

Scenario Worksheet

Practice and Scenario Description:

Information Type	Data
Region	Appalachian
State	North Carolina
Discipline Group	Wildlife Wetland
Practice Code/Name	396 - Aquatic Organism Passage
Scenario ID	5
Scenario Name	CMP Culvert
Scenario Description	<p>A corrugated metal (galvanized steel or aluminum) pipe culvert (CMP) of any shape (round, elliptical, or squash) used at a road-stream crossing to provide aquatic organism passage (AOP) and promote stream ecological and geomorphic function. CMPs used for AOP are sized according to geomorphic analyses, not just an estimate of runoff and streamflow at the site from the contributing watershed. In addition, CMPs used for AOP are filled with a mixture of rock and gravel sized to emulate site stream conditions and geomorphic units in the channel. The simulated streambed material is continuous throughout the culvert barrel, and blended with the intact streambed at the culvert inlet and outlet. The first estimate of culvert size—diameter or span—is obtained by analyzing bankfull channel width on a reach of stream not affected by an existing road crossing or other conditions that alter self-formed conditions. In the case of a culvert replacement, bankfull investigations are begun at least 10-20 estimated bankfull channel widths above the existing stream crossing. Culvert diameter or span is then increased according to channel bed composition and texture, bank characteristics, channel alignment at the crossing section, and other parameters that may affect channel dynamics and stability.</p> <p>Once the CMP diameter or span is determined, culvert length will be determined by roadway geometry and loading requirements, and site stream conditions. Concrete headwalls and/or wingwalls may be necessary in shorter installations and/or where fill/roadway cover is limited or the stream alignment is not perpendicular to the road axis. Culvert wall thickness and corrugations are determined by road loading requirements. Stream geomorphic characteristics, including the reach longitudinal profile, channel cross-sectional shape, substrate composition and arrangement, and bank shape and composition are determined.</p> <p>CMPs are installed with an assortment of equipment used for excavation, placing material, and delivering and removing material. Construction elements generally include an assortment of rock used to create riffles, cascades, or riffle-pool sequences with between 6 to 12 inches of water surface elevation drop between adjacent structures. Stream dewatering and diversion around the work site is often required, and temporary road closure or re-routing may also be required. Channel bed material within the culvert barrel varies according to prevailing stream characteristics at the crossing site. The culvert is placed within the roadway on a subexcavated compacted bed, set at a slope that matches the design longitudinal profile, and backfilled with a bed mixture that mimics adjacent stream characteristics with special attention to channel pattern. Backfill depths are typically at least 20% of the culvert diameter or rise, but may deviate based on the shape of the culvert used, channel dimensions, substrate size, and the site longitudinal profile. Special equipment such as motorized wheelbarrows may be necessary to backfill smaller CMPs. Once the simulated streambed in the culvert barrel is complete, the roadway is replaced and any necessary armoring and revegetating material is placed at the culvert inlet and outlet.</p> <p>An existing undersized culvert as contributed to general bed and bank scour downstream of a road crossing, and may have contributed to the deposition of a wedge of sediment upstream of the road crossing. The road may be overtopped by high flows, resulting in outright failure, landowner accessibility problems, access by and to emergency services, and hamper post-flood recovery efforts. An upstream impoundment created by the undersized culvert has contributed to water quality problems including high water temperatures and the deposition and later mobilization of polluted fine sediment. Native aquatic organisms are unable to pass through the road crossing because the culvert outlet is perched above the downstream pool, and high velocities are not negotiable by animals that are able to leap into the culvert barrel.</p> <p>The undersized culvert is replaced with a CMP sized, placed, and backfilled with material determined by geomorphic analyses performed in a reference reach upstream of the crossing location. Geomorphic and ecological functions are preserved through the crossing site, enhancing AOP, water quality, and culvert longevity. In addition, because the culvert is sized to promote the transport of streamflow and the materials it carries, it requires decreased maintenance activities over time. Landowners are able to access their holdings across a range of flows, and are able to seek and receive emergency and post-flood recovery services. Resource Concerns are addressed within the context of the site.</p>
Before Practice Situation	
After Practice Situation	
Scenario Feature Measure	CMP
Scenario Unit	Each
Scenario Typical Size	1 8-foot by 40-foot 14 ga. CMP and 75 cubic yards fill

