Pollution Prevention at Shipyards

A Northwest Industry Roundtable Report

Introduction

The Pacific Northwest Pollution Prevention Resource Center (PPRC) held a roundtable discussion on May 13, 1997 in Seattle, Washington, on pollution prevention issues facing the ship manufacturing and maintenance industry in the Pacific Northwest of the United States. Approximately 40 people representing military and commercial shipyards, ports, government agencies, consultants, vendors, and PPRC attended.

In organizing this roundtable, PPRC was assisted and guided by American Waterways Operators, a national trade association for inland and coastal tugboat and barge industries, and for "second-tier" shipyards, those of small and medium size.

Reasons for the Roundtable

The roundtable was held at this time for the following reasons:

- Ship manufacturing and maintenance is a major industry in the Pacific Northwest, supporting commercial shipping in the Puget Sound region; Portland, Ore.; Vancouver, BC; Anchorage and other Alaskan ports; commercial fishing vessels; and Department of Defense surface ships and submarines.

- The industry relies on processes, including painting and paint removal through abrasive dry grit blasting, that generate considerable releases to air and water, and generate solid and hazardous wastes. Among the pollutants of concern are heavy metals such as copper found in anti-fouling paints.

- The industry is working to comply with stormwater discharge regulations and with Clean Air Act requirements. The industry has been under close scrutiny, and several citizen lawsuits have been filed to compel compliance with regulations.

- Alternative paint removal methods and stormwater treatment technologies are being investigated by some of the region's shipyards, providing an opportunity for information sharing among industry peers on alternatives that reduce or eliminate releases.

The purpose of the roundtable was for participants to learn more about alternative pollution prevention and treatment technologies, become familiar with tools to analyze alternatives, find out how to work productively with government agencies in complying with stormwater regulatory requirements, share experiences and ideas with industry peers, and generate ideas for future projects that will benefit the environment and the industry.

Washington Shipyard Industry

Background

Shipbuilding and ship repair are significant components of Washington's economy. Shipyards are located in many of the state's waterfront areas, from Bellingham to Vancouver, but the greatest activity takes place in Seattle, Tacoma, Bremerton, Everett and Bellingham. The ports of Seattle and Tacoma are the fifth and sixth largest container ports in the U.S. and the 20^{th} and 25^{th} largest in the world, respectively.

The commercial shipbuilding industry in Washington state consists of eight major shipyards and more than 20 smaller yards, and employs nearly 3,000 workers. The commercial industry works in niche markets building and repairing mid-sized vessels of more than 65 feet in length, including ferries, research and patrol boats, small to mid-size container ships, tugboats, fishing boats and luxury yachts.

Military facilities include the Puget Sound Naval Shipyard in Bremerton, which is the second largest industrial employer in the state and is capable of repairing and overhauling naval vessels of all sizes. Another large-scale military facility is the Trident Refit Facility, which repairs and maintains submarines.

Repair and maintenance activities commonly carried out at shipyards include hull cleaning, repair and painting; electrical and machine work; carpentry; steel fabrication; pipe-fitting; and sand blasting of parts. While smaller vessels can be worked on beneath shop roofs, larger vessels must be worked on outdoors in dry docks or hoisted out of the water on marine railways. In both cases, hulls are typically cleaned and stripped with high and low pressure water guns and/or dry, abrasive grit blasting. Painting of ship hulls is done mainly with spray guns.

Environmental Issues

Pollution Issues. Paint stripping and painting activities are significant sources of pollution from shipyards, and their waterfront locations increase the potential for pollutants to reach bodies of water. Many of the coatings used on hulls contain "anti-fouling" heavy metals, such as copper and zinc. The metals are toxins added to marine coatings to prevent marine organisms from building up on ship hulls, which reduces speed and fuel efficiency. When a ship's hull is prepared for painting, the first stage typically is pressure washing to remove any marine growth on the hull and/or to remove old paint. This washwater characteristically contains high levels of heavy metals from the removed paints.

Blasting with dry, abrasive grit typically is the second stage in the hull preparation process, which provides the final finished surface for painting. As a result of the anti-foulants removed during the blasting process, most of the spent grit, like the washwater generated in the first step, contains high concentrations of heavy metals. Contaminants can reach nearby waterways via stormwater drainage and air deposition, or when a marine railway is flooded.

Painting can result in solvents contaminating nearby waterways. Solvent-based paints also are sources of volatile organic compounds (VOCs), an ingredient in the formation of low-level ozone, and are sources of regulated hazardous air pollutants.

Regulatory Issues. Under the Clean Water Act, National Pollutant Discharge Elimination System (NPDES) permits issued to shipyards by the Washington Department of Ecology contain effluent limitations that restrict the volume and concentration of heavy metals and other pollutants that are discharged.

Conditions and requirements imposed by permits vary among shipyards, but in the last decade, NPDES permits have begun to place a stronger emphasis on the control of heavy metal discharges, sediments contamination, and the treatment of pressure washwater and stormwater. Recent permits require studies to develop site-specific programs of Best Management Practices (BMPs) and treatment systems to minimize discharge of heavy metals and other contaminants into waterways via stormwater. These studies are known as All Known, Available and Reasonable Methods of Prevention and Treatment Technology (AKART). After the BMP and treatment programs recommended through the AKART process are in operation for a period of time, site-specific discharge limits will be set.

Shipyard compliance with permit requirements has been a source of controversy. The Department of Ecology has fined a number of shipyards for permit violations. Shipyards also have paid penalties as a result of citizen lawsuits.

