Chapter nine

Railroad Car and other types of short span bridges for stream simulation at road crossings

Filename: C:\fishpassdesign\chapter 9 bridges\chapter nine -latest revision\chapter nine-Jan 03l- short span bridges.wpd

Table of Contents

Railroad Car and other short span bridges an alternative for stream simulation

"A bridge is a stream crossing structure that spans the stream and is placed on abutments and/or piers located in or near the stream. Bridges in terms of natural resource protection should always be the preferred alternative because they allow for a natural flow of sediments and change stream habitat the least. However, when economic considerations and logistics of the particular site are taken into account there are often better economic alternatives than a bridge. "[1]

As noted above bridges are the preferred and often the most expensive stream crossing. Their advantage over other alternatives is they can span the stream without inhibiting streamflow and aquatic movements. A bridge is accordingly considered the best option for stream simulation designs when designed and constructed with abutments that do not constrict the stream channel. In this author's opinion the use and availability of short span bridges will increase and overtime may replace the use of culverts at most stream crossings. Culverts in general are constructed with widths which do not span the bank full width of the channel and leave a constricted entrance for larger flows.

"The decision to use a bridge over a culvert can be driven by the basis of economics, engineering, site parameters, environmental, hydraulic and or debris requirements. Bridges are chosen where culverts are no longer capable of carrying the design flows or managing the expected debris hazards and where fish passage requirements cannot be met by culverts due to stream gradient or where sites contain significant habitat values such as spawning locations. Bridges are also less prone to beaver problems and are chosen over culverts in many areas where beavers are a significant concern."[2]

Objectives and Purpose

The objective of this chapter is to provide an overview of several types of short span bridges found on private lands or on forest highways in Southwestern Oregon with observations on their use.

A list of suppliers is included. Using that list a reader can request site specific information and current catalogs.

This chapter is not intended as a design guide or a code book for the design of bridges. State and other regulatory agency have these codes and guides already in place. Bridges are normally designed by a registered engineer in the state or province where the bridge will be constructed.

[1] Forest Road Fish Passage Guide- State of Oregon

[2] Forest Practices guidebook for British Columbia.

Economy of Scale

"Bridges become economical as stream size increases or in steep gradient streams where many of the culvert alternatives won't work."[3]

Loadings

Bridges are designed for specific loadings. The size of their girders, stringers, decks are dependent on their intended use. The first selection criterion for a bridge type is to determine the design loading for that bridge.

1.Private bridges: Must meet county loading requirements for fire access. Private land owners can select from all the available options in that they can limit the liability to themselves and those they allow to enter unto their properties.

2.Logging roads: Loading is often determined by the size and wheel configuration of the logging equipment which will be used. In general equipment on logging roads will be moved apart from the low boys and transport trucks that hauled them to the property. The result is often a higher concentrated load then would be required if the vehicle was on a lowboy with pups and jeeps. Bridges on logging roads have a mixed liability. The bridge is a private bridge to the land owner but contractors will use it for heavy loads that may or may not have been anticipated when the bridge was installed. The type of bridge chosen will be limited by state forest practice act requirements and the insurance requirements of contractors operating on the property.

3.Farm Bridges: These are often short span structures that carry lightweight trucks and farm equipment. These bridges are often required to be wider then logging or home access bridges. These bridges often are designed for very low design loadings.

4.County and Government Roads: Bridges on county and government roads must be designed in accordance with established codes. They also must be rateable and inspected at no less then a 2 year interval. The design loading for these bridges will be often less then for logging roads. Their design will require a strict compliance with codes.

Bridge Components: a brief glossary

Abutment; A substructure supporting the end of a single span or the extreme end of a multi-span superstructure.

Pier: A substructure built to support the ends of the spans of a multiple span superstructure at intermediate points between the abutments.

Superstructure: The entire portion of a bridge structure that primarily receives and supports highway ,pedestrian, or other traffic loads and transfers the applied loads to the bridge substructure.

Substructure: The abutments, piers, bents or their constructions built to support the superstructure

---

[3]Forest Road Fish Passage Guide Book- State of Oregon

and transmits loads to the foundation.

