Guide to Placement of Wood, Boulders and Gravel for Habitat Restoration

OREGON DEPARTMENT OF STATE LANDS

OREGON DEPARTMENT OF FORESTRY

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OREGON Fish & Wildlife

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Please Note: This is a final draft, minor changes and revisions may occur.

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INTRODUCTION

This guide is an updated version of the Oregon Department of Forestry/Oregon Department of Fish & Wildlife's A Guide to Placing Large Wood in Steams (1995) with new sections added to cover the placement of boulders and gravel.

Over the past century or more, the role of large wood and large boulders in forming and maintaining stream habitat was not understood or was largely ignored. As settlement and development increased so did the removal of large wood and boulders from the state's waterways. In some streams, splash dams were built to drive logs down to mills. Opening of the splash dams resulted in a large torrent of logs and water that scoured the streambed and removed wood, boulders, gravel, and other material from the stream channel and riparian areas. Past logging practices often removed trees to the edge of the stream limiting future wood input to the stream. In some cases streams were also cleared of wood and boulders to improve navigation or fish migration. Over time, these and other, activities resulted in depletion of habitat and channel forming structure in many streams. The removal of in-stream features often altered channel form, stream flow, and how wood, boulders, rock and gravel moved through the river system. This and other activities such as channelization, the construction of dams, culverts, and stream bank protection have limited the availability of spawning gravels for native fish species.

Since natural process have been eliminated, altered, or reduced in many areas, aquatic habitat restoration activities are an important method for reintroducing the necessary structure to stream channels that have been simplified due to past management practices and/or disturbance events. Aquatic habitat restoration activities are also a key to the success of the Oregon Conservation Strategy and the Oregon Plan for Salmon and Watersheds (OPSW). In the broad context of the OPSW, habitat restoration includes a multitude of activities. Aquatic habitat restoration activities are intended to address the watershed functions necessary to support healthy watersheds. This includes improving water quality, water quantity, channel complexity, flood plain interaction and the quality of riparian vegetation. The best approach for habitat restoration is to mimic natural events and processes like a windstorm or landslide to guide the structure design. This approach is most effective when the site has all the components for good habitat except for key pieces of wood or boulders to develop complex habitat or limited spawning gravel retention.

PURPOSE OF THIS GUIDE

This guide has been developed to facilitate the placement of large wood, boulders and gravel in a manner consistent with these principles and regulations in Oregon. These techniques, when done independently or in conjunction with other restoration activities, increase the channel complexity and diversity of habitat necessary to help restore and support a healthy aquatic ecosystem. These are voluntary actions covered under the *Oregon Aquatic Habitat and Enhancement Guide* (http://www.oregon.gov/OWEB/docs/pubs/habguide99-complete.pdf) and Oregon Conservation Strategy (http://www.dfw.state.or.us/conservationstrategy/).

While overall these activities are considered to be beneficial to aquatic resources as they restore previously degraded systems, construction activities may have short-term impacts that require various local state and federal approvals. In general there are two state agencies that regulate work in waterways and wetlands. These agencies are the Oregon Department of Forestry (ODF) when a project is done as part of a forestry operation and the Oregon Department of State Lands (DSL) in most other cases.

Projects that are part of a forestry operation

This guide can be used to design large wood placement as part of a forest operation covered under the 1994 Oregon Forest Practice Rules. A "Notice of Operation" must be filed with ODF at the local office (http://egov.oregon.gov/ODF/privateforests/contact_us_sfcounty.shtml). Appendix A describes how landowners may lower their leave-tree requirements in riparian management areas by placing large wood in streams via the "basal area credit."

Activities that are covered under the Forest Practices Act do not require permits from DSL as they are reviewed by ODF. Placement of large wood is considered a silvicultural operation and does not require a Corps of Engineers Permit, however the placement of boulders and gravel does require approval from the Corps.

Projects that are NOT part of a forestry operation

This guide was written to facilitate the design and permitting of common restoration actions. There are numerous local, state, and federal agencies that may regulate some portion of the restoration work (See Table 1). Because of regulations and increased risks, this guide is most appropriate in streams that are located outside of an Urban Growth Boundary and have an active channel width of less than 50 feet. However, with an appropriate level of design expertise and agency coordination, the techniques described in this guide may be applicable in those streams. For more information on what agencies need to be involved in project review and approval please refer to the *State Water-related Permit Users Guide* (http://oregonstatelands.us/DSL/PERMITS/swrp_userguide12_06.shtml).

Projects that are consistent with this guide do not require a permit from DSL, unless they are located in a State Scenic Waterway. OAR 141-085-0534 exempts these activities from the Removal-Fill Law, provided a notice is submitted to DSL.

This guide has also been written to be consistent with the Corps of Engineers' Regional General Permit (RGP) number 3 (NWP-2007-01023, August 1, 2008) (http://www.nwp.usace.army.mil/op/g/docs/documents/RGP03_Stream_Habitat_Restoration.pdf). This RGP provides an expedited process for Corps approval. An example application form (Appendix B) can be used to provide the information necessary for Corps review and approval. There may be additional requirement specified in RGP3, please make sure to read and understand all the terms and conditions of that permit before applying.

	Agency	Program	Permit or coordination required
Local	Local planning Department	Land use approval	**Yes**
State	Department of State Lands	Removal-Fill Permit	**Yes, if in State Scenic Waterway , does not meet the exemption (141-085-0534), or is not silviculture related**
		Proprietary approval	**Maybe, if on state owned land**
	Oregon Department of Fish and Wildlife	Fish passage requirements	**Maybe**
		In-water timing guidelines	**Yes - unless otherwise approved**
		Scientific Take Permit	**Maybe, if fish salvage or dewatering are proposed**
	Oregon Parks and Recreation Department	Scenic Waterway Notification	**Maybe, if the project is within 1/4/ mile of a Scenic Waterway**
		Archeological review	**Yes**
	Department of Land Conservation and Development	Coastal Zone Certification	**If in Coastal Zone, but could use RGP 3**
	Department of Environmental Quality	Water Quality Certification	**Yes, but could use RGP 3**
Federal	Corps of Engineers	404 permit	**Yes, but could use RGP 3**
	NOAA - National Marine Fisheries Service	Endangered Species Act	**If listed species, but could use RGP 3**
	US Fish and Wildlife Service	Endangered Species Act	**If listed species, but could use RGP 3**

Table 1 This chart is adapted from the *State Water-related Permit Users Guide* and identifies the agencies and permits common to the activities identified in this guide.

DESIGNING A PROJECT

In Oregon, geology and rainfall patterns can be dramatically different from one location to another. One type of structure may achieve the desired effect in one stream but be inappropriate in another.

Locating a reference reach or wood jam structure in a stream with the same size and slope as the project stream will increase likelihood of success. The closer the reference area is to the project site the higher the probability of creating desired habitat. The reference reach allows the comparison of an intact or natural stream reach with the project stream reach. Features such as the frequency of pools, riffles, meander bends, frequency and configuration of wood and boulders, and prevalence of gravel should be evaluated. The size of a log or boulder can be measured to determine why that log or boulder is in a stable position, and what impacts it had on the stream channel. If a reference reach is not readily available, or there is any question as to the appropriateness of that reach, contact the local ODFW biologist for assistance and guidance with the project design.

This guide is intended to focus on restoring habitat features that will affect stream flow, sediment retention, and related processes. Therefore, the use of weirs (e.g., step pools, drop structures), barbs, dams, anchoring, cabling, streambank stabilization, or structural armoring of any kind is beyond the scope of this guide. These actions are technically complex, site dependent, and may affect fish passage.

Planning

In planning a restoration project, the first step is to decide whether the stream is suitable for the placement of large wood, boulders, or spawning gravel. This guide is intended to be used for streams that have an established riparian plant community. The riparian plants contribute branches (coarse wood) and leaves that will eventually be incorporated into any new structure, the roots provide soil stability and the standing trees will eventually replace or augment the large wood that is being added.

Three important questions when planning a restoration project are:

1: Is the stream fish bearing?

The information can be found in a Stream Classification Map available from any Oregon Department of Forestry (ODF) district office or from ODFW. It is helpful to determine what fish species is in that stream section since different species have different preferred habitat. A list of ODFW offices and telephone numbers can be found in Appendix C.

2: What is the limiting factor that the project would address?

Common limiting factors in Oregon's waterways include; water quality (temperature, sediment), stream flow, in-stream structure and complexity, pool size and/or frequency, spawning habitat, over-winter habitat, rearing habitat, and interaction with floodplain. Assessments identifying the limiting factors for a stream or basin have been done in many of Oregon's watersheds. These are available through the local watershed council or the Oregon Watershed Enhancement Board (http://www.oregon.gov/OWEB/WSHEDS/wshed_links.shtml)

A landowner can identify the limiting factors in their stream by using use the Basic Level Stream Survey method outlined in pages 40 to 60 at http://oregonstate.edu/dept/ODFW/freshwater/inventory/pdffiles/step.pdf

Large wood, in a stream, can accomplish multiple purposes by trapping gravel above the structure, creating pools and increasing the connection with the floodplain vegetation. The limiting factors will influence the number of structures, the spacing between structures and number of logs per structure.

Boulders can accomplish the retention of gravel by physically intercepting the bed load or slowing the water, increase the interaction with the floodplain habitat by increasing the bed elevation and providing pool habitat. Boulders are most effective in high velocity or bedrock dominated streams.

Gravel can provide substrate for food organisms, fill voids in wood and boulder habitat structures to slow water and create pool habitat and provide spawning substrate for fish.

3: When can the work be done?

When implementing a wood, boulder, or spawning gravel placement project the project should be constructed during the work period specified in the ODFW *In-water Timing Guidelines.* This window occurs when the impact to the fish is at its lowest. The *In-water Timing Guidelines* can be found at the ODFW website (http://www.dfw.state.or.us/lands/inwater/Oregon_Guidelines_for_Timing_of_%20InWater_Work2008.pdf) or by contacting the local ODFW biologist. Placement of wood may be done outside this time period but it would be dependant on the location, type of equipment used, and potential impacts. Contact the local ODFW biologist to determine if this is an option.

WOOD HABITAT RESTORATION PROJECTS

Introduction

In the last 30 years, it has been learned that large wood is an important part of the forest stream ecosystem and is critical for the survival of trout and salmon that inhabit the streams. Large Wood (LW) diverts water flow, changes water velocity to trap sediment or create pools and providing cover for juvenile fish. Wood loading varies significantly in pristine and managed streams depending on geographic location, fire history, and time since debris flow, floods or windstorms. The best approach to habitat restoration is emulating a natural event like a windstorm or landslide to guide the structure design. So prior to undertaking a large wood project the site, reach, and if possible reference reaches should be assessed in order to ensure the greatest project success.