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	\$5,596.05	\$5,596.05
Equipment/Installation	\$13,511.83	\$13,511.83
Labor	\$5,760.54	\$5,760.54
Mobilization	\$531.60	\$531.60
Acquisition of Technical Knowledge	\$0.00	\$0.00
Foregone Income	\$0.00	\$0.00
Total	\$25,400.02	\$25,400.02

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price (\$/unit)	Quantity	Cost
Materials	1834	Aggregate, river rock	Well graded, rounded mineral substrates derived from local riverine settings. Includes materials and local delivery	Ton	\$31.75	75	\$2,381.25
Materials	1835	Pipe, CMP, 96", 14 Gauge	96" Corrugated Metal Pipe, Galvanized, Uncoated, 14 gage. Material cost only.	Foot	\$75.42	40	\$3,016.80
Materials	43	Silt Fence	Silt Fence with support post, includes materials, equipment and labor	Foot	\$0.66	300	\$198.00
Equipment/Installation	932	Hydraulic Excavator, 2 CY	Track mounted hydraulic excavator with bucket capacity range of 1.5 to 2.5 CY. Equipment and power unit costs. Labor not included.	Hour	\$156.19	40	\$6,247.60
Equipment/Installation	933	Skidsteer, 80 HP	Skidsteer loader with horsepower range of 60 to 90. Equipment and power unit costs. Labor not included.	Hour	\$35.06	60	\$2,103.60
Equipment/Installation	969	Water management, Flooding & dewatering	Includes equipment, power unit and labor costs.	Acre Foot	\$63.03	1	\$63.03
Equipment/Installation	42	Geotextile, woven	Woven Geotextile Fabric. Includes materials, equipment and labor	Square Yard	\$2.11	900	\$1,899.00
Equipment/Installation	1215	Truck, dump, 12 CY	Dump truck for moving bulk material. Typically capacity is 16 ton or 12 cubic yards. Includes equipment only.	Hour	\$72.90	40	\$2,916.00
Equipment/Installation	1201	Tractor, agricultural, 210 HP	Agricultural tractor with horsepower range of 190 to 240. Equipment and power unit costs. Labor not included.	Hour	\$94.20	3	\$282.60

Labor	234	Supervisor or Manager	Labor involving supervision or management activities. Includes crew supervisors, foremen and farm/ranch managers time required for adopting new technology, etc.	Hour	\$35.43	40	\$1,417.20
Labor	231	General Labor	Labor performed using basic tools such as power tool, shovels, and other tools that do not require extensive training. Ex. pipe layer, herder, concrete placement, materials spreader, flagger, etc.	Hour	\$18.67	60	\$1,120.20
Labor	233	Equipment Operators, Heavy	Includes: Cranes, Hydraulic Excavators >=50 HP, Dozers, Paving Machines, Rock Trenchers, Trenchers >=12", Dump Trucks, Ag Equipment >=150 HP, Scrapers, Water Wagons.	Hour	\$21.98	103	\$2,263.94
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	\$23.98	40	\$959.20
Mobilization	1140	Mobilization, large equipment	Equipment >150HP or typical weights greater than 30,000 pounds or loads requiring over width or over length permits.	Each	\$173.20	2	\$346.40
Mobilization	1139	Mobilization, medium equipment	Equipment with 70-150 HP or typical weights between 14,000 and 30,000 pounds.	Each	\$92.60	2	\$185.20

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Practice and Scenario Description:

Information Type	Data
Region	Appalachian
State	North Carolina
Discipline Group	Wildlife Wetland
Practice Code/Name	396 - Aquatic Organism Passage
Scenario ID	6
Scenario Name	Bottomless Culvert
Scenario Description	<p>A multi-plate galvanized steel or aluminum culvert (arch or box) used at a road-stream crossing to provide aquatic organism passage (AOP) and promote stream ecological and geomorphic function. They commonly attach to preformed reinforced or poured-in-place concrete footings. Bottomless culverts used for AOP are sized according to geomorphic analyses, not just an estimate of runoff and streamflow at the site from the contributing watershed. In addition, bottomless culverts used for AOP are filled with a mixture of rock and gravel sized to emulate site stream conditions and geomorphic units in the channel. The simulated streambed material is continuous throughout the culvert barrel, and blended with the intact streambed at the culvert inlet and outlet. The first estimate of culvert span is obtained by analyzing bankfull channel width on a reach of stream not affected by an existing road crossing or other conditions that alter self-formed conditions. In the case of a culvert replacement, bankfull investigations are begun at least 10-20 estimated bankfull channel widths above the existing stream crossing. Culvert span is then increased according to channel bed composition and texture, bank characteristics, channel alignment at the crossing section, and other parameters that may affect channel dynamics and stability.</p> <p>Once the culvert span is determined, culvert length will be dictated by roadway geometry and loading requirements, and site stream conditions. Concrete headwalls and/or wingwalls may be necessary in shorter installations and/or where fill/roadway cover is limited or the stream alignment is not perpendicular to the road axis. Culvert wall thickness and footing requirements are determined by road loading requirements and site geotechnical investigations. Generally, the preferred footing is a T-design with a spread footing with stem wall. Connecting the culvert leg to the footing can be done by welding, grouting, bolting. Stream geomorphic characteristics, including the reach longitudinal profile, channel cross-sectional shape, substrate composition and arrangement, and bank shape and composition are determined.</p> <p>Bottomless arch or box culverts are commonly delivered in sections and bolted together in the field. Smaller arches can be delivered in one piece. They are installed with an assortment of equipment used for excavation, placing material, and delivering and removing material. Construction elements generally include an assortment of rock used to create riffles, cascades, or riffle-pool sequences with between 6 to 12 inches of water surface elevation drop between adjacent structures. Stream dewatering and diversion around the work site is often required, and temporary road closure or re-routing may also be required. Channel bed material within the culvert barrel varies according to prevailing stream characteristics at the crossing site. Footings are placed or poured, and the new streambed is set at a slope that</p>
Before Practice Situation	An existing undersized culvert as contributed to general bed and bank scour downstream of a road crossing, and may have contributed to the deposition of a wedge of sediment upstream of the road crossing. The road may be overtopped by high flows, resulting in outright failure, landowner accessibility problems, access by and to emergency services, and hamper post-flood recovery efforts. An upstream impoundment created by the undersized culvert has contributed to water quality problems including high water temperatures and the deposition and later mobilization of polluted fine sediment. Native aquatic organisms are unable to pass through the road crossing because the culvert outlet is perched above the downstream pool, and high velocities are not negotiable by animals that are able to leap into the culvert barrel.
After Practice Situation	The undersized culvert is replaced with a bottomless arch or box culvert sized, placed, and backfilled with material determined by geomorphic analyses performed in a reference reach upstream of the crossing location. Geomorphic and ecological functions are preserved through the crossing site, enhancing AOP, water quality, and culvert longevity. In addition, because the culvert is sized to promote the transport of streamflow and the materials it carries, it requires decreased maintenance activities over time. Landowners are able to access their holdings across a range of flows, and are able to seek and receive emergency and post-flood recovery services. Resource Concerns are addressed within the context of the site.
Scenario Feature Measure	Multi-plate arch or box and rock fill
Scenario Unit	Each
Scenario Typical Size	1 10' X 5'3" X 40' arch with 2'X3' precast footings, 75 cu yd fill

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	\$20,574.72	\$20,574.72
Equipment/Installation	\$13,511.83	\$13,511.83
Labor	\$5,760.54	\$5,760.54
Mobilization	\$531.60	\$531.60
Acquisition of Technical Knowledge	\$0.00	\$0.00
Foregone Income	\$0.00	\$0.00
Total	\$40,378.69	\$40,378.69

