APPENDIX F-1

Bonneville Hydroelectric Project Response Plan for Zebra Mussels (*Dreissena polymorpha*)

By

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May 2007

A. Introduction - The purpose of this Plan is to provide the Bonneville Lock and Dam Project with information that will be needed to rapidly respond to a reported introduction of zebra mussels in order protect project infrastructure. While this Plan is specific to Bonneville Lock and Dam, it should provide sufficient general information that other Columbia River basin projects could modify to cover their projects with minimal additional effort. It is most likely that projects upstream of Bonneville would be infested first.

Since zebra mussels were introduced into the United States from eastern Europe in the late 1980s, they have rapidly dispersed throughout the Great Lakes and major river systems including the Hudson, Ohio, Mississippi, lower Missouri and other rivers to the south and east including 22 states and two Canadian provinces. This rapid dispersal is due primarily to their tremendous reproductive capability and the fact that larval zebra mussels are able to remain free-floating for several weeks before setting. This ability allows them to be dispersed by downstream water currents, which has been the major vector for their rapid expansion in North America. They are also dispersed by attaching to various types of watercraft moving within or from infested waters.

If zebra mussels colonized anywhere in the Columbia River Basin (CRB) they would be expected to spread to all downstream projects and most likely to mainstem projects upstream. They could affect all submerged components and conduits of the Federal Columbia River Power System (FCRPS) such as trash racks, raw water distribution systems for turbine cooling, fire suppression and irrigation, diffuser gratings, drains, navigation locks, and fish passage facilities. Zebra mussel larvae prefer attaching to substrates in slow moving water although, in higher velocities (> 2 m/sec; > 6 ft/sec), they can find irregularities such as cracks and crevices and scaling in older pipes and flanges that provide lower velocity refugia for settlement. As the attached mussels grow, they then produce additional low flow refuges that allow colonization to progress in otherwise inhospitable flow environments. Settlement can also occur when water flow is reduced during generation outages or other facility down-time when conditions may become more conducive to attachment.

If zebra mussels are introduced and become established within the CRB, it is uncertain how densely they will colonize. They can probably be expected to thrive at least as well as the invasive Asian clam (*Corbicula fluminea*) that is already widely distributed in the CRB. Zebra mussel densities ranging up to hundreds of thousands per square meter have been observed in some areas of the eastern United States – enough to completely cover surfaces several layers deep. The severity of impacts on hydropower, navigation, and fish passage facilities and extent and frequency of mitigation actions will depend on mussel production levels. For the Plan presented here, a moderate productivity level was assumed. Maintenance costs will also be affected by the difficulty in accessing certain fouled areas, the methods available for removal and control, and the amount of time available for maintenance activities. A more detailed description of the risks and potential effects on project facilities can be provided by the Project or District Aquatic Nuisance Species (ANS) Coordinator.

B. List of Actions – Information in this Plan should assist the project in determining what immediate actions are necessary to protect project facilities and in quickly determining long-term needs in order to get funding requirements into the budget cycle. Much of what is suggested below would be too costly to fund from the normal annual O&M allocations without additional funds being included in the project budget. Hopefully this information will assist the project in prioritizing critical actions and justifying additional funding needs.

The potential severity and consequences of a zebra mussel introduction into the Pacific Northwest, particularly the CRB, will elicit immediate and concerned reactions from resource agencies, affected facility operators, and other entities that have an interest in utilizing water from the basin and/or invasive species. This is expected because those that have been involved in ANS activities are aware of the damage zebra mussels cause and that past control successes for other invasive species were primarily achieved when a region acted quickly and cooperatively. Because we have had a very cooperative relationship both within the region and nationally, we expect that to continue if/when we face a serious ANS problem such as zebra mussels. Regional efforts will initially focus on containment, control and impact mitigation to minimize dispersal to new areas.

1. **Verify Sighting and Proximity to the Project** – Depending on where the initial sighting is made, the project will first need to determine if facilities are located within or downstream of the infested area. If zebra mussels are in another drainage, then determine the likelihood of them being spread to the lower Columbia River. In a river system, it is logical to expect that mussels will disperse to facilities located downstream. Because settlement doesn't occur until 4 to 5 weeks after spawning, larval zebra mussels can disperse a considerable distance downstream. Depending on distance, productivity, and spawning conditions (water temperatures greater than 12^{o} C, 54^{o} F) it can take a few years for populations to reach a "nuisance" level. If the initial discovery is of the larval life stage, that suggests spawning adults are present and it may take a year or two before facilities are affected to the point that remedial measures must be taken. If zebra mussels are found in another drainage or isolated lake, then dispersal to the Columbia River basin in a worst-case scenario could be expected within a year or two and severe infestation within another year or two after that. Thus, early detection may provide a couple years cushion before mitigative actions need to be implemented. This can be important for developing and managing a program within budget cycles.

2. **Survey Project Facilities** – If zebra mussels have been identified at the project or in the Columbia River drainage, then project facilities should be surveyed to confirm their presence and the extent of infestation. This information will be used to determine the appropriate "rapid response". Sites to check initially include the artificial substrates that are part of the existing monitoring program, raw water system strainers, particularly those for the turbine unit air coolers and fire suppression, and surfaces of all unwatered facilities. In unwatered facilities, attention should be directed to darker areas (out of direct light) with low ($\leq$ 2 m/sec; $\leq$ 6 fps) water velocities or in higher water velocity areas where there are irregular surfaces that could provide settling sites. Unusual changes in fish condition, such as increased descaling and lacerations, could also indicate mussels are in fish passage conduits. Their shells have sharp edges that could easily descale or more severely injure fish that rub against them.

3. **Management Briefing** – If zebra mussels are confirmed on project facilities or in close proximity, immediate actions as described herein will be necessary. An early management briefing will provide information to facilitate approval of and guidance on an acceptable course of action, including identification of an action team and

confirmation of their roles and responsibilities (see paragraph 5 for more details on the team). To assist with briefings, see the attached Draft Information Paper and Draft Talking Points. These documents should be updated periodically (about every five years) to include new information and technology.

4. **Public Information** – The potential for serious environmental and economic impacts to the region from zebra mussels, as have occurred in the eastern states, will undoubtedly create a high level of public interest. Some organizations have been providing general public information and outreach for several years but the reality of an invasive species introduction “close to home” will provoke an immediate, greater interest. The attached Draft Information Paper and Draft Talking Points can be used by Public Affairs for initial responses to media inquiries. See also the attached Draft Press Release. This should also be updated periodically.

5. **Establish Corps Team** – The Corps has been involved in limited aquatic nuisance species (ANS) activities since the early 1990s, including monitoring for zebra mussels at mainstem Columbia and Snake river projects (since 1994) and active participation on regional and national committees. Some points of contact (POCs) have already been designated and additional team members will be needed to facilitate timely, coordinated response actions. See Table 1 for a list of recommended POCs and responsibilities. Those positions that have not been established or do not have a current representative can be identified at the time a response action is needed.

6. **Identify External Partners/Interested Parties** – The District or Division POCs will likely lead coordination efforts with external agencies. This will include both immediate response actions and coordination of various environmental requirements (see paragraph C). See Table 2 for a list of key agencies and POCs.

7. **Organize Resources** – If zebra mussels are present in project facilities, certain immediate actions will be necessary that will require funding, including coordination efforts. There is no current budget line item for ANS actions so funds will have to be allocated from other programs (see paragraph 8) or obtained from outside sources. Long-term funding will also be needed for detailed monitoring and control actions. Rough estimates are provided below for specific actions and, for planning longer term. Approximately $20,000 to 40,000 would be needed for initial coordination and another $100,000 to 200,000 for rapid response actions. Long term costs could be $1,000,000 to 2,000,000 for control measures and $100,000 to 200,000 per year for operations at each mainstem project. This does not include additional manpower that would be needed for physical removal of zebra mussels from project structures. This information will have to be developed once the extent of infestation is better understood but it is safe to say that it could easily be in the $ millions annually based on what has happened in the eastern U.S. and Canada.