Logs are typically placed either individually or in groups commonly referred to as log jams. Placement of a single log can provide benefits in certain situations but a logjam typically provides more habitat value. A functional logjam is an assemblage of different logs, branches and leaves of different plant species in different stages of decomposition. This diverse bio-structure provides the base for different aquatic life to find food, shelter, and space to thrive. A logjam also changes water velocity and direction to sort gravels and create pool and riffle habitat.

Designing a wood project

The potential effectiveness in changing the stream shape by large wood placement varies with the stream's slope and width. In very steep streams with very large boulders and rocks, log

placement will have little impact because the substrate is usually immovable except during extreme flow events. In low gradient or very small streams, the force of the water may not be enough to move sediment to change the shape of the stream. Figure 1 outlines a "sweet spot" where the combination of the streams width and slope mean that large wood will have the greatest impact on the physical habitat for fish. Streams whose measurements are within this "sweet spot" have enough slope and width to scour and deposit substrate material, yet probably still contain smaller material, which can be moved around when large wood placement changes flow paths.

In larger streams, log placement can provide a benefit, but logs will likely need to be stabilized to prevent excessive movement or placed only partly into the water along the edge of the stream. Larger and steeper streams that are exceed the parameters identified in Figure 1 have more stream flow or power that can lift and move large wood that makes large wood placement more complex and may require alternative techniques. Projects in these stream reaches typically require agency review and/or approval of the design.

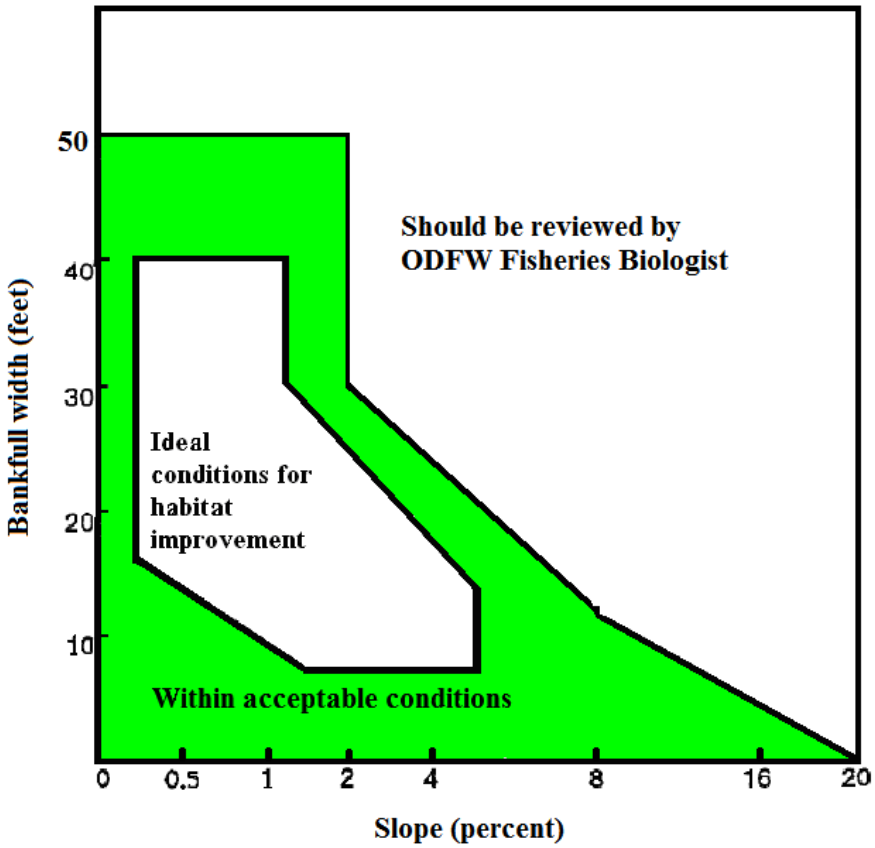


Figure 1 shows the stream slope and bankfull width which, taken together make for ideal, acceptable, or requires additional review of the design that is based on literature review and ODFW fish biologist experience .

Determining Stream Slope

Slope is determined by the change in elevation over a horizontal distance (rise over run). This can be determined by several methods, such as use of a clinometer, bubble level and string, or

surveying equipment. If the slope is at the borderline for acceptable conditions, more accuracy may be required to determine the effective restoration technique.

Determining Bank Full Width

Bankfull width is the width of the stream at bank full flow that occurs every 1 or 2 years (Leopold et al 1995). This is also known as ordinary high water or the point where water starts to flow into the floodplain. In lower gradient streams and in wider valleys where the stream has not cut down below the surrounding land (incised), the bankfull mark usually is where the bank slope changes from steeper to more gentle or even flat (see figure 2).

Unfortunately most small stream that are candidates for placement work are either incised or confined by side slopes. This is often seen as the stream channel forming a cross section shaped like a V or a U. In those cases look for clues such as an abrupt change in vegetation, material deposited on the bank or on over hanging branches during high flows. Changes in rock color or an abrupt change in texture of the bed or bank material may also be clues.

Bankfull width (also called an active channel width, ordinary high water or high water level) is measured from one side bank mark to the other (Figure 2). The width of large islands that would be dry even under bankfull conditions should be subtracted from the bank-to-bank measurement. To get an accurate bankfull width measure at least 10 points along the part of the stream where the work will be done. The measurements should be at least 1 or 2 channel widths apart covering the length of the project area. Previous stream surveys by ODFW or by other agencies may be used to determine bankfull width.

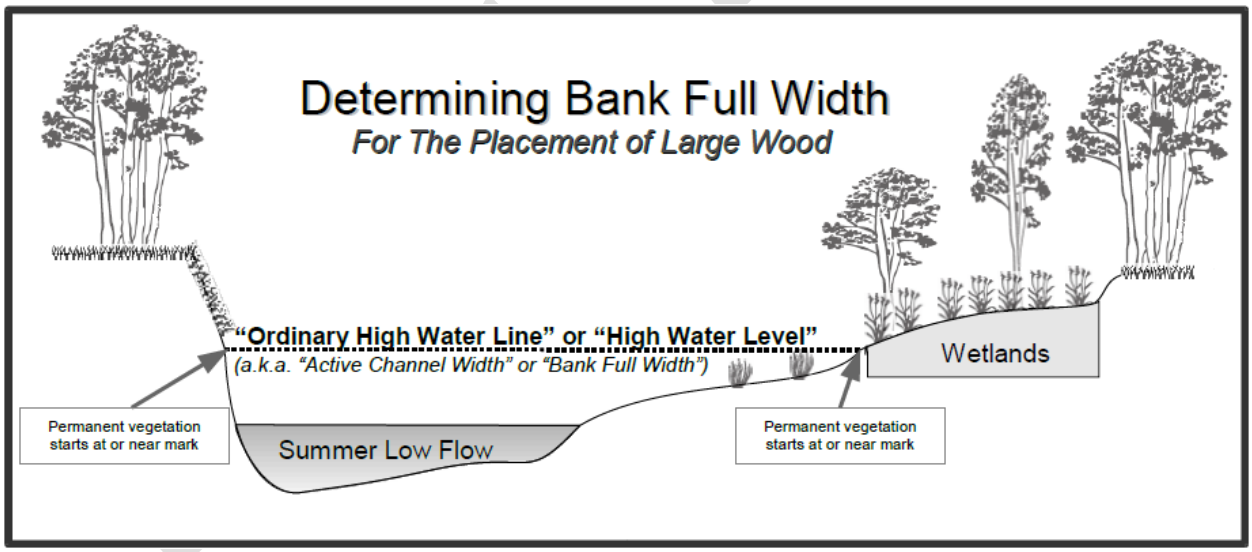


Figure 2. Cross section of a stream with normal and bankfull flow levels indicated. Area above bank full would be considered floodplain.

Diameter

The key to establishing a logjam is utilizing larger diameter wood that resists decay. These pieces of wood are often called "key pieces," and serve as the anchors for the logjam structure. Conifers (spruce, fir, cedar) have the potential to last 7 times longer than hardwoods (alder, cottonwood, and ash) given the same diameter and conditions. Therefore, conifers should be used as the key pieces of wood. The combination of conifers and hardwoods increases the complexity of the structure and the hardwoods serve other functions. Since hardwoods break

down more rapidly they serve as feeding platforms for a variety of insects increasing biological diversity. Hardwoods also are structurally weaker so during flood events the hardwood pieces will break allowing water pressure to be reduced through the new open area. The smaller pieces move down stream and can be accumulated on the next structure.

Wood can improve fish habitat only if the wood is large enough to stay, influence flow patterns, and sediment sorting. Larger diameter wood retains its size longer as abrasion and decay occurs over the years. Larger diameter wood is more effective in creating pools and complex channels that improve fish populations. The minimum diameter required for a key piece of wood depends on the bankfull width of the stream is found in Table 3.

Bankfull Width* Feet	**Minimum Diameter* Inches**
0 to 10	10
10 to 20	16
20 to 32	18
Over 32	22
*This table was taken from the 1995 A Guide to Placement of Large Wood in Streams.	

Table 3. Bankfull widths and minimum diameter of logs to be considered key pieces.

Length

The length of the wood is also important to stability. A piece that is longer than the stream is wide is less likely to be carried away when the water is high. To be considered a key piece a log with a rootwad still attached should be at least one and one-half times (1.5X) the bankfull or a log without a rootwad should be twice (2X) the length of the stream's bankfull width. As the best fish habitat is formed around jams composed of 3 to7 logs, at least 2 key pieces should be used at each structure. These logs lengths require a larger storm event to move them to a new location and have a higher probability of becoming stable at the next meander bend or obstruction. Leaving limbs and branches on the logs also increases stability and provides additional cover for fish. Hardwood logs or smaller trees with branches can be can be added to the structure to accelerated the development of a functional logjam.

Making wood placement more effective

Prior to implementing a wood placement project it is important to evaluate the existing reach conditions as it is quite possible a given stream already has enough wood in it to create multiple functional logjams. In this case the addition of more wood may be of limited resource benefit.

