Project Specific Information for Streamlining Fisheries Engineering Review

The lists provided below identify the information necessary for Department of Fish and Game (DFG) fisheries engineering staff to complete reviews of project designs for fish passage and screening projects at water diversions. The lists were developed using DFG (2000 and 2001) and National Marine Fisheries Service (NMFS) (1997 and 2001) screening criteria and new DFG information on fish passage design (2009). DFG and NMFS screening criteria, and California Salmonid Stream Habitat Restoration Manual, 3rd edition, California Department of Fish and Game are available online. [1]

Included are lists of information necessary for the adequate review of fish screens, fish ladders, boulder weirs, rock chutes, roughened channels, and at grade diversions. Use of these lists by DFG staff will streamline the engineering review process and ensure that projects provide sustainable fish protection and passage. The project applicant should submit this information with the design plans. If a listed item is considered unnecessary, the rationale for excluding it should be provided by the project applicant. Conversely, while these lists attempt to cover the key parameters for most projects, there may be site-specific opportunities to provide better fish passage and that cannot be easily translated into a simple checklist (e.g., avoidance of predation habitat).

Fish Screens: *See current DFG and NMFS screening criteria, and California Salmonid Stream Habitat Restoration Manual, 3rd edition, California Department of Fish and Game.*

1. Target species and life stages to be protected at proposed screening site (e.g. will steelhead rainbow trout fry be present?) (NMFS pg. 4-5).
2. Fish screen structure placement (e.g., on-stream, in-canal, in-reservoir, or pumped) (NMFS pg. 3).
3. Evidence of infeasibility of on-stream screen if an in canal screen is selected. Types of evidence would include, but not be limited to: coarse bed load, severely eroding banks, excessive channel velocities, etc.
4. Records of diversion flows **and** stream flows, including maximums and minimums, during irrigation season (NMFS pg. 2).
5. Stream flow vs. depth rating curve at diversion intake (NMFS pg. 2).
6. Description of fish screen openings, including porosity and dimensions of round, square, or slotted openings (NMFS pg. 5-6).
7. Applicable approach velocity and sweeping velocity criteria (NMFS pg. 4-5).
8. Fish screen area calculation performed in accordance with DFG Fish Screening Criteria (6/19/00).

[1] Current DFG and NMFS screening criteria, and California Salmonid Stream Habitat Restoration Manual, 3rd edition, California Department of Fish and Game are available at the following links:

- http://www.dfg.ca.gov/fish/Resources/Projects/Engin/Engin_ScreenCriteria.asp
- http://swr.nmfs.noaa.gov/hcd/fishscrn.pdf
- http://www.dfg.ca.gov/fish/REsources/HabitatManual.asp

9. Water depth and approach velocity calculations in front of the fish screen throughout range of diversion flows (NMFS pg 3-4).
10. Evidence that flow uniformity criterion will be met (NMFS pg. 5).
11. Sweeping velocity calculations at several locations along the length of the screen throughout range of diversion and bypass flows (NMFS pg. 5).
12. Screen exposure time calculation (NMFS pg. 7).
13. Velocity calculations between end of screen and bypass entrance (NMFS pg. 7).
14. Flow depth calculations within bypass conduit **and** in stream at bypass outlet at minimum bypass flow (NMFS pg. 8-9).
15. Estimated bypass flow needed to meet fish screen criteria (cfs) NMFS pgs. 5, 7, and 8).
16. Velocity calculations in stream at bypass outlet (NMFS pg. 8).
17. Drop height and impact velocity calculation at bypass outlet over the operating range of tailwater surfaces, if applicable (NMFS pg. 9).
18. For paddle wheel driven cleaning systems, fish screen area calculations showing passive screening criteria are met when paddle wheel driven wipers no longer operate.
19. Description of fish screen cleaning mechanism, including proposed frequency of cleaning.
20. Assessment of sediment transport/scour conditions at fish screen for on channel installations (NMFS pg. 2).
21. Specific information describing the type of corrosion-resistant screening material, bypass control/pipe and other materials that will directly affect fish. (NMFS pg. 6-8).
22. Design drawings showing site topography, control points, and dimensions of fish screen structure in plan, elevation, longitudinal profile, and cross-sectional views along with important component details.
23. Drawings should show smooth joints at bypass pipe bends and screen faces flush with adjacent walls and/or piers.
24. Any additional information which may be required to show that screen will meet current DFG/NMFS screening criteria.
25. Operation and maintenance plan which includes preventive and corrective maintenance procedures, inspection and reporting requirements, maintenance logs, etc.
26. Post construction evaluation and monitoring plan with allocated money in the construction budget.