8. **Develop Project-Specific Plan** - Project staff can use the information provided in this document to develop an action plan to prioritize necessary actions and establish a work schedule. While other projects in the CRB are different, their facilities are similar

enough to use this information to help quickly develop response plans specific for their projects. Ideally these would be completed in advance, like the Bonneville Project Plan, if the resources/manpower is available to do so.

C. Project Facilities - The project components described below are all vulnerable to some extent to zebra mussel infestations. See also Table 3 for a general list of at risk project facilities and some suggested preventative actions to reduce the impacts of a zebra mussel infestation. Potential effects are described, including ways to monitor for problems, suggestions for mitigative actions, if there are any, and potential costs. The focus will be according to water source with those facility features that rely on raw water as the primary source considered as needing initial attention. Those facilities that have domestic water sources will be noted but only addressed if they have raw water back-up systems that could be compromised. Priority facilities are identified because of their importance and vulnerability to potential zebra mussel infestations. These include turbine cooling systems, fire suppression systems, fish passage facilities, drains and sumps, and certain monitoring facilities (forebay/tailwater sensors, oil/water separators, and dissolved gas monitors). There is also detailed cost estimate information in the paper by Phillips and Darland.[1]

1. Powerhouse 1 – This powerhouse is more vulnerable than Powerhouse 2 because access is more limited, generators are on standby more often, and more areas are available for larval zebra mussel settlement (e.g., lower water velocities, more irregular surfaces, particularly from corrosion and surface deterioration). Rather than try to predict which facility components may be excluded from concern based on water velocity, this Plan will consider that as a minimum if Asian clams have been observed then zebra mussels would also be expected.

a. Generator air coolers – For each generator unit there are 12 coolers that use 900 to 1100 gpm supplied from the main raw water header, or equalizing header, which draws from the scroll case at elevation +23 (feet above mean sea level). The 24" supply line feeds two 12" lines that run through an automatic and a manual strainer (to keep debris out of the cooling coils) with porosities of 1/8" and 3/16," respectively. Each strainer services two generator units. The automatic strainers are located on odd units (3, 5, 7, and 9) and the manual strainers are located on even generator units (4, 6, 8, and 10). Generator units 1 and 2 differ from the other units in that they each have a strainer supplied from each scroll case and have the capability of using a raw water backup from the unit 0 penstock or a pier nose intake located at +68 elevation which runs through a duplex strainer at -10 level. The automatic strainers are primarily used with the manual strainer as a backup. Automatic strainers have pressure gauges to measure the differential across the screen and will alarm in the Control Room if a problem arises. After the strainer, raw water exits to a 10" line that further necks down to 8", then 6", and 4" before entering the 5/8" cooling tubes. The heated discharge water is diverted to sumps, through an oil/water separator, and, ultimately, to the tailrace. The generator unit cannot operate if the cooling water system doesn't function

[1] Potential Economic Impacts of Zebra Mussels on the Hydropower Facilities in the Columbia River Basin. 2005. Phillips, Stephen and Tim Darland. Pacific States Marine Fisheries Commission. 22 p.

properly.   No domestic water supply exists as a backup for the air coolers. The discharged water is not warm enough to cause any adverse growing conditions for zebra mussels.

Impacts: Air cooler failures could result from reduced flow in the supply pipes, strainer blockages, or flow gauge malfunctions. Zebra mussels could settle on the intake gratings, in the pipes, on the strainers, or in the flow gauges. This could result in reduced flow due to friction loss or blockages from growing mussels and dislodged shells. Zebra mussels grow to an inch or two which would be sufficient to plug the cooling tubes. Because the system goes from large diameter pipes to progressively smaller diameter pipes, it will be more difficult to difficult to remove severe mussel accumulations.

Actions: It should be noted that Asian clams are cleaned from cooling tubes during main unit overhauls (every 5 years) and they are typically larger than the strainer openings, suggesting that they grew in the supply lines between the strainers and the cooling tubes. If zebra mussels may be present, then some end bells should be removed to spot check for potential plugging. If mussels are discovered in densities that would suggest potential cooling water supply loss, then the system should be immediately checked and cleaned, beginning with the cooling tubes and working towards the intake. Because the manual strainers are checked monthly, mussels will hopefully be detected before their density reaches a critical level or they grow to a large enough size to block cooling tubes.

b. Thrust bearing coolers - For each generator unit there is one cooler that uses a total of 100 gpm supplied from the equalizing header which draws raw water from the scroll case at elevation +23. The 24” supply line feeds a 12” line that runs through an automatic strainer (1/8” porosity) to a 10” line that further necks down to 8”, then 6”, and 4” before entering the “plate and frame cooler”. There is a gauge to measure differential across the strainer and an alarm will sound in the control room if the pressure is excessive. The heated water is diverted to sumps, through an oil/water separator, and, ultimately, to the tailrace. If the thrust bearing coolers don’t operate properly, then generator units will be shut down. The discharged water is not warm enough to cause any adverse growing conditions for zebra mussels.

Impacts: Thrust bearing cooling water system failures could result from reduced flow in the supply pipes and blockage of the automatic strainer.   Zebra mussels could settle on the intake gratings, in the pipes, and the strainer. This could result in reduced flow due to friction loss or blockages from growing mussels and dislodged shells.

Actions: Because the automatic strainers have pressure differential gauges and are monitored by operators, mussels will hopefully be detected before their density reaches a critical level or they grow to a large enough size. A domestic water supply as a back-up does not currently exist.   Asian clams have never been found in the plate and frame cooler sections.

c. Fire suppression/deluge and deck wash pumps – Raw water is gravity fed from the forebay from either Unit 0 penstock or a pier nose intake located at +68 elevation which runs through a duplex strainer at -10 level. Since the intake to the pumps is gravity fed, the lines remain charged down to the duplex strainer. The strainer has 1/8" to 1/4" porosity plate and splits to the deck wash pump and fire pumps. The deluge system for the transformers is supplied from fire pump No. 1. There are 15 transformers separated into 5 banks located on the +90 deck. The fire suppression system relies solely on raw water. Because of inadequate domestic water supply from the wells on project, a domestic water backup system is not feasible. Malfunction of the fire suppression system would result in additional damage and likely cost more to repair or replace equipment.

Impacts: If zebra mussel larvae settle in the pipes from Unit 0 or from the +68 intake, plugging from mussel shells may occur in the strainer thus causing inadequate water supply to suppress a fire. Water leakage through the valves may provide enough dissolved oxygen (DO) to sustain zebra mussel growth.

Actions: The duplex strainer is checked semi-annually. If zebra mussels are present in the Columbia River, more frequent checks will be recommended (such as monthly or quarterly). The fire deluge systems for the transformers are tested every five years. In addition to checking the strainer, the project should test the deluge system more often than the five year cycle. If leaky valves exist, the project should consider replacing them to prevent DO-laden water from entering and sustaining potential zebra mussel growth.

d. Heating, Ventilation, and Air Conditioning (HVAC) - Raw water is supplied to the HVAC system from the 24" equalizing header which draws from the scroll case at elevation +23. The 24" supply line feeds a 10" line that runs through an automatic strainer (3/16" porosity) to the coils in the chiller located between generator units 8 and 9. If there is a problem with zebra mussel fouling, it should be evident by improper heating or cooling. The powerhouse air supply and exhaust fans operate continuously. Although there will be some air circulation if the HVAC system fails, air temperatures will probably reach unacceptable levels. The HVAC system that controls temperature in the Control Room and +95 level office space uses domestic water.

Impacts: HVAC failures could result from reduced flow in the supply pipes, strainer blockages, or flow gauge malfunctions. Zebra mussels could settle on the intake gratings and in the pipes and strainers. This could result in reduced cooling water flow due to friction loss or blockages from growing mussels and dislodged shells. If the HVAC system malfunctions, the powerhouse may become an unacceptable working environment due to improper air circulation and elevated air temperatures.

