Approach Road Work, Joint Seal & Concrete Barrier Construction																			
13	Remove Water Diversion & Vegetation Restoration																			
14	Prepare punch list, conduct final walk through, Remove CAS																			

Note: Red cells indicate critical path.

Construction Cost Estimate for Creek Road Bridge Seismic Retrofit

Bridge Replacement Option with a 2-Span Concrete Box Girder Bridge

Item	Quantity	Unit	Unit Price	Item Cost
Structure Concrete, Bridge	562	CY	$ 700.00	$ 393,400
Structure Concrete, Bridge Footing	108	CY	$ 450.00	$ 48,470
Bar Reinforcing Steel	185,040	LB	$ 2.00	$ 370,080
24" CIDH Piling	1,000	LF	$ 280.00	$ 280,000
48" CIDH Piling	133	LF	$ 800.00	$ 106,400
Structure Excavation	921	CY	$ 75.00	$ 69,056
Structure Backfill	538	CY	$ 150.00	$ 80,636
Joint Seal (MR=1")	120	LF	$ 100.00	$ 12,000
Structural Concrete Approach Slab Type EQ (10)	72	CY	$ 600.00	$ 43,200
Concrete Barrier (Type 26)	348	LF	$ 100.00	$ 34,800
Tubular hand railing	348	LF	$ 60.00	$ 20,880
Rock Slope Protection (1/4 Ton, Method B)	1,010	CY	$ 150.00	$ 151,500
Water Diversion	1	LS	$ 30,000.00	$ 30,000
Bridge Removal	1	LS	$ 100,000.00	$ 100,000
Utility Relocation	1	LS	$ 50,000.00	$ 50,000
Traffic Control	1	LS	$ 80,000.00	$ 80,000
Approach Roadway	1	LS	$ 25,000.00	$ 25,000
Vegetation Restoration	1	LS	$ 15,000.00	$ 15,000
Subtotal 1				$ 1,910,423
Mobilization				$ 212,269
subtotal 2				$ 2,122,692
Contingency 25%				$ 530,673
Bridge Replacement Total				**$ 2,653,365**
Construction Management (15%)				$ 398,005
Lifecycle Cost for years 40 to 80	1	LS	$ 739,500.00	$ 739,500

Grand Total with Lifecycle Costs and Construction Management: $ 3,790,869

Say $3.79 million

Construction Schedule for Creek Road Bridge Seismic Retrofit - Replacement a 2-Span Concrete Box Girder Bridge

Activity No.	**Creek Road Bridge - Replace in place of Seismic Retrofit**	No. of Weeks in Construction																									
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52
1	Clear & Grubbing, Install CAS																										
2	Submit Review & approve Submittals																										
3	Water Diversion																										
4	Bridge Removal																										
5	Structure Excavation																										
6	CIDH Piling & Footing Construction																										
7	Sub-Structure Construction																										
6	Erect F/W																										
8	Super Structure Construction (Stem & soffit)																										
9	Super Structure Construction (Deck Pour)																										
10	Remove Falsework, Structure Backfill & Rock Slope Protection																										
11	Construct Structure Approach Slab & Relocate Utilities																										
12	Approach Road Work, Joint Seal & Concrete Barrier Construction																										
13	Remove Water Diversion & Vegetation Restoration																										
14	Prepare punch list, conduct final walk through, Remove CAS																										

Note: Red cells indicate critical path.

Appendix B – Sample Bridge Photographs

Figure 1- Northwest entrance to the bridge

Figure 2 – Close proximity of private parcels to the bridge

Figure 3 –Abutment washout of New Year's Eve 2005

Figure 4 –Bridge closure after flooding of December 2005

Figure 5 –Abutment fortifications after repairs

Figure 6 – A Plaque on the bridge

Figure 7- Utility pipe on the bridge

Figure 8 – Exposed rebar due to insufficient concrete cover

Figure 9 – Exposed rebar on girder

Figure 10 –Retrofit infill wall will be between the columns

Figure 11 –Filled-in and offset expansion joint

Figure 12 – Offset expansion joint and substandard barrier

Appendix C – Caltrans 2010 Bridge Inspection Report (BIR)

California Department of Transportation
Division of Maintenance

Structure Maintenance and Investigations

BRIDGE

INSPECTION

RECORDS

INFORMATION

SYSTEM

The requested documents have been generated by BIRIS.