Whenever possible a tree with a rootwad attached should have the rootwad in the active channel. The roots create excellent hiding habitat for juvenile fish. The roots also add to the stability of the structure by maintaining contact with the stream bottom over a wider range of stream flows. In both windthrow and landslides small material is often pinned under the larger trees so coarse wood should be included in the project.

The first few upstream structures capture most of the coarse wood floating down stream and matures quickly, so the addition of coarse wood is very important for the downstream structures to become fully functional.

Windthrow emulation

As mentioned earlier, one of the keys to a successful wood placement project is to mimic natural processes. One such option is to mimic the deposit of wood that occurs during windstorms. Windthrow emulation duplicates the result of a tree or group of trees becoming up rooted during a storm and landing in the stream. In a natural process, trees may have only part of the tree in the active channel often with some of the trunk still on the stream bank. The weight of the log on the bank increases the stability and reduces down stream movement. The orientation of the wood is not important because the length and diameter of the wood along with the stream forces will position the wood to form a stable structure. Equipment can manipulate the logs to increase their stability by placing the wood between 2 standing trees that will lock the log in place by creating a pivot and stop point (Figure 3 panel A). In addition, one log can be placed on top of another so the weight of the top tree can pin the second tree (Figure 3 panel B). This is a simple windstorm emulation that allows the wood to adjust to the stream flow. Complex structures with multiple logs with interlocking pieces of wood provide better habitat and mimic wood accumulation over time. Figure 4 provides some ideas on the configuration of the key pieces of wood in a restoration structure.

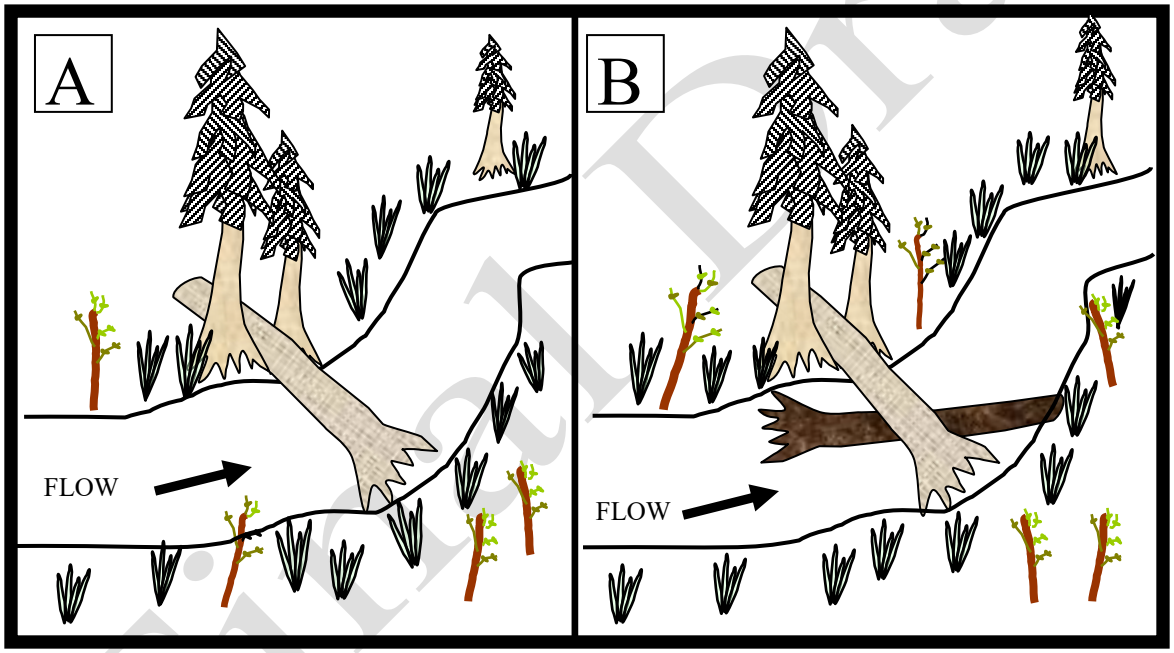
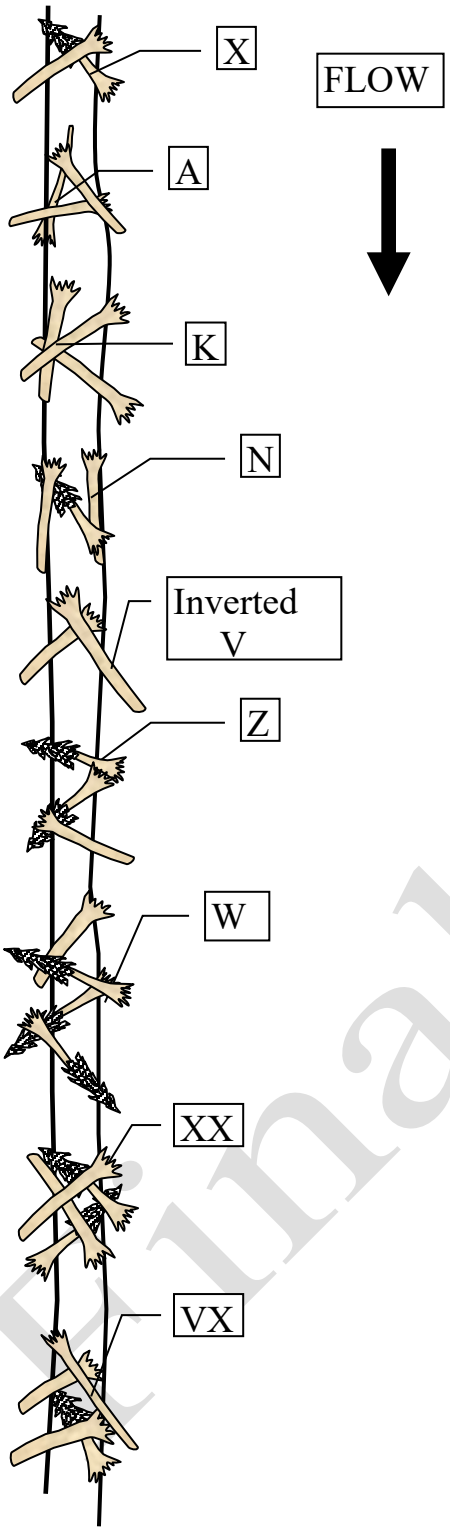


Figure 3. Panel A is single log placed between two standing trees to create a pivot and lock point. Panel B is an X pattern where the weight of the top log pins the bottom log to reduce the movement. Not shown is coarse wood (CW) or limbs that will create better habitat.



Large wood may be positioned in the stream in various configurations. The examples to the left are some patterns that can be used.

For stability, 2 of the logs should be twice the active channel if they do not have the root wads attached or 1.5 times the active channel if the roots are attached and meet the tree diameter criteria in the guidelines.

The large wood can be placed between standing trees to increase the stability by preventing the logs from rotating down stream.

To increase hiding areas for juvenile fish, it is recommended that the roots or limbs be in contact with the summer flow channel. Coarse wood can be added to the structure if the tree does not have roots wads or limbs.

Simple patterns can be combined to form complex structures of 3-7 logs.

Figure 4. Showing typical plan view wood configurations and alphabet codes for use in describing them.

Slide emulation

Another method to recreate natural processes and project success is to mimic the deposition of material that occurs during landslides. Slide emulation is the direct deposit of wood into the

channel and achieves a stable position at constricted or shallow sections of the stream. With the length of the logs being twice the active channel, the first higher water will float the logs to the natural choke points. As the flow rises, more force is exerted on the logs locking them in place. This should not be attempted in streams that are prone to flash flooding. Because this approach allows for the natural repositioning of the logs it should only be used if there are identified choke points and are well upstream of roads. A minimum of 2 meander curves should be between the last placement and any road crossing. This technique can be very useful where ground based equipment cannot safely reach the stream, where flight hazards prevent helicopter placement at the desired location, or in conjunction with timber harvest that have a cable highline suspended above the stream logs can only be lowered in the corridors.

Adding Boulders to a Wood Project

Adding boulders to a large wood project can fill in the gaps to slow down the water by increasing the pool depth and more effectively emulates a slide event. Boulders can be effective at reducing the downstream movement of wood when other anchor points are limited. When adding boulders they should be sized appropriately for the stream and only the minimum amount necessary to achieve the project objectives. Combining boulders and wood to create any sort of barbs (or similar hydraulic structures), channelize stream flow, or as streambank stabilization requires specialized expertise and is outside the scope of this guide.

For stability, it is recommended that key boulders be a minimum of twice the diameter of the average of the ten largest naturally occurring boulders in the project stream reach (measured upstream and downstream of the project site). Projects in the Umpqua River Basin found that adding a ½ cubic yard boulder for every 10-foot of tree length provided good results in long term retention of gravel. Smaller diameter boulders can be used, and remain stable, when added to a wood dominated structure because the wood in the structure can block or slow the flow of water directly on the boulder thereby reducing the pressure against the boulder. The wood can directly support the boulder and limit its movement when the boulder is integrated in the structure. The wood structure also increases gravel retention, which may result in a partially buried boulder having less area exposed to the force of water.

Acquisition

Logs and trees to be placed in streams are best obtained from locations where their removal will not conflict with other valuable functions they might serve. If other trees can fill those functions, streamside trees may be pushed or pulled over into the stream with the rootwads intact. Wood should be repositioned within the riparian area and stream channel only as necessary to alleviate threats to public safety or substantial property damage, provided the habitat and resource value of the wood is maintained in that stream segment. Downed wood serves as refuge habitat for fish and reduces the chances of avulsion, a sudden change in channel location, during extremely high flows.

Adding wood in floodplains and wetlands

In most cases it is beneficial to the stream and riparian environment if wood is not just placed in stream but rather in both the stream and on the floodplain along the stream. This addition of wood can improve the habitat of multiple-fish and wildlife species, provide refuge habitat during extreme high flows, provide future wood recruitment, and reduce the chances of avulsion or sudden channel shifts following wood placement in the stream. Many watershed professionals look at the entire area where a channel may migrate, this often extends from valley wall to valley wall. Placing wood throughout this entire area is a comprehensive restoration approach and

provides habitat and structure to side channels, wetlands, and floodplains that have been lost to development and land use. This approach is most effective in areas where infrastructure or property would not be at risk. However, as with any wood project, in areas where there is development or infrastructure near or downstream of the project area caution must be used to ensure the project does not flood or impact those properties.

