KENAI
City of Kenai | 210 Fidalgo Ave, Kenai, AK 99611-7794 | 907.283.7535 | www.kenai.city

Subject:	Request for Proposals (RFP)
Project:	Professional Civil Engineering & Construction Administration Services for Cemetery Creek Culvert Replacement
From:	Public Works Department
Released:	August 8, 2023
Preproposal Conference:	August 15, 2023 at 11:00am by Zoom details to follow
Last Day for Questions:	August 21, 2023 by 12:00pm
Delivery Deadline:	August 28, 2023, no later than 12:00pm
Proposals Received at:	Kenai City Hall 210 Fidalgo Avenue Kenai, AK 99611 ATTN: Director of Public Works
Contact Information:	publicworks@kenai.city (907) 283-8236

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KENAI

REQUEST FOR PROPOSALS (RFP)

Project Name: Professional Civil Engineering & Construction Administration Services for Cemetery Creek Culvert Replacement

Proposal Documents Available: August 8, 2023
Pre-Proposal Meeting: August 15, 2023 @ 11:00am by Zoom details to follow
Last Day for Questions: August 21, 2023 @ 12:00 PM
Proposal Due Date: August 28, 2023 no later than 12:00 PM at City Hall

The City of Kenai seeks Professional Services to assist with the development of preliminary 35% design documents for the Cemetery Creek Culvert Replacement project. The project is located between Coral St. and Birch St. just off the Kenai Spur Highway, and is in coordination with the U.S. Fish and Wildlife Service. The Project seeks to replace several existing culverts with fish passage culverts in support of salmon habitat.

Proposers should contact the Public Works Department at (907) 283-8236 to be placed on the plan holder's list to receive addenda. Attendance at the Pre-Proposal meeting is not mandatory but is recommended.

RFP documents can be obtained on the City of Kenai website at www.kenai.city or at City Hall for a non-refundable fee of $25.00.

Publish: Anchorage Daily News- August 8, 2023
Peninsula Clarion – August 8, 2023 or first available after

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REQUEST FOR PROPOSALS (RFP) INSTRUCTIONS

1.0 GENERAL INFORMATION

1.1 Purpose

The City of Kenai is seeking to enter into an agreement with a qualified firm to provide professional services toward 35% design development documents for the Cemetery Creek Culvert Replacement project. This project is in coordination with the U.S. Fish & Wildlife Service. The intent of this work is to provide a site survey, preliminary design and cost estimate to assist the City in applying for grants to cover the costs of completing 100% design documents and ultimately construction of the proposed improvements.

The Lead firm shall provide a team of professionals capable of providing solutions for Environmental, Civil, Survey, and Structural disciplines as may be required for this type of project. Based on a mutually agreed upon program and budget, the Consultant's basic services shall consist of the normal duties associated with a phased design system. These typically include: Schematic Phase Services, Design Development and Construction Document Phase Services, Bid Phase Services, and Construction Phase Services as described in this RFP. However, for this initial procurement we are only awarding to the 35% design level of effort. Once funding has been secured a future RFP will be released where the successful proposer shall take the project through the remainder of phases described above.

1.2 Background

The City of Kenai is located at the confluence of the Kenai River and Cook Inlet on the Kenai Peninsula. Current population is just under 8000 citizens, however in the summer months this fluctuates between 20,000-30,000, as tourists flock to the area as well as a large number of dip net personal use fisherman accessing the sockeye fishery. Population as a whole is seeing relatively slow growth 7100 in 2010 to approximately 7745 in 2016.

The Cemetery Creek's existing Culverts were installed in 1968 to allow a 10" AC water main to cross the creek to provide water service to the western side of Kenai. This work will require provisions for supporting or reinstalling that water line as part of the work.

1.3 Questions

Any questions regarding this proposal are to be submitted in writing to the Public Works Department by no later than the time and date specified in the ad or addendum. Questions shall be emailed to PublicWorks@kenai.city. The subject line of the fax or email should read: "Questions: Professional Civil Engineering and Construction Administration Services for Cemetery Creek Culvert Replacement.

Verbal requests for information or clarification will not be accepted. All questions will be answered and distributed to all prospective proposers via addendum. To receive project addenda, you must be on the plan holders list. To be placed on the plan holders list, please contact Lisa List either by phone at 283-8236 or email PublicWorks@kenai.city. Downloading projects from the City web site does not automatically put you on the plan holders list.

1.4 Preparation Costs

The City shall not be responsible for proposal preparation cost, nor for any cost including attorney fees associated with any (administrative, judicial or otherwise) challenge to the determination of the highest ranked proposer and/or award of contract and/or rejection of proposal. By submitting a proposal, each proposer agrees to be bound in this respect and waives all claims to such costs and fees.

1.5 Additional Services

Additional Services shall consist of providing any other services not included in the Consultant's basic services and will be authorized by a contract amendment signed by both parties and compensated at the rate listed in the Consultant's Fee Schedule for Additional Services. The fee schedule should be included with the cost proposal portion of the submitted proposal.

1.6 Timeline

Release ..... August 8, 2023
Preproposal Meeting at 11:00am via Zoom ..... August 15, 2023
Last Day for Questions by 12:00pm ..... August 21, 2023
Proposals Due by 12:00pm ..... August 28, 2023
Intent to Award (approx.) ..... *August 31, 2023*
Notice of Award (approx.) ..... *September 7, 2023*
Notice to Proceed (approx.) ..... *September 14, 2023*

These dates are approximate and subject to change.

2.0 RULES GOVERNING COMPETITION

2.1 Examination of Proposals

Proposers should carefully examine the entire Request for Proposal (RFP) and any addenda thereto, and all related materials and data referenced in the RFP. Proposers should become fully aware of the nature of the work and the conditions likely to be encountered in performing the work.

2.2 Proposal Acceptance Period

Proposals must be irrevocable for sixty (60) days following the submission date.

2.3 Confidentiality

The content of all proposals will be kept confidential until the selection of the Consultant is announced. At that time, the selected proposal is open for review by the competing proposers, excluding any tabulations and evaluations thereof. After the award of the Contract, all proposals, tabulations and evaluations will then become public information.

2.4 Proposal Format

Proposals are to be prepared in such a way as to provide a straight forward, concise delineation of the proposer's capabilities to satisfy the requirements of this RFP. Emphasis should be concentrated on:

(1) conformance to the RFP instructions;
(2) responsiveness to the RFP requirements;
(3) completeness and clarity of content.

2.5 Signature Requirements

All proposal transmittal letters and cost proposal forms must be signed. A proposal may be signed by: an officer or other agent of a corporate vendor, if authorized to sign contracts on its behalf; a member of a partnership; an owner of a privately-owned vendor; or other agent if properly authorized by a power of attorney or equivalent document. The name and title of the individual(s) signing the proposal must be clearly shown immediately below the signature.

2.6 Proposal Submission

Four (4) copies of the technical proposal are to be submitted to the City of Kenai Public Works Department at 210 Fidalgo Avenue, Kenai, AK 99611, along with one (1) copy of the Firm's Fee schedule for each discipline in a separate sealed envelope. These five (5) documents shall be submitted in a sealed envelope clearly marked with the proposer's and RFP name.

2.7 Tax Compliance

Kenai City Code requires that businesses or individuals contracting to do business with the City be in compliance with the Kenai Peninsula Borough tax provisions. No contract will be awarded to any individual or business found to be in violation.

2.8 Licenses and Certifications

Proposers shall include with their proposals copies of all licenses, certificates, registrations and other credentials required for performance under the contract. Documentation must be current and must have been issued by or under authority of the State of Alaska or, if documentation is from an outside jurisdiction, such documentation must be accepted as valid by the State of Alaska for performance in Alaska. Such documentation shall include, but is not limited to, Alaska business license and applicable professional licenses, registrations and certificates.

2.9 News Releases

News releases pertaining to the award resulting from the RFP shall not be made without prior written approval of the City of Kenai's City Manager.

2.10 Disposition of Proposals

All materials submitted in response to this RFP will become the property of the City of Kenai. One copy shall be retained for the official files of the Public Works Department and will become public record after award of the Contract.

2.11 Oral Change/Interpretation

No oral change, or interpretation, of any provision contained in this RFP is valid whether issued at a pre-proposal conference or otherwise. Written addenda will be issued when changes, clarifications, or amendments to proposal documents are deemed necessary by the City.

Proposer shall acknowledge receipt of addenda in the space provided on the Proposal Form. Only a proposal acknowledging receipt of all addenda may be considered responsive, unless the addendum, in the opinion of the City Manager, would have no material effect on the terms of the proposal. The City Manager may elect to allow a proposer to acknowledge receipt of addenda after opening proposals.

2.12 Replacement of Submitted Proposals

Replacements will be accepted by the City, and binding upon the responding firm, only if it is received by the City at the place designated for submission prior to the scheduled deadline and meets all other RFP conditions.

2.13 Late Submissions

Proposals not received prior to the date and time specified in this RFP will not be considered.

2.14 Withdrawal of Proposals

At any time prior to the scheduled closing time for receipt of RFP submittals, any responding firm may withdraw their submittal, either personally or by written request. However, a proposal may not be withdrawn after opening without the written consent of the City.

2.15 Acceptance – Rejection of Proposals

The City may reject any or all proposals if the City Manager determines that it is in the best interest of the City and may waive irregularities, other than the requirements for timeliness and manual signature, if the irregularities do not affect the competitive advantage of any proposer.

2.16 Choice of Law and Jurisdiction

The laws of the State of Alaska shall govern this RFP, and any legal action brought thereon shall be filed in the Third Judicial District at Kenai, Alaska.

2.17 Conflicts of Interests

No member of the governing body of the City of Kenai or other officer, employee or agent of the City who exercises any functions or responsibilities in connection with the carrying out of the project shall have any personal interests, direct or indirect, in any ensuing contract as a result of this Request for Proposal, without first disclosing his/her potential conflict, by submitting a letter to the Clerk's Office establishing their "intent to do business with the City." The contractor for itself and its principal employees, officers, agents, directors or shareholders covenants that neither the contractor nor any of the listed classes of individuals has nor shall acquire any interest, direct or indirect, in the project, direct or indirect, to which the contract pertains which

would conflict in any manner or degree with the performance of its work hereunder. The selected proposer further covenants that in its performance of the contract no person having such interest shall be employed, without first disclosing his/her potential conflict.

2.18 Grant Funding

While the start of this agreement is not associated with an existing Grant, it shall be understand by all parties that the City shall continue to seek and apply for Grant opportunities as they arise. The successful proposer and their sub-consultants understand that any conditions set forth as grant requirements shall be met by Owner and Proposer.

3.0 SCOPE OF WORK

3.1 Project Description

The successful proposer, once agreements have been executed, shall immediately release surveyors to gather site data while the weather still allows good visibility of conditions. Contractor shall coordinate with Utilities for this work. Location of all utilities shall be included in the initial existing conditions survey. The project area is defined as the entire 1520lf length of Lilac Ln within the existing 60' right of way, see photos attached from August 4, 2023.

The goal of this project is to repair failing asphalt areas, restore storm water drainage flow through the area by repairing concrete curb and gutter where needed, as well as adjustment of any water & sewer infrastructure to finish grade. The intent of the project is not to fully reconstruct the entire length of roadway. Drive entrances shall be looked at, providing appropriate curb cuts where necessary.

Once an existing conditions site survey is completed by the Engineer, a site walk will be conducted, in coordination with the Owner to identify locations and limits of recommended repairs. Engineer will proceed to 35% design documents with this information. With completion of 35% preliminary design, Owner will be provided with a preliminary cost estimate for review. Based on cost expectations Engineer will directed to either move forward or add / reduce potential scope of work items to comply with budgetary requirements.

3.3 Typical Project sequence expectation

The items detailed below describe what the City's expectation is for a typical project sequence once identified and funded. Projects of course vary, a Master Plan is not the same as vertical construction as example. Items below are to simply depict the course a typical project should take.

3.3.1 Program and budget

Based on a mutually agreed upon program and budget, the Consultant's basic services shall consist of the normal duties associated with a phased design system. These include: Schematic Design Phase only, as described in the Request for Proposals and the General Conditions of the Contract.

3.3.2 Task 1 - Schematic Phase Services

Plans will be submitted to the City for review at 35% completion. See also Article 1 of the General Conditions for additional requirements. Any discussions on potential value engineering components should be discussed at this time, including any additional scope of work items Owner may want to consider based on the level of understanding for project conditions at this time.

Schematic design plans (35%) should include at a minimum:

1. Cover sheet
2. Vicinity Map, legend, index and abbreviations
3. Civil [existing conditions, items requiring demolition, new fish passage culvert]
4. Preliminary cost estimate

The City will provide comments for the 35% submittal within two weeks of delivery.

3.3.3 Deliverable Conditions

Upon completion of schematic design (Task 1), the City shall be furnished with drawings and preliminary specifications in PDF file formats. In addition, one 11" x 17" and one 22" x 34" set of hard copy drawings shall be provided by the consultant. A thumb drive with all CAD files including X ref files shall be provided to Owner for the completed work. These files will be made available during a future RFP to complete the design once funding for construction has been secured.

4.0 PROPOSAL AND SUBMISSION REQUIREMENTS

To achieve a uniform review process and obtain the maximum degree of comparability, it is required that the proposals be organized in the manner specified below.

4.1 Letter of Transmittal

Briefly state your firm's understanding of the services to be performed and make a positive commitment to provide the services as specified.

List name(s) of the person(s) who are authorized to make representations for your firm, their titles, address, and telephone numbers.

The letter must be signed by a corporate officer or other individual who has the authority to bind the firm.

4.2 Firm Experience/Qualifications

Detail the firm's experience specifically within the civil design and engineering industry in Alaska. Specifically interested in number of years performing these services within Alaska, locations where these services have been performed. A firm that is willing to help the City move forward with projects of this size in a sustainable way.

4.3 Project Manager, Key Project Staff and Sub-consultants

Identify the project manager, key project staff and sub-consultants expected to provide services on behalf of the firm. Resumes should be included for each of the individuals and sub-consultants referenced. Be specific on the proposed staff regarding experience and qualifications on projects of similar size and scope.

4.4 Methodology, Approach & Timeline

Provide detailed information on the firm's methodology in assisting clients with similar needs to the City of Kenai. The firm's approach for assisting a client that may not have the funds needed to fix everything at once. Please provide a detailed timeline to complete the tasks requested.

4.5 Cost of Services / Fee Schedule

Under a separate sealed envelope submit one copy of a fee schedule for all services which may be required in performance of this work and mark on the outside of the envelope "FEE SCHEDULE". The fee schedule is to be a presentation of hourly costs per positions working on the projects. The fee schedule shall be all inclusive of overhead, general, and administrative expenses, fringe benefits, profit, insurance, etc. The Cost of Services / Fee Schedule shall count toward 25% of the available proposal points.

5.0 EVALUATION PROCESS AND CRITERIA

5.1 Evaluation Process

A committee of individuals representing the City of Kenai will perform evaluation of the proposal. The committee will rank the proposal as submitted. The City of Kenai reserves the right to award a contract solely on the written proposal.

The City also reserves the right to request oral interviews with the highest ranked firms (short list). The purpose of the interviews with the highest ranked firms is to allow expansion upon, and possible refinement of the written responses. If interviews are conducted, a maximum of three (3) firms will be short-listed. A second score sheet will be used to score those firms interviewed. The final recommendation for selection will be based on the total of all evaluators scores achieved on the second rating. The same categories and point ranges will be used during the second evaluation as for the first.

The firm, whose proposal is ranked highest by the evaluation committee, may be invited to enter into final negotiations with the City for the purposes of contract award.

5.2 Criteria

The criteria considered during evaluations are as follows:

Firm Experience/Qualifications	25%
Key Staff/Sub-consultants Experience/Qualifications	25%
Methodology/Approach/Time line	25%
Cost of Services	25%

6.0 SELECTION PROCESS

The Proposer with the highest total evaluation points may be invited to enter into contract negotiations with the City of Kenai. If an agreement cannot be reached with the highest ranked Proposer, the City shall notify the proposer and terminate the negotiations. If proposals are submitted by one or more other proponents determined to be qualified, negotiations may then be conducted with such other proposers in the order of their respective rankings. This process may continue until successful negotiations are achieved. The City of Kenai reserves the right to reject any and all proposals submitted.

7.0 APPEAL PROCEDURE

Any party submitting a proposal for this procurement and who believes that they are adversely affected by the City's procurement process, or by any acts of the City in connection with the award of a City contract, may file a protest appeal with the City's Public Works Director. All protest appeals must be filed with the City within 10 days of the issuance of the City's notice of its intent to award the contract. The City Manager will decide the appeal. The protest appeal must be in writing and shall include the following information:

A. the name, address, e-mail, and telephone and facsimile numbers of the protester;

B. the signature of the protester or the protester's representative;

C. identification of the solicitation or contract at issue;

D. a detailed statement of the legal and factual grounds of the protest, including copies of relevant documents; and,

E. the form of relief requested.

The protest appeal may be hand-delivered, faxed, or sent by U.S. mail with postage prepaid to the attention of the Public Works Director, 210 Fidalgo Avenue, Kenai, AK 99611. Regardless of the method of delivery chosen by the protester, all protest appeals must be actually received by the City within 10 calendar days of the issuance of the City's notice of intent to award. If the tenth day is a City-recognized holiday or a weekend, the deadline for appeal shall be the next work day. It is up to the protester to choose a method of delivery to assure timely receipt by the City.

The City Manager shall decide the protest appeal and issue a written decision under the following general procedures:

A. If the City Manager sustains a protest in whole or in part, the City Manager shall implement an appropriate remedy.

B. In determining an appropriate remedy, the City Manager shall consider the circumstances surrounding the solicitation or procurement including the seriousness of the

procurement deficiencies, the degree of prejudice to other interested parties or to the integrity of the procurement system, the good faith of the parties, the extent the procurement has been accomplished, costs to the agency and other impacts on the agency of a proposed remedy, and the urgency of the procurement to the welfare of the City.

C. Notwithstanding subsections A and B immediately above, if the City Manager sustains a protest appeal in whole or part, the protester's damages shall not exceed the reasonable proposal preparation costs.

The City Manager shall deliver his or her determination of the protest appeal in writing to the protester by hand-delivery at the protester's place of business or other address or via U.S. Mail or facsimile, and shall be effective immediately upon receipt if hand-delivered, upon receipt of delivery confirmation if sent by facsimile or, if mailed, three days after placement in the U.S. Mail.

A party filing a protest appeal may appeal the City Manager's decision to the Kenai Superior Court.

8.0 SAMPLE CONTRACT OR MINIMUM MANDATORY CONTRACT PROVISIONS

In addition to carefully reading all of the information in the RFP, all Proposers must carefully read and review the attached sample contract. The successful Proposer shall be required to enter into a Contract with the City of Kenai, which will be substantially similar to the sample.

Therefore, the Proposer must identify any proposed changes to the sample Contract per the procedures detailed in Section 1.3 of this RFP.

If no changes are made, the proposer shall be deemed to have accepted the sample contract. If the respondent makes changes, such changes will be considered in any negotiations with the City. Changes made to the sample contract shall not be considered during the evaluation process.

CITY OF KENAI

AGREEMENT BETWEEN OWNER AND CONSULTANT FOR PROFESSIONAL DESIGN SERVICES

MADE AS OF THE _____ DAY OF _____ 2023.

BETWEEN the OWNER: CITY OF KENAI
210 Fidalgo Avenue
Kenai, Alaska 99611

AND the CONSULTANT:

FOR the PROJECT: Professional Civil Engineering & Construction Administration Services for Cemetery Creek Culvert Replacement

The Owner and Consultant agree as set forth below.

ARTICLE 1

THE WORK

The Consultant shall perform all the work described in the Request for Proposals as Attachment "A" hereto, and in the Consultant's Proposal, as Attachment "B" hereto, consisting of:

1. Basic Services, as described in the General Conditions, including Schematic Phase Services, Design Development and Construction Document Phase Services, Bidding Phase Services, and Construction Phase Services.

2. Additional Services, if authorized, as described in ARTICLE 2 of the General Conditions.

ARTICLE 2

TIME OF COMMENCEMENT AND COMPLETION

The Consultant's performance of services required by this Agreement shall commence with a Notice to Proceed and shall be completed in accordance with the following schedule:

1.	Schematic Design Phase Services	Within 60 days of Notice to Proceed
2.	Design Development and Construction Document Phase Services	N/A
3.	Construction Bid Documents	N/A
4.	Construction Phase Services	N/A

ARTICLE 3

COMPENSATION

The Owner shall compensate the Consultant in accordance with the General Conditions of this Agreement as follows:

1. FOR THE CONSULTANT'S BASIC SERVICES, as described in ARTICLE 1 of the General Conditions, Compensation will be paid periodically on a time and expense basis in accordance with the Consultant's Cost Proposal and Fee Schedule as Attachment "B" hereto, in a total amount not to exceed the sum of $_____.

2. FOR THE CONSULTANT'S ADDITIONAL SERVICES, as described in ARTICLE 2 of the General Conditions, Compensation will be paid for Principal's, employees', and subconsultant's time at the fixed gross hourly billing rates set forth in the Fee Schedule as Attachment "B" hereto, and as per ARTICLE 6 of the General Conditions. Payment of additional services is not included in the "shall not exceed" provisions contained in the contract documents.

3. FOR THE CONSULTANT'S REIMBURSABLE EXPENSES, as described in Article 7 of the General Conditions, Compensation will be paid in accordance with the Consultant's Cost Proposal and Fee Schedule as Attachment "B" hereto, in a total Amount not to exceed $_____.

4. THE CONSULTANT'S EXTENDED BASIC SERVICES BEYOND THE CONSTRUCTION PHASE, if authorized, shall commence with a written Notice to Proceed with the performance of those services. These services will be paid as additional services. This payment is not included in the "shall not exceed" provisions contained in the contract documents.

5. The total payment under these contract documents, including payment for basic services and reimbursable expenses shall not exceed $ _____. Any payment beyond this amount including payment for additional services, extended basic services and related expenses may be made only pursuant to a fully executed change order or contract modification specifically stating the amount of payment agreed upon. In the event this paragraph conflicts with or is inconsistent with any other provision in the contract documents, this provision shall control.

Based upon applications for payment submitted by Consultant, Owner shall provide for Progress Payments to Consultant on a monthly schedule. Upon proper application submitted no later than ten (10) days prior to the next scheduled payday, Consultant shall be paid for the value of the work performed during the period preceding application. Each application for payment shall be on an approved Application for Payment form. All sums properly due shall be paid within thirty (30) days of receipt of application. Prior to final payment, the Consultant shall submit as-built drawings or other documents as required by the contract documents.

ARTICLE 4

ENUMERATION OF CONTRACT DOCUMENTS

The documents which are specifically incorporated into this agreement by reference and form the contract documents are:

A. Any and all later modifications, Change Orders, and written interpretations of the Contract Documents issued by the Owner
B. This Agreement
C. Addenda No(s)_____

D. The Contractor's Proposal, including Cost Proposal and Fee Schedule
E. Supplemental General Conditions (if any)
F. The General Conditions of the Contract
G. The Request for Proposals

Any other attachments to this agreement do not form a part of the agreement but are for reference or proof of compliance with the requirements of the agreement, except where the provisions of this agreement provide such attachments will be or are a part of the agreement.