Stringer. A longitudinal beam supporting the bridge deck.

Span. When applied to the design of beam, girder truss, or arch superstructures, the distance center to center of the end bearing or the distance between the lines of action of the reactions.

Types of Bridge Superstructures

There are numerous superstructure options. A brief list of the most common would include the following.

1. Timber bridges- sawn timber, glued laminated, dowel laminated, and nail laminated .

2. Timber bridges- log stringer: Build by cabling together trees fallen in the construction area. May have a gravel or timber deck.

3. Railroad Cars- boxcars

4. Railroad cars- flatcars

5. Flatbed truck trailers

6. Steel I beam with timber decks

7. Steel I beams with concrete deck panels bolted perpendicular to the deck

8. Hinged Portable Bridge- Normally available from a local National Guard Unit for a temporary Crossing

9. Concrete Bridges: Prestressed girders typed by span length

10. Concrete Bridges: Concrete Slab- non prestressed.- precast panels which can be locally fabricated.

Types of Bridge Abutments

The bridge abutments are earth retaining structures that support the superstructure at both ends. Bridge abutments vary by size and shape. The appropriate selection is developed from a review of the soils, the type of superstructure, the geometry of the site, and economics. The following are common types seen on forest or private roads.

1. Pile Bents: Wooden or concrete posts setting on a spread footing.

2. Surface bearing spread footings: The most common footing for temporary bridges or portable bridges. These footings may set on a rock base, a retaining wall, on rock outcrops, and in some cases on soils.

3. Pile Abutments: Soft clay, soft soil foundations. Normally includes a concrete pile cap.

4. Sawn Lumber Frame bents. Normally see variations of this design on railroad crossings.

5. Pile Bent: Used when foundation is on soft clay or soft soils to transfer the loads to rock or firm material below.

6. Pedestal. A short column on an abutment or pier which directly supports the superstructure. Loads are transmitted by the pedestal to the footings below.

Bridge layout, Sizing and Alignment

1. Clearance for floating Debris:

Per Oregon Forest Practices Act a minimum of 3 feet of clearance is required between the estimated 50 year design flow elevation and the bottom of the superstructure. This 3 feet of clearance is needed to pass large woody debris that is floating downstream. A method for calculating flow capacity of a crossing is included in the Oregon Stream Restoration guide.

2. Low Water Bridge considerations (vented ford).

A. A low fill design must contain the following elements to be approve. The structure must be large enough to handle the 2 year event.

B. The flood plain must be at least 3 times the active channel width or 100 feet at the proposed road crossing.

C. An overflow depression must be constructed in the road fill at a location away from the structure and at an elevation lower ten than the top of the bridge.

D. The road surface must be armored with rock of sufficient size and depth to protect the fill when a flood flow occurs.

E. The bridge should be anchored and designed to resist the horizontal loads caused by water and debris against the sides of the structure.

3. Width of Stream opening under bridge:

Bridge should be designed with a minimum width of the active channel width of the stream the bridge is crossing. Using a program such as WinXPRO we can model the velocity and depth of flow through the bridge crossing for various widths. Select a width that does not constrict the stream or change the backwater characteristics of the area. On private lands the county will normally want a certificate showing of no rise .

4. Rock Slope Protection

In streams where degradation is possible the channel under the bridge should be protected from down cutting. This protection will prevent undermining of the bridge abutments as well as protection of upstream ecosystem. In addition riprap slope protection should be placed around the structure to the estimated height of the peak storm event. See commentary on riprap design in chapter two.

5. Guardrails, sidewalks and or curbs

On county ,state and federal collector roads guardrails are required at the approach and across bridges. An exception to this policy is on low use federal forest access roads. Guardrails are optional depending on the agency. Curbs are a design option and have more to do with drainage then protection of the rail system. The guard rail system on the bridge and approaches are designed to AASHTO bridge standards.

On private roads rails and curbs are optional. For the most part short curbs are added to the outside of the decks to guide traffic across the bridge and control surface drainage.