BOULDER HABITAT RESTORATION PROJECTS

Introduction

In bedrock dominated systems and other areas where it may not be practical or effective to place large wood, boulders can be used to create complexity in the stream. Projects of this type should occur only in channels with intact, well-vegetated riparian areas or be conducted in conjunction with riparian restoration and/or management. This approach needs to be carefully designed to provide stable functional structures and in many cases additional permitting and agency review may be required. In order to ensure fish passage and reduce risks it is recommended an ODFW fisheries biologist be contacted and involved in the planning and design of any such project.

Designing a boulder project

Boulder placement is most effective in high energy or bedrock dominated stretches of stream where spawning gravel and summer pool habitat is lacking or where large wood is not readily available. Placing boulders in streams not dominated by bedrock can narrow the channel, increase scour, widen the channel, alter the direction of the thalweg (i.e. the path of deepest flow), cause erosion, and increase channel meandering. The key to success with a boulder project is to ensure that the boulders are sized appropriately for the stream system and placed in clusters or constellations (patterns) that replicate natural stream conditions and do not substantially modify stream hydraulics. In general, boulders should only be placed within stream channels where rock and boulders would naturally occur but are currently lacking.

For the purpose of this guide, boulder structures are not suitable for placement in:

- Low gradient meadow streams. Boulders in meadows warm the water by collecting solar radiation and cause significant changes in channel hydraulics, which can possibly destabilize the channel and banks.
- Gravel rich streams with a high bed load movement. In gravel rich streams scour around the boulders may cause the boulder to move down stream and slide into the new scour hole and eventually become buried by the gravel as it sinks rendering them ineffective (Fischenich and Seal 1999).
- Stream where the streambed and banks are composed primarily of small gravels, silts, or sands. In these systems the effects of boulders can be unpredictable and require specialized planning and design.
- Unstable, braided or aggrading channels.
- Streams with a gradient of more than 10%.

When developing a project to address spawning gravel recruitment there needs to be enough water backed up to maintain a wetted channel during lower flows. The use of unanchored wood to occupy part of the channel is important during high water events since it occupies the upper portion of the water column creating slower moving water in the area upstream from the wood. The combination of water being impeded at the streambed and the upper water column creates a deposition zone that extends further up stream.

Boulder constellations can trap gravels at the edges of the stream and narrow the summer flow into defined channels. This results in cooler water by less exposure to daytime air temperatures and increased flow through gravels. On bedrock streams this can turn shallow sheet flow into deeper summer rearing habitat. The water flowing over the top of the boulders during high flow events maintains the pools in the spaces between the sets of boulder constellations. The first sets of boulder constellations may trap most of the bed load, so gravel may need to be added for the down stream boulder sets to become functional. Boulders are effective in capturing gravel where large wood can intercept wood drifting down the stream. The combination of boulders and large wood can turn a bedrock-dominated stream to complex in stream habitat with pools, riffles, and cover that can support a wide range of fish species

Boulder Sizing

Boulders can provide stable habitat structures if the boulders are properly sized and orientated in relationship to the stream flow. For stability, it is recommended that key boulders be a minimum of twice (2X) the diameter of the average of the 10 largest naturally occurring boulders in the project stream reach. The intent of this is to identify a size for key boulders that is sufficient to be stable under expected high flows (typically a 25-year recurrence interval). Smaller sizes of key boulders should be used only if a shear stress analysis of the stream reach shows that a smaller boulder would be stable at high flows or if the overall project will be stable. In gravel rich streams it maybe difficult to determine the size of the boulder because of the boulder is partially embedded into the streambed or in bedrock areas there may not be many reference boulders. In those cases or where the 2X boulders are not available, a shear stress analysis of the stream reach may be needed. Shear stress analysis is typically performed by restoration professionals and is used to calculate the size of the boulder that would be stable at high flows. This analysis is especially important if there is a structure down stream such as a culvert or water intake. For the purposes of this guide, boulders must not be permanently anchored (including rebar or cabling to meet size or stability criteria).

Boulders change the water velocity and can be used to create a variety of habitats.
T able 2 (below) provides a rough guideline on the stream velocities needed to move different sizes of sediment. By speeding up or slowing down the water velocity, bed load sediments can either be transported or deposited.

		Diameter		Velocity	
Material	Size	mm	in	m/s	feet/sec
silt	medium	0.0160	0.0006	0.0080	0.0260
sand	fine	0.1250	0.0049	0.0120	0.0390
sand	very coarse	1.0000	0.0394	0.0216	0.0702
gravel	very fine	2.0000	0.0788	0.0360	0.1170
gravel	very coarse	32.0000	1.2600	0.1600	0.5200
cobble	small	64.0000	2.5200	0.2300	0.7475
cobble	large	128.0000	5.0400	0.3300	1.0725
boulder	small	256.0000	10.0800	0.4700	1.5275
boulder	medium	512.0000	20.0000	0.6700	2.1775
boulder	large	1024.0000	40.3500	0.9400	3.0550

Table 2. Approximate threshold conditions for granular material to start moving (adapted from Erosion and Sedimentation, Pierre Julien, 1995).

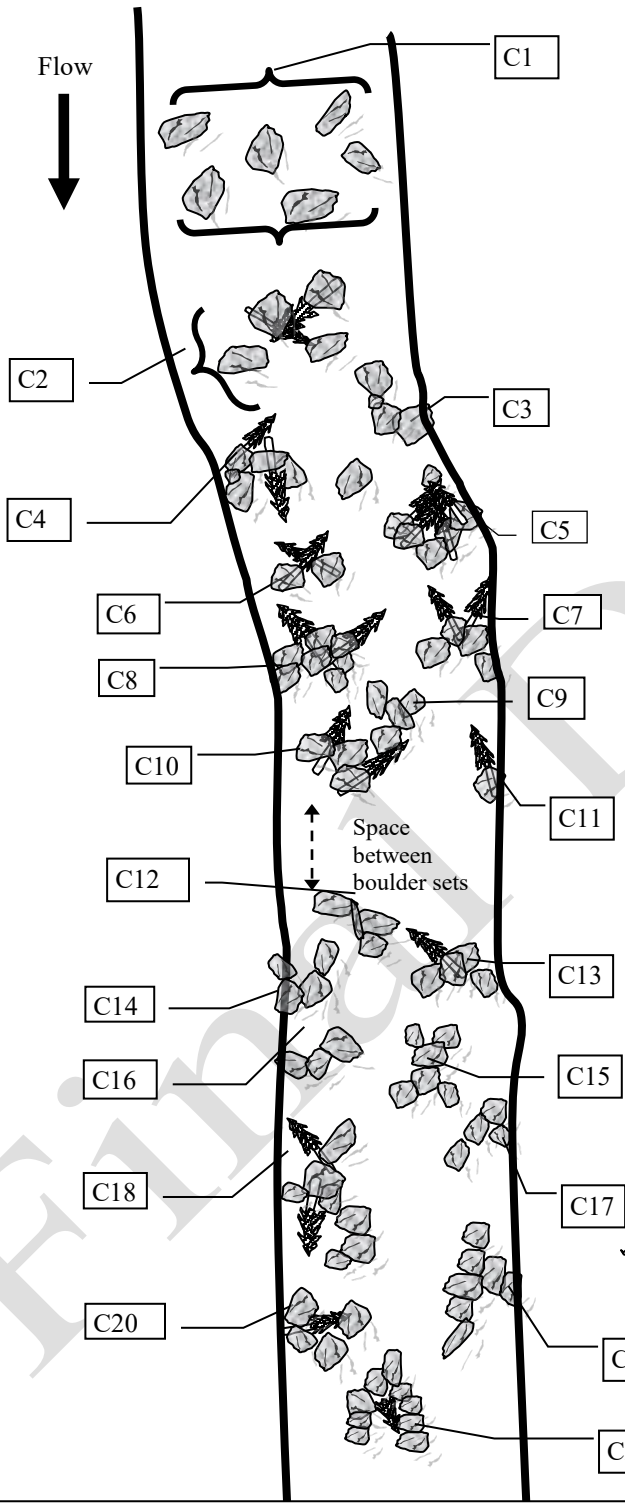
Arranging the Boulders

For the purposes of this guide the most appropriate method of boulder placement is to mimic natural boulder accumulations by installing non-full spanning boulder structures such as

randomly placed boulders, boulder fields, clusters or constellations that do not restrict fish passage (See figure 5). Full spanning structures like weirs, cross vanes, J-hooks, Newberry riffles or other drop structures while useful in certain applications require specialized expertise and significant design considerations for fish passage and stability and not covered in this guide. More information on full spanning structure can be found at the Washington Department of Fish & Wildlife Habitat Technical Assistance website: (http://www.wdfw.wa.gov/hab/ahg/shrg/18-shrg_drop_structures.pdf). Even non-full spanning structures when placed at the wrong angle or location can create additional problems that may not be easy to correct. Therefore it is recommended that the local ODFW biologist be contacted as they can review and make suggestions on the proposed structures and identify possible advantages and disadvantages. Finding a reference reach near the project site, where boulders are providing the desired habitat, will also increase the likelihood of success of the project.

In order to ensure the most effective and least problematic design, the following criteria should be followed when designing and implementing a project. Individual boulder constellations should not exceed 1/3 of the active channel width and not shift the stream flow to a single flow pattern in the middle or to the side of the stream. If the channel is narrowed to one pathway, it will increase the velocity, can cause excessive erosion, and can simplify the stream habitat. Boulder constellations should be positioned so that they are staggered and not of placed along just one side of the channel. A minimum of a 2-foot gap should be maintained between constellation structures. These design elements create alternating paths of water flow, allow the water to be concentrated in a travel pathway for adult and juvenile passage, and provides resting areas for juvenile fish. This concentrated flow allows passage during low flow periods therefore no more than 25% of the cross-sectional area of the flowing channel at the time of installation (e.g. low flow channel width) should be blocked. The use of coarse wood placed under the boulders may extend into these fish passage gaps to increase the recruitment of gravel. Smaller (12-18 inches) rock may be placed upstream from the gaps to allow resting places for juvenile fish. The distance smaller rock should be placed away from the boulder should be equal the diameter of the small rock. The combination of boulders, smaller rock and coarse wood replicates some of the elements a small landslide.

Figure 5. Boulder Constellations



Boulders may be positioned in the stream in a various configurations. The examples to the left are some patterns that can be used.

The first series of boulders should act as a velocity break and are spaced farther apart (C1 or C2).

Boulders are placed in a tighter configuration to form sets (C3-C21) of boulders that are 1-2 channel widths in length. This backs water up to create pools and areas for gravel to settle.