These form the contract and what is required by any of the documents shall be as binding as if required by all. The intention of the contract documents is to require the furnishing of all labor, material, equipment, and other items necessary for the proper execution and completion of the work and to prescribe the terms and conditions of the contract and payment, so as to include work and materials which may be necessary to produce the intended results.

ARTICLE 5

All legal notices relating to this contract, including change of address, shall be mailed to the Owner and the Consultant at the following addresses:

OWNER

City of Kenai
Scott Curtin, Director of Public Works
210 Fidalgo Avenue
Kenai, Alaska 99611

CONSULTANT

ARTICLE 6

EXTENT OF AGREEMENT

This Agreement represents the entire and integrated agreement between the Owner and the Consultant, and supersedes all prior, inconsistent negotiations, representations, or agreements, either written or oral. This Agreement may be amended only by written instrument signed by both Owner and Consultant.

IN WITNESS WHEREOF, the parties have caused this agreement to be executed in their respective names by their duly authorized representatives as of the date and year above written.

ARTICLE 7

ATTACHMENTS

In the event there is any difference between an attachment to the original of this agreement on file with the City of Kenai and any attachment to a duplicate original of the agreement, the attachments to the original filed with the City shall control.

ARTICLE 8

NO THIRD-PARTY BENEFICIARY

This agreement is intended solely for the benefit of each party hereto. Nothing contained herein shall be construed or deemed to confer any benefit or right upon any third party.

IN WITNESS WHEREOF, the parties have caused this agreement to be executed in their respective names by their duly authorized representatives as of the date and year first above written.

ARTICLE 9
JURISDICTION: CHOICE OF LAW

This contract shall be governed by the laws of the State of Alaska, and any lawsuit brought thereon shall be filed in the Third Judicial District at Kenai, Alaska.

OWNER and CONSULTANT each binds themselves, their partners, successors, assigns and legal representatives in respect to all covenants, agreements and obligations contained in the Contract Documents.

IN WITNESS WHEREOF, the parties have caused this agreement to be executed in their respective names or by their duly authorized representatives as of the date and year above written.

OWNER:
CITY OF KENAI

By: _____

Name: _____

Title: _____

STATE OF ALASKA)
)ss.
THIRD JUDICIAL DISTRICT)

THIS IS TO CERTIFY that on

this ____ day of _____, 2023

Terry Eubank, City Manager,

City of Kenai, Alaska, being personally known to me or having produced satisfactory evidence of identification, appeared before me and acknowledged the voluntary and authorized execution of the foregoing instrument on behalf of said City.

_____
NOTARY PUBLIC FOR ALASKA
My Commission Expires: _____

Approved by Legal: _____
Approved by Finance: _____

CONSULTANT:

By: _____

Name: _____

Title: _____

STATE OF ALASKA)
)ss.
THIRD JUDICIAL DISTRICT)

THIS IS TO CERTIFY that on

this ____ day of _____, 2023

_____,

(title) _____

of _____ being personally known to me or having produced satisfactory evidence of identification, appeared before me and acknowledged the voluntary and authorized execution of the foregoing instrument on behalf of said corporation.

_____
NOTARY PUBLIC FOR ALASKA
My Commission Expires: _____

GENERAL CONDITIONS OF THE CONTRACT
BETWEEN OWNER AND CONSULTANT
FOR PROFESSIONAL DESIGN SERVICES

THIS DOCUMENT MAY BE ALTERED OR AMENDED ONLY
BY ADDENDUM, CHANGE ORDER OR OTHER DOCUMENT EXECUTED BY ALL PARTIES

ARTICLE I CONSULTANT'S BASIC SERVICES

1.1 Basic Services

Without limiting any obligations arising under law, Consultant's Basic Services are enumerated for each of the phases described below and include normal Engineering and Architectural services.

1.2 Schematic Phase

1.2.1 Consultant shall review the program furnished by Owner to ascertain the requirements of the Project and shall review Consultant's understanding of such requirements with Owner.

1.2.2 Consultant shall provide a preliminary evaluation of the program and the Project budget requirements, each in terms of the other, subject to the requirements and limitations set forth in ARTICLE 4.

1.2.3 Consultant shall review with Owner alternative approaches to design and construction of the Project.

1.2.4 Based on the mutually agreed-upon program and Project budget requirements, Consultant shall prepare, for approval by Owner, Schematic Design Documents consisting of drawings and other documents illustrating the scale and interrelationship of Project components.

1.2.5 Consultant shall submit to Owner a Statement of Probable Construction Cost based on area, volume, or other unit costs, in conformity with all elements of the Schematic Design Documents.

1.2.6 Upon completion of schematic design, the Owner shall be furnished with drawings and specifications in PDF file formats. In addition, one 11" x 17" and one 22" x 34" set of hard copy drawings shall be provided by the consultant.

1.3 Design Development Phase

1.3.1 Based on the approved Schematic Design Documents and any other adjustments authorized by Owner in the program or Project budget, Consultant shall prepare, for approval by Owner, Design Development Documents consisting of drawings and other documents to fix and describe the size and character of the entire Project as to architectural, structural, civil, mechanical, and electrical systems, materials, and such other elements as may be appropriate.

1.3.2 Consultant shall submit to Owner a further Statement of Probable Construction Cost, in conformity with all elements of the Design Development Documents.

1.4 Construction Documents Phase

1.4.1 Based on the approved Design Development Documents and any further adjustments authorized by Owner in the scope or quality of the Project or in the Project budget, Consultant shall prepare, for approval by Owner, Construction Documents consisting of Drawings, Specifications, and other items as may be required to detail the requirements for the construction of the entire project in accordance with good design practice and all requirements of agencies having jurisdiction over the work.

1.4.2 Consultant shall provide all documents for this Project in a format and on media approved by Owner or as defined in the Request for Proposals.

1.4.3 Consultant shall provide in the Construction Documents all of the necessary bidding information, including site plans, floor plans, elevations, sections and details sufficient to show all the requirements of the work. If required by Owner, Consultant shall prepare the Construction Documents for additive alternate bids, unit prices, and phasing of the work.

1.4.4 The substantial aspects of the design as indicated by the Working Drawings and Specifications shall comply with the requirements and regulations adopted pursuant to the Occupational Safety and Health Act (OSHA), the Americans with Disabilities Act (ADA), and all requirements of local and state building, fire, mechanical, electrical and other codes in effect at the time of completion of the Construction Documents Phase of work.

1.4.5 Consultant shall prepare and submit the required documents for the approval of federal, state and local governmental authorities having jurisdiction over the Project and shall be responsible for obtaining all necessary approvals.

1.4.6 Consultant shall provide such additional information as may be required by regulatory agencies in order for such agencies to certify the relevant applications as complete.

1.4.7 Consultant shall submit to Owner a final detailed Statement of Probable Construction cost of the project.

1.4.8 Upon completion of final design, Owner shall be furnished with 2 DVD's or flash drives of drawings in both DWG and PDF file formats and specifications in both DOCX and PDF file formats. In addition, one 11" x 17" and one 22" x 34" set of hard copy drawings shall be provided by the consultant.

1.5 Bidding Phase

1.5.1 Consultant, following Owner's approval of the Construction Documents and the final Statement of Probable Construction Cost, shall assist Owner in conducting a pre-bid conference, in preparing addenda, in reviewing bids, and in evaluating bidder's qualifications. Based on the results, Consultant shall submit a recommendation for award of contract.

1.5.2 Consultant shall conduct any mandatory pre-bid conference and shall issue any addenda required to correct errors or omissions in the bid documents, or to clarify items in the bid documents.

1.6 Construction Phase

1.6.1 The Construction Phase will commence with the award of the Construction Contract and will terminate when the final Certificate for Payment is approved by Owner.

1.6.2 Consultant shall administer the Construction Contract as set forth herein, and the extent of Consultant's duties and responsibilities and the limitations of Consultant's authority as assigned hereunder shall not be modified without the written consent of both parties.

1.6.3 Consultant, as the representative of Owner during the Construction Phase, shall advise and consult continually with Owner. Both Consultant and Owner shall at all times have access to the Work wherever it is in preparation or progress. Instructions to the contractor shall be issued through Consultant. Consultant shall have authority to act on behalf of Owner to the extent provided herein unless otherwise modified in writing. Consultant shall provide Owner with copies of all correspondence relating to the Project and shall promptly inform Owner of any circumstances affecting the quality, cost or completion of the work. Consultant shall organize a system of filing and transmitting all documents and correspondence relating to the project.

1.6.4 Owner shall have the right to make all final determinations whether an item or material, proposed by the contractor as a substitute for a specified item or material, equals or exceeds the quality of that specified in the Construction Documents. Owner shall make a final determination within seven (7) days after receipt of written request by Consultant.

1.6.5 For the Contract fee, Consultant, appropriate staff personnel, and Consultant's consultants, shall make periodic visits to the site, as approved by Owner in advance, for familiarization generally with the progress and quality of the work, conformance with the design intent and as required for completion of record drawings. A Schedule of Visits will be incorporated by reference if included as an attachment hereto.

1.6.6 Consultant shall provide additional inspection services beyond those described herein upon request of Owner in accordance with ARTICLE 2.

1.6.7 Based upon the observations of the Project Observer at the site and upon the contractor's Application for Payment, Consultant shall determine the amount then due to the contractor and shall approve Certificates for Payment within 5 days after receipt thereof. Consultant's approval shall constitute a representation by Consultant to Owner, that the work has progressed to the point indicated; that to the best of Consultant's knowledge, information, and belief, the quality of the work is in accordance with the contract documents; and that the contractor is due payment in the amount certified. By issuing a Certificate for Payment as defined in the contract documents, Consultant shall not be deemed to represent that Consultant has made any examination to ascertain how, and for what purpose, the contractor has used the monies paid on account of the contract sum.

1.6.8 Consultant shall demand proof of payment to subcontractors or materialmen, or releases from subcontractors or materialmen, before the issuance of a final Certificate for Payment.

1.6.9 Consultant shall, in the first instance, interpret and explain the requirements of the contract documents, and be judge of the performance thereunder by the contractor. Consultant shall make the initial decision on all claims and questions of the contractor relating to the execution and progress of the Work, and on all other matters or questions related thereto.

1.6.10 Consultant shall have authority to reject Work, which does not conform to the contract documents. Whenever, in Consultant's reasonable opinion, Consultant considers it necessary or advisable to ensure the proper implementation of the intent of the contract documents, Consultant will have authority to require special inspection or testing of any Work in accordance with the provisions of the contract documents, whether or not such work be fabricated, installed, or completed.

1.6.11 Consultant shall review and accept (as complying with design concept and the requirements of the contract documents) or take other appropriate action upon the contractor's submittals such as shop drawings, product data, and samples. **Such action shall be performed within 5 working days after receipt of the contractor's submittals**. Consultant's acceptance of a specific item shall not indicate approval of assembly of which the item is a component.

1.6.12 Consultant shall prepare Change Orders for Owner's approval and execution in accordance with the contract documents. Consultant shall have authority to order minor changes in the work not involving an adjustment in Contract Sum or an extension of Contract Time, and not inconsistent with the intent of the contract documents. Consultant shall notify Owner in writing, on a form approved by Owner, of all changes including authorized extras at no additional cost.

1.6.13 Consultant shall conduct inspections to determine the dates of Substantial Completion and Final Completion as defined in the contract documents. Consultant shall determine the date of Substantial Completion and issue a Certificate of Substantial Completion allowing for beneficial occupancy by Owner. The Certificate of Substantial Completion shall set a reasonable time for the contractor to complete the work and to correct any deficiencies noted by Consultant. Consultant shall make recommendations (based on then current market values and labor costs) of the amounts of payment to be withheld by Owner until the deficiencies are corrected and the Work completed. Consultant shall receive, review, and transmit to Owner written guarantees, warranties, and related documents assembled by the contractor. Consultant shall issue a final Certificate for Payment upon final completion of the work.

1.6.14 Consultant shall not be responsible for (1) construction means, methods, techniques, sequences or procedures; or (2) the safety precautions or programs of the contractor; or (3) any acts or omissions of

the contractor, any subcontractor, or any of the contractor's or subcontractors' agents or employees, or of any other person performing any of the work.

1.6.15 Consultant shall furnish Owner, within 60 days after final completion of the work, 2 DVD's or flash drives of as-built drawings in both DWG and PDF file formats and specifications in both DOCX and PDF file formats. In addition, one 11" x 17" paper and one 22" x 34" MYLAR set of as-built drawings shall be provided. As-built documents are subject to review by owner and subsequent revision by Consultant.

ARTICLE 2 CONSULTANT'S ADDITIONAL SERVICES

2.1 If any of the following additional services are authorized by Owner in writing, Owner agrees to pay Consultant in accordance with Consultant's Fee Schedule (as attached hereto). Prior to authorization Owner must be expressly informed that the services requested require additional Consultant fees and an estimate of the amount of additional fees must be provided by Consultant. Payment will be made in accordance with Article 6.

2.2 Consultant's additional services may include the following:

2.2.1 Provide planning surveys, site evaluations, environmental studies, or comparative studies of prospective sites. Prepare special surveys, studies, and submissions required for approvals of governmental authorities or others having jurisdiction over the project.

2.2.2 Provide design services relating to future facilities, systems, and equipment which are not intended to be constructed as part of the Project.

2.2.3 Provide services to facilitate detailed appraisals and evaluations of existing conditions or facilities and make measured drawings thereof. Services may include surveys or inventories required in connection with construction performed by Owner.

2.2.4 Prepare drawings and specifications for Change Orders requested by Owner, where the changed work was not envisioned by the approved construction documents and therefore results in a construction cost which exceeds the Consultant's Statement of Probable Construction Cost.

2.2.5 Make major revisions in Drawings, Specifications, or other documents when such revisions are inconsistent with written approvals or instructions previously given and are due to causes beyond the control of Consultant.

2.2.6 Provide consultation concerning replacement of any Work damaged by fire or other causes during construction, and furnish service as may be required in connection with the replacement of such Work.

2.2.7 Provide services necessitated by default of the contractor or by major defects or deficiencies in the Work of the contractor or by failure of performance of either Owner or the contractor under the contract for construction, unless such default or failure was caused by deficiencies in the Work of Consultant.

2.2.8 Provide extensive assistance in the utilization of any equipment or system, including supervision of initial start up; testing, adjusting and balancing of equipment; preparation of operation and maintenance manuals; training personnel for operation and maintenance; and consultation during normal operation of the Project.

2.2.9 Provide contract administration and observation of construction after the Construction Contract Time has been exceeded or extended by more than 30 days through no fault of Consultant and after 20 days' written notice thereof has been given to Owner by Consultant. In that event, compensation shall revert to the hourly rates delineated in the Fee Schedule attached hereto. Owner may, however, elect to administer the contract after receipt of such notice, and no payment will be made to Consultant for extended administration and observation performed prior to issuance by Owner to Consultant of a written order to continue providing contract administration.

2.2.10 Provide services required after the approval of the contractor's final Certificate for Payment, but excluding completion of Record Drawings and necessary follow-up actions.

2.2.11 Prepare and serve as an expert witness in connection with any public hearing, arbitration proceeding, or legal proceeding in connection with the Project where Consultant is not at fault, and is not a party thereto, providing such activities occur within the one year warranty period as defined in the contract documents. For such activities occurring after the warranty period, the Fee Schedule for Additional Services shall be revised as mutually agreed to by the parties to the contract.

2.2.12 Provide any other services not otherwise included in this contract and not customarily furnished as basic services in accordance with generally accepted Consultant practice.

ARTICLE 3 OWNER'S RESPONSIBILITIES

3.1 Owner shall provide full information regarding Owner's requirements for the Project.

3.2 The City Manager is hereby designated as the representative authorized to act in Owner's behalf with respect to the Project, and the City Manager is hereby authorized to appoint, and to rescind the appointment of, a designee to exercise such authority in the City Manager's place. Owner's representative, or Owner's designee, shall examine documents submitted by Consultant and shall render decisions pertaining thereto promptly, to avoid unreasonable delay in the progress of Consultant's work.

3.3 Owner shall furnish structural, mechanical, chemical, and other laboratory tests, inspection, and reports as required by law or the contract documents.

3.4 If Owner observes or otherwise becomes aware of any fault or defect in the Project or non-conformance with the contract documents, Owner shall give prompt written notice thereof to Consultant.

3.5 Owner shall furnish to Consultant all information which Owner is required to provide as expeditiously as necessary for the orderly progress of the Work upon request of Consultant.

ARTICLE 4 BUDGETS AND COST ESTIMATES

4.1 The Construction Budget does not include the compensation of Consultant and sub-consultants, the cost of the land, rights-of-way, or other costs that are the responsibility of Owner as provided in ARTICLE 3.

4.2 Statements of Probable Construction Cost and Total Budget Estimates prepared by Consultant represent Consultant's best judgment as a design professional familiar with the construction industry. It is recognized, however, that neither Consultant nor Owner has any control over the cost of labor, materials, or equipment, over the contractor's methods of determining bid prices, or over competitive bidding or market conditions. Accordingly, Consultant cannot and does not guarantee that bids will not vary from any Statement of Probable Construction Cost or other cost estimate prepared by Consultant.

4.3 If a final Statement of Probable Construction Cost, including contingency and any anticipated cost escalations through the proposed bid date, exceeds the Construction Budget of the Project, Owner shall either: (1) give written approval of an increase in such fixed limit; (2) cooperate with Consultant in revising the Project scope and quality as required to reduce the Probable Construction Cost; or (3) cancel the project.

4.4 If the lowest bona fide bid or negotiated proposal exceeds the amount budgeted as the construction cost for this project, Owner may elect to: (1) give written approval of an increase in such fixed limit; (2) cooperate in revising the Project scope and quality as required to reduce the Construction Cost; (3) authorize rebidding the Project within a reasonable time; or (4) cancel the project.

4.5 If Owner elects to reduce the scope or quality of the Project because the construction budget may be exceeded, either before or after the opening of bids, then Consultant, without additional charge shall

modify the Drawings and Specifications as necessary to bring the statement, estimate, or bid within the fixed limit. Providing such services shall be the limit of Consultant's responsibility in this regard, and having done so, Consultant shall be entitled to the regular compensation established by the contract.

4.6 Definitions

4.6.1 Probable Cost Estimate: An estimate of the costs to construct the facility including all of the structure. Not included in this estimate are administration costs, utility costs, and Consultant fees. This estimate is to be prepared by Consultant.

4.6.2 Construction Cost Budget: The budget that is established to construct the project. Not included in this budget are administration costs, utility costs, and Consultant fees.

4.6.3 Total Budget: The total budget includes all budget items, Construction Cost Budget, administration costs, utility costs, Consultant fees, movable equipment and contingencies.

4.6.4 Contract Sum: The cost submitted by the contractor as the bid to complete all work for the construction of the Project. Not included in this cost are administration costs, utility costs, and Consultant fees.

ARTICLE 5 PAYMENTS TO CONSULTANT

5.1 Payments for Consultant's Basic Services shall be made after approval by Owner of Consultant's submissions in accordance with the contract. Owner shall review each submission and invoice, and Owner shall pay the invoice amount to Consultant within 30 days after approval of Consultant's submission and invoice by Owner. If a submission is not approved by Owner, it shall be returned to Consultant for rework, and no payment to Consultant shall be made. Consultant shall rework the submission and transmit the reworked submission with a new invoice to Owner in a timely manner for review and approval by Owner in accordance with the contract.

5.2 Payments for Consultant's Additional Services as defined in ARTICLE 2 and for Reimbursable Expenses as defined in ARTICLE 7 shall be made upon presentation of Consultant's statement of services rendered in accordance with the contract.

5.3 If Consultant's Additional Services are terminated or suspended in whole or in part through no fault of Consultant, then Consultant shall be paid compensation for services performed prior to receipt of written notice from Owner of suspension or termination, subject to the provisions of ARTICLE 6 and ARTICLE 10. If the Additional Service is resumed after being suspended for more than 90 days, Consultant's compensation for the Additional Services shall be subject to renegotiation.

5.4 Consultant shall render a final billing to Owner for all retained compensation prior to final payment to Consultant. The final billing shall be rendered within 60 days after the Project has been closed out. Owner shall not be required to pay any amounts billed after this time.

5.5 In the event the entire project is suspended for a period in excess of 90 days, or Consultant is not ordered to proceed to the next phase within 90 days after completion of a previous phase, then Consultant's compensation for basic services and additional services shall be subject to renegotiation if the project is resumed. If the renegotiated fee has not been mutually agreed upon within 14 days after issuance of Notice to Proceed to the next phase, Owner shall be free to terminate the contract and to negotiate freely with other Consultants for completion of the Project utilizing all drawings, specifications, files, notes and other work previously completed under this contract. Consultant will receive 7 days written notice of termination for failure of renegotiation efforts. In the event of such termination, Consultant shall be paid only for services already performed and shall have no further recourse.

ARTICLE 6 PAYMENT FOR ADDITIONAL SERVICES

6.1 For the purpose of determining compensation for additional services of employees or Principals engaged on the Project by Consultant, gross hourly billing rates shall be used. The term employees shall include Consultants, Technicians, Draftsmen, and Secretaries who are engaged in consultation,

research, and design, in producing Drawings, Specifications, and other documents pertaining to the Project, and in rendering additional services during construction at the site. Services of Sub-consultants or other Professional Services contracted upon prior approval of Owner shall be billed at 1.1 times the basic fee cost without markup.

6.2 Gross hourly billing rates for additional services are noted on Consultant's Fee Schedule as an attachment hereto. Such hourly rates include all wages and salaries paid to Consultant's employees engaged on the Project, payroll taxes, other taxes required by state or federal law, benefits such as vacation, sick leave, retirement plans, pension funds, profit sharing, and any other benefits contracted for or agreed to by said employees and Consultant. Such hourly rates include compensation for any overtime worked by Consultant's employees and sub-consultants, and also include Consultant's overhead and profit for additional services described herein. The aforementioned hourly rates are not subject to escalation, except as noted in ARTICLE 5.3 and 5.5.

ARTICLE 7 REIMBURSABLE EXPENSES

7.1 Reimbursable Expenses are in addition to the Compensation for Basic and Additional Services and include actual out-of-pocket expenditures made by Consultant, Consultant's employees, or Consultant's professional sub-consultants in the interest of the Project. Reimbursable expenses do not include ordinary overhead expenses and are limited to the expenses listed in ARTICLE 7. Expenses the Consultant consider reimbursable shall be approved by Owner prior to incurring the expense.

7.2 Reimbursable Expenses include the following:

a. Transportation, meals and actual lodging expenses when traveling with the prior approval of Owner in connection with the project, including Owner requested meetings with various committees, boards; long distance calls and telegrams; and fees paid for securing approval of authorities having jurisdiction over the project.

b. Except as required in these general conditions or other contract documents including the instructions to proposers, expense of reproduction, postage, and handling of drawings and specifications.

c. Surveying and Mapping, or other uses services requiring specialized training, programs, or systems when used in connection with Additional Services.

7.3 Consultant shall not be reimbursed for those expenses for which Owner has not been billed within 90 days after the expenses have been incurred, except that the final billing shall be rendered within 60 days after Project closeout.