Fish Ladders: *See Parts IX, and XII, California Salmonid Stream Habitat Restoration Manual, 3rd edition, California Department of Fish and Game.*

1. Explanation as to why the specific fish passage design was selected, including a discussion of the elements considered when designing the fish ladder entrance.
2. Target species, life stages and migration timing at project site.
3. Calculation of lower and upper fish passage stream flows for each life stage and species.
4. Calculation showing attraction flow rates are appropriate.

5. Rating curves for headwater and tailwater conditions.
6. Hydraulic analysis of flow through the fish ladder demonstrating that the ladder functions properly over the anticipated range of stream and ladder flows. This should include an assessment of the flow rate and depth over each weir and through each orifice, and an assessment of the threshold between plunging flow and streaming flow.
7. Energy dissipation factor calculations at maximum design flow in fish ladder pools.
8. Water stage calculations showing fishway has 3 ft freeboard to keep leaping fish in ladder.
9. Flow patterns and in-stream velocities at entrance to fishway.
10. Geotechnical information may be necessary to ensure project design is structurally appropriate.
11. Design drawings showing site topography, control points, and structural dimensions in plan, elevation, longitudinal profile, and cross-sectional views along with important component details.
12. Maintenance plan which includes preventative and corrective measures, assignment of personnel for maintenance during/after storms, inspection and reporting requirements, maintenance logs, etc.
13. If the ladder contains operational components, such as adjustable weirs, multiple entrances, etc., the plans should include an Operations Manual and single page operations guide that will be kept on site.
14. Post construction evaluation and monitoring plan with allocated money in the construction budget.

Boulder Weirs: *See Parts IX and XII, California Salmonid Stream Habitat Restoration Manual, 3rd edition, California Department of Fish and Game.*

1. Target species, life stages and migration timing at project site.
2. Calculation of lower and upper fish passage stream flows for each life stage and species and 100-year flow.
3. Water surface profiles at existing conditions for upper and lower fish passage stream flows and 100-year flow.
4. Water surface profiles with proposed boulder weirs for upper and lower fish passage stream flows and 100-year flow.
5. Spacing of, drops over, cross-sections shape of, and pool depths above and below boulder weirs.
6. If specific low flow notches are planned, calculations of depths and velocities within notches at fish passage flows.
7. Rock sizing calculations
8. Ditch/pump hydraulic calculations showing boulder weirs provide sufficient head to divert maximum diversion flow and bypass flow at minimum stream flow considering head losses at flow measurement devices, fish screens, pipes, open ditches, headgates, etc.
9. Geotechnical information may be necessary to ensure project design is structurally appropriate.

10. Design drawings showing site topography, control points, structural dimensions in plan, elevation, longitudinal profile, and cross-sectional views, and important component details, including construction notes on placement of bed material and boulders.
11. Post construction evaluation and monitoring plan with allocated money in the construction budget.

Rock Chutes: *See Parts IX and XII, California Salmonid Stream Habitat Restoration Manual, 3rd edition, California Department of Fish and Game*

1. Target species, life stages and migration timing at project site.
2. Calculation of lower and upper fish passage stream flows for each life stage and species and 100-year flow.
3. Water surface profiles at existing conditions for upper and lower fish passage stream flows and 100-year flow.
4. Water surface profiles with proposed rock chutes for upper and lower fish passage stream flows and 100-year flow.
5. Calculations of depths, velocities, and slope at fish passage flows along length of individual rock chutes.
6. Rock and engineered streambed material sizing calculations for both bed and banks.
7. If at a water diversion, ditch/pump hydraulic calculations showing rock chutes provide sufficient head to divert maximum diversion flow and bypass flow at minimum stream flow considering head losses at flow measurement devices, fish screens, pipes, open ditches, headgates, etc.
8. Geotechnical information may be necessary to ensure project design is structurally appropriate.
9. Design drawings showing site topography, control points, structural dimensions in plan, elevation, longitudinal profile, and cross-sectional views, and important component details, including construction notes on placement of bed material and boulders.
10. Post construction evaluation and monitoring plan with allocated money in the construction budget.

Roughened Channels: *See Parts IX and XII, California Salmonid Stream Habitat Restoration Manual, 3rd edition, California Department of Fish and Game.*

1. Target species, life stages and migration timing at project site.
2. Calculation of lower and upper fish passage stream flows for each life stage and species and 100-year flow.
3. Water surface profiles at existing conditions for upper and lower fish passage stream flows and 100-year flow.
4. Water surface profiles with proposed roughened channel for upper and lower fish passage stream flows and 100-year flow.
5. Rock and engineered streambed material sizing and thickness calculations for bed and banks.