The next boulder set located downstream so top of the first boulder in the downstream set is at the bottom elevation of the upstream set.
C10 ---------- C12.

Small trees, 6-12 feet in length can be added to any boulder constellation to enhance bedload capture.

Figure 5 is examples of boulders constellations that can be used to slow the water down to collect gravel. Each constellation may have their orientation changed to meet the site-specific requirements. For clarity of the illustration, the boulder constellations are spaced further apart than what will be used in the habitat restoration project.

Making Boulders more effective

Boulder clusters capture bed load in two major ways. The first, is physically intercepting the bed load that is sliding or salting down stream. Salting is where a bed load material slide along the stream bottom and occasionally being suspended over a short distance and may bounce off of larger material before resting in a stable position. The second way is to reduce the velocity of the water to a point where bed load material cannot be carried.

The greatest accumulation of bed load material occurs when 30 to 60% of the pre-project bankfull area is occupied by boulders or a combination of boulders and wood. For example, if 50% of the pre-project bankfull area is occupied, the 5-year floodplain may become the new bankfull elevation, and the existing 25-year flood elevation may become the new functional 5-year floodplain area. This elevation is important to determine if the new flood elevation may impact infrastructure such as roads or buildings and to determine the amount of winter refuge habitat created. The acceptable percentage of occupied bank full area must be determined on a site-specific evaluation of surrounding land uses, infrastructure, and landowner concerns.

The interception of bed load that is sliding or salting is illustrated in figure 6 where each structure blocks the down stream the direct down stream movement of coble or gravel. Boulder clusters also create low velocity backwater conditions on the upstream side of the structure. Raising the effective bed elevation reduces channel slope, flow velocity, and the stream's ability to transport sediments. Backwatering commonly induces sediment deposition and increases the water surface elevation upstream of the structure at low to moderate flows. At high flows, backwatering effect of the structure is evident provided the structure lies high enough in the channel profile and reduces the channel cross-section. Deposition upstream of a structure is particularly common in moderate to high bed load channels. Sediment deposition upstream of the structure is not as likely for low bed load or incising channels due to limited sediment availability. The upstream extent of backwater depends upon the scale of the structure and the slope of the channel. Backwater effects extend much further on low-gradient streams than on high gradient streams. However, if the structure causes a significant reduction in channel cross-sectional area or a series of structures collectively increase the hydraulic roughness of the channel, backwater effects may be more far reaching. Effects of large-scale backwatering can include increased flood levels and frequency of floodplain inundation, potential change in riparian species composition and distribution in response to changing inundation patterns and water table elevations, and reduced reach transport of sediment. Other effects associated with reduced sediment transport include channel aggradation, channel widening during high flow event and confinement during summer flows, and increased channel meandering.

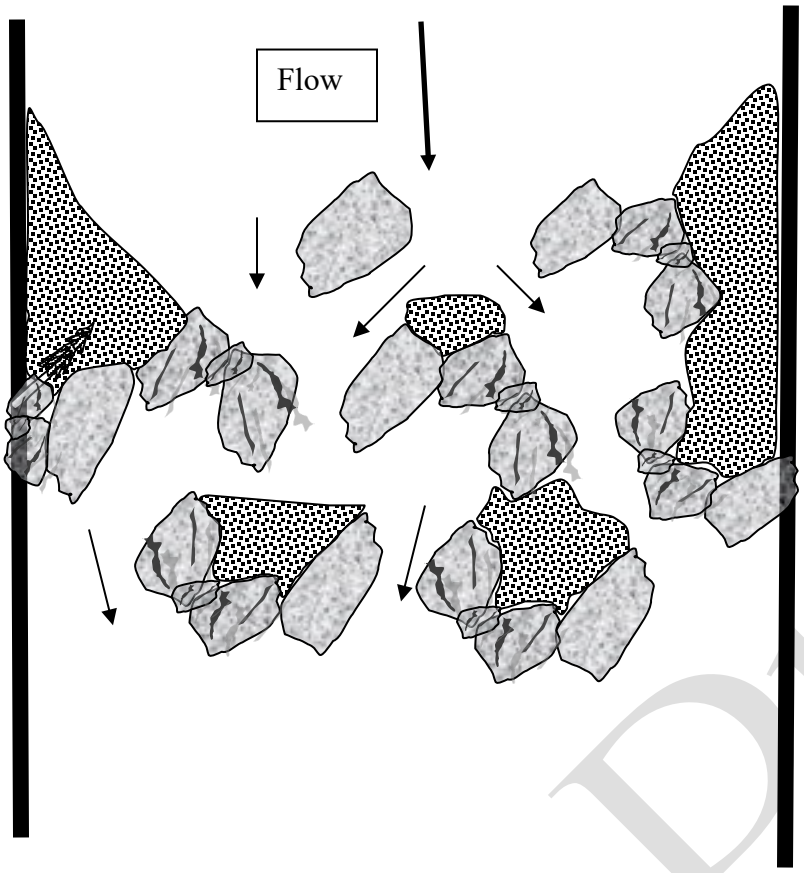


Figure 6. Shows the accumulation of bed load material above boulder constellations with gaps to allow fish passage for all life stages at all flows.

Slide Emulation

Landslides produce a combination of material that is delivered to the stream to provide the components for complex habitat structures. In bedrock-dominated areas the singular use of either wood or boulders may not achieve the desired effect. Unanchored wood can trap gravel but during channel forming events can float allowing the accumulated gravel to be transported down stream. Boulders used as the only material can intercept the gravel but as the water level raises any wood will be carried down stream. Wood can be added to a boulder structure to assist with gravel deposition or to scour pools. The wood can be placed in configurations shown in figure 4 to provide complex lateral pool habitat in the gaps between the boulder constellations or as a full spanning suspension log to increase the deposition of bed load or to scour pools at high flows.

GRAVEL HABITAT RESTORATION PROJECTS

Introduction

Areas that are appropriate candidates for the placement of large wood and or boulders frequently also lack adequate abundances of spawning gravel. Adding gravels to the stream to supplement the existing gravels can be an effective method to jumpstart the creation of areas capable of supporting spawning fish. However, prior to a gravel placement project it is important to identify why gravel is limited in the project reach. Without addressing the causes of limited gravel (e.g. lack of structure to retain gravel, upstream dams that are blocking gravel recruitment) any augmentation will only be temporary and not provide long-term benefit.

In streams where there is active bed load movement of gravel the addition of wood and boulder structures as mentioned previously in this guide will help slow the transport of gravels and retain them in the system. However, supplementation may be needed to address short-term deficiencies or speed up the recovery process. When the restoration project involves a long reach of a stream, the first few structures may intercept all the gravel and coarse wood until such time as sufficient gravels accumulate and flows move the gravels to the next structure down stream. Addressing the short-term deficiency by the placement of gravel above the wood or boulder structures in the middle and lower segments will achieve the full function in a shorter timeframe.

Designing a gravel project

The primary purpose of placing spawning gravels is to improve spawning substrate by compensating for an identified loss of a natural gravel supply. Therefore gravel placement should occur only in locations where gravel would naturally occur but is currently lacking and be done in association with a current or past in-stream habitat restoration project. The following criteria allows for the stream to naturally sort and distribute the gravel to provide optimum spawning habitat and suitable substrate for aquatic insects:

a) Gravel should be made up of multiple sizes of material, with no more than 5% of the gravel being smaller than 0.25 inch and 10% of the gravel being larger than 4 inches .
b) Gravel should be rounded (less than 25% fractured face), composed of hard durable particles resistant to weathering, and be composed of similar type of rock to that which is found in the stream basin. Organic soils, silt, clay or soft friable particles should not be included as part of the gravel placement.
c) Gravel must come from a commercial source or an upland source outside of the riparian area. Removing gravels from a stream system typically requires a permit and agency review as it is not always considered restoration and can have other impacts to the stream system.
d) Fabric or wire mesh must not be used to hold the gravel in the stream. Experience has shown that these only provide limited short-term retention and pose future risks to fish and wildlife species in the waterway. The placement of coarse wood to retain gravel is encouraged.
e) Gravel placement should not be done in low gradient depositional areas where historically it would not be present.

As accessibility to project sites is highly variable gravel may not be able to be placed in the most desirable manner or method. The best option is to add gravel at the time of the construction of in-stream wood and boulder structures as gravel can be placed with the available equipment. In areas with limited access or where impacts to riparian areas need to be minimized or avoided the use of a conveyor belt or helicopter can be effective methods to deliver gravels. With any of these methods gravel can be placed above a structure to properly seed the area or below the structure to allow it to be mobilized to down stream structures. If the gravel is placed to be mobilized with the first significant rain event the deposition should not exceed 1/3 of the active channel width and at no time block fish passage.

Gravel placement is not an appropriate restoration technique as a stand-alone project in most circumstances. In high-energy channel reaches, gravels may be washed out of the reach in a relatively short period of time. High-energy sites are typically dominated by cobbles and boulders where such material is available or by bedrock or hardpan where it is not. In bedrock-dominated streams the lack of in stream structure may be the only limiting factor. A survey of

the stream should include notations on pockets of gravel accumulated at the streams edge, next to wood or boulders hydraulic shadow. Some high-energy sites might have supported salmonid spawning habitat in the past, but the historic gravel deposits have been scoured out due to channel modifications that have increased the shear stress on the channel bed preventing the retention of gravel.

CONSIDERATIONS FOR PROJECT CONSTRUCTION

While this guide provides considerations and tools for the selection and design of these types of restoration projects, it must be noted that there are additional requirements that must be considered prior to final design and construction. With every project there are actions that could have a negative impact if not properly implemented. These are often addressed through conditions that state or federal regulators may impose as part of a permit. These conditions can vary with the permit or exemption used and the project scope and location, thus are not thoroughly discussed in this guide.

Examples of some of types of conditions and best management practices that can get applied to these types of restoration actions to minimize the impacts include:

- prevention and clean up of petroleum spills,
- erosion and sediment prevention and control,
- restrictions on when construction can occur,
- restoration of construction related disturbance,
- providing fish passage,
- and avoidance of cultural resources.