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price (\$/unit)	Quantity	Cost
Materials	1834	Aggregate, river rock	Well graded, rounded mineral substrates derived from local riverine settings. Includes materials and local delivery	Ton	\$31.75	75	\$2,381.25
Materials	1836	Footing, concrete, precast	Precast spread footing with stemwall, T-shaped, with channel built to accept arched culvert leg. Materials only.	Foot	\$166.42	80	\$13,313.60
Materials	1979	Culvert, Multi-Plate arch	Multi-plate arch culvert, typically 7 Gauge corrugated plate. Includes metal arch materials only, does not include footings.	Pound	\$0.87	1	\$0.87
Materials	1842	Geocell, 6"	6-inch thick cellular confinement system, three-dimensional, expandable panels made from high-density polyethylene (HDPE), polyester or another polymer material. Includes materials, labor and equipment for the geocell only, does not include backfill.	Square Yard	\$9.23	500	\$4,615.00
Materials	43	Silt Fence	Silt Fence with support post, includes materials, equipment and labor	Foot	\$0.66	400	\$264.00
Equipment/Installation	932	Hydraulic Excavator, 2 CY	Track mounted hydraulic excavator with bucket capacity range of 1.5 to 2.5 CY. Equipment and power unit costs. Labor not included.	Hour	\$156.19	40	\$6,247.60
Equipment/Installation	933	Skidsteer, 80 HP	Skidsteer loader with horsepower range of 60 to 90. Equipment and power unit costs. Labor not included.	Hour	\$35.06	60	\$2,103.60

Equipment/Installation	969	Water management, Flooding & dewatering	Includes equipment, power unit and labor costs.	Acre Foot	\$63.03	1	\$63.03
Equipment/Installation	42	Geotextile, woven	Woven Geotextile Fabric. Includes materials, equipment and labor	Square Yard	\$2.11	900	\$1,899.00
Equipment/Installation	1215	Truck, dump, 12 CY	Dump truck for moving bulk material. Typically capacity is 16 ton or 12 cubic yards. Includes equipment only.	Hour	\$72.90	40	\$2,916.00
Equipment/Installation	1201	Tractor, agricultural, 210 HP	Agricultural tractor with horsepower range of 190 to 240. Equipment and power unit costs. Labor not included.	Hour	\$94.20	3	\$282.60
Labor	234	Supervisor or Manager	Labor involving supervision or management activities. Includes crew supervisors, foremen and farm/ranch managers time required for adopting new technology, etc.	Hour	\$35.43	40	\$1,417.20
Labor	231	General Labor	Labor performed using basic tools such as power tool, shovels, and other tools that do not require extensive training. Ex. pipe layer, herder, concrete placement, materials spreader, flagger, etc.	Hour	\$18.67	60	\$1,120.20
Labor	233	Equipment Operators, Heavy	Includes: Cranes, Hydraulic Excavators >=50 HP, Dozers, Paving Machines, Rock Trenchers, Trenchers >=12", Dump Trucks, Ag Equipment >=150 HP, Scrapers, Water Wagons.	Hour	\$21.98	103	\$2,263.94
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	\$23.98	40	\$959.20
Mobilization	1140	Mobilization, large equipment	Equipment >150HP or typical weights greater than 30,000 pounds or loads requiring over width or over length permits.	Each	\$173.20	2	\$346.40
Mobilization	1139	Mobilization, medium equipment	Equipment with 70-150 HP or typical weights between 14,000 and 30,000 pounds.	Each	\$92.60	2	\$185.20

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Practice and Scenario Description:

Information Type	Data
Region	Appalachian
State	North Carolina
Discipline Group	Wildlife Wetland
Practice Code/Name	396 - Aquatic Organism Passage
Scenario ID	7
Scenario Name	Concrete Box Culvert
Scenario Description	<p>A four-sided precast concrete box (square or rectangular) culvert used at a road-stream crossing to provide aquatic organism passage (AOP) and promote stream ecological and geomorphic function. Concrete box culverts are generally available in sections of 1-foot increments. Concrete box culverts used for AOP are sized according to geomorphic analyses, not just an estimate of runoff and streamflow at the site from the contributing watershed. In addition, concrete box culverts used for AOP are filled with a mixture of rock and gravel sized to emulate site stream conditions and geomorphic units in the channel. The simulated streambed material is continuous throughout the culvert barrel, and blended with the intact streambed at the culvert inlet and outlet. The first estimate of culvert width is obtained by analyzing bankfull channel width on a reach of stream not affected by an existing road crossing or other conditions that alter self-formed conditions. In the case of a culvert replacement, bankfull investigations are begun at least 10-20 estimated bankfull channel widths above the existing stream crossing. Culvert width is then increased according to channel bed composition and texture, bank characteristics, channel alignment at the crossing section, and other parameters that may affect channel dynamics and stability.</p> <p>Once the culvert width is determined, culvert length will be determined by roadway geometry and loading requirements, and site stream conditions. Concrete headwalls and/or wingwalls may be necessary in shorter installations and/or where fill/roadway cover is limited or the stream alignment is not perpendicular to the road axis. Stream geomorphic characteristics, including the reach longitudinal profile, channel cross-sectional shape, substrate composition and arrangement, and bank shape and composition are determined.</p> <p>Concrete box culverts are delivered in sections and assembled onsite, and require adequate bed compaction throughout the crossing section. They are installed with an assortment of equipment used for excavation, placing material, and delivering and removing material. Construction elements generally include an assortment of rock used to create riffles, cascades, or riffle-pool sequences with between 6 to 12 inches of water surface elevation drop between adjacent structures. Stream dewatering and diversion around the work site is often required, and temporary road closure or re-routing may also be required. Channel bed material within the culvert barrel varies according to prevailing stream characteristics at the crossing site. The new streambed is set at a slope that matches the design longitudinal profile, and backfilled with a bed mixture that mimics adjacent stream characteristics with special attention to channel pattern. The roadway is replaced and any necessary armoring and revegetating material is placed at the culvert inlet and outlet where it intersects the road fill prism. Other actions include construction staking</p>
Before Practice Situation	An existing undersized culvert as contributed to general bed and bank scour downstream of a road crossing, and may have contributed to the deposition of a wedge of sediment upstream of the road crossing. The road may be overtopped by high flows, resulting in outright failure, landowner accessibility problems, access by and to emergency services, and hamper post-flood recovery efforts. An upstream impoundment created by the undersized culvert has contributed to water quality problems including high water temperatures and the deposition and later mobilization of polluted fine sediment. Native aquatic organisms are unable to pass through the road crossing because the culvert outlet is perched above the downstream pool, and high velocities are not negotiable by animals that are able to leap into the culvert barrel.
After Practice Situation	The undersized culvert is replaced with a concrete box culvert sized, placed, and backfilled with material determined by geomorphic analyses performed in a reference reach upstream of the crossing location. Geomorphic and ecological functions are preserved through the crossing site, enhancing AOP, water quality, and culvert longevity. In addition, because the culvert is sized to promote the transport of streamflow and the materials it carries, it requires decreased maintenance activities over time. Landowners are able to access their holdings across a range of flows, and are able to seek and receive emergency and post-flood recovery services. Resource Concerns are addressed within the context of the site.
Scenario Feature Measure	Concrete box culvert and rock fill
Scenario Unit	Each
Scenario Typical Size	1 6'X6'X40' concrete box, 75 cu yd fill

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	\$31,397.45	\$31,397.45
Equipment/Installation	\$13,722.83	\$13,722.83
Labor	\$5,760.54	\$5,760.54
Mobilization	\$439.00	\$439.00
Acquisition of Technical Knowledge	\$0.00	\$0.00
Foregone Income	\$0.00	\$0.00
Total	\$51,319.82	\$51,319.82