Actions: The automatic strainer is checked quarterly. Asian clams have not been found in the strainer or exchanger tubes. If zebra mussels are present in the Columbia River more frequent checks will be recommended (such as monthly) along with the addition of a domestic water backup system.

d. Drain galleries - Drains and sumps exist to handle leakage and discharge water from various cooling systems and expansion joints. They collect mainly raw water from a variety of sources. Although some domestic drain water mixes in, the discharge should be considered raw water. There are no pumps or water level sensors associated with the drain galleries. Asian clams have been found on level +23 from a leak between generator units 7 and 8 therefore it is likely that zebra mussels could also settle in the area. Operators regularly inspect drain galleries to monitor for plugged drains.

Impacts: Zebra mussels could plug drains causing water to back up and flood certain areas. Zebra mussels could settle in pipes under the drain gratings, therefore reducing effective water passage.

Actions: Continue to inspect drains for the presence of zebra mussels. If water is backing up through a drain and no visible debris is present on the drain grating, the project should suspect for zebra mussel fouling and clean the pipes or divert the drain water through an alternate route.

f. Sumps – There are two sumps that receive raw drain water. One is located on the south and one on the north side of Powerhouse 1. The south sump is normally used first with the north sump as a backup. In addition, the north sump is primarily used to dewater generator units (e.g., scroll case and draft tube). Failure to operate properly could result in flooding and additional equipment malfunction on the -53 level. Project operators inspect the sumps daily.

Impacts: Zebra mussel larvae could settle in the sump chambers or piping thus causing reduced flow or plugged lines to the oil/water separator. In turn, this would cause more wear on pumps and, possibly, water level sensor malfunctions.

Actions: Continue to monitor sumps for the presence of zebra mussels. If detected, closer monitoring of sump pumps and motor amperage readings should indicate if flow is being reduced. In addition, more frequent cleaning of the chambers and sump piping will be recommended.

g. Oil/water separator – Drain water (raw) from the south sump is pumped to an oil/water separator. Raw water in the north sump is pumped directly to the tailrace. The oil/water separator contains an oil absorbing filter that is cleaned bi-weekly. Once residual oil is removed, the water is gravity fed to an oil monitoring building before it is discharged to the tailrace. If the oil/water sensor system fails, then unacceptable amounts of oil could be discharged to the river and potentially violate state water quality standards.

Impacts: Zebra mussel shells could plug sensitive oil monitoring equipment and cause erroneous readings leading to oil discharge into the river. Since the raw water is gravity fed once it reaches the oil/water separator and at a lower velocity, zebra mussels could more easily settle in the discharge line to the oil monitoring building causing water to back up in the separator. If this occurs, contaminated water may be inadvertently discharged to the river in the old navigation lock channel.

Actions: If zebra mussels are present in the Columbia River, more frequent checks should be conducted in the separator chambers and oil monitoring building. The system may require frequent cleaning.

h. Air Compressors - There are two separate air compressor systems that are vital for generator operation. The 300 lb air compressor supplies the governor oil tanks and the 100 lb air compressor supplies the generator head cover pumps and provides service air to the entire powerhouse. Since this is such a vital system, domestic water is used to cool the air compressors with raw water as a backup. The project would be forced to shut down generator units if the compressors malfunction.

Impacts: Little impact is expected since domestic water is primarily used to cool air compressor coils. If raw water were needed for a brief period, subsequent return to domestic water would provide little or no food for zebra mussels to filter and grow in the system. During raw water use, some shells may be dislodged and need to be removed from the compressor cooling coils.

Actions: Continue to maintain equipment to minimize raw water use. Record the dates of raw water use during the year. Depending on the time of year, larval zebra mussels could be present in the system (summer months).

i. Forebay/Tailwater Sensors – These sensors are located throughout the project and are in direct contact with raw water. They provide water level information, mainly to fish passage facility components, that is used to adjust valves controlling water level differentials at fishway entrances and the smolt monitoring facility (SMF) outfall pipes. In addition to fish passage components, sensors inform the control room about forebay and tailwater levels to avoid operating outside design criteria.

Impacts: Mussel growth in the sensor wells could cause false readings to be used for valve operation to control fish passage facilities. Erroneous information would cause fishways to operate out of criteria and impact fish passage and survival past the project. Improper forebay and tailwater levels could cause other problems both at the project and farther upstream/downstream - e.g., structural integrity, navigation, irrigation, and recreation facilities.

Actions: Verify whether mussels have settled in the sensor wells and, if so, remove them. Set up more frequent maintenance schedules. If the sensor still wells fail, the project can rely on above water sensors that are designed to send water level information to the generator 3-D cams for unit efficiency.

j. Juvenile Fish Bypass and Monitoring – Juvenile bypass facilities consist of screened diversions, powerhouse collection channel, auxiliary water supply system, and monitoring facilities. They are operated from 1 March through 14 September for juvenile bypass and from 15 September through 15 December for adult fish fallback. Loss of the juvenile bypass system capability could force the project to provide more spill as an alternative means of bypass.

Impacts: All submerged surfaces in low velocity areas could become colonized by zebra mussels and, if they are in areas where fish are present, could cause increased descaling and more severe injuries if the fish come in contact with the sharp shell edges. Water velocities commonly associated with most fish screen systems are ideal (< 1 m/sec; < 3 ft/sec) for zebra mussel colonization. Zebra mussels attached to dewatering screens and porosity plates, would affect the open area and reduce the water volume passing through and increase the water velocity at the screen resulting in an increased rate of impingement. These systems are specifically designed to provide particular flow characteristics. Fish guidance efficiency (FGE) could be reduced if less flow passed through submersible fish bypass screens and was instead diverted around the lower end. More flow would be directed up into the gatewell slots by plugged or partially plugged screens. This would create adverse hydraulic conditions for juvenile fish. This could be further aggravated if the vertical barrier screens (VBS) and porosity plates were also partially blocked. Major colonization by zebra mussels on trash racks and other screens would hinder flow and increase the weight of these structures.

If some components of the fish bypass systems are not functional, such as the STSs and VBSs, then generally fish passage criteria do not allow turbine operation in affected units. Problems resulting from zebra mussel colonization could cause this to occur. Even more of a concern might be that severe zebra mussel fouling could require extensive maintenance and removal from within the turbine intake, scroll case, and draft tube. The schedule for this could impact normal fish operations if it exceeded the 2-3 month winter maintenance period currently allowed. Even if it could be done quickly, it would add to other fish facility maintenance activities occurring at the same time.

Some of the emergency bypass lines and drain lines would be at risk as described previously. Dewatering screens with fine mesh could be at risk even though they would be unwatered for part of the year. There could be sufficient time for zebra mussels to establish and grow large enough to affect flow through the screens. Even if they didn't cause enough blockage to seriously hinder the operation, their presence might cause the screens to have a rougher surface that could be more susceptible to debris buildup. The cleaning brushes should keep this risk low on those surfaces that are brushed regularly.

Actions: It will be important to assure that the facilities are entirely unwatered as zebra mussels could persist through the winter in pools (areas that receive leakage) as long as they didn't freeze. Although the STSs are pulled and dogged off at deck level during the winter, a portion of the screen remains submerged and at risk.

k. Adult Fish Passage – Adult fish passage facilities include entrance and collection facilities, ladders, auxiliary water supply system, and counting stations. They are operated exclusively with raw water. Depending on the circumstances, forced outage of adult fish facilities could result in delayed fish passage and may require modified or curtailed powerhouse operations. This occurred in 2000 when Powerhouse 2 ladder diffuser gratings were dislodged after they became plugged with debris and both the ladder and powerhouse were taken out of service until repairs could be made.