In order to avoid delays in project construction and determine what conditions may be applied to a specific project it is recommended that the following agencies are coordinated with during the planning and design process. As mentioned at the start of this document, when projects are part of a forestry operation the local Department of Forestry Stewardship Forester should be the primary contact. For all other projects that meet the DSL exemption the Corps of Engineers Regional General Permit number 3 (RGP 3) will most likely be the permitting option. The DSL exemption is dependent on certain conditions being met so the rule (OAR 141-085-0534) should be consulted and the local DSL resource coordinator contacted with any questions. The Corps of Engineers RGP 3 includes conditions to comply with the Endangered Species Act, 401 Water Quality Certification, Coastal Zone Certification, and State Historic Preservation Office and Tribal Coordination. Therefore RGP 3 should be reviewed thoroughly prior to project design. Contact the Corps Project manager with any questions to determine if the project can meet all the stipulated conditions.

Other agencies that can add conditions to a project or influence the project design should also be contacted during the design. Early coordination can save both time and money. These agencies are primarily the State Historic Preservation Office, the local planning office, and the Department of Fish and Wildlife.

- Coordination with the State Historic Preservation Office and local tribes regarding cultural resources is often overlooked until applications are submitted. The presence of a cultural resource and the measures necessary to protect those resources can affect the design and methods used to construct a project.
- The addition or modification of in-stream structures has the potential to effect fish passage and in-water work has the potential to impact fish that are present in the stream.

It is recommended that the local District Fisheries Biologist of the Department of Fish and Wildlife be coordinated with during design to determine what the in-water work period is and if fish passage review will be necessary.

- Many local governments also regulate work within waterways and floodplains and may require that certain design parameters are applied to ensure consistency with various local and federal regulations.

Reporting

Anyone conducting restoration activities is strongly encouraged to report their efforts to the Oregon Watershed Restoration Inventory (OWRI). Managed by the Oregon Watershed Enhancement Board (OWEB), OWRI is the single largest database containing information about restoration projects in the western United States. This database originated as the means to track detailed information about the restoration efforts undertaken in the name of the Oregon Plan for Salmon and Watersheds. Initiated in 1995, the database contains over 10,000 records of restoration projects completed throughout Oregon. While the database contains information about grants funded by OWEB, the majority of the OWRI entries represent voluntary actions of private citizens and landowners, working in partnership with federal, state, and local groups to improve aquatic habitat and water quality conditions. The forms can be found at: http://www.oregon.gov/OWEB/MONITOR/OWRI_reporting.shtml

Post project reporting is also a requirement of the Corps RGP. If using this option to permit a project it is important to read the terms and conditions of the RGP and understand when reporting must occur and what information needs to be included.

LITERATURE CITED

Fischenich, C., and Seal, R. (1999). "Boulder clusters," *EMRRP TechnicalNotes Collection* (ERDC TN-EMRRP-SR-11), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Julien, P. Y., *Erosion and Sedimentation*, 280 pp., Cambridge Univ. Press, New York, 1995.

Leopold, L.B., Wolman M.G., Miller, J.P. Fluvial Processes in Geomorphology . Dover Publication, 1995

A Guide to Placing Large Wood in Streams. (1995) Oregon Department of Forestry/ Oregon Department of Fish & Wildlife

APPENDIX A – BASAL AREA CREDIT

Introduction

It is the policy of the Oregon Forest Practices Act (FPA) to focus protection measures in riparian management areas due to the special emphasis on providing water quality and fish and wildlife habitat (OAR 629-635-0100). Within these areas, the goal is to ensure that vegetation is retained in order to maintain water quality, shade, large wood, and nutrients. Consistent with this goal, the FPA recognizes that many fish-bearing streams lack adequate amounts of large wood or other important habitat elements. To create an incentive for restoration in such streams, the FPA allows landowners to lower their leave-tree requirements in riparian management areas within certain limits by placing large wood in streams. The leave-tree reduction is given as a "basal area credit." This appendix describes how restoration projects such as wood placement in streams in conjunction with a forest operation can make a landowner eligible to receive a basal area credit. For further details, see Oregon Forest Practices Rules OAR 629-640-015 through OAR 629-640-0110.

To meet the minimum administrative requirements to qualify for a basal area credit, a project must be able to demonstrate the following:

1) **Is the wood placement project in conjunction with a forest operation?** If addressed in a written plan for a forest operation and in the same vicinity of that operation, the project may qualify for a basal area credit. When wood is placed in conjunction with a forest operation neither a DSL removal-fill permit or Corps of Engineers permits are required.

2) **Is the stream fish bearing?** In order to qualify for the basal area credit, the stream has to be classified as fish bearing. Consult a Stream Classification Map, available from any ODF district office, to find out the stream's fish-bearing status.

3) **Is the riparian area well stocked with conifer?** The basal area credit applies in riparian management areas that have basal areas greater than the "active management target." This stocking-level target varies throughout the state (see OAR 629-640-0110).

Agency consultation needs will vary with the complexity of the stream restoration project design. When the design of a proposed woody-debris placement project meets the following criteria, the project may occur in consultation with the local Oregon Department of Forestry (ODF) Stewardship Forester:

- Relies on the size of wood for stability;
- Excludes artificial anchoring;
- Mimics patterns of large wood that occur from natural riparian processes over time;
- Does not rely on constructed habitat structures; and
- Utilizes the principles for wood placement within the main body of this Guide.

Other stream and riparian area projects (construction of backwater alcoves, riparian grazing exclosures, complex wood placements involving anchoring, boulder placement, etc.) can be done to reduce the riparian leave-tree requirement. These other projects require consultation with the

Oregon Department of Forestry and the Oregon Department of Fish and Wildlife (ODFW) and in some case Corps of Engineer Permits. When the project is done in conjunction with a forest operation a covered under a "notice of operation" a DSL removal-fill permit is not required.

How to successfully qualify for basal area credit

Consultation with the local Stewardship Forester prior to starting an operation including a stream restoration project will help ensure success in receiving a basal area credit. Information about the large woody debris source, number of pieces, and basal area to be placed in the stream is a critical component of the written plan for the harvest operation. **The basal area credit can, at most, reduce the leave-tree retention requirement from the "standard" target to the "active management" target.** (See Forest Practice Rules OAR 629-640-0110.) The basal area credit applied to an operation will depend on the basal area of the material placed in the stream. Basal area can be determined using Table 1 or by the following equation:

Basal Area (in square feet) =
0.0055 x diameter (in inches) x diameter (in inches)

Table 1. Basal area of a log or tree by diameter class.

Diameter (inches)	Basal Area (square feet)	Diameter (inches)	Basal Area (square feet)
6 to 10	0.3	41 to 45	10.1
11 to 15	0.9	46 to 50	12.6
16 to 20	1.8	51 to 55	15.3
21 to 25	2.9	56 to 60	18.3
26 to 30	4.3	61 to 65	21.6
31 to 35	5.9	66 to 70	25.2
36 to 40	7.9	71 to 75	29.0

To determine the basal area of a bucked log, measure the diameter of the larger end. To determine the basal area of a tree placed in the stream with the rootwad attached, measure the diameter at breast height.

The basal area credit can be used only on fish-bearing streams (that is, those that the Oregon Department of Forestry classifies as Type F). The amount of credit varies with stream size.

- For each conifer log placed in the channel of **a large or medium Type-F stream, the basal area credit is twice the basal area of the placed log**. (ODF Stream classification sizes as based on average annual flow: Large ≥10 cubic feet per second (cfs), medium >2 and <10 cfs, small ≤2 cfs (See Oregon Forest Practice Rules OAR 629-635-200).
- For each conifer log placed in the channel of **a small Type-F stream, the basal area credit is the basal area of the placed log.**

Larger diameter wood pieces generate increased basal area credit more efficiently because basal area is a function of the piece diameter squared and increases exponentially as diameter increases.

The stream in which large wood is placed need not always be the stream right next to the harvest operation. Streams in the immediate vicinity of the operation (and under the same ownership) could be the project site; the basal area credit still goes to the harvest operation. The timing of a stream improvement project also can be varied to best meet the conditions of the site, to protect fish present in the stream, and for convenience.

Only conifer logs are eligible for basal area credit when placed in streams. Conifer logs are eligible because they can last from decades to centuries depending on conditions, whereas hardwoods decay considerably faster. When selecting a conifer log, cedars, and redwoods are the most durable followed by spruce, pine, fir, and Douglas-fir

Wood within 20 feet of the bankfull flow marks of fish-bearing (Type F) streams may be used only with a plan for alternate practice from the Oregon Department of Forestry. Wood in the outer zone of the riparian management area can be used if not dedicated to another purpose such as conifer retention or snag/green leave-tree requirements. Down wood within the riparian management area should generally be kept for wildlife habitat rather than relocated into the channel. However, if there is a high density of cull logs that are not too badly decayed, they can be moved into the stream and are eligible for basal area credit.

APPENDIX B

APPLICATION FOR THE PLACEMENT OF LARGE WOOD, BOULDERS, AND/OR SPAWNING GRAVELS.

This from has been developed to facilitate application to the Corps of Engineers for Regional General Permit Number 3 (RGP #3) for Stream Habitat Restoration in the State o f Oregon (NWP-2007-01023, issued August 1, 2008). While this is not an official Corps application form, it has been designed in collaboration with the Corps to present the information necessary for a timely review and permit decision.

	US Army Corps Of Engineers (Portland District)	**Corps Number**	

Project Name	

1. ELIGIBILITY CRITERIA:
The following criteria must be met in order for your project to qualify for this authorization and use this application form:

Please read any instructions and project-specific rules before legibly completing this application form.
The criteria listed on this form paraphrase the requirements for this authorization; please refer to the Corps of Engineers, Regional General Permit for specific standards.

1A). This application is for the placement of: (choose all that apply) **Fill Out**

- ☐ Unanchored large wood in stream segments with a — Section 9
  1. Bankfull width of under 50 feet, and
  2. Gradient of 15% or less.
- ☐ Boulders to stabilize large wood. — Section 9C
- ☐ Boulders to improve habitat complexity where — Section 10
  1. The gradient is 10% or less and
  2. Cumulatively less than 500' lineal feet of stream will be treated.
- ☐ Spawning gravel. — Section 11

- Other activity types may not be applied for on this form.

To qualify the projects must be consistent with the criteria listed in each applicable section of this application. It is recommended that you verify the project will fit before completing the application.

The sections of the application that correspond to the activity types checked to the left must be completed for the application to be complete.

1B). The primary purpose of this project is to: (pick up to two)

- ☐ Increase coarse sediment storage.
- ☐ Retain gravel for spawning habitat.
- ☐ Provide long-term nutrient storage.
- ☐ Provide refuge for fish during high flows.
- ☐ Increase habitat diversity and complexity.
- ☐ Improve diversity of flow patterns.
- ☐ Provide substrate for aquatic organisms.
- ☐ other uses, including streambank stabilization, **may not be applied for on this form. Use the Joint Application Permit form**.