These documents are the property of the California Department of Transportation and should be handled in accordance with Deputy Directive 55 and the State Administrative Manual.

Records for “Confidential” bridges may only be released outside the Department of Transportation upon execution of a confidentiality agreement.

Photo No. 1
Roadway looking east.

Photo No. 2
Elevation looking south.

Photo No. 3
Soffit spalls.

Photo No. 4
Soffit spalls.

Photo No. 5
Spalls in the reinforced concrete caps.

Photo No. 6
Incipient spalls in the reinforced concrete caps.

DEPARTMENT OF TRANSPORTATION
Structure Maintenance & Investigations

Bridge Number : 27C0144
Facility Carried: CREEK ROAD
Location : IN FAIRFAX
City : FAIRFAX
Inspection Date : 09/22/2010

Bridge Inspection Report

Inspection Type

Routine	FC	Underwater	Special	Other
X				

STRUCTURE NAME: SAN ANSELMO CREEK

CONSTRUCTION INFORMATION

Year Built : 1929
Year Widened: N/A
Length (m) : 41.5

Skew (degrees): 42
No. of Joints : 2
No. of Hinges : 0

Structure Description: A 4-span simple supported reinforced concrete T-beam(4) bridge supported on RC 2 column bents and RC abutments. There are no as-builts available but as the structure was constructed in 1929 it is believed that the structure is supported on spread footings.

Span Configuration : 33.1 ft, 2 @ 34.1 ft, 33.1 ft

LOAD CAPACITY AND RATINGS

Design Live Load: UNKNOWN
Inventory Rating: 14.9 metric tonnes — Calculation Method: FIELD EVAL/ENG JUDGMENT
Operating Rating: 24.9 metric tonnes — Calculation Method: FIELD EVAL/ENG JUDGMENT
Permit Rating : XXXXX
Posting Load : Type 3: Legal — Type 3S2: Legal — Type 3-3: Legal

DESCRIPTION ON STRUCTURE

Deck X-Section: 1.0 ft br, 3.0 ft sw, 20.0 ft, 3.0 ft sw, 1.0 ft br

Total Width: 8.7 m
Net Width: 6.2 m
No. of Lanes: 2
Rail Description: Concrete ballaster
Rail Code : 0000
Min. Vertical Clearance: Unimpaired

DESCRIPTION UNDER STRUCTURE

Channel Description: Cobbles

INSPECTION COMMENTARY

INSPECTION ACCESS

1. The water depth on this date was approximately 2 inches under Span 3. All portions of the substructure are accessible for inspection.
2. The depth of AC overlay on the bridge deck was 2 inches at the time of this inspection. The investigation of the top side of the concrete deck was inhibited by the AC overlay.

CONDITION OF STRUCTURE

DECK AND RAIL:

The deck AC overlay and rails were inspected and there are no cracks, spalls or signs of distress.

SUPERSTRUCTURE:

There are numerous spalls in the soffit of every bay. Exposed corroding rebar was observed at these locations. Typical exposure of rebar is 8" in length with areas exposed up to a length of 2'. These spalls are the result of insufficient concrete cover over the steel reinforcement. A work recommendation from 1999 is still outstanding for this condition. See photos 3 and 4.

INSPECTION COMMENTARY

SUBSTRUCTURE:
There are numerous spalls in the reinforced concrete caps. Exposed corroding rebar was observed at these locations. Typical exposure of rebar is between 4" to 6" in length. These spalls are the result of insufficient concrete cover over the steel reinforcement. A work recommendation from 1999 is still outstanding for this condition. See photos 5 and 6.

SAFE LOAD CAPACITY
No as-built plans are available for this structure/culvert. Load ratings are assigned based on the guidelines provided in the Section 5.8.3.2 of the Assigned Load Rating Procedures for Bridges and Culverts:

The estimate design live load is H10
The Inventory rating is 14.9 metric tonne (RF = 0.46)
The Operating rating is 24.8 metric tonne (RF = 0.77)
Permit rating is XXXXX

Since this bridge has been carrying legal trucks without showing distress, it is assumed that the bridge has adequate capacity to carry the largest demand from the legal trucks and bridge capacity is assinged to be equal to the largest demand from the legal truck.