Impacts: The presence of zebra mussels could diminish the water carrying efficiency of the auxiliary water supply system. If valves are not operated on a regular basis, the valve plates, seals, and guide channels could become colonized and not function properly. Diffuser gratings would be particularly susceptible to fouling that could further aggravate the current problems with fine woody debris and other materials that clog the gratings. Even if zebra mussels did not colonize the diffuser gratings sufficiently to plug them (such as if the gratings were removed and cleaned periodically), they could still be clogged by druses (clumps of zebra mussels 2-3" in diameter) that break off from colonies inside the water supply conduits. Water level and velocity monitoring equipment could be affected by zebra mussel colonies and give erroneous information to the automatic control systems. All concrete surfaces in the ladders and collection systems could become colonized and, where fish are present, cause descaling.

Actions: If the zebra mussels cannot be controlled, they would have to be physically removed. Depending on the growth rate, this would be necessary at least annually and would require unwatering the facilities. Access to much of the auxiliary water supply systems is limited and it requires the entire ladder system be unwatered. Physical removal would be time consuming and limited by in-water work windows and by regulations regarding work in confined spaces. Picketed lead fouling would be similar to that described above for diffuser gratings. Counting station crowders should be operated on a regular basis to prevent any buildup of zebra mussels that could cause them to malfunction.

If the Powerhouse 1 adult passage system had to be shut down for additional maintenance associated with zebra mussel accumulations, all passage would be diverted through Powerhouse 2 facilities.   During this time, Powerhouse 1 would also need to be taken out of service to prevent adult fish from being attracted into the tailrace.

l. Gland water for cooling/lubrication – The main turbine shaft packing glands keep raw water from entering the packing because the river water contains sediments that would damage the packing and shaft. Gland water is fed from a domestic line with raw water backup and flows at a rate of 10 gal/min. Gland water continues to flow regardless of whether the unit is in service.   If the domestic system malfunctioned, raw water would automatically begin since the decrease in pressure would allow the back flow valve to open. The gland water system is monitored/maintained quarterly to detect any deficiencies that may be occurring.

Impacts: Little to no impact is to be expected with using domestic water above the Teflon packing. If raw water were to be used frequently, the generator unit could become inoperable due to zebra mussels clogging the gland water lines and additional sediments wearing on the shaft and packing material.

Actions: Continue to maintain equipment to minimize raw water use. Record the dates of raw water use during the year. Depending on the time of year, zebra mussel larvae could be present in the system (summer months). Additional inspections would be recommended.

2. Powerhouse 2 – Many of the systems are similar to those for Powerhouse 1, described above, therefore mainly the features that are different or that should be treated differently will be discussed here in more detail.

a. Generator air coolers – See information discussed for Powerhouse 1 above (paragraph C.1.a.). These coolers are similar to those for Powerhouse 1 units except that there are only 8 coolers per unit in Powerhouse 2. In addition, Powerhouse 2 units are on a 4 year overhaul schedule. Flow ranges from 650 to 750 gal/min to each unit.

Impacts: Impacts would be similar to those described above for Powerhouse 1.

Actions: Actions would be similar to those described above for Powerhouse 1.

b. Thrust bearing coolers – For each generator unit there are several 5/8" cooling tubes that are located within the bearing oil tub. Raw water is supplied from the scroll case and passes through automatic strainers located on the +5 level.

Impacts: See information for Powerhouse 1 above (paragraph C.1.b.). Any service needed on these cooling tubes will require an extensive unit outage.

Actions: See information for Powerhouse 1 above.

c. Fire suppression and deck wash pumps – See information discussed for Powerhouse 1 above (paragraph C.1.c.). The project has modified the deck wash system that services the +90 deck to use raw water instead of domestic water. The deck wash water is used to clean VBSs and, due to the cleaning frequency of the new VBSs, regional biologists wanted to minimize the amount of chlorinated domestic water entering the river.

Impacts: See information for Powerhouse 1 above.

Actions: See information for Powerhouse 1 above. The project should consider leaving the existing valving from the domestic water line intact. This would allow a simple modification to reconnect the domestic line back into the deck wash piping as a backup to raw water. The project should test the deluge system more frequently than the current four year cycle if zebra mussels are discovered in the Columbia River.

d. HVAC The HVAC system is currently being reconfigured to a closed loop system.

This system will use a refrigerant with raw water as the primary source of exchange. Domestic water will be available as a backup to the raw water cycling through the exchanger.

Impacts: See information for Powerhouse 1 above (paragraph C.1.d.).

Actions: See information for Powerhouse 1 above.

e. Drain galleries The draft tube gallery has live Asian clams living in the drain ditch. The clams were also found in the drain gallery located under the turbine intakes. Shells were not far from the leak and all appeared dead (some were checked by a project biologist).

Impacts: See information for Powerhouse 1 above (paragraph C.1.e.).

Actions: See information for Powerhouse 1 above.

f. Sumps See information discussed for Powerhouse 1 above (paragraph C.1.f.). There are two separate sumps located at Powerhouse 2. One sump receives water from the draft tube and is pumped out to the corner collector channel. This sump contains an oil monitor and will stop pumping if oil quantities exceed criteria. The second sump receives raw drain water and is pumped directly to the tailrace.

Impacts: See information for Powerhouse 1 above.

Actions: See information for Powerhouse 1 above.

g. Oil/water separator - The discharged water from the head cover pumps goes directly to the oil/water separator. From there it is discharged into the tailrace.

Impacts: See information for Powerhouse 1 above (paragraph C.1.g.).

Actions: See information for Powerhouse 1 above.

h. Air Compressors - See information discussed for Powerhouse 1 above (paragraph C.1.h.). The main difference between first and second powerhouse air compressors is that the governor oil tank is 1000 lbs and the service air and head cover supply is 125 lbs.

Impacts: See information for Powerhouse 1 above.

Actions: See information for Powerhouse 1 above.

i. Forebay/Tailwater Sensors - See information for Powerhouse 1 above (paragraph C.1.i.).

Impacts: See information for Powerhouse 1 above.

Actions: See information for Powerhouse 1 above.

j. Juvenile Fish Bypass and Monitoring - Juvenile fish bypass facilities at Powerhouse 2 are similar to those at Powerhouse 1 (paragraph C.1.j.) plus there are some unique features, including a corner collector on the south end, turbine intake extensions (TIEs) in the forebay, and a smolt monitoring facility with surface outfalls 2 miles downstream on the Washington shore. They are operated from March through October for juvenile fish bypass and from November through December 15 for adult fish fallback. Loss of juvenile bypass system capability at Powerhouse 2 could also force the project to provide more spill as an alternative means of bypass.

Impacts: Impacts would be generally similar to those described for Powerhouse 1. The corner collector bypass channel and long bypass pipes to the smolt monitoring facility may not be severely affected because they operate with high water velocities. Of most concern would be irregular surface areas and other places with small eddies where mussel larvae could settle and grow, particularly if they weren't completely unwatered during the non-bypass season. Because the bypass pipe is buried, winter temperatures probably would not be low enough to kill mussels that settled in areas that were not completely unwatered.

Actions: Just as at Powerhouse 1, it will be important to assure that the facilities are unwatered as much as possible to minimize refugia where zebra mussels could persist through the winter. Any areas where water remains should be inspected for mussel growth. The current practice of TIE removal during the non-bypass season should be sufficient to kill any zebra mussels attached to them.

k. Adult Fish Passage - Adult fish passage facilities at Powerhouse 2 include entrance and collection facilities, ladders, auxiliary water supply system, and counting stations. There is also an adult fish monitoring facility on the north shore of Powerhouse 2. They are operated exclusively with raw water.

Impacts: Impacts would be generally similar to those described for Powerhouse 1 (paragraph C.1.k.). Depending on the circumstances, forced outage of adult fish facilities could result in delayed fish passage and modified/curtailed powerhouse operations.

Actions: Impacts would be generally similar to those described for Powerhouse 1. If the Powerhouse 2 adult passage system had to be shut down for additional maintenance associated with zebra mussel accumulations, then all passage would be diverted through the Powerhouse 1 facilities.   During this time, Powerhouse 2 would also need to be taken out of service to prevent adult fish from being attracted into the tailrace.

l. Adult Fish Monitoring Facility - There is an adult monitoring facility on the north shore of Powerhouse 2. This is operated exclusively with raw water. Depending on the circumstances, forced outage could result in lost monitoring/research data. Some of this information is important for fish stock management.