Spread Footing abutment options for railroad car, portable, or temporary bridges on private lands.

The abutment for temporary bridges will typically be designed to the same standards as abutments for any other type of superstructure. An important difference is these superstructure types can withstand a considerable degree of settlement with minimal or no structural damage.

Assuming the bridge site is not a public road and some settlement is acceptable, the following abutment options have been used.

1. Gabion Baskets filled with rock or rock and concrete

2. Precast Concrete blocks

3. Stone or Riprap Abutments

4. Reinforced Rock or aggregate .

5. Logs placed under the ends and notched to distribute the load.

6. Timbers and Planks for load distribution.

Gabion Basket Abutment

Gabions have been used as retaining walls for bridges and have been used as abutments to temporary bridges . I discussed installation options with two suppliers: Hilkiker Retaining Wall Company of Eureka and Maccaferri Gabions of West Coast Inc.

The gabions provide an abutment wall and disburse the loading of the bridge to the soil below. The following plan is proposed. Construct the gabions to grade as shown on the drawings. Place a 6 x 12 wood or concrete pad across the top of the baskets. The purpose of the beam is to provide a level support for the bridge and to distribute the load of the bridge equally across the Gabion baskets. An equally good alternative would be to concrete grout the rock in the baskets after they are assembled.

Gabion Baskets are supplied locally by Hilfiker Company of Eureka Oregon. The cost of two baskets 12' x 3' x 3' delivered to a work site near Coos Bay would be $250.00. Those baskets would require 8 Cubic Yards of Fractured Rock to fill. The cost of that rock is estimated at 8 x $25 =200.00. The total materials cost is $450.00. The baskets would still need to be filled and tied. The total installed cost would be around $1000.00 A logical improvement would be to fill the voids in the basket with concrete after they are filled though this would not be necessary.

1. Installation of Gabion abutments for a temporary bridge crossing.:

1. Excavate to depth indicated on drawings,

2. Install baskets level. Fill with rock to design grade. Optional pour concrete around the stones when their filled and level off to better set the bridge superstructure.

3. Install wooded beam   across top of baskets.

4. Set bridge on beams

Precast Abutment Beams

Abutment beams for bridges are available from commercial and non commercial sources. The following suppliers of Precast Concrete abutment beams for temporary bridges were found on the South Coast of Oregon.

1. Morse Brothers of Harrisburg Oregon

2. Hilfiker Retaining Wall Company, Eureka, California

3. Joe Buldac of Bandon, Oregon 541-347-2848

4. Rick Franklin Company, Lebanon ,Oregon   541-451-1275

These beams are not difficult to fabricate and can be constructed on site if necessary. The cost from the two suppliers above is minimal and contractors will often order the abutment beams rather then make them.

The beams are typically 2' wide , 2' thick and 11' long.   These blocks would be set directly from the delivery truck onto a rocked pad. A typical pad would be constructed by constructing a three foot wide x two foot deep rock base . Use   3" to 6" rock for this base. If base is on weak soils the design engineer may require stabilization fabric placed in layers in the base rock.. The concrete blocks would then be placed onto the rock pad. The estimated costs for the beams in place is summarized below.

Blocks 2 each at $500 = $1000.00

Rock 4 cubic yards x 25.00= $100.00

Installation = $200.00

The costs of the concrete beams is comparable with the gabion baskets noted above.   With the rock subbase they each will have the same bearing capacity . Settlement is not considered a problem   with either of the structures as long as we have a footprint of approximately 3 ‘ x 12 feet. Increasing that footprint will further reduce any concerns of settlement.

Rock or Riprap Abutments.

A common abutment on farm and forest roads is a riprap fill constructed at the edge of the stream or into the bank. The top of the rock works are filled with smaller stones and then gravel to provide a level base. The bridge is then set directly on the rock or on a concrete abutment beam placed on top of the rock.

The size of the stones are normally in the range of 2 -3 foot or larger with smaller stones placed between to fill the voids.   Typically the rock is classified as Class IV or Class V Riprap.   The rock is typically placed on a 1-1/2:1 fill slope or steeper.   In wet areas a geotextile is placed under the rock. As noted above soil conditions will dictate the type of rock base   or abutment appropriate for the site.