1C). The project will not be located:

- ☐ In a Federal Wild and Scenic Waterway.
- ☐ In an area that is tidally influenced.
- ☐ Within city limits or urban growth boundary.

- If any of the above are not checked you may not use this form

1D). The project will:

- ☐ Not use permanent anchoring (including rebar, cabling, or keying into the streambank).
- ☐ Not cause more than minimal adverse effect on navigation.
- ☐ Not include construction of access roads (grading, sloping, placing material) within waters of the US or associated riparian areas. Operation of equipment across the surface of the ground with minimal soil disturbance, or use of preexisting roads, skid roads, or similar constructed features is allowable.
- ☐ Not result in adverse impact to wetlands including converting wetlands to open water.
- ☐ Not occur within the range of OR will not affect any federally listed plant or invertebrate species.
- ☐ Not occur in critical habitat or habitat occupied by the Modoc sucker.
- ☐ Avoid taking heavy equipment through off-channel habitats such as beaver oxbows, side channels, and backwater sloughs that are occupied or unsurveyed suitable habitat for Oregon chub or Warner sucker.

- If any of the above are not checked you may not use this form

2. APPLICANT INFORMATION					
If there will be more than one person or entity applying, please copy this table and paste below for each co-applicant.					
Name of Applicant			Affiliation (name of company or agency)		
Applicant mailing address or PO Box					
Town/City		State		Zip code	
Phone number		Cell number Or alternate #		Fax number	
E-mail			**By identifying an authorized agent in section 3 below, I authorize that person to act in my behalf in the processing of this application and to furnish, upon request, supplemental information in support of this permit application.**		
Applicant signature					

By signing above:

- I certify that I possess the authority (landowner, or permission) to undertake the proposed activities and will be responsible for compliance.
- I certify that all the information is true, and understand that failure to provide complete or accurate information may lead to suspension or revocation of the authorization.
- I authorize the Corps of Engineers to access the project site for the purpose of verifying information contained in this form and determining compliance with the rules.
- I understand that **I may not proceed with the work until I receive a written notice of approval from** the Corps of Engineers. A copy of this approval shall be kept on-site during construction.

3. AUTHORIZED AGENT					
Name of Authorized Agent			Affiliation (name of company or agency)		
Agent's mailing address or PO Box					
Town/City		State		Zip code	
Phone number		Cell number Or alternate #		Fax number	
E-mail					

4. LANDOWNER INFORMATION					
If the project will occur on multiple properties, please copy this table and paste below for each landowner.					
Name of Landowner (if different from applicant)			Affiliation (name of company or agency)		
Landowner mailing address or PO Box					
Town/City		State		Zip code	
Phone number		Cell number Or alternate #		Fax number	
E-mail					

5. PROJECT LOCATION INFORMATION: (to be completed for each segment of stream treated)												
If the project will occur in more than 2 segments, please copy this table/page and complete the data for each waterway/segment.												
5A). TREATMENT SEGMENT #1												
County					Town/City							
Stream name					Sub-basin							
Tributary of					For sub-basin name, enter 4th field HUC name (preferred) or main waterbody name							
Upstream End	Latitude-decimal degree format (DD.DDDD)					Longitude -decimal degree format (DD.DDDD)						
Township		Range		Section		Quarter/quarter		Tax Lot				
Downstream End	Latitude-decimal degree format (DD.DDDD)					Longitude -decimal degree format (DD.DDDD)						
Township		Range		Section		Quarter/quarter		Tax Lot				
Other sections in treatment area	Township		Range		Sections		Tax Lots					
	Township		Range		Sections		Tax Lots					
Street address, nearest intersection, or other descriptive location												
Directions to the site from nearest highway junction.												

5B). TREATMENT SEGMENT #2 (To be completed only if there is more than one)												
County					Town/City							
Stream name					Sub-basin							
Tributary of					For sub-basin name, enter 4th field HUC name (preferred) or main waterbody name							
Upstream End	Latitude-decimal degree format (DD.DDDD)					Longitude -decimal degree format (DD.DDDD)						
Township		Range		Section		Quarter/quarter		Tax Lot				
Downstream End	Latitude-decimal degree format (DD.DDDD)					Longitude -decimal degree format (DD.DDDD)						
Township		Range		Section		Quarter/quarter		Tax Lot				
Other sections in treatment area	Township		Range		Sections		Tax Lots					
	Township		Range		Sections		Tax Lots					
Street address, nearest intersection, or other descriptive location												
Directions to the site from nearest highway junction.												

6. GENERAL PROJECT INFORMATION

6A). Anticipated project dates: Start (mo)_____(yr)_____ Completion (mo)_____(yr)_____

6B). The primary species targeted by this project (check all that apply):

☐ Coho Salmon ☐ Steelhead ☐ Chinook Salmon ☐ Cutthroat Trout ☐ Rainbow Trout ☐ Bull Trout
☐ Other Fish Species (specify) _____ ☐ Bird Species (specify) _____
☐ Mammal Species (specify) _____ ☐ Reptile Species (specify) _____
☐ Amphibian Species (specify) _____ ☐ Other Species (specify) _____

6C). How was the proposed restoration action selected (check one box and answer associated question)

☐ Watershed Assessment/Action Plan/Habitat Conservation Plan
Name_____ Conducted by _____ Year _____
☐ Other (briefly describe how restoration need was identified and why project location and activity were chosen)

7. HISTORIC AND CULTURAL RESOURCE INFORMATION (* SHPO = State Historic Preservation Office)

Are there any buildings, structures, or artifacts (arrowheads, grindstones, pottery, bottles, homestead, etc) that are over 75 years old (50 for federal projects/land) in or near the project area?			☐Yes ☐No ☐Unknown
Has a cultural resource survey been conducted by a professional or tribal archaeologist:		In the project area?	☐Yes ☐No ☐Unknown
		In close proximity?	☐Yes ☐No ☐Unknown
If yes, has it been:	☐Submitted to SHPO* ☐Approved by SHPO*	SHPO* Case #	
		SHPO* Report #	
If Yes, has it been reviewed by a tribal cultural program?	☐**Yes** ☐**No** ☐**Unknown**	Name of tribe	
		Tribal file #	

8. ENDANGERED SPECIES ACT INFORMATION

8A). Has a separate Endangered Species Act (ESA) consultation been: ☐initiated ☐completed ☐unknown
If initiated or completed, please attach the concurrence letter, Opinion, or identify the status of consultation with the copy of the application sent to the Corps of Engineers.

The Corps of Engineers will determine ESA species presence and apply the appropriate reasonable and prudent measures in the terms and conditions of the permit*. Please note: Delays may occur if unknown species are identified or the criteria relevant to given species are not met.

Are there any known ESA species at or close to the project site:

☐ Coho Salmon ☐ Steelhead ☐ Chinook Salmon ☐ Cutthroat Trout ☐ Rainbow Trout ☐ Bull Trout
☐ Other Fish Species (specify) _____
☐ Mammal Species (specify) _____
☐ Bird Species (specify) _____
☐ Amphibian Species (specify) _____
☐ Reptile Species (specify) _____
☐ Plant Species (specify) _____
☐ Other Species (specify) _____

**It is recommended that applicants review RGP #3 during project development and become familiar with the terms and conditions that might be apply to the project.*

9. INFORMATION ON THE PLACEMENT OF LARGE WOOD, including logs, trees and rootwads, in stream channels where large wood should naturally occur, but is currently lacking due to past management practices or other conditions.

Key pieces = logs that are at least two times bankfull stream width, or 1.5 times if rootwad attached, and meet diameter, stream size, and slope requirements. Key pieces of wood must be intact, hard, and not more than partially decaying.

9A). Description of Stream Reach

☐ The riparian area is intact, well vegetated, or being restored and reestablished as part of project.

☐ The following criteria for the stream width, slope and log diameter will be met:

- Bankfull width 0-10 feet and stream slope of ≤ 15%, the diameter of key pieces will be ≥ 10 inches
- Bankfull width 10-20 feet, and stream slope of ≤ 9%, the diameter of key pieces will be ≥ 16 inches
- Bankfull width 20-32 feet, and stream slope of ≤ 5%, the diameter of key pieces will be ≥ 18 inches
- Bankfull width 32-50 feet, and stream slope of ≤ 3%, the diameter of key pieces will be ≥ 22 inches
- **If the above thresholds cannot be met this application form may not be used.**

9B). Description of Wood Placement

_____ Feet☐/miles☐ of stream to be treated (total).

_____ Number of large wood structures to be placed (total).

_____ to ____ Number of key pieces to be placed per structure (range) **- a minimum of two is required.**

_____ Number of key pieces to be placed (total).

_____ Estimated volume of wood placement (in cubic yards)

☐ Rootwads will be attached to some key pieces

☐ Smaller materials will be added to key pieces in structures

Source of logs

☐ Commercial

☐ Other, but will not be from locations where they serve a valuable function, serve as wildlife trees, or are partially decayed.

Method of placement:

☐ Helicopter

☐ Tracked vehicle (excavator)

☐ Rubber tired vehicle (spider hoe, back hoe)

☐ Winching/Yarding

☐ Other (describe)_____

Boulders will be used to stabilize key pieces ☐ Yes (complete 9C) ☐ No

9C). Description of Boulders Used to Stabilize Wood (only complete if answered yes to question above)

_____ Cubic yards of boulders used for stability of wood

_____ Number of Large wood structures to be stabilized with boulders

_____ to _____ Number of boulders pieces to be placed per structure (range)

Source of boulders:

☐ Upland source (quarry, etc)

☐ Commercial source

☐ Other (describe) _____

- **in-stream removal/alteration is not covered by this application**

☐ Boulders will meet the following criteria:

- The volume of boulders will be limited to the minimum amount necessary to provide resistance to downstream movement.
- Boulders will be sized appropriately for the stream, but be of a size sufficient to be stable and provide stability under expected high flows (typically 25-year recurrence interval).
- Boulders and wood will not be combined to form barbs (or similar hydraulic structure), to channelize stream flow, or to stabilize streambanks.

9D). Additional project details *(optional)*

10. INFORMATION ON THE PLACEMENT OF BOULDERS within stream channels where rock and boulders would naturally occur to retain substrate but are currently lacking.