Impacts: The submerged, inaccessible parts at the Bonneville adult evaluation facility would be susceptible similar to other fish passage facilities with piping, gratings, concrete and metal surfaces, and moveable structures. Forced outages of the adult fish monitoring facility would mean that important fish stock information might not be available for regional fish managers to use for making fisheries management decisions.

Actions: Similar to those for adult passage facilities.

m. Gland water for cooling/lubrication - See information discussed for Powerhouse 1 above (paragraph C.1.l.). The gland water system is monitored/maintained monthly to detect any deficiencies that may be occurring.

Impacts: See information for Powerhouse 1 above.

Actions: See information for Powerhouse 1 above.

3. Spillway - Other than fouling, spill gates and hoisting equipment are not likely to be impacted by zebra mussels to the point that they would be inoperable.

a. Sumps - See information for Powerhouse 1 sumps above (paragraph C.1.f.).

Impacts: No Asian clam shells have ever been found in the sump.

Actions: See information for Powerhouse 1 above.

4. Navigation Lock

a. Fire suppression pumps - See information for Powerhouse 1 above (paragraph C.1.c.). In addition to fire suppression, the pumps are used for irrigation around the navigation lock. The system contains a manual strainer that is checked and flushed once per week.

Impacts: See information for Powerhouse 1 above.

Actions: See information for Powerhouse 1 above.

b. Floating mooring bits – There are 8 floating mooring bits located on the navigation lock walls. They are used to secure vessels during lockages and they move up and down with the changing water level in the lock.

Impacts: Although zebra mussels could settle in the guide channels, the mooring bits are used frequently enough that they would constantly scrape off any mussels that do settle and begin growing. The weight of mussels that could accumulate on the mooring bits between normal maintenance periods should not be sufficient to affect their buoyancy.

Actions: Clean during lock maintenance to prevent buildup that could cause increased corrosion. The project might want to consider anti-fouling paint if available for this application (there may be environmental constraints).

5. Service Building – The Service Building houses maintenance, technical, and operations staff. Along with office space, there are several service bays that the structural, electrical, mechanical, and paint crews use to conduct day to day activities. This includes machine shops, paint and sandblast booths, welding stations, and equipment fabrication/repair facilities.

a. Fire suppression pumps – There are two pumps located at "Windy Welders" on the south side of the main dam (+82 deck). They draw raw water (only on demand) from the forebay through an 8” line and debris is filtered through a manual strainer. A malfunction of the fire suppression system would result in displaced project staff (approximately 50%), additional damage, and likely cost more to repair or replace equipment.

Impacts: See information for Powerhouse 1 above (paragraph C.1.c.).

Actions: See information discussed for Powerhouse 1 above. The fire suppression system is checked and operated annually which should be sufficient to monitor for zebra mussels.

6. Ice and Trash Sluiceways – The ice and trash sluiceways are located upstream of each powerhouse and they pass debris and fish. Little impact is expected due to the high water velocity through the channels. Even where there are surface irregularities that might allow zebra mussel settlement, there should never be accumulations that would prevent adequate operation. If the sides became coated with zebra mussels, the project would need to physically remove them. Since the project passes debris through the sluiceways, this may help scour out mussels.

7. Other Facilities

a. Turbine intake trashracks - There are trashracks for all of the turbine intakes to prevent debris from entering the intakes. Bar spacing varies from 1 inch on fish units to 6 inches for main generator units.

Impacts: The trashracks are located in areas with low water velocity where zebra mussels could easily colonize. This could affect fish passing through them (descaling/injury) and, if fouling was severe enough, affect turbine efficiency.

Actions: Typically the trashracks are cleaned by raking however they would have to be removed to clean zebra mussels because they could also grow on the downstream side where the trash rake doesn't reach. During trashrack cleaning, either by removal or raking, the unit must be shut off. If this occurs during a high river flow period, it could result in increased spill.

b. Irrigation Systems - These systems are located at the navigation lock, Bradford Island, Cascades Island, and the Washington shore. They are supplied with raw water, either pumped directly from the forebay or from other large raw water distribution lines (navigation lock only). They are operated annually from March until October.

Impacts: Since these systems are shut down in the winter, zebra mussels should not survive in the distribution lines. The lines will either be unwatered or segments containing water should stagnate and become anoxic. All irrigation intakes could contain mussels that inhibit flow into the system. This would cause increased load on the pumps and possibly poor valve operation. Also, mussels (shells) could dislodge from various parts of the supply lines, travel through the distribution lines and plug sprinkler heads. No Asian clam shells have ever been found in the irrigation system.

Actions: Immediate response actions would be mainly to maintain the sprinklers to remove any shells plugging the outlets. Any valve leaks should be repaired so that mussels can not survive in the line during the non-irrigation season.

c. Total Dissolved Gas (TDG) Monitors – These monitors are located in the forebay and tailrace inside fixed pipes (6-inch diameter) that are submerged to approximately 15 feet. River water flows freely through the pipes to the sensors, creating a perfect site for zebra mussels to inhabit. Data from these monitors are used by Reservoir Control Center to adjust project spill levels to meet water quality standards and to protect ESA-listed salmon. The sensors are removed for maintenance and calibration every 3 weeks during the spill season (April 15 – August 31). Any zebra mussels that have settled on the sensor should be noticed.

Impacts: Accumulations of zebra mussels could inhibit removal and replacement of the sensors during routine maintenance and obstruct water flow to the sensors. Erroneous TDG readings could result from either incorrect placement of the sensors or poor circulation in the pipe.

Actions: Immediate actions would include verification that no mussels are obstructing the pipes. If they are found, they should be removed or the pipe replaced and a periodic maintenance plan developed.

d. Dock, Boat Ramps, and Boats – The project has one boat that is moored downstream of the navigation lock. Typically it is kept in the water all year long.

Impacts: Zebra mussels would likely attach to the hull, particularly on the underside and this would result in a loss of efficiency for boat operation. More importantly, the mussels are commonly found inside cooling water intakes because of their preference for less exposed areas. If they plug this intake, the motor could be damaged if it is operated before the intake is cleared. It may be difficult to see the mussels if they are very far up in the line.

Actions: Boat operators should verify that the boat hull and cooling water intake are clean. If the boat becomes fouled with zebra mussels then at least the intake must be thoroughly cleaned, including the bilge, before the boat is used. It the boat is taken to any other location off-project, then it should be thoroughly cleaned before being taken anywhere else to prevent potential spread of the zebra mussels. If zebra mussels are in the river, then it would be better to not leave the boat in the water except when it is being used.

e. Parks and Recreation - Little impact is expected at any of the parks or other recreation facilities with the exception of irrigation systems mentioned above.

f. Visitor Centers - Little impact is expected at either of the visitor centers. The water systems are all domestic, including fire suppression. Fish viewing windows are cleaned daily with automatically-timed brushes that should remove zebra mussels.

g. Bonneville Hatchery – This hatchery, operated by Oregon Dept of Fish and Wildlife, uses water from wells and Tanner Creek for operations. Tanner Creek is such a small tributary it is not likely to become infested with zebra mussels. Underwater fish release pipes are particularly vulnerable to zebra mussels however Bonneville Hatchery's fish release pipe is exposed. Therefore, no impact is expected at this facility from zebra mussels.

D. Environmental Constraints – Advanced planning and environmental coordination for invasive species rapid response actions will facilitate timely actions and regional coordination.

1. Endangered Species Act (ESA) – Most project activities include consideration of ESA-listed species and any response to zebra mussels would be no different. The Action Agencies' Updated Plan of Action (UPA) references this rapid response planning effort which sets the stage for future follow-up if/when it becomes necessary. At that time, coordination letters could be prepared fairly quickly to address specific actions that are deemed necessary.