Log abutments

Log abutments have been used extensively for temporary crossings under railroad cars and other types of temporary bridges. . They are easily installed and easily replaced assuming there remains a viable supply of logs.   See photo below.   Depending on the availability of large diameter logs this may or may not be an economical alternatives. The life of a typical log abutment on the coast is 10 years depending on the type of wood use. In drier areas such as near Roseburg the logs are expected to last 2 or 3 times longer.

Railroad Car Bridge Superstructures: for portable or temporary bridges

Railroad Car Bridges- an overview

"A common **modular** bridge system is the railroad car bridge constructed from salvaged railroad cars. The frame acts as the bridge stringers and the steel or timber deck as the road surface. Bridges have been constructed from box, gondola, and flat cars which are approximately 9 foot wide and come in lengths up to 86+ feet."[4]

A. Railroad cars are manufactured by approximately 12 companies

B. Scrapping occurs when repair costs exceed the depreciated value of the car. Age and the condition of the running gear are the most often reasons that cars are scrapped.

C. Selection of a railroad car for a bridge should include a physical inspection of the car body. This condition survey should determine:

    A. Length and width of the car.

    B. Spacing of all members

    C. Location and condition of bent, twisted or cracked members

D. Yield Strength of the members can be determined by the Hardness Tess and stress -strain curves developed from samples. When purchasing a car the following tests are suggested by Professor Parsons of the University of Arkansas.

    A. Test the main members for cracks using a dye penetrate

    B. Support the car on timbers and drive over it with a D8 tractor

    C. Support the car on timbers , load it and measure deflections, then compare calculated deflections vs. actual stiffness.

E. Flatcar Frames are typically stronger then boxcar frames. Several suppliers offer only the flatcars to insure that a light weight car will not be used for commercial traffic.

F. When using two or more layers of timber decking, do not nail the top layer to the bottom layer. Lag screws and more effective connectors as traffic vibration tend to loosen nails.

G. "Foundations for railroad car bridges are not much different from foundations for any bridge structure. Railroad cars bridges however concentrate the loading in a single area under the main longitudinal beams.   A wide steel plate placed under the main beams is essential for the railroad car bridge."[5]

---

[4] Bridges Constructed From Railroad Cars, Thomas J. Parson, Arkansas State University Department of Engineering, Final Report TRC 8901, Dec l991.

[5] Railroad Car Bridges: Asset or Liability, Bruce Suprenant ,

H. “Two center I shaped beams carry the load to each end of the car. The moment resistance of the car is dependent on the size, shape, and strength of these two members. Two exterior members usually consisting of a single channel are connected by tapered members the main longitudinal I shaped beam . The load on the exterior channel is transferred to the main beams through the tapered members. Miscellaneous angles running in both directions stabilize the compression edge of exterior channels and interior beams.”[6]

I. Abutment Connections; Local contractors all indicate they do not attach the bridge to the abutment of spread footing type foundations. They will routinely cable the bridge to a tree as an anchor in case of high water. The recommended design is to bolt the bridge to the abutment on one end and install a sliding connections on the other. A connection detail is s available from the University of Arkansas. That detail is included in typical drawings included in Appendix B to this chapter. Abutment beams should set directly under the axles (circular plate) The cars are designed for the greatest strength with the loading on the axles . Shims will be needed between the side beams and the abutment as the axle plates are often lower then the side beams at this point. Local Suppliers of Railroad Car bridges

J. The following suppliers were located.

A. Rick Franklin Corporation , Lebanon, Oregon, 541-451-1275
541-258-5153 (home)

B. Schnitzer Steel Products, Portland, Oregon 800-888-5571 (6922)

C. Jim McKenzie, White City, Oregon 541- 831-1553

D. Oscar Marteney, 541- 998-6605, 541- 729-7993

E. Skip Gibbs Company, Redwood Valley, California, email: bridges@skipgibbs.com
Phone 707-485-5822

Discussions with Suppliers and Installers of Railroad Car Bridges

Schnitzer Steel

Schnitzer Steel will provide railroad cars for bridges installed with steel decks. If clients want the cars modified or trimmed they will trim the cars to the requested length. Their inventory fluctuates during the year. Clients should call to find out availability then visit their company to select a bridge and discuss any modifications needed.