ARTICLE 8 INSURANCE

8.1 The services to be rendered under this contract are those of an independent Contractor.

8.2 Contractor and all subcontractors, if any, shall be responsible for the purchase and maintenance of all insurance required by law and at a minimum purchase the insurance coverage as specified in ARTICLE 8. Such insurance shall be by a company/corporation currently rated "A-"or better by A.M. Best.

8.3 This insurance coverage required by ARTICLE 8 shall be in acceptable form, and for the amounts specified by the City of Kenai, or as required by law, whichever is greater.

8.4 The insurance policies shall remain in force for the life of the contract and shall be a part of the contract price.

8.5 Commercial general liability with minimum coverage of $1,000,000, automobile liability insurance with minimum coverage of $1,000,000 combined single limit bodily injury and property damage per occurrence, and insurance covering work on this project that provides a minimum coverage of $1,000,000 against any claim arising out of professional liability/errors or omissions of Consultant and/or

Consultant's subcontractors. This insurance shall be primary and exclusive of any other insurance carried by the City of Kenai. The commercial general liability insurance shall be without limitation on the time within which the resulting loss, damage, or injury is actually sustained.

8.6 Per Alaska State Statutes, Worker's Compensation and Employers Liability Insurance shall be provided for all employees who are performing work under this contract.

8.7 Certificate(s) of Insurance shall be provided by Contractor and all subcontractors, or their Insurance Companies and/or their Agents, naming the City of Kenai as an additional insured for the work specified in this contract with a waiver of subrogation for commercial general liability insurance and automobile liability insurance. The certificates of insurance must reference the specific contract by name. Workers compensation insurance must be endorsed for waiver of subrogation against the City. Certificates of Insurance, acceptable in form and content, will be delivered to Owner at the address designated for legal service in the agreement, at or prior to presentation of the contract for execution by owner.

8.8 There shall be no cancellation or material change of the insurance coverage, or intent not to renew the insurance coverages as specified in this contract, without thirty (30) days prior written notice to the City of Kenai. Notice of cancellation, material change in coverage, or intent not to renew will be delivered to the address designated for legal notice in the agreement.

8.9 Upon renewal or change in policies during the contract, Certificates of Insurance shall be delivered to the address designated for legal notice in the agreement.

8.10 Owner shall have the option to purchase and maintain such insurance as will protect Owner against property losses or liability claims, which may arise from operations under the contract. Insurance providing coverage against fire and extended coverage perils, may, at Owner option, provide coverage to the full insurable value of the project and insure the interests of Contractor and all subcontractors as their interests may appear. Any recovery for loss insured pursuant to this General Condition is to be adjusted to Owner and made payable to Owner as trustee for the insured, as their interests may appear. This section does not modify the contractor or subcontractors' responsibility to provide insurance as required in ARTICLE 8.

ARTICLE 9 CONSULTANT'S ACCOUNT RECORDS

9.1 Records of reimbursable expenses and expenses pertaining to additional services and services performed on the basis of gross hourly billing rates shall be in a form acceptable to Owner and shall be available to Owner or Owner's authorized representative for audit at mutually convenient times for a period of up to three years after completion of services and final payment. Allowable Consultant's compensation may be modified to conform to the results of any audit, and any excess compensation or expenses shall be refunded to Owner.

ARTICLE 10 PROJECT CLOSE-OUT AND TERMINATION OF AGREEMENT

10.1 Contract between Owner and Consultant will be closed out when the Project has been satisfactorily completed and Consultant has performed all of Consultant's obligations under the contract. Project shall not be closed out until Final Completion has been certified and all record drawings and other documentation have been provided to Owner. Project shall be formally closed out by a written memorandum signed by both Consultant and Owner specifying any adjustments to the contract, together with any sums of money remaining due. The memorandum closing out the Project shall constitute a resolution of all payments for contractual services and reimbursable expenses except those specifically noted in the memorandum. Within 30 days after Owner and Consultant have executed the memorandum closing out the Project, Owner shall pay to Consultant all sums of money remaining due to Consultant including all remaining retained money.

10.2 This contract may be terminated by either party upon 30 days written notice, should the other party fail substantially to perform in accordance with the Terms and Conditions hereof.

10.3 This contract may be suspended or terminated by Owner for Owner's convenience, for any reason deemed by Owner to be in the best interest of Owner.

10.4 In the event of termination not due to fault of Consultant, Consultant shall be paid compensation for services actually performed and for reimbursable expenses actually incurred in accordance with the contract and ARTICLE 5, if services are performed and expenses incurred prior to the dates specified in the termination notice.

10.5 Should this agreement be terminated because Consultant has failed substantially to perform Consultant's duties in a satisfactory or in a timely manner, then Consultant shall be paid only for the actual value of Consultant's services to date, less any damages or additional costs incurred by Owner as a result of Consultant's failure to perform Consultant's duties. In the event that additional costs to Owner exceed the amount of money then otherwise due and owing to Consultant, then Owner shall retain those monies and may immediately proceed against Consultant for excess damages.

ARTICLE 11 OWNERSHIP OF DOCUMENTS/DESIGNS

11.1 All Drawings, Specifications, and Designs are considered instruments of service. Owner shall retain an ownership interest in all instruments of service and any similar work including all intellectual property rights associated with them, whether or not completed, which are produced or provided by Consultant in performance of this contract, whether the project for which they are made is constructed or not. Owner and Consultant each reserve unlimited rights of use, without any further compensation, for this project and any subsequent project in which owner or consultant participate. Owner specifically relieves Consultant of any responsibility or liability pertaining to any subsequent use of the document by owner. Any Drawing, Specification, Design, or similar work produced or provided by Consultant in performance of this contract that contains a copyright in the name of the Consultant or any other entity other than Owner will not be accepted, and Owner will consider such submittal to be a breach of the contract.

ARTICLE 12 SUCCESSORS AND ASSIGNS

12.1 Owner and Consultant each binds themselves, their partners, successors, assigns, and legal representatives to the other party to this contract and to the partners, successors, assigns, and legal representatives of such other party with respect to all terms of this contract. Neither Owner nor Consultant shall assign, sublet, or transfer any interest in this contract without the written consent of the other.

ARTICLE 13 INDEMNIFICATION

13.1 The consultant shall indemnify, defend, and hold harmless the contracting agency from and against any claim of, or liability for, negligent acts, errors, and omissions of the Consultant under this agreement. The consultant is not required to indemnify, defend, or hold harmless the contracting agency for a claim of, or liability for, the independent negligent acts, errors, and omissions of the contracting agency. If there is a claim of, or liability for, a joint negligent act, error, or omission of the consultant and the contracting agency, the indemnification, defense, and hold harmless obligation of this provision shall be apportioned on a comparative fault basis. In this provision, "consultant" and "contracting agency" include the employees, agents, and contractors who are directly responsible, respectively, to each. In this provision, "independent negligent acts, errors, and omissions" means negligence other than in the contracting agency's selection, administration, monitoring, or controlling of the consultant, or in approving or accepting the consultant's work.

Following are definitions for terms in the above clause:

(1) "construction" means the process of building, altering, repairing, maintaining, improving, demolishing, planning, and designing a public highway, a structure, a building, a utility, infrastructure, or another public improvement to real property, but does not mean the routine operation of a public improvement;

(2) "consultant" means a person who contracts with a public agency to provide professional services;

(3) "professional services" means professional, technical, or consultant's services that are predominantly intellectual in character, result in the production of a report or the completion of a task, and include analysis, evaluation, prediction, planning, or recommendation;;

(4) "public agency" means a department, institution, board, commission, division, authority, public corporation, committee, school district, political subdivision, or other administrative unit of a municipality, of a political subdivision, or of the executive or legislative branch of state government, including the University of Alaska, the Alaska Aerospace Development Corporation, the Alaska Housing Finance Corporation, the Alaska Industrial Development and Export Authority, the Alaska Energy Authority, the Alaska Railroad Corporation, and a regional educational attendance area.

ARTICLE 14 GOVERNING LAW

14.1 This contract shall be governed by the Laws of the State of Alaska, and any lawsuit brought thereon shall be filed in the Third Judicial District Court at Kenai, Alaska.

ARTICLE 15 SEVERABILITY

15.1 Should a provision of this Agreement be found to be unenforceable or void for any reason, it shall be considered as severed from this Agreement, and the remaining portions of this Agreement shall stand as if that provision had never been included in the contract. Should the unenforceable or void provision be legally essential to the continuing existence of the contract, the parties shall attempt to substitute a reasonable replacement provision.

ARTICLE 16 NONDISCRIMINATION

16.1 Contractor must comply with all federal and state laws, rules, regulations and orders, and all local ordinances, regulations and rules concerning wages, taxes, social security, workers' compensation, nondiscrimination, licenses, registration requirements, and similar provisions governing employment of individuals.

16.2 Contractor will not discriminate against any employee or applicant for employment or refuse employment to a person, or bar a person from employment, or discriminate against a person in compensation or in a term, condition, or privilege of employment because of the person's race, religion, color, or national origin, or because of the person's age, physical or mental disability, sex, marital status, changes in marital status, pregnancy, or parenthood when the reasonable demands of the position do not require distinction on the basis of age, physical or mental disability, sex, marital status, changes in marital status, pregnancy, parenthood, or political affiliation. Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices setting forth the provisions of this nondiscrimination clause. Contractor further agrees to insert this provision in all subcontracts hereunder and to require the subcontractors to insert this provision in their subcontracts.

Notwithstanding the prohibition against employment discrimination on the basis of marital status or parenthood stated above, an employer may, without violating this provision, provide greater health and retirement benefits to employees who have a spouse or dependent children than are provided to other employees.

END GENERAL CONDITIONS

Tax Compliance Certification
Kenai Peninsula Borough
Finance Department

144 N. Binkley Street
Soldotna, Alaska 99669-7599
www.kpb.us

Phone: (907) 714-2197
or: (907) 714-2175
Fax: (907) 714-2376

For Official Use Only

1.) Fill in all information requested. 2.) Sign and date. 3.) Submit with solicitation, or other.

Reason for Certificate: ☒ Solicitation ☐ Other:		For Department:	
		Dept. Contact:	
Business Name:			
Business Type:	☐ Individual ☐ Corporation ☐ Partnership ☐ Other:		
Owner Name(s):			
Business Mailing Address:			
Business Telephone:		Business Fax:	
Email:			

As a business or individual, have you ever conducted business or owned real or personal property within the Kenai Peninsula Borough? (If yes, please supply the following account numbers and sign below. If no, please sign below.)
☐ Yes ☐ No Kenai Peninsula Borough Code of Ordinances, Chapter 5.28.140, requires that businesses/individuals contracting to do business with the Kenai Peninsula Borough be in compliance with Borough tax provisions. No contract will be awarded to any individual or business who is found to be in violation of the Borough Code of Ordinances in the several areas of taxation.

REAL/PERSONAL/BUSINESS PROPERTY ACCOUNTS	
ACCT. NO.	ACCT. NAME

TAX ACCOUNTS/STATUS (TO BE COMPLETED BY KPB)	
YEAR LAST PAID	BALANCE DUE

KPB Finance Department (signature required)

Date ☐ **In Compliance** ☐ **Not in Compliance**

SALES TAX ACCOUNTS	
ACCT. NO.	ACCT. NAME

TAX ACCOUNTS/STATUS (TO BE COMPLETED BY KPB)		
FILED THRU	M/F's	BALANCE DUE

KPB Sales Tax Division (signature required)

Date ☐ **In Compliance** ☐ **Not in Compliance**

CERTIFICATION: I, _____ (Name of Applicant) the _____ (Title), hereby certify that, to the best of my knowledge, the above information is correct as of _____ (Date).

_____
Signature of Applicant (Required)

IF ANY BUSINESS IS CONDUCTED OR IS AWARDED A BID WITHIN THE KENAI PENINSULA BOROUGH YOU MUST BE REGISTERED TO COLLECT SALES TAX. THE SALES TAX DEPARTMENT CAN BE REACHED AT (907) 714-2175.

SAMPLE

Alaska Department of Commerce, Community, and Economic Development
P.O. Box 110806, Juneau, Alaska 99811-0806

ALASKA BUSINESS LICENSE

The licensee named below holds Alaska Business License Number _____
Covering the period of: _____ through _____
Line of Business: _____

COMPANY NAME

ADDRESS

Owner:
NAME OF OWNER

This license shall not be taken as permission to do business in the state without having complied with The other requirements of the laws of the State of Alaska or of the United States.

Alaska Department of Commerce, Community, and Economic Development
Commissioner: _____

This license must be posted in a conspicuous place at the business location. It is not transferable or assignable.

SAMPLE

No. _____
Effective: _____
Expires: _____

STATE OF ALASKA

DEPARTMENT OF COMMERCE, COMMUNITY & ECONOMIC DEVELOPMENT
Division of Occupational Licensing

Division of Occupational Licensing

Certifies that

COMPANY NAME

Is a Registered

Specialty

Commissioner: _____

ACORD®

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY)

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER	CONTACT NAME:
	PHONE (A/C, No, Ext): FAX (A/C, No):
	E-MAIL ADDRESS:

INSURED	INSURER(S) AFFORDING COVERAGE	NAIC #
	INSURER A :	
	INSURER B :	
	INSURER C :	
	INSURER D :	
	INSURER E :	
	INSURER F :	

COVERAGES **CERTIFICATE NUMBER:** **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS		
A	GENERAL LIABILITY X COMMERCIAL GENERAL LIABILITY CLAIMS-MADE X OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: X POLICY PRO-JECT LOC	X	X				EACH OCCURRENCE	$	1,000,000
							DAMAGE TO RENTED PREMISES (Ea occurrence)	$	100,000
							MED EXP (Any one person)	$	5,000
							PERSONAL & ADV INJURY	$	1,000,000
							GENERAL AGGREGATE	$	2,000,000
							PRODUCTS - COMP/OP AGG	$	2,000,000
								$	
A	AUTOMOBILE LIABILITY X ANY AUTO ALL OWNED AUTOS HIRED AUTOS SCHEDULED AUTOS NON-OWNED AUTOS	X	X				COMBINED SINGLE LIMIT (Ea accident)	$	1,000,000
							BODILY INJURY (Per person)	$	
							BODILY INJURY (Per accident)	$	
							PROPERTY DAMAGE (Per accident)	$	
							Underinsured motorist	$	1,000,000
A	X UMBRELLA LIAB EXCESS LIAB DED X RETENTION $ 10,000						OCCUR / CLAIMS-MADE		
							EACH OCCURRENCE	$	
							AGGREGATE	$	4,000,000
								$	
A	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) Y/N N/A If yes, describe under DESCRIPTION OF OPERATIONS below		X				X WC STATU-TORY LIMITS / OTH-ER		
							E.L. EACH ACCIDENT	$	1,000,000
							E.L. DISEASE - EA EMPLOYEE	$	1,000,000
							E.L. DISEASE - POLICY LIMIT	$	1,000,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

Re: PROJECT NAME

The Certificate Holder is an Additional Insured on General Liability & Automobile policies, but only with respect to work done by or on behalf of the named insured for the project referenced. The Certificate Holder is granted Waiver of Subrogation on the General Liability, Automobile and Workers' Compensation policies as respects the referenced project

CERTIFICATE HOLDER

City of Kenai
Public Works
210 Fidalgo Ave
Kenai, AK 99611

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

DRAFT

Landowner Agreement No.: AK-23-5

PARTNERS FOR FISH AND WILDLIFE PROGRAM
LANDOWNER AGREEMENT

This Landowner Agreement (Agreement) dated July 21, 2023, between the City of Kenai (Landowner) and the U.S. Fish and Wildlife Service (USFWS) is entered into pursuant to authority contained in the Partners for Fish and Wildlife Act (P.L. 109-294), the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), and the Fish and Wildlife Act of 1956 (16 U.S.C. 742a-j), as amended. This project was selected for funding because the Landowner shares a common objective with the USFWS to restore habitat for the benefit of Federal trust species on City of Kenai lands, and the project supports priority actions identified in the Regional Partners for Fish and Wildlife (Partners) Program Strategic Plan.

City of Kenai, 2010 Fidalgo Ave, Kenai, AK 99611, (907) 690-1398, hereby agrees to participate with the USFWS in conducting certain fish and wildlife management practices on lands managed by them in the Kenai Peninsula Borough, State of Alaska, described as follows: all of, or within,

Parcel ID Number: 04327036
Legal Description: Section 6, T5N, R11W
Latitude/Longitude: 60.559, -151.265

In signing this Agreement, the Landowner joins as a participant in a habitat improvement program and grants to the USFWS authority to complete the habitat improvement project or the Landowner may personally carry out management activities with financial or material support as described in attached Exhibit A. Any donation of supplies, equipment, or direct payment from the USFWS to the Landowner for carrying out the habitat improvements is included in Exhibit A. The activities conducted pursuant to this Agreement are not to replace, supplement or otherwise contribute to any mitigation or compensation that may be required of the Landowner, or other parties, as a result of any mandated requirements.

The term of this Agreement (also referred to as the habitat retention period) will be completed on July 21, 2033. This Agreement may be modified at any time by mutual written consent of the parties. It may be terminated by either party upon 30 days advance written notice to the other party(ies). However, if the Landowner terminates the Agreement before its expiration, or if the Landowner should materially default on these commitments, then the Landowner agrees to reimburse the USFWS prior to final termination for the prorated costs of all habitat improvements placed on the land through this Agreement. The USFWS will determine how those funds will be used. For these purposes, the total cost of the habitat improvements to the USFWS is agreed to be **$25,000.00** (see Exhibit A, Budget Table).

Landowner:

The Landowner or his/her land manager, with legal authority over land management decisions, guarantees control of the above-described land and warrants that there are no outstanding rights that interfere with this Landowner Agreement.

The Landowner will notify the USFWS of planned or pending changes in ownership or leasing of the property. A change in the property ownership or lease shall not change the terms of this Agreement. The Agreement and terms shall be in effect on the described land for the term of the Agreement.

The Landowner agrees to allow access (with advance notice) to the USFWS to provide assistance towards completion of the project described in Exhibit A, and to monitor project success.

The Landowners retains all rights to control trespass and retains all responsibility for taxes, assessments, and damage claims.

During the habitat retention period, the Landowner agrees to maintain the habitat restored under this award per Exhibit A and allow the habitat restored under this award to remain in place.

At the end of the habitat retention period, the habitat improvement project will become the complete responsibility of the Landowner. There shall be no obligation to the USFWS after the term of the Agreement has expired.

The Landowner will be responsible for securing any necessary permits. Technical advice and support will be provided by participating agencies in the application for the permit(s). The Landowner agrees to identify USFWS and contributions to the project during public presentations, reports, or other information published about the project, as appropriate.

The Landowner will not be responsible for replacing wildlife habitat developments that are damaged or destroyed by severe acts of nature.

USFWS:

The USFWS will work with the Landowner signing this Agreement, throughout the entire Agreement term to support actions needed to ensure that the project is designed and constructed per the Agreement and functions as intended.

The USFWS, its agents, or assignees will provide advanced notice prior to accessing the property to implement or assist in the project described in the work plan, and to monitor project success. The USFWS assumes no liability for damage or injury other than that caused by their own negligence, on the above acreage. The USFWS does not assume jurisdiction over the premises by this Agreement.

Spatial Information Sharing: In accordance with the Privacy Act of 1974, permission must be obtained from the Landowner before any personal information can be released. The only information that can be shared is payment information that is authorized by law. Therefore, Landowner consent is requested to allow for sharing of spatial information about this project solely with conservation cooperators providing technical or financial assistance with the restoration, enhancement or management of fish and wildlife habitat.

☐ I, the Landowner, consent to having spatial information about this project shared with other conservation cooperators

☐ I, the Landowner, do NOT wish to have any spatial information about this project shared with other conservation cooperators

Signatures:

Terry Eubank, City of Kenai, City Manager Date

Kyle Graham, USFWS Fish and Wildlife Biologist Date

Trent Liebich, USFWS Habitat Restoration Branch Lead Date

EXHIBIT A
Statement of Work

The habitat improvements described below are agreed to by City of Kenai and the USFWS in a Landowner Agreement dated July 21, 2023. Non-signatory partners to this Landowner Agreement include the Kenai Soil and Water Conservation District (KSWCD) and the Kenaitze Indian Tribe.

Landowner Information and Project Location:

City of Kenai Terry Eubank 210 Fidalgo Ave. Kenai, AK 99611 teubank@kenai.city	Project Location: Unnamed Stream (locally known as Cemetery Creek) Parcel ID Number: 04327036 Legal Description: S6-T5N-11W Lat/Long: 60.559, -151.265

Description of Habitat Improvement Project and Approved Work Plan:
The project site is located along an unnamed tributary to the lower Kenai River on the Kenai Peninsula of southcentral Alaska. The tributary is informally and locally known as Cemetery Creek and is referred to as such in this Exhibit. Cemetery Creek is an anadromous stream that begins on the northern bank of the mouth of the Kenai River in Kenai Alaska. Cemetery Creek has documented occurrences of rearing chinook, coho salmon and Dolly Varden throughout the upper reaches of the watershed to the float plane landing strip (see exhibit B).

The objective of this project is to enhance flood capacity and improve fish passage at the Cemetery Creek/Coho Avenue crossing in Kenai Alaska. The conveyance structure survey and design will adhere to the USFWS "Culvert Design Guidelines for Ecological Function." The new structure will be designed to convey a 100-year flood event and maximize fish passage by simulating the natural stream upstream, in and around the culvert.

The requested funding is for phase 1 of a culvert replacement project intended to improve anadromous fish passage to upper reaches of Cemetery Creek. The funding requested for this phase of the project will support initial surveying and conceptual design services associated with project planning for culvert replacement.

Project activities associated with phase 1 include: (1) collect survey data both upstream and downstream of the culvert, including a reference reach (2) develop a draft Hydrologic and Hydraulic (H&H) field investigation and analysis to develop conceptual structure and stream channel improvements, and (3) prepare 30% design package including drawings and cost estimate for stakeholder review and comment.

Species and Project Benefits:
Cemetery Creek is a tributary to the Kenai River and has been documented as providing habitat for chinook and coho salmon and resident Dolly Varden. This project will benefit these species through the improved culvert design reducing negative impacts to the stream and allowing improved fish passage during changing hydroperiods. This project supports the Service's mission in providing for healthy self-sustaining fish populations, specifically Pacific salmon. Indirectly, this project also benefits the Kenai Peninsula brown bear, various migratory bird species, marine mammals, and other native wildlife requiring salmon as a sustaining and important food source.

Partner Responsibilities:

USFWS and Landowner:

- USFWS will provide technical assistance towards development and implementation of the project activities.
- USFWS and landowner will coordinate and provide funding as outlined in the Budget Table below. KSWCD will provide reimbursements to landowner for completed activities on behalf of the USFWS and will subsequently be reimbursed by the USFWS for the project costs.

Landowner:

- The Landowner agrees to obtain, prior to initiating any project activities, all necessary approvals or permits for restoration work and permit modifications if project activities are adjusted.
- The Landowner agrees to hire a contractor to conduct the project activities as outlined in this Agreement.
- The Landowner agrees to pay all contractors for services rendered and will submit receipts of work completed and proof of payment to any contractors to the USFWS for reimbursement as outlined in the Budget Table.