2. National Environmental Protection Act (NEPA) - Consider filing a Programmatic Environmental Impact Statement (EIS) covering possible actions and treatments, including chemicals that may be used. With such a document available, having already gone through the agency and public review process, the time required to take specific actions can be greatly shortened. An emergency supplement can then be filed based on the Programmatic document that can be approved fairly quickly.

3. EPA – A similar approach can be made with the water quality variance permit, which can be obtained relatively quickly if it is based on information presented and reviewed by EPA and State water quality agencies during the Programmatic EIS process.

4. **Other** – If materials were to be placed in the water to control zebra mussels, then Corps of Engineers permits (Section 10 or Section 404) could be required, as well as state hydraulic permits. However, at this time, there is no application known that would be suitable for use at a hydropower project.

E. Control Options – There are no silver bullets to solve zebra mussel problems but there are some applications available under certain conditions that are described below. Rather than attempt to be too prescriptive, examples will be presented that project personnel familiar with various systems can consider for specific applications.

Typically zebra mussel growth increases when water temperatures reach 10^{o} C and spawning begins at about 12^{o} C. Spawning will continue until water temperatures drop below 10 – 12^{o} C. This is important to know because, if lethal control methods are to be applied, they should be scheduled for some time in early spring or in the fall after the mussels have finished spawning to minimize recruitment of new mussels into the area. The project should have time to schedule activities unless zebra mussels have already reached a critical level that is causing serious problems. This is unlikely since they should be discovered well before the population reaches problem levels. This section should be updated periodically as new information and technology becomes available.

1. **Physical Control** – The easiest control, if available, is to switch from raw to domestic water and eliminate the potential for mussel contamination. The volume of water needed however would be prohibitive for some activities (e.g., generator air coolers) due to structural constraints and/or supply well capacities but there may be some useful applications (e.g., fire suppression). As a minimum, domestic water systems with raw water back-up should be evaluated for leaks that could allow mussel larvae to enter the system. These should be corrected as soon as possible to minimize mussel contamination because, once they settle in an area, they will either have to be killed or physically removed. While it will be nearly impossible to stop all leaks in all of the watered systems, particularly at Powerhouse 1, priority should be placed on leaks in critical systems such as generator air coolers and fire suppression systems.

In accessible areas, mussels can be physically removed by a variety of means, including scraping, pressure washing, or pigging. Pressures of 2,000 to 3,000 psi should remove mussels but it may take 4,000 to 10,000 psi to remove their byssal fibers (the fibers that they use to attach to hard surfaces). While the byssal fibers may not have to be removed to substantially improve water flow, their presence could allow increased corrosion of metal surfaces by anaerobic bacteria. Pigging would not be practical in pipes and conduits with lots of bends or size changes.

Physical removal can be labor intensive and time consuming which may pose problems meeting in-water work windows. Once the mussels are removed, they will have to be disposed of and the potentially large volume of dead and putrefying mussels must be considered when choosing this option and disposal locations.

Zebra mussels are susceptible to exposure and desiccation and they are more sensitive to longer exposure times and either higher temperature or freezing. If this is an option, the project should plan on unwatering a facility for a minimum of 3 weeks in non-freezing temperatures. This can be reduced to about a week if air temperatures can be raised to > 25^{o} C. Freezing will kill zebra mussels within a day although exposure time will need to be increased to a few days if there are clumps of mussels to assure thorough freezing. After a facility is watered up, there will still be dead mussel bodies and shells to collect and dispose of.

In systems that cannot be unwatered, the project may elect to try and isolate the area for either treatment with hot water or through oxygen deprivation (anoxia). The water temperature should be about 33 to 35^{o} C to assure a kill and this should be repeated once or twice a year for longer-term applications. For oxygen deprivation to work, the system must be well sealed as the mussels will survive for long periods in low-oxygen environments. Depending on water volume and mussel density, it could take several weeks for a system to go sufficiently anoxic to assure a kill. This can be accelerated if the water is warmer (up to about 25^{o} C) or if certain chemicals, such as hydrogen sulfide gas or sodium metasulfite, are added to eliminate oxygen. Additives should not be used without consideration of their potential impacts in discharge water. As with desiccation, there will be mussel disposal requirements post-treatment.

Antifouling surface coatings or foul-release coatings may be longer-term options for certain facilities but are less applicable for rapid response. These are typically expensive and difficult to apply and more information can be provided if/when long-term plans are developed.

2. **Chemical Control** – Chemical controls fall into two general categories, those that are lethal and those that are “irritants” (generally oxidizing chemicals) that discourage settlement or inhibit respiration, growth, or metabolic function. General information will be provided to illustrate possible chemical control options but, because of their potential impacts on non-target organisms, including ESA-listed species in the CRB, prescriptive alternatives will be left for later development and coordination once mussel control is needed. This section should be periodically updated, particularly if new, effective chemical products become available.

Lethal chemicals include molluscicides, copper sulfate, and certain metal ions (e.g., potassium). These may be used with or without detoxification and some are proprietary (e.g., Clam-trol). Use of chemicals will also likely require a National Pollution Discharge Elimination System (NPDES) permit from the EPA. Copper sulfate and most metal ions are also toxic to other organisms in the Columbia River and would have to be contained.

Oxidizing chemicals approved for use in drinking water, such as chlorine, potassium permanganate, ozone, and bromine, are effective in controlling zebra mussels but they also impact non-target organisms. If they were used, they could not be discharged into the river without serious environmental impacts. Sodium hypochlorite (NaOCl) injection systems are used by Ontario Power Generation, Canada, under a permit similar to the NPDES permit in the U.S. Another product, BioBullets, has been developed that uses the encapsulation of an active ingredient (KCl) in microscopic particles of edible material designed for ingestion by mussels. It is also supposed to affect Asian clams.

***************This section of the Plan should be updated periodically as new products or technologies are developed.****************

3. Biological Control – No biological control options are available at this time. Some waterfowl (e.g., lesser scaup) and fish (e.g., freshwater drum, carp, and some sunfish) will feed on zebra mussels but not to the point of controlling populations and certainly not within project facilities. Research is ongoing to determine if any known mussel parasites or microbes could be used to control zebra mussels. Again, these organisms are unlikely to provide controls for project facilities, however this Plan should be updated if any organisms are identified that may be useful.

F. Monitoring and Evaluation – An in-progress evaluation should be conducted to provide feedback on the efficacy of rapid response actions and to provide recommendations for improvements to either process or to identify additional actions. In addition, a follow-up evaluation should be conducted to identify opportunities to improve rapid response capabilities. Plans should also be made for a long-term monitoring strategy to address continuing risks from zebra mussels as well as other potentially harmful invasive species.

G. Looking Forward – Although the purpose of this Plan is to provide information for project use in responding to a reported zebra mussel invasion, some opportunities may arise to modify project facilities during routine maintenance or facility upgrades to "less friendly" mussel habitat. If these proactive changes could be made at little or no extra cost, they could be very important compared to potential future, unscheduled project impacts. These are the types of concepts that have been applied in Europe where they have been successfully dealing with zebra mussels for hundreds of years.

1. Redundant systems – If possible and cost effective (facility cost versus maintenance and loss of facility operation costs), add redundancy to existing systems or build new systems with redundancy. This will allow one part to operate while the second is down for maintenance, isolation, or other treatment.

2. Short versus long conduits or pipes – Short conduits will have less surface area to deal with if it becomes fouled.

3. Water velocity – Less zebra mussel settling will occur in smaller diameter pipes with higher water velocities (> 2 m/sec; > 6 fps) and smooth surfaces that are continuously running as opposed to intermittent high-velocity pipes or larger, slow-moving systems.

4. **Over-design** – Systems should be over-designed to be able to deliver enough water despite some level of mussel colonization that would otherwise inhibit water flow.