10A). Description of Stream Reach

☐ The streambed consists of bedrock, and predominantly coarse gravel or larger sediments.
☐ The gravel depth is less than 30 inches over bedrock in over 50% of the treatment area.
☐ The riparian area is intact, well vegetated, or being restored and reestablished as part of project.
_____to_____ Stream bankfull width in feet where boulders will be placed (list range)
_____to_____ Stream bankfull depth in feet where boulders will be placed (list range)
_____to_____ Stream gradient where boulders will be placed (list range) - **may not exceed 10%**

10B). Description of Boulder Project

_____ Number of treatment segments
_____to_____ Feet treated per segment (list range)
_____ Total length of stream to be treated: **- if more than 500 feet cumulative you may not use this form.**
_____ Number of Boulders to be placed
_____ Average boulder size (in cubic yards)

Coarse wood will be added: ☐ Yes ☐ No

Source of boulders:

☐ Upland source (quarry, etc)
☐ Commercial source
☐ Other (describe) _____

- in-stream removal/alteration is not covered by this application

Method of placement: **Note: Boulders must be individually placed - no end dumping is allowed**

☐ Helicopter
☐ Tracked vehicle (excavator)
☐ Rubber tired vehicle (spider hoe, back hoe)
☐ Winching/Yarding
☐ Other (describe) _____

10C). Verification of Design Criteria

☐ Boulders will be sized appropriately for the stream:
☐ Boulders will be sized appropriately for the stream, but be of a size sufficient to be stable and provide stability under expected high flows(typically 25-year recurrence interval).
☐ Boulders will not be permanently anchored (including rebar or cabling to meet size or stability criteria).
☐ No boulders will be placed to form weirs (e.g., step pools), barbs, dams, or for streambank stabilization or structural armoring of any kind.
☐ Boulders will be placed in clusters or patterns that replicate natural stream conditions and that do not substantially modify stream hydraulics.
☐ Boulder clusters and patterns will not:

- Individually, exceed one-third of the bankfull channel width.
- Be placed on just one side of the stream.
- Be configured to shift the stream flow to a single flow pattern in the middle or to the side of the stream.
- Block more than 25% of the cross-sectional area of the flowing channel at the time of installation (e.g. low flow channel width).
- Have a gap of less than two feet between clusters to allow adult and juvenile fish passage.
- Be placed in aggrading or braided channels.

10D). Additional Project Details *(optional)*

11. INFORMATION ON THE PLACEMENT OF GRAVEL, in stream channels where it would naturally occur but is currently lacking. (please complete all questions if your project includes this activity)

11A). Description of Stream Reach

_____to_____ Stream bankfull width in feet where gravels will be placed (list range)
_____to_____ Stream bankfull depth in feet where gravels will be placed (list range)
_____to_____ Stream gradient where gravels will be placed (list range)

11B). Description of gravel placement

_____ Number of placement sites
_____to_____ Length of placement sites (range)
_____to_____ Width of placement sites (range)
_____to_____ Depth of gravel to be placed per site (range)
_____ Cubic yards of gravel to be placed

Method of placement:

- ☐ Helicopter
- ☐ Tracked vehicle (excavator)
- ☐ Rubber tired vehicle (spider hoe, back hoe)
- ☐ conveyor/chute
- ☐ Other (describe) _____

11C). Verification of design criteria

☐ The purpose is to improve spawning substrate by compensating for an identified loss of a natural gravel supply.
☐ Gravel will be placed in association with a current or past in-stream habitat restoration project.
☐ Gravel placement will meet the following criteria:

- Gravel will come from a commercial source, an upland source outside the riparian area, or from a previously approved in-stream source.
- Gravel will be of varied sizes, with no more than 5% of the gravel smaller than 0.25 inch and no more than 10% of the gravel larger than 4 inches.
- Gravel will be washed, rounded (less than 25% fractured face), composed of hard durable particles resistant to weathering, and of a type similar to that found in the stream basin. No organic soils, silt, clay or soft friable particles will be part of the gravel placement
- Fabric or wire mesh will not be used to hold the gravel in place.
- Gravel will not be placed in pools, or be placed in a way that may impede fish passage.

11D). Additional project details *(optional)*

12. SUPPLEMENTAL INFORMATION

Your application form will be considered incomplete without the following required attachments.
Attachments need to be legible, on 8 ½" x 11" paper, be reproducible in black and white, and include appropriate labels (scaling, key, north arrow, etc.)

☐ **Location map** that clearly shows the project and how to get to the project site from the nearest city or major intersection, including streets and roads. More than one map may be necessary. Please clearly identify the project location(s) on maps. Extent of project area and individual sites must be clearly identified and labeled.

☐ **Drawings** (cross section and plan view) of proposed project, which clearly depict all activities proposed within waters. Typical drawings may be used as long as the applicable locations are referenced.

For wood projects:

☐ Wood project will follow the typical plan view diagram (Figure 4) in the Oregon Guide to Placement of Wood, Boulders and Gravel for Habitat Restoration 2010. A table with the sight location that corresponds to the provided map, the anticipated number of key logs per site and the range of diameter of the logs will be provided.

☐ Wood project will not follow the typical plan view diagram (Figure 4) in the Oregon Guide to Placement of Wood, Boulders and Gravel for Habitat Restoration 2010. These projects require detailed drawings including the number of key logs for each site and range of log diameters.

For boulder projects:

☐ Include plan view diagram or photographs that clearly show the length of the section of the stream to be treated, configuration of boulders, wood to be added and stream flow.

☐ For boulders placed in a reaches with a stream slope of 3 to 10 percent, provide a longitudinal profile diagram for the length of stream in which the boulders will be placed.

Optional information (not required for completeness but can help facilitate review**)**

☐ **Tax map** with the project location and affected property clearly identified (not highlighted).

☐ **Recent Aerial photo** (best quality copy and highest resolution available, 1:200 preferred)

☐ **Photographs** clearly showing existing condition of project area, including the proposed impact area, existing structures, surrounding land, and waterbody in or adjacent to work location. Mount or print color photographs of proposed work site(s)on 8-1/2" x 11" paper.

13. COASTAL ZONE CERTIFICATION

If the proposed activity described in your permit application is within the Oregon coastal zone, the following certification is required before your federal permit may be issued.

All applications in the coastal zone must be reviewed by the Department of Land Conservation and Development, Oregon Coastal Management Program for consistency with the coastal management program. **After completing this form, please forward a copy to: DLCD**, Coastal Permit Specialist, 635 Capitol St NE, Ste 150, Salem, Oregon 97301. You may also contact the DLCD by email at coastpermits@lcd.state.or.us, or by calling 503-373-0050.

I certify that, to the best of my knowledge and belief, the proposed activity described in this application complies with the approved Oregon Coastal Zone Management Program and will be completed in a manner consistent with the program.

Applicant signature:		**Title:**	
Print Name:		**Date:**	

Send One Signed Copy of Your Application To:

US Army Corps of Engineers
District Engineer
ATTN: CENWP-OD-GP
PO Box 2946
Portland, OR 97208-2946
503-808-4373

APPENDIX C – OREGON DEPARTMENT OF FISH & WILDLIFE OFFICES

Oregon Department of Fish & Wildlife **Headquarters** 3406 Cherry Avenue N.E. Salem, OR 97303-4924 Tel: (503) 947-6000, Toll Free: (800) 720-ODFW, TTY: (503) 947-6339	
North Willamette Watershed District Office **(Regional Office)** 17330 SE Evelyn Street Clackamas, OR 97015 Tel: (971)-673-6000 Fax: (971)-673-6070	**North Coast Watershed District Office** 4907 Third Street Tillamook, OR 97141 Tel: 503-842-2741 Fax: 503-842-8385
Newport Field Office Annex **810 SW Alder St Unit C** Newport, OR 97365 Tel: 541-867-265-8306 Fax 541-265-9894	**ODFW Florence Satellite Office** PO Box 1 Florence, OR 97439 Tel: 541-902-1384 Fax: 541-997-2958
South Willamette Watershed District Office 7118 NE Vandenberg Avenue Corvallis, OR 97330-9446 Tel: (541) 757-4186 Fax: (541) 757-4252	**Springfield Field Office** 3150 E Main Street Springfield, OR 97478-5800 Tel: 541-726-3515 Fax: 541-726-2505
Umpqua Watershed District Office **(Regional Office)** 4192 N. Umpqua Hwy Roseburg, OR 97470 Tel: 541-440-3353 fax: 541-673-0372	**Rogue Watershed District Office** 1495 E. Gregory Road Central Point, OR 97502 Tel: 541-826-8774 Fax: 541-826-8776
Charleston Field Office 63538 Boat Basin Blvd. P.O. Box 5003 Charleston, OR 97420 Tel: 541-888-5515 fax: 541-888-6860	**Gold Beach Field Office** 29907 Airport Way, PO Box 642 Gold Beach, OR 97444 Tel: 541-247-7605 Fax: 541-247-2321
Grande Ronde Watershed District Office **(Regional Office)** 107 20th Street LaGrande, OR 97850 Tel: 541-963-2138 Fax: 541-963-6670	**John Day Watershed District Office** 73471 Mytinger Lane Pendleton, OR 97801 Tel: 541-276-2344 Fax: 541-276-4414
Baker City Field Office 2995 Hughes Lane Baker City, OR 97814 Tel: 541-523-5832 Fax: 541-523-5874	**Enterprise Field Office** 65495 Alder Slope Road Enterprise, OR 97828 Tel: 541-426-3279 Fax: 541-426-3055
John Day Field Office PO Box 9 John Day, OR 97845 Tel: 541-575-1167 Fax: 541-575-0948	**Ontario Field Office** 3814 Clark Blvd. Ontario, OR 97914 Tel: 541-889-6975 Fax: 541-889-8133
Deschutes Watershed District Office **(Regional Office)** 61374 Parrell Road Bend, OR 97702 Tel: 541-388-6363 Fax: 541-388-6281	**Klamath Watershed District Office** 1850 Miller Island Road Klamath Falls, OR 97603 Tel: 541-883-5732 Fax: 541-883-5521
Prineville Field Office 2042 SE Paulina Hwy Prineville, OR 97754 Tel: 541-447-5111 Fax: 541-447-8065	**The Dalles Field Office** 3701 W 13th Street The Dalles, OR 97058 Tel: 541-296-4628 Fax: 541-298-4993
Hines District Office 237 Highway 20 South, PO Box 8 Hines, OR 97738 Tel: 541-573-6582 Fax: 541-573-5306	**Lakeview Field Office** 101 N "D" Street, PO Box 1214 Lakeview, OR 97630 Tel: 541-947-2950 Fax: 541-947-4632