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price (\$/unit)	Quantity	Cost
Materials	1834	Aggregate, river rock	Well graded, rounded mineral substrates derived from local riverine settings. Includes materials and local delivery	Ton	\$31.75	75	\$2,381.25
Materials	1837	Culvert, box, 6' x 6'	Precast concrete box culvert, 6'X6'. Typically in 4' sections. Materials only.	Foot	\$603.43	40	\$24,137.20
Materials	1842	Geocell, 6"	6-inch thick cellular confinement system, three-dimensional, expandable panels made from high-density polyethylene (HDPE), polyester or another polymer material. Includes materials, labor and equipment for the geocell only, does not include backfill.	Square Yard	\$9.23	500	\$4,615.00
Materials	43	Silt Fence	Silt Fence with support post, includes materials, equipment and labor	Foot	\$0.66	400	\$264.00
Equipment/Installation	932	Hydraulic Excavator, 2 CY	Track mounted hydraulic excavator with bucket capacity range of 1.5 to 2.5 CY. Equipment and power unit costs. Labor not included.	Hour	\$156.19	40	\$6,247.60
Equipment/Installation	933	Skidsteer, 80 HP	Skidsteer loader with horsepower range of 60 to 90. Equipment and power unit costs. Labor not included.	Hour	\$35.06	60	\$2,103.60
Equipment/Installation	969	Water management, Flooding & dewatering	Includes equipment, power unit and labor costs.	Acre Foot	\$63.03	1	\$63.03
Equipment/Installation	42	Geotextile, woven	Woven Geotextile Fabric. Includes materials, equipment and labor	Square Yard	\$2.11	1000	\$2,110.00

Equipment/Installation	1215	Truck, dump, 12 CY	Dump truck for moving bulk material. Typically capacity is 16 ton or 12 cubic yards. Includes equipment only.	Hour	\$72.90	40	\$2,916.00
Equipment/Installation	1201	Tractor, agricultural, 210 HP	Agricultural tractor with horsepower range of 190 to 240. Equipment and power unit costs. Labor not included.	Hour	\$94.20	3	\$282.60
Labor	234	Supervisor or Manager	Labor involving supervision or management activities. Includes crew supervisors, foremen and farm/ranch managers time required for adopting new technology, etc.	Hour	\$35.43	40	\$1,417.20
Labor	231	General Labor	Labor performed using basic tools such as power tool, shovels, and other tools that do not require extensive training. Ex. pipe layer, herder, concrete placement, materials spreader, flagger, etc.	Hour	\$18.67	60	\$1,120.20
Labor	233	Equipment Operators, Heavy	Includes: Cranes, Hydraulic Excavators >=50 HP, Dozers, Paving Machines, Rock Trenchers, Trenchers >=12", Dump Trucks, Ag Equipment >=150 HP, Scrapers, Water Wagons.	Hour	\$21.98	103	\$2,263.94
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	\$23.98	40	\$959.20
Mobilization	1140	Mobilization, large equipment	Equipment >150HP or typical weights greater than 30,000 pounds or loads requiring over width or over length permits.	Each	\$173.20	2	\$346.40
Mobilization	1139	Mobilization, medium equipment	Equipment with 70-150 HP or typical weights between 14,000 and 30,000 pounds.	Each	\$92.60	1	\$92.60

Scenario Worksheet

Practice and Scenario Description:

Information Type	Data
Region	Appalachian
State	North Carolina
Discipline Group	Wildlife Wetland
Practice Code/Name	396 - Aquatic Organism Passage
Scenario ID	12
Scenario Name	Low Water Crossing
Scenario Description	<p>Structure installed on low volume or on unimproved roads at watercourse crossings. Primary use is to allow livestock and equipment access to other parcels of land or operational units. Low-water crossings provide safe and stable stream crossings that don't negatively impact water and ecological quality while remaining stable across a wide range of flows. Variations exist, but a common application consists of an improved or hardened ford located above a hydraulic control (e.g., bedrock outcropping, riffle, or step composed of coarse substrates). Properly designed and installed low water crossings provide aquatic organism passage (AOP), promote stream ecological and geomorphic function, remain stable over time, and can pass sediment and woody debris.</p> <p>Conservation planning and interaction with the landowner is vital to determine if existing crossings can be consolidated into fewer, more reliable locations. Characterizing a site according to its watershed position and geomorphic function will aid design decisions. Optimal AOP conditions are usually realized when the backfill is composed of a mixture that mimics bed material as evaluated from a reference reach adjacent to the crossing—preferably at least 10-20 estimated bankfull channel widths above an existing crossing to avoid effects that alter channel geometry or bedform composition and spacing.</p> <p>Low water crossings are installed with an assortment of equipment used for excavation, placing material, and delivering and removing material. Low water crossings provide the best mix of function and longevity when they are designed and built to conform to existing channel geometry and slope, constructed to match the shape of the existing channel, and oriented to cross the stream at a 90 degree angle. Crossing width, measured along the downstream axis, should not exceed 2X bankfull width. Low water crossings are commonly constructed by overexcavating the crossing section 6-12 inches below the existing streambed and backfilling the void with well-graded rock back to natural bed elevation. Geotextile lining may be required in some settings. Rock size and gradation is the smallest mix needed to remain stable under prevailing flow conditions—larger rock can endanger livestock and turbulence impairs passage. Sand or soil may be added into the mix to seal the section to ensure that the stream doesn't percolate into the crossing substrate. Smaller material increases bed diversity, chokes voids between bigger stones, and helps preserve passage quality. Smaller rock smaller (< 2 inches) at the finished surface may become lodged in livestock hooves. The road/trail surface of the crossing should be extended to an elevation that exceeds the known high water level on each side of the crossing. The downstream edge of the crossing should not produce a sharp drop in water surface to preserve AOP quality and discourage sediment deposition and debris accumulation. Other actions include construction staking and signage, soil erosion and pollution control, removal and disposal of the old culvert, and topsoil conservation for site reclamation. Disturbed areas are</p>
Before Practice Situation	<p>A small farming operation has a mixture of pastures, hay meadows, and crops that all require seasonal movement of equipment and livestock between parcels. Four unimproved stream crossings provide unreliable access across the property and require yearly maintenance to clear debris and sediment. Farm equipment has gotten stuck in the past, and uncontrolled livestock access and frequent crossing or loafing in the stream contributes to chronic water quality problems associated with elevated fine sediment, high water temperatures, invasive aquatic vegetation, and fecal coliform bacteria. Livestock avoid three of the crossings when streamflow increases moderately. Two of the crossings are overwide and shallow, and impair AOP. The property and landowner's yearly operations are reviewed by conservation planners and—with the input and agreement of the landowner—it is decided that three of the four crossings can be eliminated and consolidated at one site above a cobble/boulder deposit in the stream.</p>
After Practice Situation	<p>An improved ford is constructed by excavating the channel just upstream of the boulder/cobble hydraulic control. The cut is lined with geotextile to control seepage and subsurface flow, and backfilled up to the existing bed elevation with a well-graded mix of rock sized to mimic the material in the channel upstream of the crossing. The finished crossing surface is at grade with the up and downstream channel elevation, and no drop exists along the downstream edge. Approaches on either side of the crossing are extended up to the adjacent floodplain surface, and the finished instream portion of the ford matches the existing channel cross section. Approach slopes are shallow enough for expected equipment traffic, including towed combinations, and armored as needed with larger rock to protect against erosion that may occur when the floodplain is inundated. The crossing is fenced and gated to control livestock access and provide greater flexibility to the landowner's grazing needs. AOP is provided, and the crossing remains stable across a range of flow and sediment and debris transport events. Resource Concerns are addressed within the context of the site.</p>
Scenario Feature Measure	Cubic Yard
Scenario Unit	Cubic Yard
Scenario Typical Size	60 Assume 15' wide, 75' long, 1.5' deep cut