5. **Pipe/conduit surfaces** – Smooth or slippery surfaces are preferable to minimize settling opportunities (silicone or other slick surfaces). Copper and galvanized metals also provide less hospitable settling sites. These are not, however preferred in anadromous fish passage conduits. Likewise, straight pipes/conduits would be preferred over numerous bends to also minimize potential settling sites.

6. **Isolate systems** – Provide the capability to isolate systems so they can be sealed and treated (e.g., desiccation, thermal, or chemical).

7. **Access** – Improved access for people and equipment will facilitate maintenance activities for zebra mussel removal and control.

8. **Spare parts** – If critical components could be easily and quickly replaced with spares, then outage times could be minimized. Easy access would also simplify periodic monitoring of critical areas.

9. **Steam injection** – Steam injection could be used for periodic thermal control. Consideration would have to be given to discharge water temperatures to avoid downstream impacts.

Table 1. List of Corps of Engineers points of contact and roles/responsibilities.

Office	Position	Current Member	Phone	Roles/Responsibilities	Alternate Member	Phone
Northwestern Division	Division ANS Coordinator	Rock Peters	(509) 808-3723	Coordinate ANS activities with Division/Districts and with regional/national committees and programs	Lonnie Mettler	(509) 529-7131
Portland District	District ANS Coordinator	Tim Darland	(541) 374-4551	Coordinate ANS activities with District/projects and with Division and regional programs	Blaine Ebberts	(503) 808-4763
Bonneville	Project ANS Coordinator	Tim Darland	(541) 374-4551	Coordinate ANS activities on project and with District Coordinator		
The Dalles/John Day	Project ANS Coordinator	Jeff Randall	(541)-296-1181	Coordinate ANS activities on project and with District Coordinator		
Willamette Valley	Project ANS Coordinator	Greg Taylor	(541) 937-2131	Coordinate ANS activities on project and with District Coordinator		
Environmental Resources		Blaine Ebberts	(503) 808-4763	Coordinate environmental aspects of ANS activities		
Public Affairs		Matt Rabe	(503) 808-4501	Coordination with news media		
Office of Counsel		To be determined		Legal review/guidance		
Walla Walla District	District ANS Coordinator	Lonnie Mettler	(509) 529-7131	Coordinate ANS activities with District/projects and with Division and regional programs		
McNary	Project ANS Coordinator	Brad Eby	(541) 922-2263	Coordinate ANS activities on project and with District Coordinator		
Ice Harbor	Project ANS Coordinator	Mark Plummer	(509) 543-3208	Coordinate ANS activities on project and with District Coordinator		

Office	Position	Current Member	Phone	Roles/Responsibilities	Alternate Member	Phone
Lower Monumental	Project ANS Coordinator	Bill Spurgeon	(509) 282-7211	Coordinate ANS activities on project and with District Coordinator		
Little Goose	Project ANS Coordinator			Coordinate ANS activities on project and with District Coordinator		
Lower Granite	Project ANS Coordinator	Mike Halter	(509) 843-1493	Coordinate ANS activities on project and with District Coordinator		
Dworshak	Project ANS Coordinator			Coordinate ANS activities on project and with District Coordinator		
Environmental Resources		To be determined		Coordinate environmental aspects of ANS activities		
Public Affairs		To be determined		Coordination with news media		
Office of Counsel		To be determined		Legal review/guidance		
Seattle District	District ANS Coordinator	Carol Hewes		Coordinate ANS activities with District/projects and with Division and regional programs		
Chief Joseph	Project ANS Coordinator			Coordinate ANS activities on project and with District Coordinator		
Libby	Project ANS Coordinator			Coordinate ANS activities on project and with District Coordinator		
Environmental Resources		To be determined		Coordinate environmental aspects of ANS activities		
Public Affairs		To be determined		Coordination with news media		
Office of Counsel		To be determined		Legal review/guidance		

Table 2. List of agencies that have an interest in zebra mussel activities and their points of contact.

Agency	POC	Phone	Alternate POC	Phone
Federal				
US Fish and Wildlife Service	Paul Heimowitz	(503) 872-2763	Kevin Aitkin	(360) 753-9508
Bureau of Reclamation	Scott Lund		Joe DiVitorrio	
Bonneville Power Administration	Jim Irish	(503) 230-5914	Mark Jones	
National Marine Fisheries Service				
EPA	Joan Cabreza	(206) 553-7369		
USGS	Tim Counihan	(509) 538-2299	Jill Hardiman	(509) 538-2299
State				
Oregon				
Washington	Scott Smith	(360) 902-2724	Pam Meacham	(360) 902-2741
Idaho	Amy Ferriter	(208) 332-8686		
Montana	Eileen Ryce	(406) 444-2448	Nancy Podolinsky	
Others				
Portland State University	Mark Sytsma	(503) 725-3833	Robyn Draheim	(503) 725-4994
Pacific States Marine Fisheries Commission	Stephen Phillips	(503) 595-3100	Susan Anderson	(503) 595-3100
Columbia River Inter-Tribal Fish Commission	Blaine Parker	(503) 731-1268		
Forest Service	Cynthia Tait	801-625-5358	Linda Ulmer	503-808-2929
Bureau of Land Management	Joe Moreau	503-808-6418	Linda Ulmer	503-808-2929

Table 3. General list of most vulnerable project facilities and some potential preventative actions to reduce the impacts of a zebra mussel infestation. It is not intended that the project immediately begin making changes but, rather, to provide information that could be used to modify facilities during the normal course of project maintenance and replacement activities.

Facility	Level of Risk	Reason for Risk Level	Potential Preventative Actions
Turbine cooling systems	High	Use raw water with no domestic water backup	- Provide redundancy in supply lines - Provide additional water supply capacity - Repair/replace leaking valves
Fire suppression systems	High	Use raw water with no domestic water backup	- Provide redundancy in supply lines - Provide additional water supply capacity - Repair/replace leaking valves - Provide domestic water backup
Fish passage facilities	High	Use raw water with no domestic water backup	- Provide redundancy in supply lines - Provide additional water supply capacity - Repair/replace leaking valves - Provide/improve access to all components/facilities in contact with raw water - Eliminate leakage of raw water into unwatered facilities - Provide backup equipment for removable components (e.g., various screens and gratings)
Drains and sumps	High	Exposure to raw water	- Provide redundancy in drain lines - Repair/replace leaking valves - Provide backup pumps
Monitoring facilities - Forebay/tailwater sensors	High	Exposure to raw water	- Provide redundant sensing capability
- Oil/water separators	High	Exposure to raw water	- Provide redundancy in supply lines - Provide additional water supply capacity - Repair/replace leaking valves
- Dissolved gas monitors	High	Exposure to raw water	- Provide redundant monitoring capability
HVAC[1] systems	High	Use raw water with no domestic water backup	- Provide redundancy in supply lines - Provide additional water supply capacity - Repair/replace leaking valves - Convert to domestic water
Turbine intake trashracks	High	Exposure to raw water	- Provide backup equipment to allow replacement of racks for cleaning
Boats	High	Exposure to raw water	- Provide site for storing boat out of the water when not in use

Facility	Level of Risk	Reason for Risk Level	Potential Preventative Actions
Air compressors	Medium	Use domestic water with raw water backup	- Repair/replace leaking valves in raw water system - Provide redundancy in supply lines - Provide additional water supply capacity - Repair/replace leaking valves
Gland water for cooling/lubricating	Medium	Use domestic water with raw water backup	
Spillway	Medium	Exposure to raw water but should remain operable	- Paint with protective, antifouling coating
Navigation lock - floating mooring bits	Medium	Exposure to raw water but should remain operable	- Paint with protective, antifouling coating
Irrigation systems	Medium	Seasonal use raw water with no domestic water backup	- Repair/replace leaking valves - Provide domestic water backup - Provide capability to drain systems when not in use
Ice and trash sluiceways	Low	Exposure to raw water (at high velocity)	
Bonneville hatchery	Low	Use well water and Tanner Creek	
Visitor centers	Low	No exposure to raw water	

[1] Heating, ventilation and air conditioning

ATTACHMENT 1

Draft Information Paper: Introduction of Zebra Mussels into the Columbia River Basin

1. Background: Since zebra mussels (*Dreissena polymorpha*) were introduced into the United States in the late 1980s from eastern Europe, they have rapidly dispersed throughout the Great Lakes and major river systems including the Hudson, Ohio, Mississippi, lower Missouri, and other rivers to the south and east covering 22 states and two Canadian provinces. This rapid dispersal is due primarily to its tremendous reproductive capability and the fact that larval zebra mussels are able to remain free-floating for several weeks before settling. This ability allows them to be dispersed by downstream water currents, which has been the major vector for their rapid expansion in North America. They are also dispersed by attaching to various types of watercraft moving within or from infested waters. They are particularly troublesome because of their ability to attach to any submerged hard surface, preferring secluded areas with moving water.