Project Budget:

The cost of the phase 1 project work will be shared by the USFWS and the Landowner. Future phases of the project work will be a joint effort between the USFWS, City of Kenai, and the various project partners. The USFWS will remain engaged in all phases of the project development and construction. When phases of the project work have been completed and reviewed by the USFWS, the KSWCD will pay the Landowner for the USFWS portion of the project costs upon receipt of respective invoices, according to this Exhibit. The Landowner is responsible for paying any contractor(s) for work completed on the project. Funding will be available to complete this project for two years from the date of this Agreement. At the end of two years, all unspent USFWS funds will require an extension, or the funds will be forfeited to other habitat projects. Reimbursement of project costs may be reduced or withheld if the project is not completed to satisfaction of all parties and as approved in any applicable permits.

Any work to be completed may be modified with the mutual agreement of the aforementioned parties. Modifications to the project activities or Landowner Agreement must be within the scope and intent of the original Landowner Agreement and also within the scope of any permits issued for the project. Project modifications may require modifications to permits issued for the project; it is the responsibility of the Landowner to ensure that permit modifications are secured.

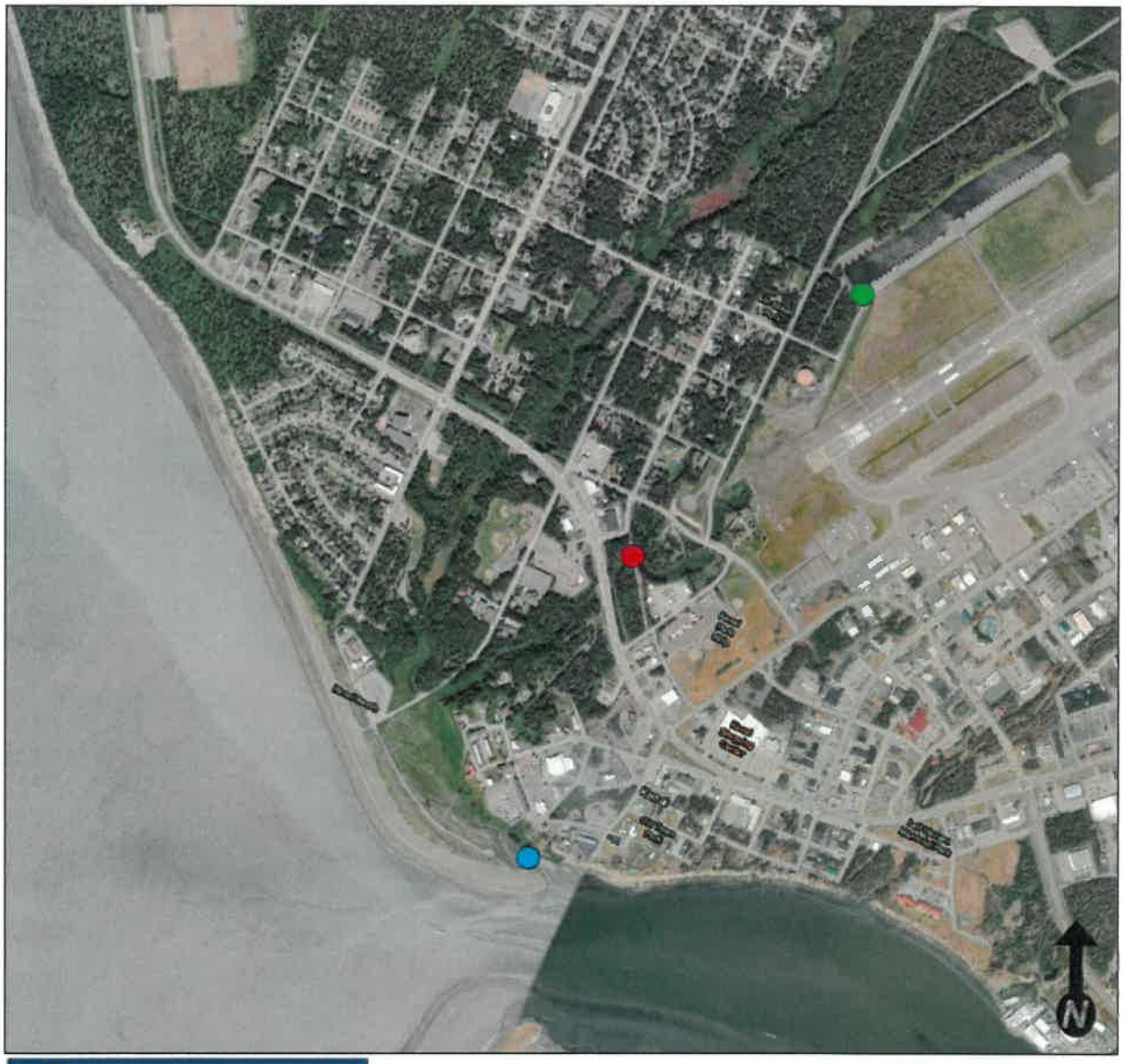
Budget Table:

	USFWS/KSWCD	Landowner	Totals
Elevational and morphological survey of Cemetery Creek and culvert, and engineering and design.	$25,000.00	$5,000.00	$30,000.00
Totals	$25,000.00	$5,000.00	$30,000.00

**Funding for this portion of the project will be reimbursed to the KSWCD by the USFWS through a Cooperative Agreement between the USFWS and the KSWCD. USFWS/KSWCD contributions to the project ($30,000.00) will be directed specifically towards the elevational and morphological survey of Cemetery Creek and culvert, and conceptual engineering and design.*

EXHIBIT B

Project Name: Cemetery Creek Culvert Replacement - Phase 1
Practice: Survey, Engineering, and Design of Culvert Replacement
Lead Biologist: Kyle Graham
Location: 60.559, -151.265



Project Name: Cemetery Creek Culvert Replacement - Phase 1
Practice: Survey, Engineering, and Design of Culvert Replacement
Lead Biologist: Kyle Graham
Location: 60.559, -151.265

Partners for Fish & Wildlife

FWS 3-2454
11/13

Culvert Outflow – Picture taken facing east.

Culvert Outflow – picture taken facing west.

Culvert inflow - picture taken facing west

FWS 3-2454
11/13

Culvert inflow – picture taken facing east

Inside of culvert – picture taking at inflow looking toward outflow.

CULVERT DESIGN GUIDELINES FOR ECOLOGICAL FUNCTION

U.S. Fish and Wildlife Service

Alaska Fish Passage Program

Executive Summary

The purpose of this document is to provide basic culvert design guidelines preferred by the U.S. Fish and Wildlife Service (USFWS) Alaska Fish Passage Program. These guidelines are intended to be used when a culvert is selected as the stream-crossing structure in a fish-bearing stream. Whenever possible, the USFWS supports minimizing the degradation of the ecological continuity of stream corridors and wetlands by choosing transportation routes that avoid the stream crossing altogether or by using bridges that span across the floodplain.

This document is not meant to be comprehensive, but is meant to be a collection of design considerations, terms, and references to provide guidance for the design of ecologically important stream crossings in Alaska.

This document is made up of four sections. Section 1: **Introduction** outlines the background of the method used in these guidelines, and discusses other agency resources and support. Section 2: **Designing a Crossing** contains the general procedures for design, a collection of considerations divided by subject, an example, and additional references. Section 3: **Constructing a Crossing** contains a collection of considerations and potential pitfalls for consideration during construction. A construction inspection checklist is also provided. Section 4: **References** contains the resources and documents that were used to compile these guidelines.

Throughout this document, terms in italics are defined in **Appendix A: : Description of Terms and Commentary**. **Appendix B: Design Aids** is a collection of useful graphics and forms. **Appendix C: Guidelines Comparison Table by Agency** outlines the similarities and differences of selected stream crossing culvert design guidelines for fish-bearing streams.

The Alaska Fish Passage Program, is a voluntary, non-regulatory initiative in the USFWS to provide funding and technical assistance to reconnect aquatic habitats. Additional information on the USFWS Alaska Fish Passage Program can be found here.

Disclaimer: The ability of a structure to pass fish, water, sediment, and debris is highly dependent on local hydrology, species, life stage, geomorphic setting and other site-specific considerations. The guidelines herein provided, while based on national, state, and local experience and studies, are not universally applicable and should not replace site-specific recommendations, limitations or protocols. The guidelines are not intended as an alternative to active consultation with USFWS and application of these guidelines in the absence of consultation does not imply approval by USFWS or other agencies. This document will be updated on a periodic basis to address new research, comments, or questions. Please submit comments or questions to heather_hanson@fws.gov or william_rice@fws.gov.

Contents

1. INTRODUCTION TO THE METHOD

The importance of this document lies in the understanding of *ecological functioning* in relation to stream crossings. The USFWS Alaska Fish Passage Program (AFPP) wanted to put together a concise guideline that not only allows for flood events or passage of fish (hydraulically or biologically) but also supports natural stream processes at the crossing site to the greatest extent possible.

Other publications commonly used for design of culverts at road stream crossing in Alaska include the United States Forest Service (USFS) stream simulation publication (USFS 2008) and a Memorandum of Agreement (MOA) between the Alaska Department of Fish and Game and the Alaska Department of Transportation and Public Facilities (ADF&G and ADOT&PF 2001). Both documents use the term "stream simulation" to describe a "nature like" design method; however, these two documents present two very different approaches to stream simulation designs. The USFS publication (USFS 2008) focuses on providing crossings that mimic sediment transport and geomorphic channel geometry up to the *bankfull discharge* stage for passage of all aquatic organisms while the MOA (ADF&G and ADOT&PF 2001) uses the width defined by the *Ordinary High Water Mark* as the primary standard for fish passage.

Figure 1: Bankfull width, ordinary high water mark and a low flow channel on an E3b stream type.

The AFPP has taken the lesson learned from crossings constructed using the aforementioned guidelines and criteria over the last 20 years and has adopted a *geomorphic analog method* as the basis for these guidelines. These guidelines generally follow the USFS stream simulation approach, with modifications outlined in this document. The goal of this guidance is to address the specific challenges of the unique environments in Alaska and to provide for ecological function and crossing stability in these environments, with the goal of creating road stream crossings that will meet the requirements of the Alaska Fishway Act (Alaska Statute §16.05.841) over a 50 to 75 year structure service life. As described above, stream simulation has been used over the years to describe very different approaches to design a "nature like" channel at a road stream crossing. In order to avoid confusion, we have chosen the term geomorphic analog to more precisely describe the methodology adopted in this guidance. Refer to Appendix C for a

detailed breakdown and comparison of the guidance and criteria in the documents discussed above. Looking at Figure 2, the AFPP method is characterized by crossings b and c.

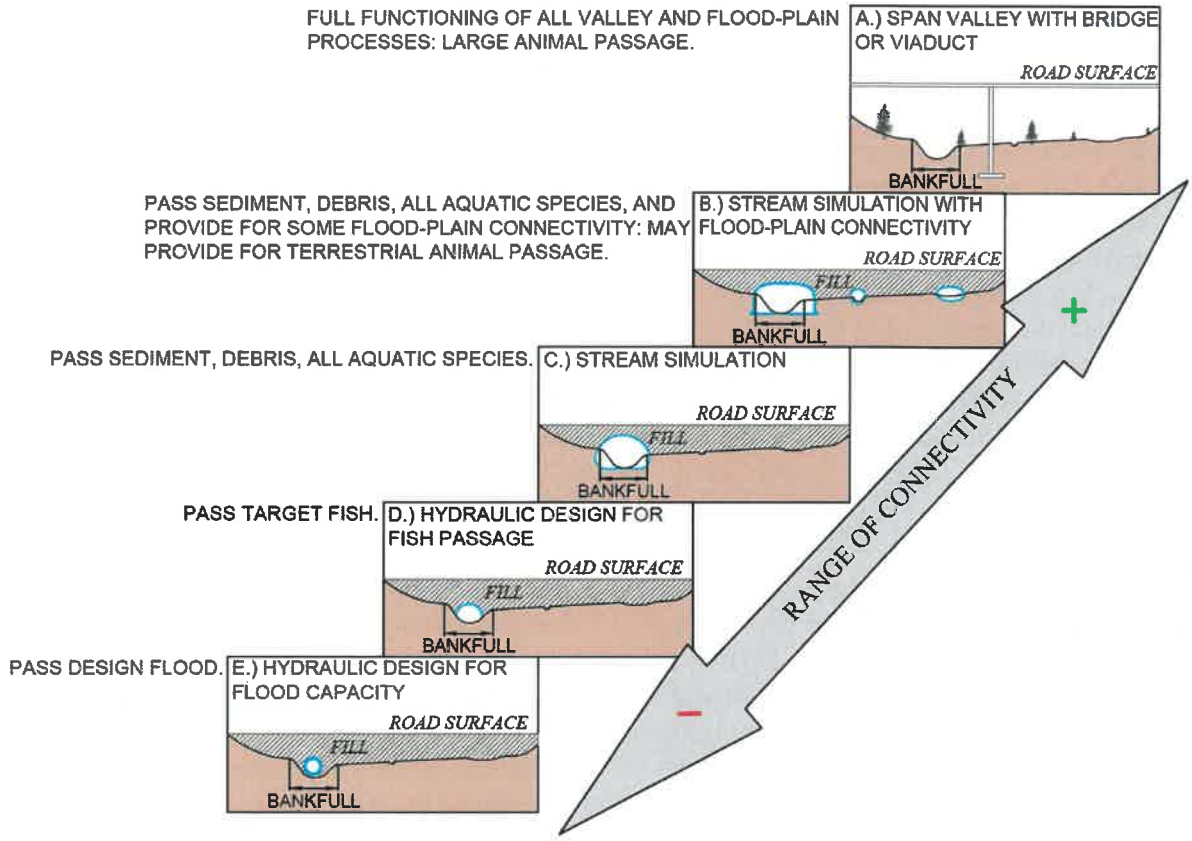


Figure 2: Range of crossing ecological objectives and examples of corresponding design approaches (USFS, 2008).

In order to apply a method of crossing design, a stream first needs to be classified using its geomorphic characteristics. Stream type classification allows the stream for the crossing in question to be generally characterized so that a type of crossing structure can be selected and an appropriate channel type can be constructed through the structure. AFPP has chosen the Rosgen stream classification method as it provides a rigorous, repeatable and widely accepted classification method based on stream channel, floodplain, and substrate characteristics.

The geomorphic analog design method that AFPP has adopted is recommended for stable Rosgen type A, B, C or E channels. Bridges should be used for Rosgen type D channels if the flow is actively moving between braids. Refer to Rosgen (1996) or the Environmental Protection Agency Watershed Academy Web (USEPA 2021) for more explanation of the Rosgen classification system.

2. DESIGNING A CROSSING

When designing an ecologically functioning crossing, there are many more things to take into consideration than hydraulic capacity and passage of a target species. This document is not meant to be all encompassing, but rather a collection of references, topics to consider, examples, and the AFPP's specific preferences where applicable. If you are new to nature like culvert design, please refer to the USFS Stream Simulation Guidelines (USFS 2008) and the NRCS Stream Restoration Design Handbook (Rosgen 2007) to get started.

Alaska has 40% of the fresh water resources of the United States (ADNR 2021), but less than 2% of the stream gauges to provide information about the resulting stream flows (USGS 2021). One of the goals of an ecologically functioning stream crossing is to provide passage for a wide range of species and life stages at a wide range of flows. With the low density of gauge data in Alaska, it is rare to find a stream gauge that will provide the designer with the data needed to understand the lower end of the flow regime. Data regarding species presence and their swimming abilities is often incomplete. Given these uncertainties, the surest way of providing for ecological function is to mimic the natural stream characteristics. Thus, a detailed geomorphic stream survey is necessary to gather information about the natural channel. In addition to completing a geomorphic stream survey, the designer should talk to local residents and road crews about historical flows, *flashiness*, the debris load, aufeis issues, sediment load, and beaver activity.

For predicting flood flows the designer should use multiple methods; regression equation predictions should be compared with the bankfull discharge obtained from the geomorphic survey and any local gauge data. LIDAR can be used to better understand flow paths and look for nearby crossing structures but it should not replace a site visit and stream survey. Section 2.1 provides guidance on using the geomorphic survey, hydrology, and GIS data to design a crossing. For a sample step-by-step process while designing an alluvial channel crossing, refer to Section 2.2. Reference Section 2.1.5 for recommendations for wetlands, sloughs and relic channels where a reference reach may not be available or not reflect the current flow regime.

2.1 Design Considerations

This section will cover a variety of topics, such as: ecological functioning, culvert size, slope, and substrate; use of the *reference reach*; special conditions; and habitat conservation measures.

2.1.1 Ecological Functioning

2.1.1.1 Structure Width

The width of the primary crossing structure should not be less than 1.0 times the *bankfull width* of the channel (USFS 2008). United States Forest Service (USFS) guidelines for stream simulation are based on emulating the geomorphic condition of the bankfull channel (Figure 3).

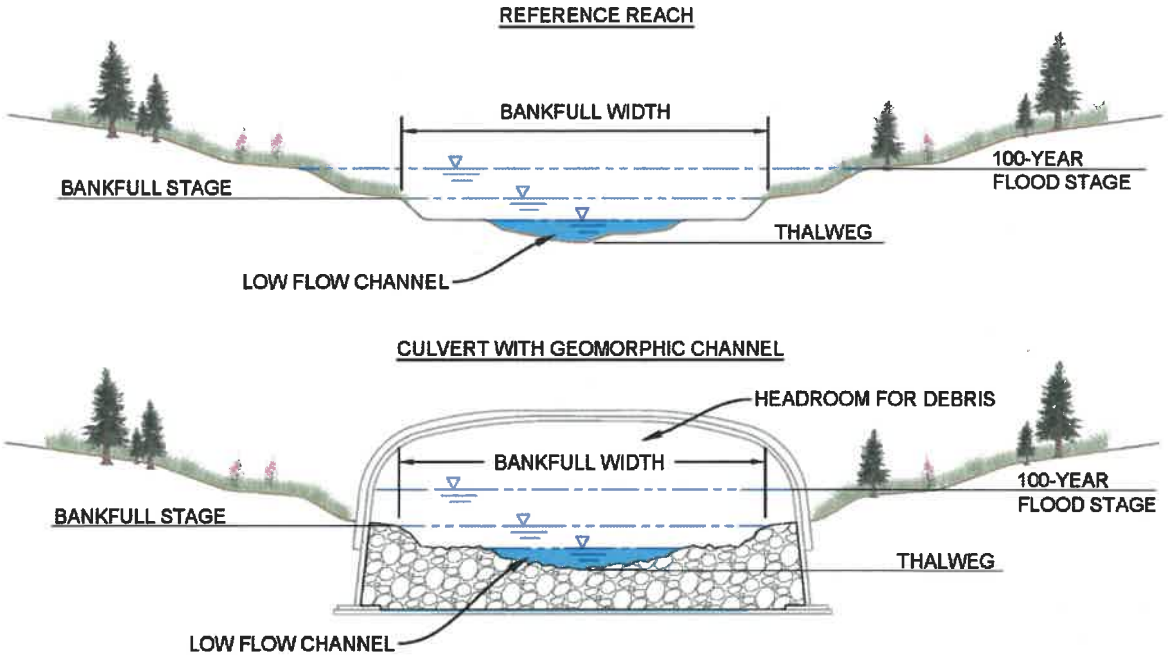


Figure 3. Example culvert placement relative to geomorphic channel features.

2.1.1.2 Debris

Studies in the Pacific Northwest have also shown road/stream crossing channels that are at least bankfull width carry the propensity of debris down a channel. The goal of this guidance is to provide a crossing that will pass aquatic organisms, water AND debris to the extent reasonable and possible. The design should provide adequate clearance for debris to pass through the structure at the *100-year flood* (Figure 3).

2.1.1.3 Sediment Transport and Channel Geometry

Flows up to the bankfull stage have been shown to be responsible for forming and maintaining channel features and transporting the majority of sediment in alluvial systems. By maintaining the hydraulic geometry of the channel up to the bankfull stage we can maintain sediment transport equilibrium between the crossing and the natural channel (Figure 3).

2.1.1.4 Channel Stability

Culvert crossings in systems that are actively degrading such as Rosgen F or G channels, should be avoided (Rosgen 1996). If they cannot be avoided, these channels must be stabilized at least on a reach-length basis to prevent headcut or excessive lateral movement prior to the construction of a new crossing structure.

2.1.1.5 Horizontal Alignment

Crossing structures should be placed within/over the pre-development natural channel alignment when possible. New road alignment should be as close to perpendicular to the channel as possible. The crossing location should also be chosen to cross at a straight riffle feature. The

stream may need to be realigned at existing roads; however, avoid cutting off meander bends. Avoid placing crossing structures at pools or stream bends, including immediately downstream of meander bends. For the stable creeks that these guidelines are recommended for, lateral movement typically occurs on the order of hundreds of years (Knighton 1998), therefore it is reasonable to assume that the minimum amount of movement risk is associated with the current natural channel alignment. Additionally, putting a road crossing over as straight a section of the stream as is present generally represents the most stable lateral movement portion of the stream. If possible, we recommend not locating a crossing immediately downstream of a meander bend as they are more likely to migrate downstream and may impact the road prism when roads persist for 50 years or more. If realignment of the stream is required, we recommend mimicking the meander geometry of the reference reach and keeping the slope within 25% of the reference reach as described in Section 2.1.2.4. Refer to Chapter 6 of USFS (2008) for a discussion and preferred solutions to many typical alignment challenges).

2.1.1.6 Riparian and Floodplain Connectivity

Culverts used in stream crossings should be designed, constructed, and maintained so as to provide for *ecological functioning* of the stream, including connectivity of wetlands and riparian areas adjacent to stream channels to allow for the unrestricted movement of water, all species of fish and wildlife, nutrient, sediment and woody debris, to the greatest extent possible. A longer span structure such as a bridge that spans the entire flood plain is the ideal solution for providing ecological functioning, refer back to Figure 2. If a bridge is not feasible, floodplain culverts (Figure 4) can also be considered to reduce the alteration of wetland hydrology upstream and downstream of the crossing.

2.1.2 Use of a Reference Reach

2.1.2.1 Reference Reach Selection

Reference Reach selection recommendations may be found in Appendix A under the definition of the *Geomorphic Analog Method*.