6. Geotechnical information may be necessary to ensure project design is structurally appropriate.
7. Calculations of depths and velocities at fish passage flows along length of roughened channel.
8. Calculation of overall drop and slope along roughened channel.
9. If at a water diversion, ditch/pump hydraulic calculations showing roughened channel provides sufficient head to divert maximum diversion flow + bypass flow at minimum stream flow considering head losses at flow measurement devices, fish screens, pipes, open ditches, headgates, etc.
10. Design drawings showing site topography, control points, structural dimensions in plan, elevation, longitudinal profile, and cross-sectional views, and important component details, including construction notes on placement of bed material and boulders.
11. Post construction evaluation and monitoring plan with allocated money in the construction budget.

At-Grade Diversions:

1. Instream and ditch/pump hydraulic calculations showing there is sufficient head to divert maximum diversion flow and bypass flow at minimum stream flow considering head losses at flow measurement devices, fish screens, pipes, open ditches, headgates, etc.
2. Design drawings showing site topography, control points, structural dimensions in plan, elevation, longitudinal profile, and cross-sectional views, and important component details.

Stream Simulation: *See Parts IX and XII, California Salmonid Stream Habitat Restoration Manual, 3rd edition, California Department of Fish and Game.*

1. Justification/suitability of reference reach (include photographs).
    a. Stability of reach
    b. Similarity to project reach
    c. Location on plan view of crossing or description of location of reference reach in relation to crossing
2. Scaled plan view of reference reach showing meanders, woody debris/rootwads, steep cohesive banks, boulder/bedrock outcroppings, floodplains, etc.
3. Longitudinal Profile (with slopes identified).
    a. Reference reach
    b. Road crossing/project reach
    c. Downstream of project reach
    d. Range of possible bed profiles
4. Representative Cross-Section.
    a. Bankfull width
    b. Channel features (i.e. bedforms, banklines, floodplains, etc.)
5. Channel type – pool riffle, step pool, etc.
6. Gradation curves from bed samples in reference reach with photos of sampling location and location shown on plan view of reference reach.

7. Description of how roughness elements in reference reach are being simulated in project reach.
8. Model output from hydraulic analysis of:
    a. Channel-forming flows in reference and project reaches
    b. Q25 for stability of key pieces
    c. Q100 for channel and crossing capacity and floodplain and floodplain culvert hydraulics.
9. Stream simulation bed material mix and keystone sizing calculations.
10. Culvert dimensions and embedment.
11. Completed Design Form from Part XII.
12. Design drawings showing site topography, control points, structural dimensions in plan, elevation, longitudinal profile, and cross-sectional views, and important component details, including construction notes on placement of bed material and keystones.
13. Geotechnical information may be necessary to ensure project design is structurally appropriate, especially when replacing a culvert with a bridge.
14. Post construction evaluation and monitoring plan with allocated money in the construction budget.

No-slope Culvert Design: *See Parts IX, and XII, California Salmonid Habitat Restoration Manual, 3rd edition, California Department of Fish and Game.*

1. Target species, life stages and migration timing at project site.
2. Documentation that other fish passage methods are not feasible at site and that this installment meets the appropriate criteria for the no-slope method.
3. Documentation of natural channel slope in reach of crossing.
4. Demonstration of natural channel bankfull width.
5. Geotechnical information may be necessary to ensure project design is structurally appropriate.
6. Design drawings showing site topography, control points, structural dimensions in plan, elevation, and cross-sectional views, and important component details such as embedment. Channel and culvert slope as well as channel width outside the influence of the culvert must be shown. If profile control is being used, these elements (and appropriate items from other checklists) must be included.
7. Cattle exclusion, if planned, must be included in design drawings.
8. Maintenance plan which includes preventative and corrective measures (such as trash racks, if used), assignment of personnel for maintenance during storms, inspection and reporting requirements, maintenance logs, etc.
9. Post construction evaluation and monitoring plan with allocated money in the construction budget.

Hydraulic Design Culvert (new): *See Parts IX, and XII, California Salmonid Habitat Restoration Manual, 3rd edition, California Department of Fish and Game.*

1. Completed Design Form from Part XII.

2. Target species, life stages and migration timing at project site.
3. Documentation that other fish passage methods are not feasible at site.
4. Calculation of lower and upper fish passage stream flows.
5. Calculation of average water velocities and depths at lower and upper fish passage flows for each target species and life stage.
6. Demonstration that inlet and outlet conditions are not forming a velocity or height barrier over the range of fish flows.
7. Geotechnical information may be necessary to ensure project design is structurally appropriate.
8. Design drawings showing site topography, control points, structural dimensions in plan, elevation, and cross-sectional views, and important component details. Plan view must be of sufficient channel length to show culvert alignment with respect to the existing channel. Channel and culvert slope as well as channel width outside the influence of the culvert must be shown. If profile control is being used, these elements (and appropriate items from other checklists) must be included.
9. If crossing has multiple bores, all bores must be shown. If one is being designated or designed for fish passage, that bore must be so labeled.
10. Cattle exclusion, if planned, must be included in design drawings.
11. Maintenance plan which includes preventative and corrective measures (such as trash racks, if used), assignment of personnel for maintenance during storms, inspection and reporting requirements, maintenance logs, etc.
12. Post construction evaluation and monitoring plan with allocated money in the construction budget.