Jim McKenzie

He gets his cars from H and S construction . At the time ,I called him they did not have any cars available.

Rick Franklin Corporation

---

[6]The Bridge, Michigan Technological University, Vol 3, No. 2 Winter 1989

Rick Franklin said he had several good bridges available at this time in addition to the concrete abutments noted in his brochure. He has a brochure that will be forwarded to prospective clients.

Available Bridges from Rick Franklin Corporation as of Feb 2002

53 foot	10'-6" width	$9000 each
56 foot	10'-6" width	
57 foot	10'-6 “ width	
60 foot		20 available,$10,000 each
62 foot	10'-6" width	1 available
89 foot	9'-6" width	12 available $15,000 with flat steel decks

Mr. Franklin made the following recommendations on the use of railroad cars. He also provided us a list of references who have purchased bridges from their company.

1. *Width of Deck:*

Their company does not recommend that decks be wider then 14 feet on a single car. Using a 14 foot wide deck will provide a running surface between rails of approximately 12'. If additional width is needed they recommend using two bridges. There is a high risk that traffic will wander to side of bridge and a wheel fall through deck..

2. *Concrete Abutment Beams:*

Their company sells a precast abutment beam for $500.00 each. The bridge can be set directly on this beam over a prepared foundation. The beams are 11' x 2' x 2'.

3. Types available: In their opinion Box cars have very low strengths. Accordingly, they only sell Flat Cars for use as bridges.

Skip Gibbs Company

The Skip Gibbs Company has a large inventory of bridges on hand which they purchased several years ago.   Their company is one of the leading suppliers of railroad cars for bridges in Northern n California. They have an impressive brochure which includes an extensive list of completed sites.

Skip Gibbs company will provide a quote for bridges installed to any site. Unloading and setting of the bridge is the responsibility of the client. They strongly advised not installing a 16 foot wide deck on a single railroad car bridges. The risks of an accident was too great in their opinion.

There company recommends a local engineer who will select a bridge for clients based on the clients foundation and layout requirements. That engineer will then load rate the bridge.

Oscar Marteney,

Oscar Marteney is a retired logger who had installed these bridges. Now he locates the cars and arranges for the delivery of the cars to purchasers. He has a good record of providing quality cars to purchasers at reasonable prices. The availability of cars varies from year to year. At the time of my conversation with him, he has only a few left. He said they extremely well made, heavy duty flat car bridges. He included several photos of the bridges. I have included those photos and his quote in the appendix. The bridges he is selling come from Kenwich Washington. He is asking $6000 for the 60 foot long flat car and $6500 for the 65 foot long flatcar. As he said they are very heavy bridges and may require several loaders or a crane to unload

Keith Comstock

Mr. Comstock is the lead engineer for Plumb Tree working out of their Coos Bay office. His companies installs 3 to 5 railroad car bridges a year on their tree farms. They installed 10 railroad car bridges one year.

1. Generally, their company will use a wooden deck system on the railroad car bridges. The diagonal beams are 8 x 8 pressure treated timbers placed 20" on center. The running planks are 4 x 12 pressure treated timbers which are placed three to each side. The outside to outside dimensions of their bridges are 14 feet. Bridge spikes are used to secure the 4 x12 s to the 8 x 8's.

2. They contract the installation of these bridges. Dave Palmer of Palmer Construction does the majority of their work..

3. They buy their cars from the suppliers noted above. Mr. Comstock noted that we should ask for heavy cars with a load rating of at least 140,000 lbs. In recent years they have purchased cars with ratings up to 180,000 lbs.