2.1.2.2 Reference Reach Survey

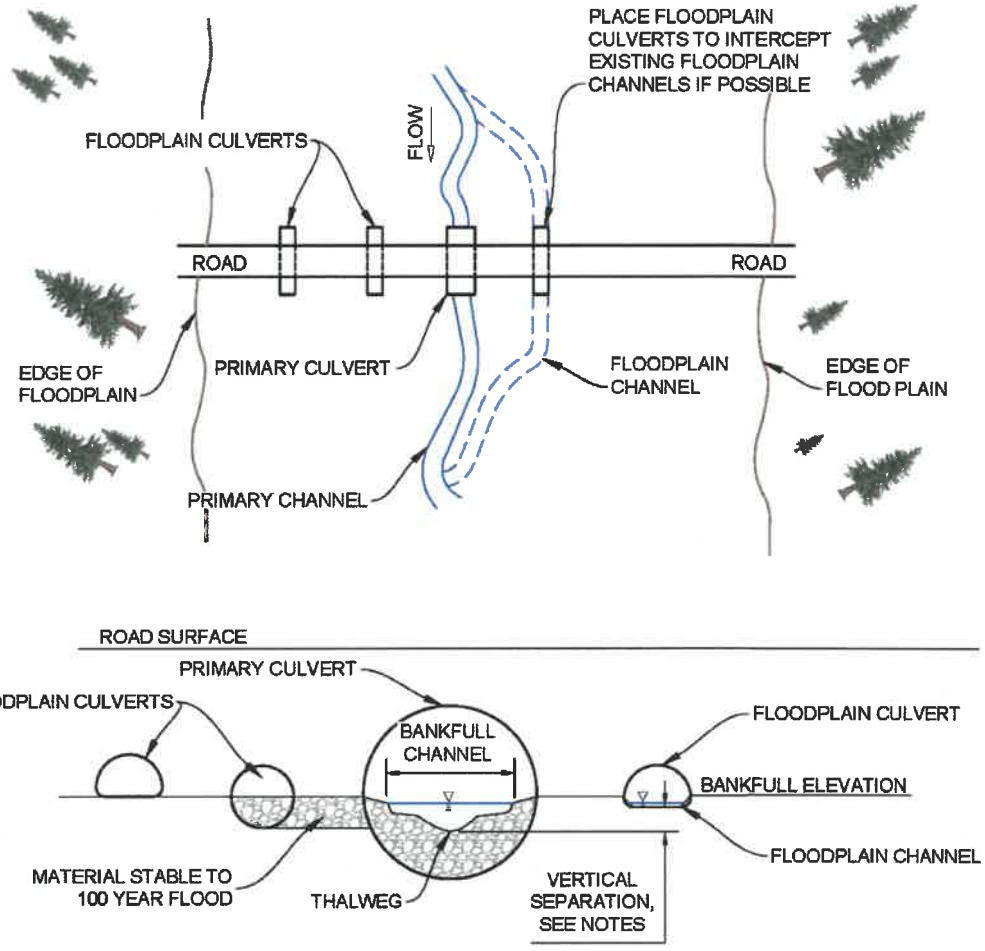
Data gathered should include at a minimum: channel width at bankfull, *bankfull cross-sectional area*; the *bankfull slope* and *slope ratio*; *substrate grain size*; key pieces; stream type; bankfull average and maximum depth; *low flow channel* geometry; *flood prone width*; stream order; and watershed area (USFS 2008). The reference reach bankfull dimensions should be determined in the field by surveying a detailed cross section at the upper 1/3 of a representative riffle. See Section 2.3.

2.1.2.3 Reference Reach Use in Design

The channel in the crossing structure should not substantially differ from the reference reach condition in regards to the channel width at bankfull, bankfull and low flow channel cross-sectional area, stream type and bankfull average depth (USFS 2008). Refer to Figure 3.

2.1.2.4 Slope

The crossing slope should be within 25% of the bankfull slope of the selected reference reach. For example, if a reference reach is 1.0% slope, the minimum design slope of the stream simulation culvert would be 0.75% and the maximum design slope would be 1.25% (USFS 2008).



CONSIDERATIONS FOR FLOODPLAIN CULVERTS:

- FLOOD PLAIN CULVERTS CAN BE PLACED ANYWHERE IN THE FLOODPLAIN WHERE FLOWS WILL REACH THEM AT HIGHER FLOOD STAGES.
- THEY MUST BE SEPARATE VERTICALLY EITHER BY HIGH INVERT OR BY STABLE SUBSTRATE TO PREVENT THE STREAM FROM BYPASSING THROUGH THEM AT NORMAL FLOWS. VERTICAL SEPARATION IS REQUIRED TO ENSURE ADEQUATE DEPTH IN THE PRIMARY FLOW CULVERT TO ALLOW FOR FISH PASSAGE AT LOW FLOWS. THE IDEAL INVERT ELEVATION IS THE BANKFULL ELEVATION.
- THEY CAN BE EMBEDDED IF VERTICAL CONSTRAINTS OR COVER REQUIREMENTS DICTATE OR IF SMALL ANIMAL PASSAGE IS DESIRED (PROVIDE SOIL COVERAGE ALONG BOTTOM TO FACILITATE).
- WELL GRADED MATERIAL STABLE TO THE 100 YEAR FLOOD FLOW SHOULD BE USED TO DIRECT FLOWS AND PROVIDE EMBEDMENT OF FLOOD PLAIN CULVERTS. THE GOAL IS BE TO PREVENT WASHOUT OF THE MATERIAL AND SUBSEQUENT FLOW SPLITTING AFTER FLOOD WATERS RECEDE IF A FLOOD PLAIN CULVERT IS EMBEDDED.
- PIPE-ARCH SHAPES CAN BE USED TO DEVELOP CAPACITY EARLIER IN THE FLOOD CYCLE.

Figure 4. Placement of floodplain culverts.

2.1.3 Culvert Design

2.1.3.1 Hydraulic Conveyance

For the Geomorphic analog method, crossing structures should be designed to accommodate at least the *100-year flood flow* (USFS 2008). Designing for the 100-year flood is a choice we have made for projects funded by AFPP to maximize success over the long term considering the wide margin of error in hydrologic predictions and expected life of an installation. Although the 100-year flood flow only has a 1% probability of occurring in any given year, for any 50-year period, there is a 40% chance that the 100-year flood will occur and a 64% chance that the 50-year flood will occur. Given the rather high likelihood of exceeding the design flow during the culvert lifetime, the designer should carefully consider the consequences of potential failures during flood events. While keeping in mind that many jurisdictions have minimum hydraulic standards by road type, the road owner and project funders may select a larger design flood that takes into account their tolerance for risk of failure. ADOT&PF design standards require a 50-year flood flow for culvert design at primary and secondary highways, but only a 10-year flood flow for low importance secondary highways (ADOT&PF 2006). During conversations, hydraulic engineers at ADOT&PF have stated they use the 50-year as the design flood as a minimum most of the time, even in low importance areas, as it provides for the more cost effective design in the long run.

2.1.3.2 Minimum Diameter

Culverts should have a minimum diameter of five feet (5'). This minimum allows sufficient space to construct and maintain the stream channel inside the culvert. While FHWA, 2010 recommends a minimum diameter of six feet (6'), both AFPP and USFS Tongass programs have had success utilizing the five foot diameter minimum. However, each site is unique and needs to be evaluated as such with the ownership and equipment available. This minimum diameter applies for small streams with a bankfull width of five feet or less. For larger streams, a longer span structure (bridge or culvert) should be used that meets the requirements of these guidelines. A bridge should also be considered for all stream widths in order to provide better floodplain connectivity.

2.1.3.3 Culvert Material

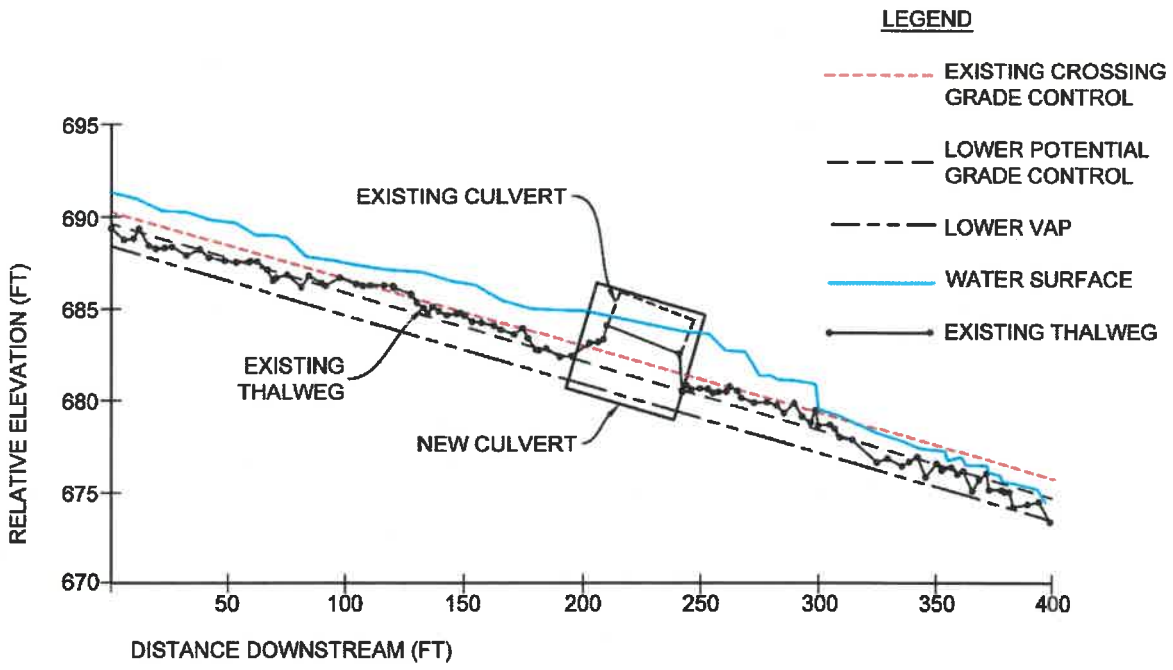
Pipes and arches should be corrugated; smooth concrete is possible, smooth wall metal or plastic pipes should not be used. This guidance is based on the need for culverts to have some frictional surface to assist in keep substrate within them as well as have some corrugations for small fish passage along the edges in cases where no streambanks are incorporated. Conversations with hydraulic engineers and fish passage professionals over the years indicate that smooth bore pipes readily evacuate sediment adversely compared to corrugated pipes. Modeling experiences by

AFPP, ADOT&PF and others also indicate that fish passable velocities are much harder to meet without some friction, particularly at slopes greater than 1%.

2.1.3.4 Minimum Invert Burial Depths

Round culvert pipes should have a minimum invert burial depth (measured from the thalweg) of

forty percent (40%) of the culvert diameter into the substrate; box culverts and pipe arch culverts, should have a minimum invert burial depth of twenty percent (20%) of the culvert's rise into the substrate, unless *vertical adjustment potential* (VAP) analysis shows less fill is acceptable (Figure 5). Bottomless culverts with footers need to have sufficient burial depth and armor material to protect the footings from potential scour over the life of the structure. In areas where permafrost is very close to the surface, a hybrid of the stream simulation and hydraulic method may be considered to reduce the culvert embed and prevent thaw of the permafrost. This guideline is based on discussions with Fairbanks ADOT&PF and ADF&G in what is the current practice based on their experiments in applying the ADOT&PF/ADF&G MOA and geomorphic culvert design in Arctic conditions.



DELINEATE THE LOWER VERTICAL ADJUSTMENT POTENTIAL (SCOUR) LINE.

- CHOOSE DEEPEST POOL ALONG CHANNEL NOT INFLUENCED BY THE UNDERSIZED CULVERT.
- ADJUST LINE TO REFLECT SCOUR/FILL PROCESSES THAT OCCUR DURING FLOODS. RECOMMENDED CRITERIA
  - 1.0 POOL MAX DEPTH (PMD): STEP-POOL CHANNELS, S> 5%, BOULDER-COBBLE BOUNDARIES.
  - 1.25 X PMD: STEP-POOL CHANNELS WITH S<5%, COBBLE-GRAVEL BOUNDARIES.
  - 1.50 X PMD: RIFFLES, GRAVEL-COBBLE BOUNDARIES.
  - 1.75 X PMD: RIFFLES, SAND-FINE GRAVEL BOUNDARIES.
  - 2.00 X PMD: RIFFLES, SAND-FINE GRAVEL BOUNDARIES.
  - NO ADJUSTMENT FOR BEDROCK.

Figure 5. Vertical adjustment potential example and factor of safety for various types of substrate.

2.1.4 Stream Channel Design Inside Culverts

2.1.4.1 Streambanks

- ***Streambanks*** are recommended inside of culverts where feasible to protect the culvert from abrasion, provide resting areas for fish, and provide for small mammal crossing. If streambanks are constructed through a crossing, the streambanks should be constructed of rock substrate designed to be stable at the 100-year flood (USFS 2008). The streambank width should be a minimum of 1.5 times *D100* of the streambank material. The crossing width should be increased to allow for the channel width plus the streambanks; however the crossing width should not exceed 1.4 times the bankfull width (Figure 6).

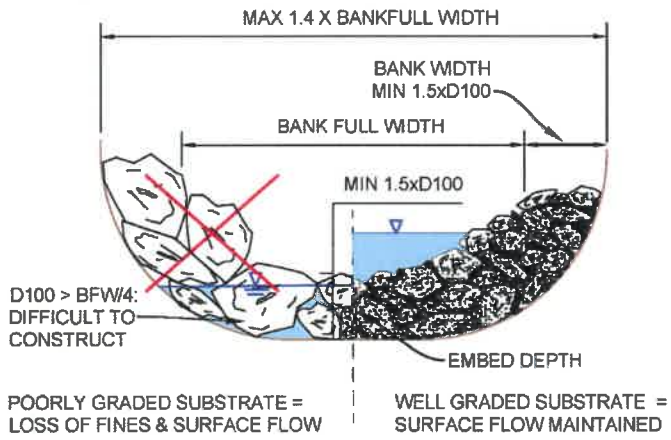


Figure 6. Streambank width, culvert width and embedment depth recommendation.

- **Streambanks are not recommended** for areas with permafrost or severe freeze-thaw issues, for areas with large amounts of sheet flow or ice flows, or in the intertidal zone. Incorporation of streambanks inside of culverts is typically recommended when feasible. Streambanks should not be used if the rock size needed for streambank stability results in an overall crossing width of greater than 1.4 times the bankfull width as the risk of aggradation is much higher for the wider crossing if the streambanks fail. For permafrost and freeze-thaw, aufeis areas, the risk of exacerbation of these icing areas and potential risk and maintenance of the road should streambanks fail is significantly higher than other locations so they are not recommended to reduce risk. In the intertidal zones, these are transitional areas so the benefits of streambanks is less apparent for fish passage and the risk of sedimentation in some intertidal settings by lowering the velocities through the culvert with streambank evacuation can be high. Again, these are generalities to conservatively accommodate all situations in Alaska and there may be project locations where streambanks can be installed at lower risk than what is being accommodated here.

- **Streambanks and Stream Entrenchment:** For streams with entrenched channels, the designer should err on the side of caution to ensure the stability of banks constructed inside culverts or use a bankfull width culvert. Channels in entrenched environments should have streambanks designed with a higher factor of safety concurrent with the associated risk of higher energy environments and error in correctly predicting the design flood events. For an *entrenchment ratio* less than 1.4, streambanks are not recommended inside the culvert. For entrenchment ratios between 1.4 and 2.2, a higher safety factor may be appropriate. Banks inside culverts are generally more stable for streams with entrenchment ratios greater than 2.2 as long as sufficient flood plain

culverts are provided and/or the culvert is wide enough to keep the shear stresses on the banks inside the culvert low.

2.1.4.2 Substrate Design

- **Substrate Stability:** Culvert substrate material within the crossing structure should remain *dynamically stable* at all flood discharges up to and including a *50-year flood flow*. (FHWA 2010). For culverted crossings without an adequate upstream sediment supply, the substrate material within the crossing should be designed to resist the predicted critical shear forces up to the 100-year flood. For culverts in sand bed channels sediment *retention sills* may be used if necessary. For culverts with slopes 6% or greater, steps and cascade features should be sized and keyed in so not to move up to the 100-year flood event, but if necessary sills can be used to keep footer rock in place (USFS 2008). The use of sills can often be avoided by using large, stable rock. FHWA methodology has established design for dynamic stability of the culvert substrate at the design flood as a standard of good engineering practice. We maintain that in embedded culverts there is always some sediment movement into and out of the culvert if upstream sources exist but significant movement between upper and lower VAP lines should be designed to occur at the 50-year flow or higher for locations with upstream sediment sources and 100-year flow or higher at locations without sediment sources such as lake outlets. Exceptions can exist, for instance "D" type stream with multiple channels on alluvial fans, where a stream simulation approach to streambed design may be more appropriate.

- **Low Flow Channel:** Substrate material within/under the crossing structure should incorporate a continuous *low flow channel* that simulates the reference reach to allow for adequate fish passage during minimum flows. We recommend using forcing features such as rock bands or rock clusters that are stable up to the 100-year flood for better persistence of the low flow channel over time. (Figure 10). A "V" shaped thalweg is recommended for channels with the potential for very low flow regimes to prevent aggradation and maximize fish passage during drought conditions (Figure 7). See Appendix A for more guidance on design of low flow channels.

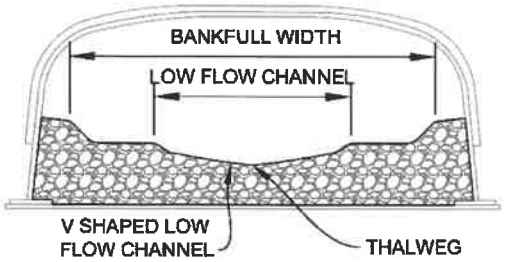


Figure 7. Two stage channel with V shaped low flow channel.

- **Substrate Gradation:** The gradation of the substrate material within a culvert should be designed to be a dense, well graded mixture with adequate fines to ensure that the majority of the stream flows on the surface and the minimum water depth is maintained (FHWA 2010). Refer back to Figure 6 for a graphical illustration of this difference between a well graded and gap graded substrate. The Fuller-Thompson equation should be used to ensure a minimum void content (See Figure B-5 for example calculations). In addition, the combined gradation should have a minimum of 5% passing the #10 sieve (2 mm). (USFS 2008).
- **Retention Sills:** If substrate *retention sills* must be used (for example, sand bed systems or on slopes >6%), they should have a maximum weir height of one half (0.5) of the

culvert invert burial depth (i.e. 20% of diameter for round pipes and 10% of rise for pipe arches) (USFS, 2008). Substrate retention sills should be spaced so that the maximum drop between weirs is four inches (4"). Sills should not be used without substrate. A 4" drop is the maximum perch for juvenile salmon passage per historic discussions with ADF&G in case there is complete evacuation of sand from the culvert, fish passage is technically possible until the next flood event. AFPP experience is that sills can be 1) used in step-pool or cascade environments to help hold steps in place and 2) in sand bed systems to capture sand on the receding limb of flood events for a streambed. While USFS guidance indicates that sills should be placed below the lower VAP line, we maintain that in step-pool or cascade environments, sills should be based on where the stability is needed; for a sand bedded channel, it will depend on the longitudinal surveys and minimizing headcut potential upstream. (USFS 2008)

- **Maximum Substrate Size:** The D100 of the substrate should not exceed the *bankfull width* divided by 4 (Figure 6) (USFS 2008).

2.1.5 Special Conditions

2.1.5.1 Wetland Complexes, Relic Channels and Sloughs

Wetland complexes, relic channels and sloughs pose a challenge as the geomorphic evidence often does not provide information about the current flow regime or bankfull channel. In these cases, the designer may rely on a geomorphic analog from a nearby stream or use flood frequency predictions to size the bankfull channel. Regression equations may introduce very large errors into the design process as confidence intervals for these equations may result in a full order of magnitude of potential error at the 95% confidence level (See Table 1). If the designer must use hydrologic flood flow predictions instead of a reference reach, we recommend relying on local stream gauge data to size the bankfull and low flow channels or installing a gauge and developing local information. In these challenging environments, we have installed continuous stream gauging for two to three years prior to finalizing a crossing design in order to better estimate the bankfull and low flow discharge.

Table 1. Example comparison between local gauge predictions and regression equation predictions for the Little Tonsina River.

			2016 Regional Regression Method		
RI	Q/A Method LittleTonsina Gauge 15207800	Q/A Method Squirrel Creek Gauge 15208100	2016 Regression Method	2016 Regression 5% Lower Confidence	2016 Regression 95% Upper Confidence
yr	cfs	cfs	cfs	cfs	cfs
2	495	376	1,030	359	2,930
5	654	604	1,590	567	4,450
10	777	780	2,000	716	5,610
25	951	1,032	2,550	893	7,300
50	1,097	1,237	2,970	1,020	8,670
100	1,257	1,474	3,410	1,140	10,200
200	1,432	1,712	3,850	1,250	11,900
500	1,692	2,081	4,460	1,380	14,400

2.1.5.2 Relic Channel or Slough

Should field geomorphic data show an existing stream in a relic channel (i.e. old glacial outwash) or slough, with no defining bankfull features, the synthetic width method may be used. See Section 2.1.5.4.

2.1.5.3 Wetland complexes:

If possible, avoid crossing wetlands to minimize the ecological impacts on these important ecosystems. If they must be crossed, the ideal crossing in a wetland complex is a low or zero slope crossing that emulates the low velocity and water depth of the surrounding wetland environment, yet meets flood standards on its own or with additional floodplain culverts. To develop initial widths for such a crossing, the following situational methods could be applied:

- Method A: The designer may use a *reference reach* upstream or downstream in a single thread portion of the creek to size the proposed crossing (Figure 8). Recommendations for choosing a reference reach may be found under the definition for the *Geomorphic Analog Method*.

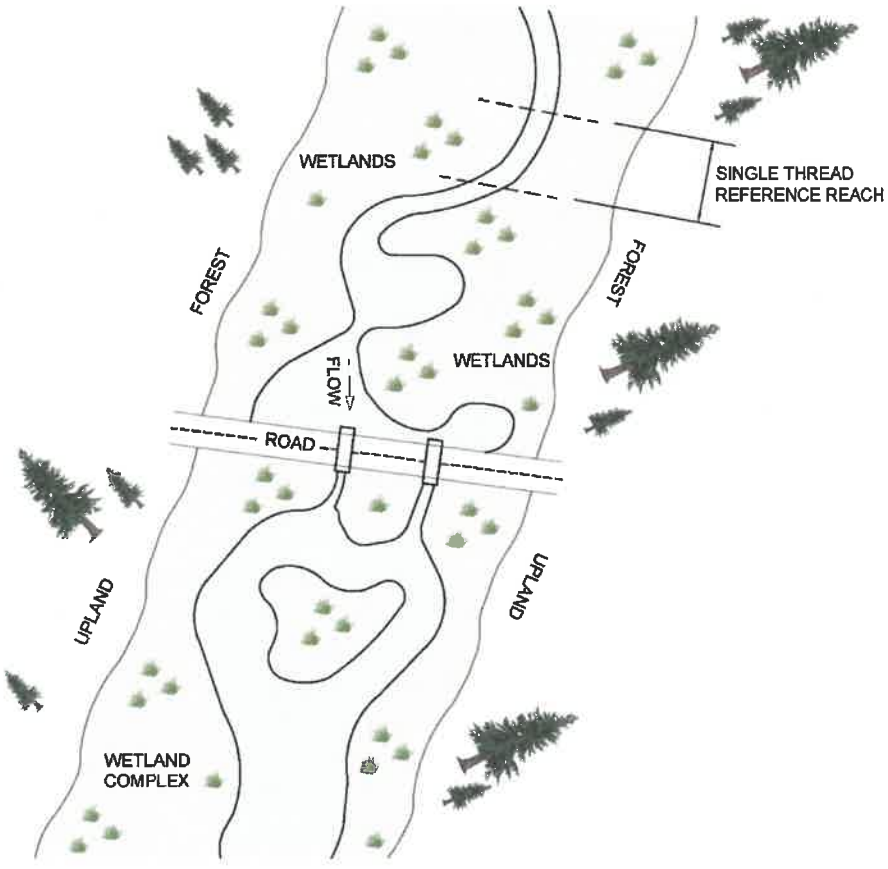


Figure 8. Graphical Illustration of Method A in a wetland complex.