Hydraulic Design Culverts (retrofit): *See Parts IX, and XII, California Salmonid Habitat Restoration Manual, 3rd edition, California Department of Fish and Game.*

1. Completed Design Form from Part XII.
2. Target species, life stages and migration timing at project site.
3. Documentation that other fish passage methods are not feasible at site.
4. Calculation of lower and upper fish passage stream flows.
5. Calculation of current passage conditions.
6. Calculation of average water velocities and depths at lower and upper fish passage flows for each target species and life stage with modified conditions.
7. Demonstration that inlet and outlet conditions are not forming a velocity or height barrier over the range of fish flows.
8. Geotechnical information may be necessary to ensure project design is structurally appropriate.
9. Design drawings showing site topography, control points, structural dimensions in plan, elevation, and cross-sectional views, and important component details. Channel and culvert slope as well as channel width outside the influence of the culvert must be shown. If profile control is being used, these elements (and appropriate items from other checklists, must be included.

10. If crossing has multiple bores, all bores must be shown. If one is being designated or designed for fish passage, that bore must be so labeled. If a splitter wall is being used, it must also be shown.
11. Cattle exclusion, if planned, must be included in design drawings.
12. Maintenance plan which includes preventative and corrective measures (such as trash racks, if used), assignment of personnel for maintenance during storms, inspection and reporting requirements, maintenance logs, etc.
13. Post construction evaluation and monitoring plan with allocated money in the construction budget.

Baffles (only allowed on retrofits): *See Part XII, especially Appendix C, California Salmonid Habitat Restoration Manual, 3rd edition, California Department of Fish and Game.*

1. Completed Design Form from Part XII.
2. Target species, life stages and migration timing at project site.
3. Documentation that other fish passage methods are not feasible at site.
4. Calculation of lower and upper fish passage stream flows.
5. Design drawings showing site topography, control points, structural dimensions in plan, elevation, and cross-sectional views (including length and slope of existing culvert), and important component details. Channel and culvert slope as well as channel width outside the influence of the culvert must be shown. If profile control is being used, these elements (and appropriate items from other checklists must be included).
6. Calculation of current passage conditions (depth and average velocities).
7. Spacing and geometry (shape and height), material and attachment method for baffles.
8. Calculation of post-baffle passage conditions (depth and average velocities), EDF, plunging and streaming flow regimes, new hydraulic capacity at 100 yr storm.
9. Demonstration that inlet and outlet conditions are not forming a velocity or height barrier over the range of fish flows.
10. If crossing has multiple bores, all bores must be shown. If one is being designated or designed for fish passage, that bore must be so labeled. If a splitter wall is being used, it also must be shown.
11. Cattle exclusion, if planned, must be included in design drawings.
12. Maintenance plan which includes preventative and corrective measures including baffles and if used), assignment of personnel for maintenance during storms, inspection and reporting requirements, maintenance logs, etc.
13. Post construction evaluation and monitoring plan with allocated money in the construction budget.

Bridge and Bottomless Culverts *(Review pertains to impacts to stream and aquatic environment, but not structural integrity or bridge loading)*

1. Identify and apply applicable fish passage technique: stream simulation, hydraulic design, not applicable, etc.
2. Calculation of 100-year flow and any other design flow

3. Water surface profiles and average channel velocities for the design flows and the 100-year flow.
4. Description of geomorphic setting of bridge and why bridge design is appropriate for the setting
5. Potential for debris loads or jams at bridge site
6. Scour analysis
7. Justification for increases in water surface elevation or velocities near the bridge (if any) and the use of any scour protection.
8. Geotechnical assessment may be necessary to ensure project design is structurally appropriate.
9. Design drawings showing site topography, control points, dimensions of bridge/culvert structure in plan, elevation, longitudinal profile, and cross-sectional views, and important component details.
10. HEC-RAS model files including boundary conditions and other model parameters.

Bank Protection

1. Calculation of design flow and 100-year flow
2. Water surface profiles and average channel velocities for design and 100-year flows
3. Geotechnical assessment may be necessary to ensure project design is structurally appropriate.
4. Design calculations, i.e. shear stress, rock sizing; root strength and suitability of selected vegetation; and determination of spur, groin, bendway weir dimensions, spacing, angle, etc.
5. Alternatives analysis and justification for using rock slope protection, if applicable.
6. Design drawings showing site topography, control points, dimensions of the bank protection in plan, elevation, longitudinal profile, and cross-sectional views, and important component details, and planting plans.