Cost Summary:

Cost Category	Scenario Cost	Scenario Cost/Unit
Materials	\$2,579.25	\$42.99
Equipment/Installation	\$21,450.96	\$357.52
Labor	\$8,877.74	\$147.96
Mobilization	\$531.60	\$8.86
Acquisition of Technical Knowledge	\$0.00	\$0.00
Foregone Income	\$0.00	\$0.00
Total	\$33,439.55	\$557.33

Cost Details:

Cost Category	Component ID	Component Name	Component Description	Unit	Price (\$/unit)	Quantity	Cost
Materials	1834	Aggregate, river rock	Well graded, rounded mineral substrates derived from local riverine settings. Includes materials and local delivery	Ton	\$31.75	75	\$2,381.25
Materials	43	Silt Fence	Silt Fence with support post, includes materials, equipment and labor	Foot	\$0.66	300	\$198.00
Equipment/Installation	926	Backhoe, 80 HP	Wheel mounted backhoe excavator with horsepower range of 60 to 90. Equipment and power unit costs. Labor not included.	Hour	\$45.37	80	\$3,629.60
Equipment/Installation	932	Hydraulic Excavator, 2 CY	Track mounted hydraulic excavator with bucket capacity range of 1.5 to 2.5 CY. Equipment and power unit costs. Labor not included.	Hour	\$156.19	60	\$9,371.40
Equipment/Installation	933	Skidsteer, 80 HP	Skidsteer loader with horsepower range of 60 to 90. Equipment and power unit costs. Labor not included.	Hour	\$35.06	80	\$2,804.80
Equipment/Installation	42	Geotextile, woven	Woven Geotextile Fabric. Includes materials, equipment and labor	Square Yard	\$2.11	1000	\$2,110.00
Equipment/Installation	50	Earthfill, Manually Compacted	Earthfill, manually compacted, includes equipment and labor	Cubic yard	\$4.23	50	\$211.50
Equipment/Installation	1215	Truck, dump, 12 CY	Dump truck for moving bulk material. Typically capacity is 16 ton or 12 cubic yards. Includes equipment only.	Hour	\$72.90	40	\$2,916.00

Equipment/Installation	1201	Tractor, agricultural, 210 HP	Agricultural tractor with horsepower range of 190 to 240. Equipment and power unit costs. Labor not included.	Hour	\$94.20	3	\$282.60
Equipment/Installation	40	Clearing and Grubbing	Clearing and Grubbing, includes materials, equipment and labor	Acre	\$250.11	0.5	\$125.06
Labor	234	Supervisor or Manager	Labor involving supervision or management activities. Includes crew supervisors, foremen and farm/ranch managers time required for adopting new technology, etc.	Hour	\$35.43	40	\$1,417.20
Labor	231	General Labor	Labor performed using basic tools such as power tool, shovels, and other tools that do not require extensive training. Ex. pipe layer, herder, concrete placement, materials spreader, flagger, etc.	Hour	\$18.67	60	\$1,120.20
Labor	233	Equipment Operators, Heavy	Includes: Cranes, Hydraulic Excavators >=50 HP, Dozers, Paving Machines, Rock Trenchers, Trenchers >=12", Dump Trucks, Ag Equipment >=150 HP, Scrapers, Water Wagons.	Hour	\$21.98	223	\$4,901.54
Labor	230	Skilled Labor	Labor requiring a high level skill set: Includes carpenters, welders, electricians, conservation professionals involved with data collection, monitoring, and or record keeping, etc.	Hour	\$23.98	60	\$1,438.80
Mobilization	1140	Mobilization, large equipment	Equipment >150HP or typical weights greater than 30,000 pounds or loads requiring over width or over length permits.	Each	\$173.20	2	\$346.40
Mobilization	1139	Mobilization, medium equipment	Equipment with 70-150 HP or typical weights between 14,000 and 30,000 pounds.	Each	\$92.60	2	\$185.20