- Method B: If no reference reach is available on the same stream or if the crossing slope needs to be steeper than any reference reach on the same stream due to constraints such as road height or maintaining upstream water levels, crossing stream types should be selected using an appropriate geomorphic analog primarily based on slope (see Figure A-1) in conjunction with the *synthetic width method* to develop the crossing structure dimensions. A geomorphic analog (Figure A-2) should be used to develop the channel geometry.
- For both Method A and Method B, floodplain culverts should be provided as conditions permit to allow for wetland continuity across the floodplain area and to minimize flow constriction at flood levels (USFS, 2008). Floodplain culverts (Figure 4) should be placed in the floodplain outside of the primary channel and at a higher elevation to insure a minimum depth will be maintained in the primary crossing structure for fish passage at low flows.

2.1.5.4 Synthetic Width Method

A synthetic width may be estimated for culvert sizing by utilizing a calculated 2-year flood event with an average cross-sectional velocity of less than 4 feet per second (fps), unless there is additional supporting data or other agency criteria to design otherwise. The recommended maximum velocity of 4 fps was chosen based on the observation by Leopold (1994) that "For rivers of moderate size (2 to 100 square miles of drainage area), the flow at bankfull stage will ordinarily have a mean velocity on the order of 4 feet per second" (p. 33). Note that this method or velocity may not be applicable for all cases and the velocity would ideally be less, particularly in stream gradients of 1% or less.

2.1.5.5 Barriers and Trash Racks

Beaver barriers, trash racks or debris interceptors should not be used because of the potential to block adult salmon without robust and regular maintenance. Bollards at least one bankfull width upstream of the culvert may be used if needed to trap debris or move beaver dam building upstream. However, we have found that these are not usually needed when the culvert is designed with sufficient headroom for large woody debris to pass at the 100-year flood. In addition, our experience has been that beavers are not attracted to entrances as long as there is no increase in velocity and sound over the natural stream conditions.

2.1.5.6 Tidally Influenced Culverts

Fish passage criteria for tidally-influenced culverts should be satisfied 90 percent of the time (Figure 9). This is the same criteria in place in the Anchorage design standards for fish passage and is based on fish passage criteria reviewed from Puget Sound and compared to tidal movements in Upper Cook Inlet. Tidally-influenced streams may sometimes be impassable due to insufficient depth at low flow and low tide. If the tidal area immediately downstream of a culvert is impassable for fish at low tide under natural conditions, the 90 percent passage criterion would apply only to the time during which fish can swim to the culvert.

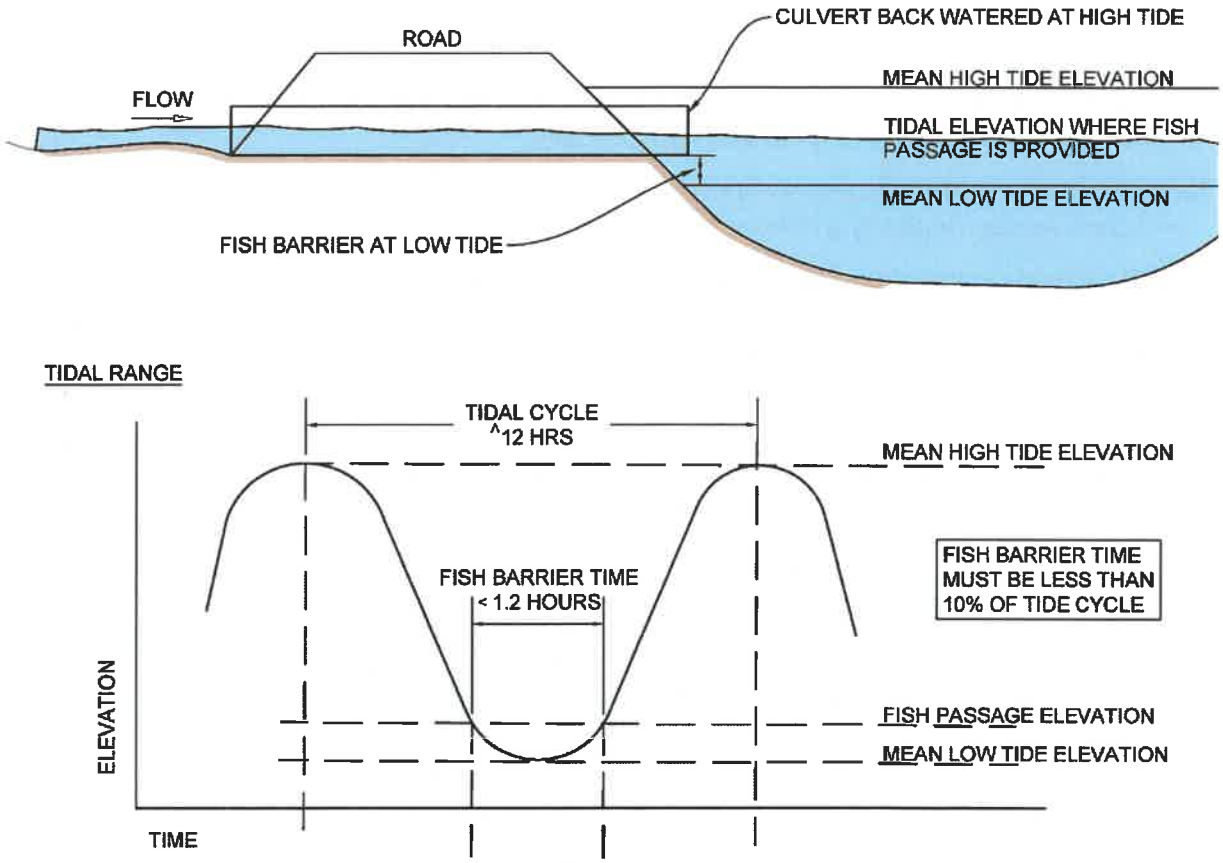


Figure 9. Recommendations for fish passage relative to tidal cycles.

2.2 Typical Culvert Design Procedure for Ecological Function in Alluvial Channels

The following list sequentially describes a procedure used by the USFWS Alaska Fish Passage program for Fish Passage Culvert Design in alluvial channels. It is not intended to preclude other design approaches. Whatever design approach is chosen, we do not recommend omitting any of the steps outlined in this section. We recommend consultation with the local Alaska Department of Fish and Game (ADF&G) habitat permitting office early in the design process.

2.2.1 Complete a hydrology report. If site is un-gauged try multiple flood frequency estimation methods (USGS Regression Equations, Manning's Equation, TR-55 Method, etc.). Use LIDAR data and imagery to better understand flow paths.

2.2.2 Complete crossing survey and *reference reach* survey (See site survey checklist in Section 2.3). Historical imagery may also be useful for understanding how the stream has evolved over time.

2.2.3 Use channel survey data and site observations to determine the channel type and valley type at the crossing using the Rosgen classification system (Rosgen 1996).

2.2.4 Determine the geomorphic design approach to meet the objectives of the crossing. (See Figure A-1).

2.2.5 Upload survey data and pebble count data to a computer aided design (CAD) or a spreadsheet as appropriate for analyzing the data.

2.2.6 Plot long profile and cross sections and determine *bankfull width* (Wbkf) of the reference cross section (typically a representative riffle).

2.2.7 Determine valley slope from CAD, GIS, or field measurements.

2.2.8 Determine reference reach slope from long pro. Look at the water surface head of riffle to head of riffle. Compare with bankfull slope and adjust bankfull calls if necessary. (Bankfull slope should match water surface slope. If it doesn't this may indicate the bankfull calls made in the field were incorrect or that channel evolution is occurring). Make sure Wbkf of reference cross section makes sense with the other bankfull calls along the profile. (Use CAD or other graphical program for this task).

2.2.9 Determine new culvert alignment, slope, *vertical adjustment potential* (VAP) lines, tie in points to the existing stream thalweg and draw this in on the long pro. Reference chapter 6 of the USFS Stream Simulation Publication (USFS 2008) for considerations in choosing tie in points. Make sure new culvert design slope is within 25% of reference reach slope. Expect there may be sediment deposition upstream and/or downstream at the culvert that may need to be removed. Check actual length of culvert in CAD based on tie in points to existing thalweg, embedment depth, minimum cover depth, road width and embankment slope.

2.2.10 Fill out reference reach stream classification page – "River Stability Field Guide" WS2-3 (See Figure B-1) (Rosgen 2008). See Figures B-3 and B-4 for guidance on the Rosgen channel classification system. For more in depth guidance on collecting reference reach data and the Rosgen classification system refer to the National Resources Conservation Service publication "Stream Restoration Design National Engineering Handbook" (Rosgen 2007).

2.2.11 Determine bankfull discharge and velocity for the reference cross section based on the cross section hydraulic dimensions, bankfull slope, and Manning's or other open channel equations. (Manning's n should be estimated from D84 of riffle pebble count, stream type, tables, etc. and compare results of different methods. ("River Stability Field Guide" WS2-2, Figure B-2) (Rosgen 2008). Check that average bankfull velocity is between 2.5 to 5 fps for fish streams. Check that bankfull discharge is relatively close to the 1 to 2-year flood flow predicted by hydrology assessment or gauge data.

2.2.12 Create model of the existing crossing in HY8 so the existing flood capacity can be compared with the new crossing design capacity. (Note: Other hydraulic analysis software such as HEC-RAS or other culvert design software may be used in lieu of HY8 throughout the design).

2.2.13 Model new culvert in HY8. Design flow should be 100-year flood (Q100). Check the bankfull flow as well to see if the elevation is as expected. Create tail water cross section with bankfull channel, floodplain, and low flow channel. (See Appendix A for guidance

on low flow channel dimensions and Table 2 for guidance on floodplain width). Model the channel cross section inside the culvert by choosing an appropriate average embedment depth that accounts for the area blocked by fill. Or use a user generated culvert cross section to model the bankfull channel and low flow channel shape directly. Choose a culvert that passes the Q100 with HW/D =0.8 or with enough headroom to pass the expected debris during a flood. Culvert should either be bankfull width a minimum bankfull width + 3 x D100 if streambanks are constructed inside. Designer should assume D100 and check it in next step (iterate as needed). Banks are desirable for fish passage and small mammals if feasible. Mammal crossing is more important on higher volume roads. We recommend culvert width be less than or equal to 1.4 x Wbkf for culverts less than 12 feet or 1.2 x Wbkf for culverts greater than 12 feet or aggradation may result. USFS (2008) recommends not increasing the designed channel width to more than 1.25 x Wbkf. Desired bank widths are 2 to 3 feet per side unless you are using class 3 (D100=30") or larger rip rap to construct the banks. Slope bankfull surfaces towards the thalweg at min 5% slope both inside and outside of the culvert to avoid isolated pools that may strand fish.

2.2.14 Size coarse material using Corps of Engineers equation for rip rap design found in FHWA "River Engineering for Highway Encroachments", page 6.25 to 6.30 (Richardson, Simons and Lagasse 2001). FWS has developed the "Streambed Material Sizing Analyzer.xlsx" spreadsheet to use this method (See Figure B-5 for example). Input the design flood velocity in culvert (use average velocity at a given cross section) and model flow height to determine the D30 size of the coarse material required for stability. Use HY8 water surface profile to find where the max average velocity is; which may be inlet or outlet. Determine coarse and fine aggregate gradation using Fuller Thompson equation as a target (compare in the Streambed Material Sizing Analyzer spreadsheet). The spreadsheet is set up to use the ADOT&PF rip rap sizes or to use a custom coarse aggregate gradation. Note, ADOT&PF rip rap gradations are very uniform and will need to be mixed (i.e. 33% Type I + 33% Type II + 34% Fine Aggregate) in order to achieve a well graded combined gradation. For a copy of the spreadsheet contact the AFPP. Note: Refer to FHWA (2009) for alternative methods for rip rap design.

2.2.15 Determine if there is adequate upstream sediment supply to move through the culvert. You will not have adequate sediment if the culvert is at a lake outlet, you have a wetland upstream, or a stream with a silty substrate. If there is adequate sediment supply design the culvert substrate for the 50-year (Q50) flood. If sediment supply is not adequate, design culvert substrate for Q100. Check design substrate size against the upstream reach wide pebble count (Q50) and key pieces count (Q100). If the pebble counts are showing larger material than the sizes calculated, your hydrologic estimate may be low. However, in a relic channel you may have a larger pebble count in the system than would be mobilized by the current flow regime. (Note: the USFS stream simulation method relies on sediment moving through the culvert to replenish scoured sections inside the culvert. In contrast, the USFWS modified approach is to have a minimum stability for the coarse sediment in the culvert corresponding to the Q50 flow recognizing that mobility will only occur for the fine fraction of the sediment or at flows higher than Q50. See Appendix E, USFS (2008) for further discussion of the USFS approach.

2.2.16 Design immobile key pieces and stream bank material inside the culvert for Q100. Use either rock clusters or rock bands to define the low flow channel and design for Q100. Check Q100 size against key pieces count data. See Figure 10 for spacing and design guidance.

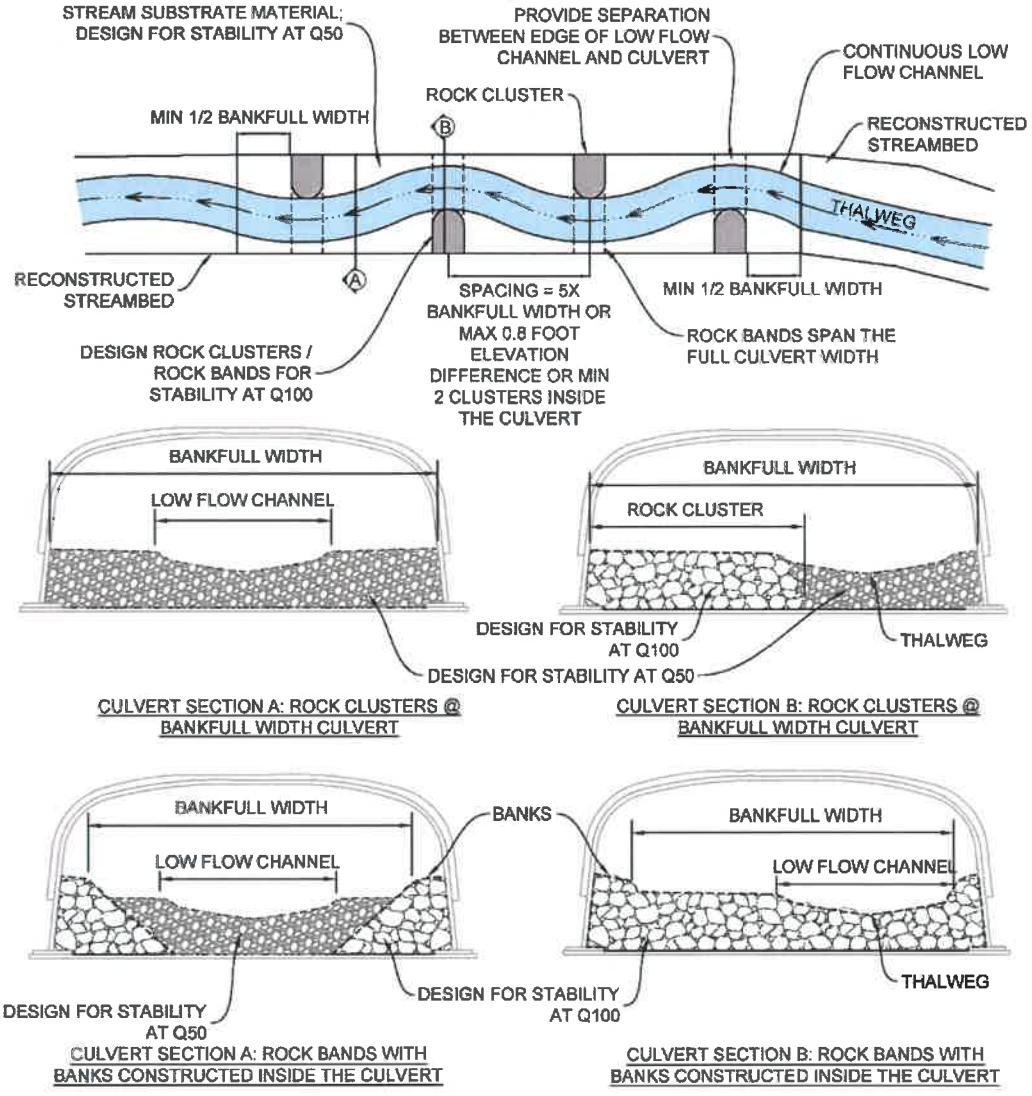


Figure 10. Example rock cluster or rock band layout used to stabilize the low flow channel.

2.2.17 Check embed of culvert is 1.5xD100 (USFS 2008) and allows for potential scour (lower VAP, See Figure 5). Typical embedment depths range from 25-40% of culvert height. Also check culvert width is adequate to construct banks of 1.5xD100 per side if using banks. Will likely need to iterate to find a solution.

2.2.18 Check culvert hydraulic capacity for potential aggradation to the upper VAP line. This would be head of riffle to head of riffle and this could reduce capacity if there is a concave slope change. If there's potential for debris flows use bankfull elevation for upper VAP instead of head of riffle. Situational awareness is key in determining the potential for debris flow. Look for landslides, old failing banks and talk to locals about the history debris flows at the crossing.

2.2.19 Consider floodplain relief culverts where entrenchment ratio is greater than 2.0 and / or obvious side channels exist. (See Figure 4 and chapter 5 of USFS (2008) for guidance). Floodplain relief allows water on the floodplain to drain more quickly during flows greater than bankfull and helps to prevent aggradation of the floodplain that is common in large flood events. Floodplain relief culverts should be placed with their flow line at bankfull elevation at a minimum. (Rock stable to the Q100 may be used to infill the culvert and set the elevation of the flow line). They should not be placed at the same elevation as the thalweg of the main culvert to eliminate chance of capturing creek. Allow enough space between culverts to construct stable banks for the main culvert and not reduce the competence of the main culvert fill compaction. Use a higher Manning's n for the floodplain relief culvert in HY8 assuming brush and grass will grow on the floodplain (Reference Arcement and Schneider (1989) for guidance on Manning's n for floodplains).

2.2.20 Transfer design to CAD. Double check alignment, slope and tail water cross section for final culvert design and iterate if necessary.

2.2.21 Continue culvert substrate upstream and downstream of inlet and outlet for approximately 50% of Wbkf. Design substrate in constructed channel outside of culvert for Q50 or pebble count, depending on scour mitigation as flow transitions from culvert to natural channel and floodplain. If streambanks are designed in the culvert, extend rock banks outside of culvert a minimum of 2 times the D100 rock size (parallel to the flow direction) to transition to natural or bioengineered banks, depending on length of channel disturbance.

2.2.22 Design stream banks to withstand predicted velocities using appropriate bioengineering techniques. (See Fischenich (2001) for design guidance and ADF&G's Streambank Revegetation and Protection guide (Walter, Hughes, Moore and Inoue 2005) for details commonly used in Alaska). In the long run, mature vegetation is expected to protect the banks from erosion after the temporary measure such as root wads and toe wood deteriorate. Therefore, it is important to plant and maintain vegetation until it is well established along the reconstructed banks. Vegetation should mimic stable banks in undisturbed areas of the stream.

2.2.23 Construct cross section for reconstruction of disturbed stream upstream and downstream of the culvert. The cross section should include the low flow channel, bankfull channel and bankfull bench dimensions as well as bioengineering details. See Table 2 for bankfull bench width recommendations and Figure 1 and Figure 3 for an illustration of typical

channel, floodplain and terrace features for different types of channels. Also look at floodplain width in the reference reach for guidance. If the contractor is able to disturb less streambank than anticipated we will typically preserve undisturbed stable streambanks if possible.

Table 2: Recommended bankfull bench widths as a function of percent of bankfull channel width from Wildland Hydrology 2017 Level IV River Restoration and Natural Channel Design Workshop.

Bankfull Channel Width (ft)	Recommended Bankfull Bench Width (% of Channel Width)
<20 ft	75%
20-50 ft	50%
>50 ft	25%

2.3 Site Survey Checklist

- ☐ Use imagery and LIDAR prior to site visit if possible to select potential reference reach locations
- ☐ Call in utility locates prior to site visit.
- ☐ Walk stream and select reference reach. Reference reach should be a minimum length of 20 times the bankfull width and include at least 3 stable grade control features.
- ☐ Draw sketch maps of reference reach and road crossing.
- ☐ Road crossing: Survey longitudinal profile at least 20 times the bankfull width both upstream and downstream of the crossing, or longer if there are indications of instability or other information needs like headcut potential, debris jams, etc. The longitudinal profile should contain at least 4 stable grade control features outside of the area of influence of the existing road crossing (2 upstream and 2 downstream). If there is a slope break at the road, then 6 stable grade control features are recommended (3 upstream and 3 downstream).
- ☐ Capture OHW within the potential construction impact area upstream and downstream of culvert.
- ☐ Road crossing: Collect cross section at riffle outside of zone of influence of the crossing if possible (downstream is usually better).
- ☐ Reference reach: Flag potential bankfull indicators along length of reference reach using vegetation types, benching, and changes in substrate depositional patterns as clues. Alder and spruce are good bankfull indicator species; willows and grasses will grow below the bankfull elevation.
- ☐ Reference reach: Collect reference reach longitudinal profile data.
- ☐ Reference reach: Survey stream cross section locations in a single thread portion of the channel (recommend minimum 2 riffle cross sections and 1 pool cross section for use in road stream crossing designs; additional cross sections may be needed depending on the scope of the proposed channel restoration). Include flood plain in cross section; survey should include 2x bankfull depth if possible for channel entrenchment calculations (or indicate that flood plain is wider than 2x bankfull depth where appropriate).
- ☐ Road crossing: Collect road prism and topographic survey data

- ☐ Representative Reach Pebble Count – 100 particles total. Refer to Bunte and Abt (2001) for recommended pebble count sampling methods.
- ☐ Representative Riffle Pebble Count – 1 at each riffle cross section – 100 particles each count.
- ☐ Key Piece Count (Record dimensions of the 20 largest rocks in the channel for the length of the reference reach).
- ☐ Longitudinal profiles should capture major slope change in the thalweg (top of riffle, bottom of riffle, max pool depth), bankfull calls along the profile. Capture thalweg & top of water at each station. Capture bankfull elevations at all potential bankfull surfaces; an inner berm surface can easily be mistaken for a bankfull surface and vegetation is not always a reliable indicator. This allows use of other resources, such as coordination with the water surface slope and other bankfull calls along the profile, regression equation predictions, gauge data, and available regional curve data to ensure the correct bankfull cross section is selected for design. (Note, at this time regional curve data is not widely available in Alaska).