If zebra mussels are introduced and become established within the CRB, it is uncertain how densely they will colonize. They can probably be expected to thrive at least as well as the invasive Asian clam (*Corbicula fluminea*) that is already widely distributed in the CRB. Densities ranging up to hundreds of thousands per square meter could be attained under favorable conditions – enough to completely cover surfaces several layers deep. The severity of impacts on hydropower, navigation, and fish passage facilities and extent and frequency of mitigation actions will depend on mussel production levels.

2. Potential Impacts: If zebra mussels colonized the Columbia River Basin (CRB) they could affect all submerged components and conduits in contact with raw water in the Federal Columbia River Power System (FCRPS) such as trash racks, raw water distribution systems, turbine cooling systems, diffuser gratings, service and fire suppression systems, drains, navigation locks, and fish passage facilities. Zebra mussel larvae attach to substrates, including in moving water where they can find irregularities such as cracks and crevices and scaling in older pipes and flanges that provide lower velocity refugia for settlement. The attached mussels then grow and produce additional low flow refuges, allowing colonization to progress in otherwise inhospitable flow environments. Settlement can also occur when water flow is reduced during generation or other facility down-time when conditions may become more conducive to attachment.

3. Risk to Corps Facilities: Critical facility components that could be affected by zebra mussels include turbine cooling systems, fire suppression systems, adult and juvenile fish passage facilities, drains and sumps, and some monitoring equipment. Heavy zebra mussel infestations could force these facilities out of service until remedial actions could be taken. Aside from the serious economic impacts of forcing the turbines out of service, or biological effects of disrupted fish passage, the river flow might have to be diverted through the spillway which could have other negative effects (e.g., high dissolved gases downstream).

4. Response Actions: Initial response is to determine if zebra mussels are present, where they have settled, and how dense the population is. If critical facilities are in imminent danger of failure, then remedial actions will be developed. If components can be removed and replaced or backup systems can be used, the response can be more rapid and effective. If facilities are accessible but not removable, then the mussels must be physically removed until prevention/control measures can be installed. Inaccessible areas will be most difficult and may need to be taken out of service until access is achieved or control measures can be installed. At this time, effective chemical or other control measures are limited due to risks to the environment.

ATTACHMENT 2

Draft Talking Points: Introduction of Zebra Mussels into the Columbia River Basin

1. Where did zebra mussels come from?
Zebra mussels originated in the Balkans, Poland, and the former Soviet Union and were introduced in the mid-1980s into the Great Lakes as a result of ballast water discharge. Since their introduction, zebra mussels have spread to 22 states and two Canadian provinces. They rapidly dispersed throughout the Great Lakes and much of the Mississippi River basin due to their tremendous reproductive capability, the planktonic nature of the larvae allowing water currents to cause downstream drift over great distances, and ability to attach to boats traveling within and from infested waters. The recently-discovered population in ______ is believed to have been from mussels attached to ________ (a recreational boat) that was brought from ______.

2. What is the problem?
If zebra mussels colonized the Columbia River Basin (CRB) they could affect all submerged components and conduits in contact with raw water in the Federal Columbia River Power System (FCRPS) and throughout the rest of the basin. These small mussels could reach densities in excess of 100,000 per square meter and no effective means of eradication exists to eliminate established populations. All other public and private facilities on or in contact with infected waters would also be affected.

3. How will they affect Corps of Engineers facilities?
Critical facility components that could be affected by zebra mussels include turbine cooling systems, fire suppression systems, adult and juvenile fish passage facilities, drains and sumps, and some monitoring equipment. Heavy zebra mussel infestations could force these facilities out of service until remedial actions could be taken. Aside from the serious economic impacts of forcing the turbines out of service, or biological effects of disrupted fish passage, the river flow might have to be diverted through the spillway which could have other negative effects (e.g., high dissolved gases downstream).

4. What can/is being done to deal with them?
A comprehensive, coordinated regional effort, led by ________ Team, has been assembled to address the problem. First priority is to contain and control the existing population to prevent further dispersal into the region. This could include a general quarantine of the infected area with access restricted to authorized parties or _______. At the same time, discussions are underway to determine if any practical means of eliminating the zebra mussels exists. As this is unlikely, long-term management options are also being developed. These efforts are being guided by a Rapid Response Plan that was developed by the Columbia River Basin Coordinating Committee in 2006 to deal with this very problem.

5. What is the Corps doing?
The Corps of Engineers is participating with the regional coordination team to assist in development and implementation of a regional response strategy. We are also evaluating potential impacts to Corps facilities and developing remedial actions to protect the integrity of project facilities and to prevent the interruption of vital services. Our priority is to protect critical facilities, including those listed above, while at the same time not inflicting any environmental damage on non-target species.

ATTACHMENT 3

Draft Press Release Example: Introduction of Zebra Mussels into the Columbia River Basin Raises Concerns [Public Affairs Office review for style/content]

The recent discovery of zebra mussels in _____ has raised serious concerns among regional experts about their potential effects on our aquatic resources and economy. This small freshwater mussel, originally from eastern Europe, was introduced into the Great Lakes area in the late 1980s and rapidly spread throughout the eastern United States and Canada. They are believed to have been brought into our area by _____.

Some estimates of the economic impact of these small mussels to water intake and conveyance facilities in the eastern U.S. are several $1 billion. Much of the existing infrastructure had to be modified or replaced to deal with the prolific mussels that are able to attach to about every hard surface in contact with raw water supplies. Possibly even more significant, are the as of yet unquantified, monetary impacts they are expected to have on recreation and natural resource values.

It is not certain how great the impact will be in ______ (the Northwest) but an interagency coordinating group, led by _______, is extremely concerned. Once the zebra mussels become established, it is almost impossible to get rid of them. The best hope is to launch an early, coordinated program to contain the current infestation and hopefully determine a means of control.

The _________ (group) is fortunate to have a head start using a rapid response strategy that was developed earlier in anticipation of just this kind of problem. Other similar rapid response programs have been most successful when there was early detection of an invasive species and all of the agencies that had to be involved were able to quickly respond with a well-coordinated plan.

In the meantime, the _______ (agency) has _________ (restricted access) to _______ (infected location) to help prevent further dispersal of the zebra mussels. The public can help by avoiding the ____ (infected area) and following some good general guidelines. They should clean all boats, trailers, and other equipment after leaving a lake or stream and never release any live organisms into the wild.

Additional information could be added about other species already in the region and how they are being dealt with – Eurasian watermilfoil, New Zealand mudsnails, Asian clam, and kudzu (which showed up in Oregon and was successfully eradicated).

Quotes:
"We have been aware of problems zebra mussels have caused in the Great Lakes region and have been working with various agencies organizations since the early 1990s to prevent their introduction into the west."
"Although eradication is extremely difficult, our first concern is to contain the zebra mussel infestation within _________ to avoid it being spread to other vulnerable areas."
"Although the recent discovery of zebra mussels is alarming, we are fortunate to have a Rapid Response Plan available to facilitate a coordinated regional effort to deal with this new invader. "The successes we have seen in other areas were the result of the region's ability to rapidly respond with a coordinated intense effort."