ELEMENT INSPECTION RATINGS

Elem No.	Element Description	Env	Total Qty	Units	Qty in each Condition State St. 1	St. 2	St. 3	St. 4	St. 5
13	Concrete Deck - Unprotected w/ AC Overlay	2	360	sq.m.	360	0	0	0	0
110	Reinforced Conc Open Girder/Beam	2	166	m.	166	0	0	0	
205	Reinforced Conc Column or Pile Extension	2	6	ea.	6	0	0	0	
215	Reinforced Conc Abutment	2	23	m.	23	0	0	0	0
234	Reinforced Conc Cap	2	35	m.	0	30	5	0	0
256	Slope Protection	2	1	ea.	1	0	0	0	0
300	Strip Seal Expansion Joint	2	27	m.	27	0	0	0	0
331	Reinforced Conc Bridge Railing	2	107	m.	107	0	0	0	0

WORK RECOMMENDATIONS

RecDate: 08/10/1999
Action : Sub-Patch spalls
Work By: LOCAL AGENCY
Status : PROPOSED

EstCost:
StrTarget: 2 YEARS
DistTarget:
EA:

Patch spalls along the reinforced concrete cap @ the exterior shear keys at Bents 2 and 3.
Clean exposed bar reinforcing on the underside of the bridge deck and on the reinforced concrete caps at Bents 2, 3, and 4 and paint exposed rebar with epoxy paint.

Inspected By : AN.Dang/AR.Nojoumi

Andy N. Dang (Registered Civil Engineer)

PROFESSIONAL ENGINEER
REGISTERED
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No. 63640
09/30/2012
CIVIL
STATE OF CALIFORNIA

STRUCTURE INVENTORY AND APPRAISAL REPORT

**************** IDENTIFICATION ***************

(1) STATE NAME- CALIFORNIA 069
(8) STRUCTURE NUMBER **27C0144**
(5) INVENTORY ROUTE(ON/UNDER)- ON 150000000
(2) HIGHWAY AGENCY DISTRICT 04
(3) COUNTY CODE 041 (4) PLACE CODE 23168
(6) FEATURE INTERSECTED- SAN ANSELMO CREEK
(7) FACILITY CARRIED- CREEK ROAD
(9) LOCATION- IN FAIRFAX
(11) MILEPOINT/KILOMETERPOINT 0
(12) BASE HIGHWAY NETWORK- NOT ON NET 0
(13) LRS INVENTORY ROUTE & SUBROUTE
(16) LATITUDE 37 DEG 58 MIN 59.82 SEC
(17) LONGITUDE 122 DEG 35 MIN 27.21 SEC
(98) BORDER BRIDGE STATE CODE % SHARE %
(99) BORDER BRIDGE STRUCTURE NUMBER

******** STRUCTURE TYPE AND MATERIAL ********

(43) STRUCTURE TYPE MAIN:MATERIAL- CONCRETE
TYPE- TEE BEAM CODE 104
(44) STRUCTURE TYPE APPR:MATERIAL- OTHER/NA
TYPE- OTHER/NA CODE 000
(45) NUMBER OF SPANS IN MAIN UNIT 4
(46) NUMBER OF APPROACH SPANS 0
(107) DECK STRUCTURE TYPE- CIP CONCRETE CODE 1
(108) WEARING SURFACE / PROTECTIVE SYSTEM:
A) TYPE OF WEARING SURFACE- BITUMINOUS CODE 6
B) TYPE OF MEMBRANE- NONE CODE 0
C) TYPE OF DECK PROTECTION- NONE CODE 0

*************** AGE AND SERVICE ***************

(27) YEAR BUILT 1929
(106) YEAR RECONSTRUCTED 0000
(42) TYPE OF SERVICE: ON- HIGHWAY-PEDESTRIAN 5
UNDER- WATERWAY 5
(28) LANES:ON STRUCTURE 02 UNDER STRUCTURE 00
(29) AVERAGE DAILY TRAFFIC 255
(30) YEAR OF ADT 1981 (109) TRUCK ADT 2 %
(19) BYPASS, DETOUR LENGTH 2 KM