3. CONSTRUCTING A CROSSING

This section is both for designers considering the constructability and sustainability of their crossings, as well as construction engineers and inspectors needing a better idea of what to look out for during construction.

3.1 General Habitat Conservation Measures

The designer should address the following habitat conservation measures in project specifications:

3.1.1 Minimize Disturbance

Reduce the project footprint to the maximum extent and locate associated activities in already disturbed areas or lower functioning/quality habitat, where possible

3.1.2 Reconstruct Impacted Channels

Design and reconstruct the disturbed channel upstream and downstream of the project to mimic the reference reach. Fill in scour holes and remove excess sediment in the channel deposited as a result of undersized culverts and previous crossing failures. Outside of reconstructing scour holes, banks with healthy native plants should be left intact if possible.

3.1.3 Native Revegetation

Specify vegetative mat with native plants that reflect typical riparian area species for the stream location along all disturbed streambanks (4' width is typical). At least 9", including topsoil and underlying soil layer, should be harvested for transplanting. If available mat has thinner soils, spread imported topsoil under the vegetative mat, prior to transplanting. Specify native riparian species that mimic the reference reach in disturbed riparian areas not covered by vegetative mat.

3.1.4 Bioengineered Banks

Design and specify appropriate bioengineering techniques such as root wads or toewood to protect reconstructed banks until vegetation is established.

3.1.5 Weed Free Construction Protocols

Specify weed free gravel, weed free topsoil, and weed free erosion control materials (compost wattles or coconut fiber roll instead of straw wattles). Wash all equipment prior to mobilization to the site. Use native weed-free seed (preferably locally collected), specific to the habitat type, applied at specified rates, and cover the seed to specified depth. Consider using a tackifier, mulch, or other bonding agents to keep seed in place.

3.1.6 Avoid Plastic Netting

Plastic degradable netting should not be used in erosion control for any aspect of the proposed project. Prior to degradation, the netting can entangle wildlife, including amphibians, birds, and small mammals.

3.1.7 Environmentally Stable Insulation

If using foam sheets for permafrost insulation, specify closed-cell foam rather than styrofoam insulation. Styrofoam pellets degrade water quality and break into tiny pieces creating an ingestion hazard for fish, mammals, and birds.

3.1.8 Migratory Birds

Avoid removing vegetation during the bird nesting season, when possible.

3.1.9 Riparian Areas

Consider strategically placing root wads, large logs, or boulders in the riparian area after seeding, to provide topographical relief and micro-climates, and to increase the variety of plant species difficult to establish by seed (e.g., increase habitat complexity).

3.2 Construction Inspection Checklist

Pre-construction:

- ☐ Verify environmental permitting is current (e.g. USACE Section 404, DNR water use, ADFG habitat).
- ☐ Verify all necessary ROW and easements have been obtained
- ☐ Notify local residents and businesses of construction activity and closures
- ☐ Check that utility locates have been done
- ☐ Check that utilities have been relocated by 3rd parties as necessary
- ☐ Verify the stream profile has not experienced significant grade changes compared to the design profile.
- ☐ Inventory owner supplied materials and sign over to contractor
- ☐ Check that survey monuments are located and a plan to relocate disturbed monuments is made
- ☐ Review diversion and dewatering plan with contractor and ADFG.

- ☐ Ensure contractor has adequate pump capacity, discharge hose, correct fuel types for pumps, extra suction hose gaskets, and backup stream diversion materials. If pumping stream flows around the construction site, use screened intake for water withdrawals to avoid suction entrapment and entrainment injury to small and juvenile fish present in the area of the withdrawal.
- ☐ Confirm that the fish resource permit has been obtained and review plan for relocating fish with ADFG
- ☐ Confirm that contractor has obtained traffic control permit if required
- ☐ Review erosion and pollution control plan; ensure SWPPP permit obtained from ADEC if > 1 acre.
- ☐ Plastic degradable netting is not allowed for use in erosion control for any aspect of the project. Prior to degradation, the netting can entangle wildlife, including amphibians, birds, and small mammals.
- ☐ Isolate wetlands from construction-generated sediment and pollutants by maintaining a minimum 200-foot setback from waterways when storing hazardous or toxic material or refueling. Confirm that containment and cleanup materials are on site prior to starting work.
- ☐ Review the revegetation plan. Confirm source of vegetative mat. Vegetative cover should be capable of stabilizing the soil against erosion. In addition to topsoil and seed, consider transplanting willows, alder and/or spruce in the riparian area behind the vegetative mat. If rip-rap was used, backfill with finer sediments, cover with topsoil, and seed with native seed.
- ☐ Confirm and review aggregate material sources and gradations
- ☐ Use weed free gravel, weed free topsoil, and weed free erosion control materials (compost wattles or coconut fiber roll instead of straw wattles). Wash all equipment prior to mobilization to the site. Use native weed-free seed (preferably locally collected), specific to the habitat type, applied at specified rates, and cover the seed to specified depth. Use a tackifier, mulch, or other bonding agents to keep seed in place.
- ☐ Count number of trees to be removed or already removed if a replacement ratio is specified
- ☐ Review area of disturbance required for construction. Reduce the project footprint to the maximum extent and locate associated activities in already disturbed areas or lower functioning/quality habitat, where possible.

During construction and prior to re-watering culvert:

- ☐ Confirm culvert alignment has been staked out according to drawings and meets project objectives; notify engineer if adjustment are needed
- ☐ Check grade elevation and slope of excavation prior to setting the culvert
- ☐ Check top (or invert) of culvert placed at correct elevation and correct slope per drawings prior to filling with substrate

- ☐ Prior to placement in culvert, inspect streambed infill materials at quarry or stockpile; check against design gradation, ensure enough fines are present to seal streambed during wash-in procedure
- ☐ Check stream material is sufficiently sealed and water pools on surface prior to re-diverting the creek back into the culvert
- ☐ Check that substrate has been sprayed down and discharge is clean and clear
- ☐ Walk thru culvert and check substrate is firm (similar to the natural streambed)
- ☐ Discuss plan to remove diversion
- ☐ Discuss revegetation plan and revise where necessary; save undisturbed banks if possible
- ☐ Check channel thalweg and bank elevations at culvert inlet and outlet
- ☐ Check channel tie in location and elevation upstream and downstream
- ☐ For culverts with streambanks constructed inside of the culvert, check that the banks are extended outside of the culvert 2xD100 minimum and tied into natural banks.
- ☐ Check channel planform matches drawings
- ☐ Check bankfull channel width and depth matches drawings
- ☐ Check low flow channel width and depth matches drawings
- ☐ Check channel dimensions upstream and downstream from culvert
- ☐ Check rootwads or toewood constructed per plans or revise as necessary to adapt to site conditions. Check elevation of rootwads – centerline of bole at OHW or top of bole at bankfull

During construction after re-watering culvert:

- ☐ Check embed depth of willow cuttings (min 2/3 in dirt) and trim as needed
- ☐ Check live vegmat placed as noted on drawings
- ☐ Check disturbed areas without vegmat have topsoil that has been track walked and seeded
- ☐ Check revegetation matches plans and discuss required watering going forward
- ☐ Check volume of flow in culvert matches flow upstream (not losing water in the substrate)
- ☐ Check rip rap collar placed as noted on plans.
- ☐ Check rip rap in the collar has been filled with fines.
- ☐ Verify compaction methods are adequate and meet specs during backfill of the road prism.
- ☐ Check minimum cover provided over culvert
- ☐ Check roadway width and surface material
- ☐ Check roadway grade
- ☐ Check for correct installation of post-construction erosion and sediment controls.

- ☐ Re-contour slopes to blend with surrounding topography and use waterbars or contour furrowing (by track walking or manual raking- see ADOT&PF spec section 618) on steeper slopes.
- ☐ Strategically place root wads, large logs, or boulders in the riparian area after seeding, to provide topographical relief and micro-climates, and to increase the variety of plant species difficult to establish by seed (e.g., increase habitat complexity).

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Appendix A: Description of Terms and Commentary

100-Year Flood Flow (Q100): The stream discharge that has a reoccurrence interval of 100 years, or a 1 in 100 chance of occurring in a given year; also known as the 100-year recurrence interval event. If the crossing structure is not designed to accommodate the 100-year flow, a route must be established to safely convey flows exceeding the design flow without causing damage to property, endangering human life or public health, or causing significant environmental damage. In cases of crossings within high entrenchment ratio environments (flood prone width/bankfull width >2) then floodplain overflow culverts may be beneficial to floodplain connectivity and can be used to pass the 100-year flood, but minimum width requirements for the primary culvert still apply.

50-Year Flood Flow (Q50): The stream discharge that has a reoccurrence interval of 50 years, or a 1 in 50 chance of occurring in a given year

Bankfull: For non-entrenched stream types (C, D, DA and E), bankfull is the height on the streambanks where water flow fills the channel and begins to spread out onto the floodplain. (See Figure 3). For entrenched stream types(A, B, F and G), other indicators are required to identify the bankfull elevation such as the highest active depositional feature, slope breaks, change in particle size distribution, small benches, staining of rock, lichens, and certain riparian vegetation species (Rosgen, 1996). Use multiple indicators wherever possible to determine a common bankfull stage elevation. Where possible, calibrate field-determined bankfull stage elevation and corresponding bankfull channel dimensions to known recurrence interval discharges at gauge stations. Bankfull features are typically wider than the *ordinary high water mark*. Correctly identifying the bankfull channel dimensions is critical to the success of the geomorphic analog method. The design professional should pursue training in this area and use hydrologic data to verify bankfull dimensions are reasonable. Further information on ways to do this is available in Appendix A.

Bankfull width: The surface width of the stream measured at bankfull. (See Figure 1 for an example of bankfull width on a small stream).

Bankfull cross sectional area: The sum of products of unit width and depth at the bankfull stage elevation in a riffle cross section.

Bankfull discharge: A frequently occurring peak flow whose stage represents the incipient point of flooding. The bankfull discharge is expressed as the momentary maximum of instantaneous peak flows rather than the mean daily discharge. It is often associated with a return period of 1-2 years, with an average of 1.5 years (Rosgen, 1996). (Note: return intervals for bankfull of up to 5 years have been found for some streams in the continental United States. Stream gaging is recommended if the designer desires confidence in the bankfull discharge return interval).

Bankfull slope: The average slope through the bankfull indicators recorded at multiple locations along the longitudinal profile. The bankfull slope of a given reach should match the water surface slope measured between stable grade control features. See "Slope Ratio" term for more

information on measuring the slope of a reference reach.

Dynamically Stable: Dynamic stability means that channel dimensions, slope and planform do not change radically even though they adjust to changing inputs of water, sediment and debris. (FHWA, 2010). Dynamically stable channel features will fluctuate around a mean value but will stay within the predicted VAP lines.

D100 particle size: This corresponds to the largest particle size in a given material gradation. In other words, 100 percent of the particles in the material are smaller than the D100 size.

D84 particle size: This corresponds to the size of the particle in a material gradation such that 84 percent of the particles in the material are smaller than the D84 size.

Ecological Functioning: A crossing is considered to be ecologically functioning if it allows for conveyance of water, sediment, debris, marine derived nutrients, and passage of fish and other organisms in the channel, floodplain and riparian area floodplain both upstream and downstream during flows ranging from low flows during dry periods up to a 100-year flood flow. Sediment transport should remain in equilibrium throughout the range of flows so that no significant aggradation or degradation will result. In embedded culverts there is always some sediment movement into and out of the culvert if upstream sources exist. However, vertical adjustment of the channel beyond the upper and lower VAP lines should be designed to occur at the 50-year design flow or higher for locations with upstream sediment sources and 100-year or higher at locations without sediment sources such as lake outlets. Also, constructed banks should be designed for stability up to the 100-year flood flow.

Entrenchment Ratio: The vertical containment of a river, obtained by dividing the flood-prone width by the bankfull width at a reference riffle (Rosgen 1996).

Flashiness: The speed of short term changes in stream flow in response to storm events. Streams that rise and fall quickly are considered flashy and will have higher peak flows than streams that are less flashy. Impermeable surfaces, such as pavement or clay layers, will increase the flashiness of a system.

Flood-prone Area and Width: Per Rosgen stream type methodology, the flood prone area and width is the area adjacent to the watercourse constructed by the watercourse in the present climate and inundated during periods of high flow. The flood-prone width is the width of the floodplain at an elevation two times (x2) the maximum bankfull depth (Rosgen 1996).

Geomorphic Analog Method: A geomorphic analog means that the crossing is designed using reference data from a representative section (reference reach) of the specific water body being crossed. The geomorphic analog method is a crossing design technique that attempts to replicate the natural stream channel conditions found upstream and downstream of the crossing. Sediment transport, flood and debris conveyance, and fish passage function much as they do in the natural channel if designed correctly. The geomorphic analog uses bankfull channel dimensions to size the crossing structure and channel. If there are no suitable reference reaches on the specific body of water being crossed, a reference reach may be chosen from another water body with similar geomorphic and hydrologic characteristics (Figure A-1).

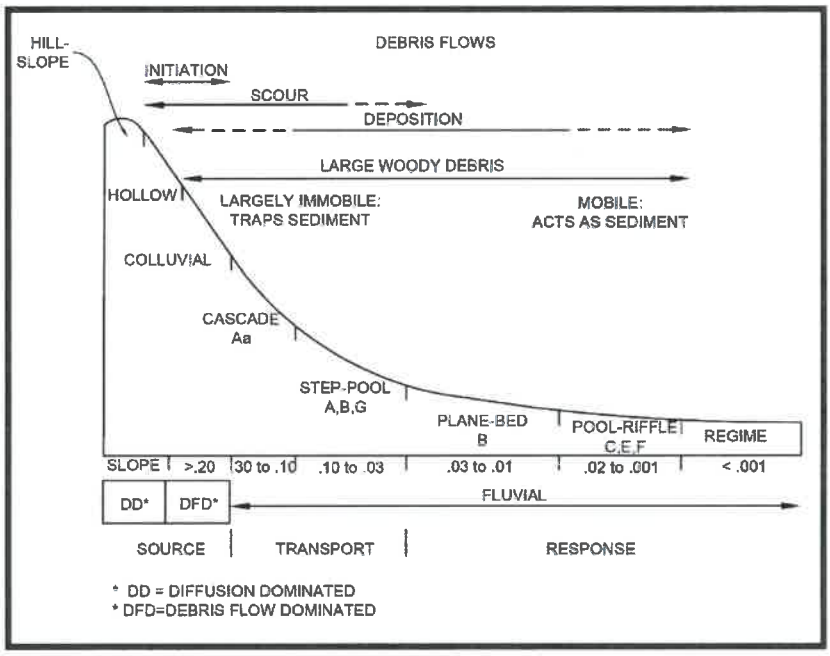


Figure A-1: Geomorphic processes and stream types relative to channel slope (Montgomery and Buffington, 1993).

In these cases, we recommend following the criteria outlined in the River Morphology and Applications workshop by Wildland Hydrology for selecting a reference reach:

- The reference reach bankfull width should be at least one half, but not more than two times the water body being crossed
- The reference reach bankfull discharge should be at least one half and no more than one and one half times the bankfull discharge of the water body being crossed
- The stream order of the reference reach should be within one stream order of the water body being crossed
- The reference reach should be within 25% of the crossing gradient as noted in Section 2.1.2.4.

The crossing design channel width, area and other features should be scaled to the reference reach using ratios to the bankfull dimensions (Figure A-2).

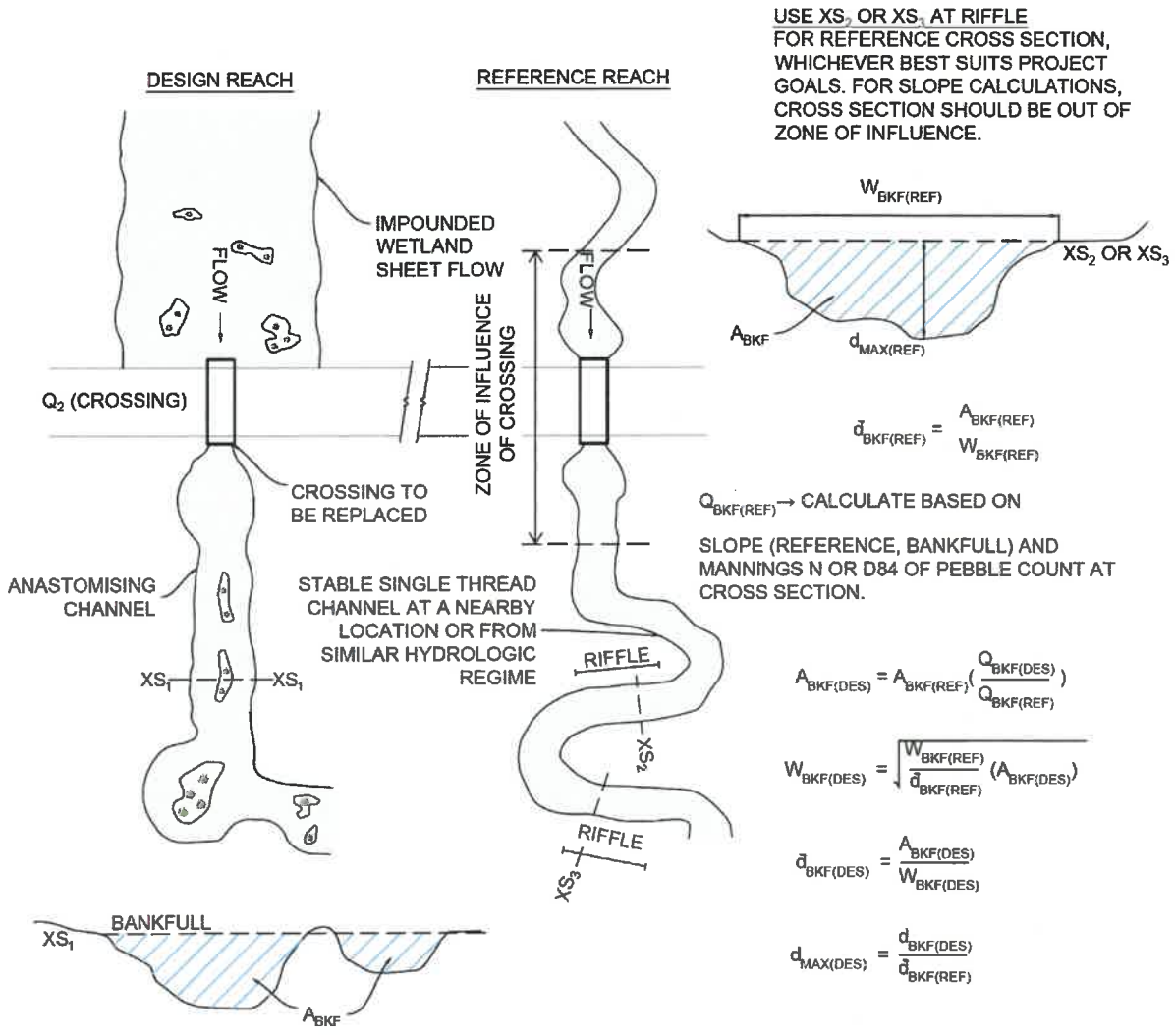


Figure A-2: Example application of the geomorphic analog method.

Hydraulic Methods: A culvert designed with the hydraulic method is designed to maintain flow velocities to be less than the swimming abilities for the weakest swimming fish at the high fish passage flow predicted with hydrologic modeling. Due to the limitations of hydrologic modeling accuracy and the limited data on fish swimming abilities, the hydraulic method should be avoided if possible. Overall, there are very limited situations where the hydraulic method can meet the 1 fps criteria for juvenile salmon and other weak swimming fish for high fish passage flow events. Hydrology estimates and fish swimming speeds provide the basis for the success of the hydraulic design method. Yet, there are significant errors associated both with the estimation of hydrology and fish swimming speeds. We do not believe a culvert can be designed with conservative assumptions that resolve the very large margins of error common for hydrologic predictions, especially when there is no gauge data on which to base these predictions. Another problems with the Hydraulic Design method is that it is species dependent so not all fish or other aquatic organisms may be able

to pass the culvert even if you are confident of your flow predictions and fish swimming abilities. The biggest concern with the Hydraulic Design method is it does not require maintenance of the geomorphic form of the channel. Mimicking the geomorphic form of the natural channel is the best way to maintain sediment transport in equilibrium because it helps to maintain the hydraulic geometry and thus the shear stresses experienced by the stream substrate at varying flow levels. Providing for sediment transport equilibrium is important both to the health of the ecosystem and the long term maintenance and viability of a culvert as a fish passage structure.

Low Flow Channel: A low flow channel is intended to provide fish passage at minimum flows. The low flow channel should mimic the reference reach where possible. A "V" shaped thalweg is recommended for streams that have periods of very low flow. If the low flow channel dimensions are not discernable from the reference reach, the low flow channel should have a cross section sectional area of 15-30% of the bankfull cross sectional area and a minimum depth of four inches (4") for small streams up to twelve inches (12") for larger streams. The low flow channel should be defined by rock features that will resist critical shear forces up to the 100-year flood. (See Figure 1 for an example of a low flow channel on a small stream).

Ordinary High Water Mark (OHWM): OHWM is a legal, non-geomorphic term defined by Alaska statute §41.17.950 (15) which states the "ordinary high water mark means the mark along the bank or shore up to which the presence and action of tidal or non-tidal water are so common and usual, and so long continued in all ordinary years, as to leave a natural line impressed on the bank or shore and indicated by erosion, shelving, changes in soil characteristics, destruction of terrestrial vegetation, or other distinctive physical characteristics" (Alaska Legal Resource Center 2008). Reference http://www.adfg.alaska.gov/index.cfm?adfg=uselicense.faqs#howdoiknow for more information on identifying the OWHM. Also, see Figure 1 for an example of the OHWM on a small stream.

Reference Reach: A portion of a stream that represents a stable channel (dimension, pattern, profile) within the geomorphic context that exists in that segment and can represent a natural or a stable, modified condition (USFS 2008). A reference reach should be a minimum 20 times the reference bankfull width and no less than 200 feet in length for creeks less than 10 feet in bankfull width. A reference reach should also include a minimum of 4 stable grade control features. See the definition for Geomorphic Analog Method for further reference reach selection recommendations.

Retention Sills: Metal or wood plates welded or bolted into a culvert with a height of no more than one half of the embedment depth. Retention sills are intended to hold substrate in place in culverts greater than 6% slope. Retention sills should not protrude into the flow (USFS 2008).

Slope ratio: The ratio of the culvert bed slope to the upstream reach or reference reach channel slope. The slope of the reference reach should be calculated using the water surface elevations between stable grade control features at the top and bottom of the reach assuming the reach slope is consistent. In order to verify grade control features are accurately identified and stable, at least three grade control features should be included along the longitudinal profile. For stable streams without obvious grade control features use of the average water surface slope is acceptable. Unstable streams should not be used for a reference reach.

Streambanks: The streambanks correspond to the bankfull elevation of a natural channel.

Streambanks inside a culvert may be simulated with large rock designed to be stable up to the 100-year flood flow.

Substrate Grain Size: A particle size distribution based on a particle count taken in the reference reach of at least 100 particles. This is also commonly referred to as a "pebble count." Refer to Bunte and Abt (2001) for recommended sampling methods.