4. They normally set the cars on a riprap foundation with a leveling course to bring them to grade. He noted that each site was different. He suggested that I visit some of their installations on Camas Creek Road outside of Sitkum. They purchased their abutment beams from Joe Buldac of Bandon. (347-2848)

Concrete bridges

The leading supplier of concrete bridges in South Western Oregon is Morse Brothers. Their office is in Harrisburg. They engineer and provide precast or prestressed deck and abutment beams. They will provide a brochure describing their products and work with their clients to help select the beam system that best fits their site.

Concrete bridges can be used on short span crossings of any length. In general the cost of materials delivered is in the area of $30.00 per square foot. Bridge decks are similar to decks for precast culverts discussed later in this chapter but will have fundamental differences. The decks are bolted to the abutments as well as having diagonal bolts between them . In addition the decks are grouted together with shear keys that make the entire superstructure act as a single unit.

Concrete bridge decks for short span bridges are typically precast and prestressed. Companies such as Morris Brothers have a quality control program that maintains the temperature and humidity needed for concrete to reach design strengths. Bridges with spans greater than 65 feet will require deck sections such as a box girder or T beam. The longer spans may also have cast in place decks.

Bridges with Wooden and Concrete Decks

Bridge superstructures can be constructed on site, delivered as components, or delivered as modular units partly assembled. Companies provide an entire range of options. Decks can be attached on delivery or assembled in place. Local economics will dictate which is the best for a particular client. For federal or state agencies having a load rated superstructure provided by a vendor is very desirable.

The following companies provide prefabricated steel and wood bridge superstructures to South Western Oregon.

Name of Company	**Location**	**Phone Number**
Big R Manufacturing	Greeley Colorado	1-800-234-0734
Shur Span Construction Ltd	West Vancouver, B.C.	1-604-925-3337
Hamilton Bridge Company- Easy Bridge Supplier	Eugene ,Oregon,	1-541-746-2426
Permapost	Hillsboro ,Oregon	1-503-648-4156
Western Wood Structures	Tualatin, Oregon	1-503-692-6900

Supplier will provide quotes on a variety of configurations such as Steel beams with wood decks, Steel beams with composite concrete decks, Steel beams with concrete non composite slab decks, Glue-Lam beams with wood decks, etc.

Steel and wood beams are competitively priced . The supplier from of wood bridges noted that for spans up to 55 foot spans wood bridges are less expensive then other types even with replacement estimated in 85 years. The total costs between options is worth the time of a detailed comparison. .

WEYCO Minibridges

A local timber company has developed a culvert with spans of up to 25 feet. Technically the structure is a bridge with a soil deck. . The supports are totally to the footings. Two variations of decks have been used wood and concrete slabs. The wood decks were constructed from salvaged wood beams. The concrete decks were constructed with their own crews. The costs of these structures are significantly lower then commercially provided culverts. Design Features:

1 Deck: Recycled treated timbers

2 foundations: Ecology blocks on grade

3 Surfacing: aggregate surface

4 Cost= $12,000 each+-

Mini-bridge or Modular Box Culvert

A variation on the mini-bridge design was developed using concrete blocks and a precast slab. These components can be field assembled into various sizes and shapes. Various suppliers have been contacted to provide the blocks and slabs. At this time we are considering:

1 Abutment blocks: Local Supplier in Roseburg or Coos Bay, or Hilfiker Company of Eureka California.

2 Abutment slabs- prestressed for reduced weight: Morris Brothers of Harrisburg, Oregon

3 Welded Wire soil reinforcements: Hilfiker Company of Eureka, California.

The structure is hydraulicly similar to the open bottom arch and like other open bottom structures may requires a riprap blanket. The depth of the riprap if needed will depend on the site. See chapter two- foundation riprap design for sizing. Widening the structure to full stream simulation widths will reduce the velocities and depth and potentially the amount of costs for the foundation improvements. Preliminary material costs have been developed for component.