*************** GEOMETRIC DATA ****************

(48) LENGTH OF MAXIMUM SPAN 10.4 M
(49) STRUCTURE LENGTH 41.5 M
(50) CURB OR SIDEWALK: LEFT 0.9 M RIGHT 0.9 M
(51) BRIDGE ROADWAY WIDTH CURB TO CURB 6.2 M
(52) DECK WIDTH OUT TO OUT 8.7 M
(32) APPROACH ROADWAY WIDTH (W/SHOULDERS) 6.1 M
(33) BRIDGE MEDIAN- NO MEDIAN 0
(34) SKEW 42 DEG (35) STRUCTURE FLARED NO
(10) INVENTORY ROUTE MIN VERT CLEAR 99.99 M
(47) INVENTORY ROUTE TOTAL HORIZ CLEAR 6.2 M
(53) MIN VERT CLEAR OVER BRIDGE RDWY 99.99 M
(54) MIN VERT UNDERCLEAR REF- NOT H/RR 0.00 M
(55) MIN LAT UNDERCLEAR RT REF- NOT H/RR 0.0 M
(56) MIN LAT UNDERCLEAR LT 0.0 M

*************** NAVIGATION DATA ***************

(38) NAVIGATION CONTROL- NO CONTROL CODE 0
(111) PIER PROTECTION- CODE
(39) NAVIGATION VERTICAL CLEARANCE 0.0 M
(116) VERT-LIFT BRIDGE NAV MIN VERT CLEAR M
(40) NAVIGATION HORIZONTAL CLEARANCE 0.0 M

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SUFFICIENCY RATING = 54.1
STATUS
HEALTH INDEX 93.1
PAINT CONDITION INDEX = N/A

************* CLASSIFICATION ************* CODE

(112) NBIS BRIDGE LENGTH- YES Y
(104) HIGHWAY SYSTEM- NOT ON NHS 0
(26) FUNCTIONAL CLASS- LOCAL URBAN 19
(100) DEFENSE HIGHWAY- NOT STRAHNET 0
(101) PARALLEL STRUCTURE- NONE EXISTS N
(102) DIRECTION OF TRAFFIC- 2 WAY 2
(103) TEMPORARY STRUCTURE-
(105) FED.LANDS HWY- NOT APPLICABLE 0
(110) DESIGNATED NATIONAL NETWORK - NOT ON NET 0
(20) TOLL- ON FREE ROAD 3
(21) MAINTAIN- CITY OR MUNICIPAL HIGHWAY AGENCY 04
(22) OWNER- CITY OR MUNICIPAL HIGHWAY AGENCY 04
(37) HISTORICAL SIGNIFICANCE- NOT ELIGIBLE 5

**************** CONDITION **************** CODE

(58) DECK 7
(59) SUPERSTRUCTURE 7
(60) SUBSTRUCTURE 6
(61) CHANNEL & CHANNEL PROTECTION 6
(62) CULVERTS N

********* LOAD RATING AND POSTING ********* CODE

(31) DESIGN LOAD- UNKNOWN 0
(63) OPERATING RATING METHOD- FIELD EVAL/ENG JUDG 0
(64) OPERATING RATING- 24.9
(65) INVENTORY RATING METHOD- FIELD EVAL/ENG JUD 0
(66) INVENTORY RATING- 14.9
(70) BRIDGE POSTING- EQUAL TO OR ABOVE LEGAL LOADS 5
(41) STRUCTURE OPEN, POSTED OR CLOSED- A
DESCRIPTION- OPEN, NO RESTRICTION

**************** APPRAISAL **************** CODE

(67) STRUCTURAL EVALUATION 4
(68) DECK GEOMETRY 4
(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL N
(71) WATER ADEQUACY 7
(72) APPROACH ROADWAY ALIGNMENT 6
(36) TRAFFIC SAFETY FEATURES 0000
(113) SCOUR CRITICAL BRIDGES U

********** PROPOSED IMPROVEMENTS **********

(75) TYPE OF WORK- CODE
(76) LENGTH OF STRUCTURE IMPROVEMENT M
(94) BRIDGE IMPROVEMENT COST
(95) ROADWAY IMPROVEMENT COST
(96) TOTAL PROJECT COST
(97) YEAR OF IMPROVEMENT COST ESTIMATE
(114) FUTURE ADT 313
(115) YEAR OF FUTURE ADT 2028

*************** INSPECTIONS ***************

(90) INSPECTION DATE 09/10 (91) FREQUENCY 24 MO
(92) CRITICAL FEATURE INSPECTION: (93) CFI DATE
A) FRACTURE CRIT DETAIL- NO MO A)
B) UNDERWATER INSP- NO MO B)
C) OTHER SPECIAL INSP- NO MO C)