Synthetic Width Method: A method of calculating culvert width dimensions when the current flow regime does not coincide with the geomorphic bankfull indicators such as in a relic channel or slough or no defining bankfull features exist (See *bankfull* definition). The synthetic width method was developed by USFWS fish passage engineers William Rice and Heather Hanson as a design method for culvert sizing in extensive wetland environments with very low entrenchment. In many cases in these environments the bankfull width is very ill-defined, road fill height is to be minimized and velocity and substrate regime can be created to facilitate fish passage without the need to span the entire length of the wetland complex. AFPP notes this is still considered a work in progress. A description of the synthetic width method can be found under the Special Conditions, Section 2.1.5.4.

Vertical Adjustment Potential: The elevations between which the streambed might vary over the service life of the structure. Refer to Chapter 5 of USFS (2008) for a thorough explanation of the factors that should be considered when determining the vertical adjustment potential (VAP).

Appendix B: Design Aids

Worksheet 2-3. Field form for *Level II* stream classification.

Stream:			
Basin:	Drainage Area:	acres	mi^2
Location:			
Twp.&Rge:	Sec.&Qtr.:		
Cross-Section Monuments (Lat./Long.):		Date:	
Observers:		Landscape Type:	

Bankfull Width (W_{bkf}) The surface width of the stream at bankfull stage elevation, in a riffle section.		ft
Bankfull Mean Depth (d_{bkf}) Mean depth of the stream channel cross-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A_{bkf} / W_{bkf}$).		ft
Bankfull Cross-Sectional Area (A_{bkf}) Area of the stream channel cross-section, at bankfull stage elevation, in a riffle section.		ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) *Bankfull Width* divided by *Bankfull Mean Depth*, in a riffle section.		ft/ft
Bankfull Maximum Depth (d_{max}) Maximum depth of the bankfull channel cross-section, or distance between the bankfull stage and Thalweg elevations, in a riffle section.		ft
Flood-Prone Area Width (W_{fpa}) Width of the channel at an elevation that is twice the *Bankfull Maximum Depth*, measured perpendicular to the fall line of the valley in a riffle section.		ft
Entrenchment Ratio (ER) The *Flood-Prone Area Width* divided by *Bankfull Width* (W_{fpa} / W_{bkf}), in a riffle section.		ft/ft
Channel Materials (Particle Size Index D_{50}) The D_{50} particle size index represents the median or dominant diameter of channel materials, as sampled proportionately from the channel surface between the bankfull stage and Thalweg elevations.		mm
Average Water Surface Slope (S) The elevation difference of water surface measurements over the stream length between two similar bed features (e.g., start of riffle to start of last riffle) for several riffle–pool or step–pool sequences, representing channel gradient.		ft/ft
Channel Sinuosity (k) An index of channel pattern determined from stream length divided by valley length (SL / VL), or from valley slope divided by average water surface slope (S_{val} / S).		ft/ft
Stream Type		**See Classification Key (Figure 2-35)**

 River Stability Field Guide page 2-60

Source: Rosgen, D.L. (2008). River Stability Field Guide and River Stability Forms & Worksheets.

Figure B-1: Stream Classification Worksheet

Worksheet 2-2. Computations of bankfull mean velocity and bankfull discharge using various methods.

Bankfull VELOCITY & DISCHARGE Estimates

Stream:		Location:	
Date:	Stream Type:	Landscape Type:	
Observers:		HUC:	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Riffle Cross-Sectional Area		A_{bkf} (ft^2)	Bankfull Riffle Mean Depth		d_{bkf} (ft)
Bankfull Riffle Width		W_{bkf} (ft)	Wetted Perimeter ≈ (2 * d_{bkf}) + W_{bkf}		W_p (ft)
D_{84} Particle Size at Riffle		D_{84} (mm)	D_{84} Particle Size in Feet D_{84} (mm) / 304.8		D_{84} (ft)
Bankfull Slope		S_{bkf} (ft/ft)	Hydraulic Radius A_{bkf} / W_p		R (ft)
Gravitational Acceleration	32.2	g (ft/sec^2)	Relative Roughness R (ft) / D_{84} (ft)		R / D_{84} (ft/ft)
Drainage Area		DA (mi^2)	Shear Velocity $u^* = (gRS)^{½}$		u^* (ft/sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor / Relative Roughness $\bar{u} = [2.83 + 5.66 * Log\{R / D_{84}\}] u^*$		ft/sec		cfs
2. Roughness Coefficient: a) Manning's n from Friction Factor/Relative Roughness (Figs. 2-29, 2-30) $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$		ft/sec		cfs
2. Roughness Coefficient: b) Manning's n from Stream Type (Fig. 2-31) $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n =$		ft/sec		cfs
2. Roughness Coefficient: c) Manning's n from Jarrett (USGS): $\bar{u} = 1.49 * R^{2/3} * S^{1/2} / n$ $n = 0.39 * S^{0.38} * R^{-0.16}$ Note: This equation is applicable to steep, step/pool, high boundary roughness, cobble- and boulder-dominated stream systems; i.e., for Stream Types A1, A2, A3, B1, B2, B3, C2 & E3 $n =$		ft/sec		cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.)		ft/sec		cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.)		ft/sec		cfs
4. Continuity Equations: a) USGS Gage Data $\bar{u} = Q / A$ Return Period for Bankfull Q $Q =$ year		ft/sec		cfs
4. Continuity Equations: b) Regional Curves $\bar{u} = Q / A$		ft/sec		cfs

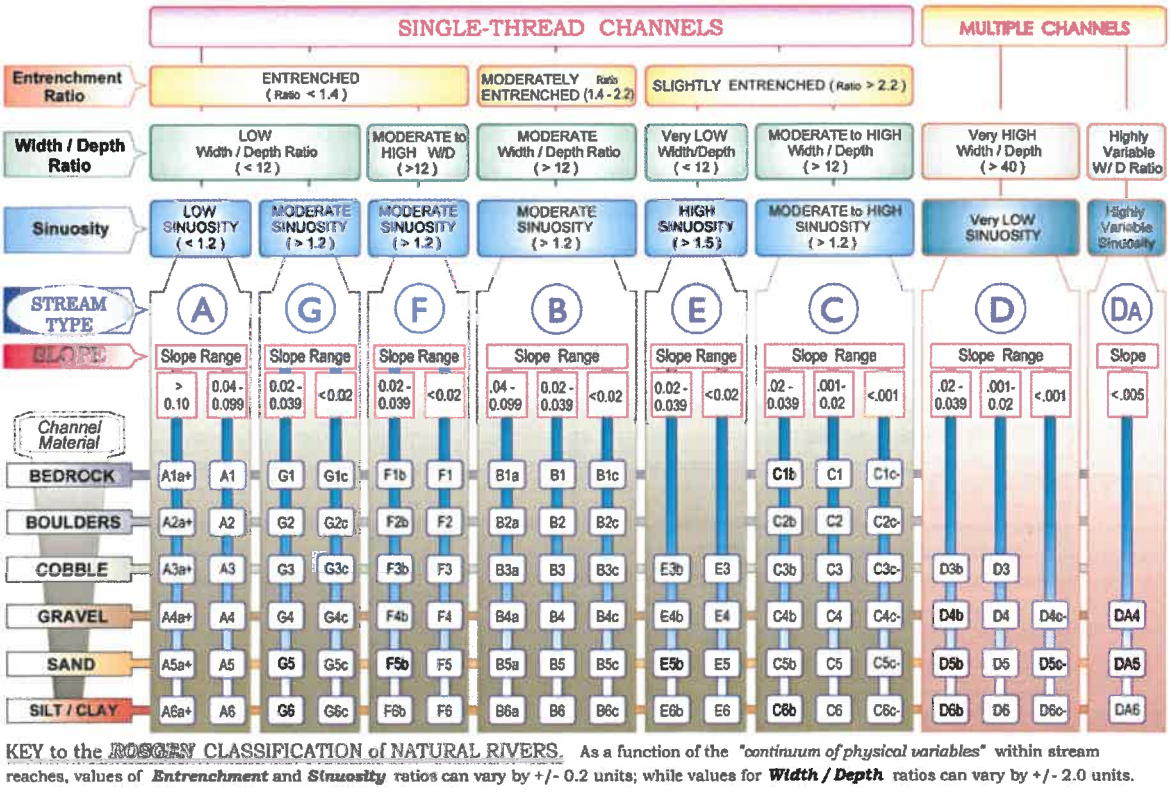
Protrusion Height Options for the D_{84} Term in the Relative Roughness Relation (R/D_{84}) – Estimation Method 1

Option 1.	For sand-bed channels: Measure 100 "protrusion heights" of sand dunes from the downstream side of feature to the top of feature. Substitute the D_{84} sand dune protrusion height in ft for the D_{84} term in method 1.
Option 2.	For boulder-dominated channels: Measure 100 "protrusion heights" of boulders on the sides from the bed elevation to the top of the rock on that side. Substitute the D_{84} boulder protrusion height in ft for the D_{84} term in method 1.
Option 3.	For bedrock-dominated channels: Measure 100 "protrusion heights" of rock separations, steps, joints or uplifted surfaces above channel bed elevation. Substitute the D_{84} bedrock protrusion height in ft for the D_{84} term in method 1.
Option 4.	For log-influenced channels: Measure "protrusion heights" proportionate to channel width of log diameters or the height of the log on upstream side if embedded. Substitute the D_{84} protrusion height in ft for the D_{84} term in method 1.

 River Stability Field Guide page 2-49

Source: Rosgen, D.L. (2008). River Stability Field Guide and River Stability Forms & Worksheets.

Figure B-2: Bankfull Discharge Worksheet



KEY to the ROSGEN CLASSIFICATION of NATURAL RIVERS. As a function of the *"continuum of physical variables"* within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units; while values for ***Width / Depth*** ratios can vary by +/- 2.0 units.

Figure B-3: Rosgen Classification Key

Source: Rosgen, D.L. (2007). In Part 654 Stream Restoration Design National Engineering Handbook (210-VI-NEH), J. Bernard, J.F. Fripp & K.R. Robinson (Eds.). USDA Natural Resources Conservation Service, Washington, D.C.

Table 11–2 General stream type descriptions and delineative criteria for broad-level classification (level 1)

Stream type	General description	Entrench-ment ratio	W/d ratio	Sinuosity	Slope	Landform/ soils/features
Aa+	Very steep, deeply entrenched, debris transport, torrent streams	<1.4	<12	1.0 to 1.1	>.10	Very high relief. Erosional, bedrock, or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with deep scour pools; waterfalls
A	Steep, entrenched, cascading, step-pool streams. High energy/ debris transport associated with depositional soils. Very stable if bedrock or boulder-dominated channel	<1.4	<12	1.0 to 1.2	.04 to .10	High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step-pool bed morphology
B	Moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools. Very stable plan and profile. Stable banks	1.4 to 2.2	>12	>1.2	.02 to .039	Moderate relief, colluvial deposition and/or structural. Moderate entrenchment and width-to-depth ratio. Narrow, gently sloping valleys. Rapids predominate with scour pools
C	Low gradient, meandering, point bar, riffle/pool, alluvial channels with broad, well-defined flood plains	>2.2	>12	>1.2	<.02	Broad valleys with terraces, in association with flood plains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/ pool bed morphology
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks	n/a	>40	n/a	<.04	Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment with abundance of sediment supply. Convergence/divergence bed features, aggradational processes, high bed load and bank erosion
DA	Anastomizing (multiple channels) narrow and deep with extensive, well-vegetated flood plains and associated wetlands. Very gentle relief with highly variable sinuosities and width-to-depth ratios. Very stable streambanks	>2.2	Highly variable	Highly variable	<.005	Broad, low-gradient valleys with fine alluvium and/or lacustrine soils. Anastomized (multiple channel) geologic control creating fine deposition with well-vegetated bars that are laterally stable with broad wetland flood plains. Very low bed-load, high wash load sediment
E	Low gradient, meandering riffle/pool stream with low width-to-depth ratio and little deposition. Very efficient and stable. High meander width ratio	>2.2	<12	>1.5	<.02	Broad valley/meadows. Alluvial materials with flood plains. Highly sinuous with stable, well-vegetated banks. Riffle/pool morphology with very low width-to-depth ratios
F	Entrenched meandering riffle/pool channel on low gradients with high width-to-depth ratio	<1.4	>12	>1.2	<.02	Entrenched in highly weathered material. Gentle gradients with a high width-to-depth ratio. Meandering, laterally unstable with high bank erosion rates. Riffle/pool morphology
G	Entrenched gully step-pool and low width-to-depth ratio on moderate gradients	<1.4	<12	>1.2	.02 to .039	Gullies, step-pool morphology with moderate slopes and low width-to-depth ratio. Narrow valleys, or deeply incised in alluvial or colluvial materials (fans or deltas). Unstable, with grade control problems and high bank erosion rates

Figure B-4: Desription of Rosgen Stream Types

Source: Rosgen, D.L. (2007). In Part 654 Stream Restoration Design National Engineering Handbook (210-VI-NEH), J. Bernard, J.F. Fripp & K.R. Robinson (Eds.). USDA Natural Resources Conservation Service, Washington, D.C.

New Stream Channel Design (Culvert, Rock Ramp)

Using Corps of Engineers Equations - FHWA Circular on Development in the River System - Page 6.25.
FHWA NHI 01-004; River Engineering for Highway Encroachments, 2001
http://www.fhwa.dot.gov/engineering/hydraulics/library_arc.cfm?pub_number=8&id=20

YELLOW ARE INPUTS		
Safety Factor	1.5	
Stability Coefficient for Incipient Failure	0.3	(0.36 round rock, 0.3 angular rock)
Vertical Velocity Distribution Coeff	1.00	(1.0 for straight channels)
Blanket Thickness Coeff	1	(1xD100 or 1.5 or D50 max, whichever is greater)
Local depth of flow	2.5	ft for 100 year event
Unit Weight of water	62.4	lb/ft^3 assumed
Unit weight of rock	165	lb/ft^3 assumed
Local depth-average velocity	9.8	ft/s from 100-year event avg. velocity in pipe
Side Slope correction factor	1	
Gravitational Acceleration	32.2	ft/s^2
D85/D15	3.8	(1.7-5.2)
D50/D30	2	

Note: This method is based on the minimum D30 size

Riprap Design Method - Selecting Proper Gradation, Page 131.
Design Hydrology and Sedimentology for Small Catchments, Haan, Barfield and Hayes, 1981.

D15	0.5	ft	7.0	inches
D30	0.8	ft	10.0	inches
D50	1.2	ft	15.0	inches
D85	2.0	ft	24.0	inches
D100	2.4	ft	29.0	inches

Coarse

Using D50 size, used FHWA circular for Rip Rap design to spec out D100, D85 and D15.
D100 = 2.0D50

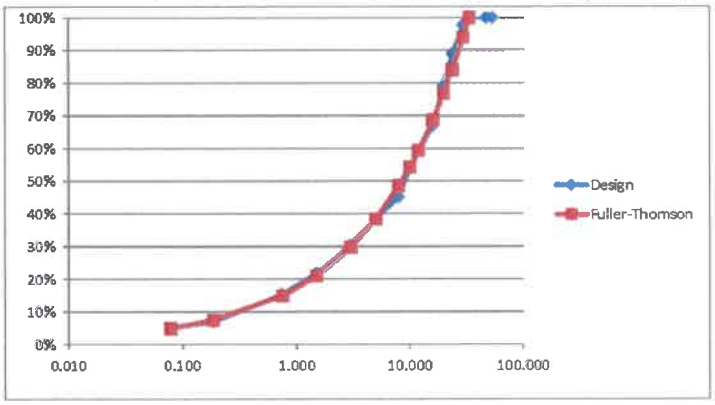
Fuller-Thompson Estimating for Maximum Density:
Method Adapted from US Forest Service Stream Simulation Guidelines

D100 (inches) 34 input designed D100 from table below
D30 10.0 Stability (D30) OK
D30 Req'd 10.0

YELLOW ARE INPUTS

		COARSE MATERIAL					FINES
		Custom	Type IV Rip Rap	Type III Rip	Type II Rip R	Type I Rip Rap	FA
	relative %	0	0	0.22	0.2200	0.2200	0.3400
Size (inches)	Sieve Size	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing
54	54"	0.00	1.00	1.00	1.00	1.00	1.00
48	48"	0.00	0.90	1.00	1.00	1.00	1.00
34	34"	0.00	0.50	1.00	1.00	1.00	1.00
30	30"	0.00	0.35	0.90	1.00	1.00	1.00
24	24"	0.00	0.25	0.50	1.00	1.00	1.00
20	20"	0.00	0.15	0.15	0.90	1.00	1.00
16	16"	0.00	0.00	0.00	0.50	1.00	1.00
12	12"	0.00	0.00	0.00	0.15	1.00	1.00
10	10"	0.00	0.00	0.00	0.00	0.90	1.00
8	8"	0.00	0.00	0.00	0.00	0.50	1.000
5	5"	0.00	0.00	0.00	0.00	0.20	1.000
3	3"	0.00	0.00	0.00	0.00	0.10	0.830
1.5	1.5"	0.00	0.00	0.00	0.00	0.00	0.640
0.75	.75"	0.00	0.00	0.00	0.00	0.00	0.450
0.187	#4	0.00	0.00	0.00	0.00	0.00	0.200
0.0787	#10 Sand	0.00	0.00	0.00	0.00	0.00	0.150

Gradation values should be within +/-5% of this gradation (Rice)
AND we need to have at least 5% sand size (#10) or smaller (Forest Service) in the combined gradation



DATA for Graph & Fuller-Thomson Eqn

Size (in)	Combined % pa	F-T equation
54.000	100%	126%
48.000	100%	119%
34.000	100%	100%
30.000	98%	94%
24.000	89%	84%
20.000	79%	77%
16.000	67%	69%
12.000	59%	59%
10.000	54%	54%
8.000	45%	49%
5.000	38%	38%
3.000	30%	30%
1.500	22%	21%
0.750	15%	15%
0.187	7%	7%
0.079	5%	5%

Figure B-5: Sample Streambed Material Sizing

Appendix C: Guidelines Comparison Table by Agency

	Summary and Comparison of Agency Culvert Design Guidance and Criteria				
	Guidance Topic	**USFWS** **Geomorphic Analog Method - 2019**	**USFS** **Stream Simulation Method - 2008**	**NOAA** **Streambed simulation design method (Northwest Region) 2011**	**ADOT&PF/ADF&G MOA** **Tier 1 – Stream Simulation Design - 2001**
Culvert Design	Culvert conveyance - Design Flood	100-year flood	Design flood - per designer or agency	No guidance or criteria	Varies; between 10-year and 100-year flood depending on importance of road
	Hydraulic Design Method	Not recommended	Not recommended	Allowed for streams with less than 1% slope	Not allowed under tier 1.
	HW/D ratio at design flood	0.8 or as needed to pass debris at 100-year flood	0.8 at design flood	Min 6 feet clearance between culvert bed and ceiling	1.0 at design flood
	Culvert width	1.0-1.4 x bankfull width	Min 1.0 x bankfull width + 1.0xD100 banks, no max width.	Min 1.3 x bankfull width unless stream is fully entrenched (Rosgen A or B stream type)	Min 0.9 x ordinary high water width for culvert slope >0.5%; min 0.75 x ordinary high water width for culvert slopes ≤ 0.5%
	Culvert Slope	Within 25% of reference reach	Within 25% of reference reach	Approximate average slope of adjacent stream or reference reach; max slope 6%	Within 1% of the natural grade; max slope 6%
	Embedment depth	Round - 40%; Arch & Box - 20%; or use a VAP analysis	VAP analysis to determine required embedment	30% min, 50% max, min 3'	Round – 40%; Arch – 20%
	Max culvert length	No guidance	No guidance	150 feet	No guidance or criteria
	Smooth wall metal pipes	Do not use	Not recommended	No guidance or criteria	No guidance or criteria
	Culvert Batteries (multiple culverts installed at the same elevation)	Do not use	No specific prohibition on culvert batteries. However, min bankfull width culvert is recommended.	No guidance or criteria	No guidance or criteria
	Flood plain culverts (culverts have flow only when water reaches the bankfull or floodplain elevation)	Recommended	Recommended	Connectivity of flood plain systems is recommended by increasing the width of primary culvert.	No guidance or criteria
Channel Design	Substrate stability (for crossings with upstream sediment supply)	50-year flood	Mimic stability of reference reach. (ie - D84 in culvert moves at same flow as D84 in reference reach). May increase particle sizes to a max of 25% larger than reference reach to account for flow constriction and increase bankfull channel width to 25% wider to reduce shear stresses in the culvert. If similar stability/mobility to upstream sediment supply is not possible, use a hybrid design method.	Must demonstrate ability to maintain substrate over life of culvert using stability analysis - reference Washington Dept. of Fish and Wildlife Fish Passage Culvert Design Criteria (WDFW), 2003	50-year flood

	Summary and Comparison of Agency Culvert Design Guidance and Criteria (continued)				
		USFWS	USFS	NOAA	ADOT&PF/ADF&G MOA
	Guidance Topic	Geomorphic Analog Method - 2019	Stream Simulation Method - 2008	Streambed simulation design method (Northwest Region) 2011	Tier 1 – Stream Simulation Design - 2001
Channel Design (continued)	Substrate stability (for crossings without upstream sediment supply)	100-year flood	Stream simulation method does not apply.	Must demonstrate ability to maintain substrate over life of culvert using stability analysis - reference WDFW 2003	50-year flood
	Substrate retention sills	Only for >6% slope or sand bed streams, 4" max drop between sills, height limited to 50% of substrate depth.	Only for >6% slope, should not project above the lower VAP line.	No guidance or criteria	Allowed for substrate at any slope; height limited to 50% of substrate depth.
	Bank stability (inside culverts)	100-year flood	Design flood	No guidance or criteria	No guidance or criteria
	Forcing features for low flow channel stability (Inside culverts)	100-year flood	Design flood	No guidance or criteria	No guidance or criteria
	Low flow channel	Yes, mimic reference reach	Yes, mimic reference reach	Yes, mimic reference reach	Low flow evaluation- based on hydrologic predictions and fish morphology.
	Channel hydraulic geometry	Mimic reference reach geometry	Mimic reference reach geometry	Mimic velocities in reference reach, refers to hydraulic design method	No guidance or criteria
Fish and Veg Design	Check of culvert velocity versus fish swimming ability	Not required	Not required	Not required	Not required
	Fish resting zones	Streambed roughness creates fish resting zones	Key features to mimic reference reach create fish resting zones	Larger materials provides fish resting areas	Streambed roughness creates fish resting zones
	Revegetation	Bioengineering and revegetation with native riparian species recommended	Bioengineering and revegetation with native riparian species recommended	Re-vegetation with native riparian species recommended. No dicussion of bioengineering techniques.	No guidance or criteria
Other	Tidal Culvert	Passable 90% of the time	No guidance; mentioned as a special condition	Passage required for entire range of tidal fluctuation	No guidance or criteria
	Trash racks	Not recommended, bollards upstream are OK	Not recommended	Prohibited except if installed above bankfull elevation	No guidance or criteria