1. Deck slabs- $23.00 per sq foot with curbs ,bolts, and fabric

2. Abutment panels or blocks -$11.00 sq foot

3. Prefabricated footings- $44.00 per linear foot.

Total costs for materials was competitive with a pipe arch and slightly less then an open bottom arch.   The advantages to design include

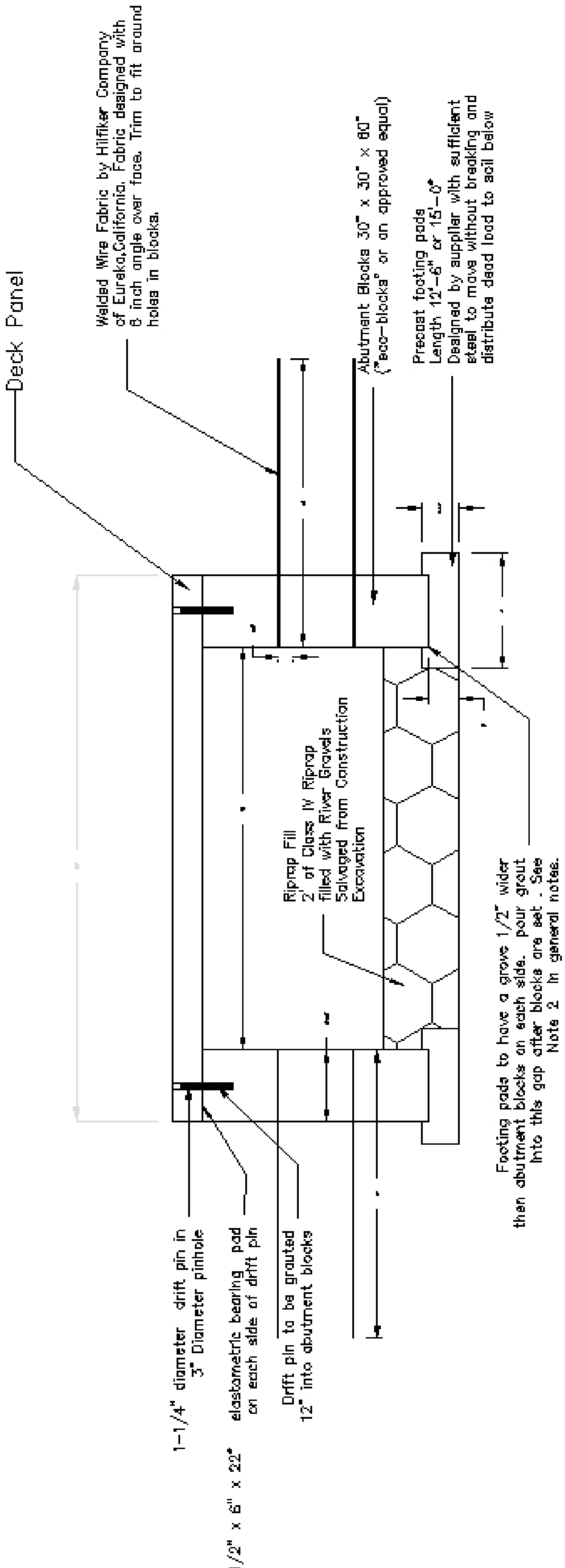
1. Structure does not rely on soil strength for structural integrity.

2. Approximately the same length to install as a culvert.

3. For minor costs can widen structure to full simulation criterion per chapter four.

4. All components prefabricated. which should translate into a lower installation costs.

5. See drawings on following page for details of assembly.


Deck Panel
Welded Wire Fabric by Hilfiker Company of Eureka,California. Fabric designed with 6 inch angle over face. Trim to fit around holes in blocks.
Abutment Blocks 30" x 30" x 60" ("eco-blocks" or an approved equal)
Precast footing pads Length 12'-6" or 15'-0" Designed by supplier with sufficient steel to move without breaking and distribute dead load to soil below
Riprap Fill 2' of Class IV Riprap filled with River Gravels Salvaged from Construction Excavation
Footing pads to have a grove 1/2" wider then abutment blocks on each side. pour grout into this gap after blocks are set. See Note 2 in general notes.
1-1/4" diameter drift pin in 3" Diameter pinhole
1/2" x 6" x 22" elastometric bearing pad on each side of drift pin
Drift pin to be grouted 12" into abutment blocks