Summary of Pollution Prevention Opportunities

Pollution prevention measures can be implemented to minimize release of heavy metals and other contaminants during paint stripping, painting and other shipyard activities. Opportunities are described below:

- ***Best Management Practices.*** BMPs are a series of maintenance, housekeeping and materials management practices that minimize wastes from activities such as paint stripping and surface preparation, painting, dry dock maintenance, engine maintenance and materials handling. *(For a list of shipyard BMPs, refer to* ***Appendix C****.)*

- ***Sandblasting Alternatives.*** Alternatives to dry, abrasive grit blasting for removing marine coatings from ship hulls include high-pressure water blasting and blasting with wetted grit that is chemically treated to bind heavy metals and isolate them from aquatic life.

- ***Coating Alternatives.*** Alternative anti-fouling coatings are available which rely on surface properties rather than toxicity to discourage buildup of marine organisms on hulls. Among the alternatives are slippery coatings based on Teflon and silicone. The Navy is studying a polymer coating with a chemistry that prevents formation of the strong adhesive bonds marine organisms use to attach themselves to hulls. Reducing emissions of volatile organic compounds and hazardous air pollutants can be achieved with coatings with reduced or no solvent content. Among the alternatives are water-borne coatings, high-solids paints and powder coatings.

- ***Training.*** More efficient painting techniques, properly maintained and cleaned spray guns, and high-efficiency application equipment also add to a shipyard's efforts for preventing pollution. These practices allow workers to apply coatings with less paint waste and consequent reductions in hazardous waste generation and air emissions.

- ***Total Cost Assessment.*** A more complete picture of the costs and benefits of pollution prevention strategies can be obtained through total cost assessment (TCA), an economic analysis tool which helps facilities make better informed investment choices.

Roundtable Agenda

- ***AKART.*** Roundtable attendees were briefed on the AKART process. The briefing included a summary of a joint AKART analysis in which 11 Puget Sound shipyards participated cooperatively. The briefing was provided by HartCrowser, an environmental consulting firm headquartered in Seattle, Wash., which conducted the joint AKART analysis.
- ***Total Cost Assessment.*** A briefing was provided on Total Cost Assessment by the Department of Ecology and PPRC.
- ***Alternatives to Abrasive Dry Grit Blasting.*** Shipyards that have used alternative paint removal methods gave presentations and responded to questions.
- ***BMPs, Barriers and Wrap-up.*** The roundtable concluded with a general discussion of BMPs, including opportunities for and barriers to implementing BMPs.

Four vendors had information displays outside the meeting room. Two of the vendors that supply products tested in the AKART analysis referred to above made presentations on their products.

AKART Study

Background

Pollutants of concern released in shipyard operations include total suspended solids and turbidity, total petroleum hydrocarbons, heavy metals, chlorinated compounds found in solvents, and acids and bases.

Of particular concern are pollutants that enter shipyards' stormwater and subsequently are released to waterways. There are two approaches to complying with water quality regulations involving stormwater:

1) Source control and Best Management Practices;
2) Engineered treatment and controls.

The first line of defense for keeping pollutants out of receiving waters is source control and BMPs—minimizing waste, limiting or eliminating the use of toxic materials, and using alternatives to abrasive grit for paint removal. The more pollution is prevented through source control and BMPs, the less need there is for engineered treatment.

In the Department of Ecology's view, source controls and BMPs are not 100 percent effective in preventing release of significant quantities of pollutants via stormwater. To address the stormwater discharge problem, the department has required a number of Puget Sound-area shipyards to prepare site-specific All Known, Available and Reasonable Methods of Prevention and Treatment Technologies (AKART) reports. AKART is an engineering and economic decision-making process for identifying current, effective and economical pollution prevention and treatment technologies for protecting water quality.

In reports produced through the AKART process, shipyards are required to characterize their stormwater runoff, evaluate pollution prevention methods, review technologies for treating polluted stormwater, and make source reduction and treatment recommendations. Reports produced through the AKART process will be used to set site-specific source reduction and treatment plans for each shipyard. Once treatment methods are selected through the AKART process, shipyards will be required to prepare engineering design reports that describe the recommended treatment process, expected results and systematic maintenance. After construction, startup and a period of operation, "technology-based" discharge limits will be set based on experience with the installed treatment system. *(For a summary of regulations affecting the shipyard industry, refer to* ***Appendix B****.)*

The Department of Ecology suggested that Puget Sound-area shipyards cooperate to produce a shipyard AKART analysis. Accordingly, 11 shipyards jointly sponsored an AKART analysis to confirm whether filtration is the best known and available treatment technology for shipyard stormwater, and to evaluate costs, effectiveness and technical feasibility of three types of enhanced filtration media. The Department of Ecology's expectation of the final joint AKART analysis is a document that participating shipyards can use while preparing site-specific AKART reports.

The analysis examined treatment requirements for a "typical" shipyard with five acres of impervious surfaces, experiencing a six-month, 24-hour storm (1.35 inches) in the central Puget Sound area. (A six-month storm is a storm of an intensity statistically likely to occur every six months.)

Media Testing

Two test series were conducted on each of the three enhanced filtration media—a short-term test using two actual shipyard stormwater samples; and a long-term test using simulated stormwater samples over 10 time intervals. Media tested were:

- ❑ A proprietary peat-based medium produced by Aero-Terra-Aqua (ATA) Technologies of Cleveland, Ohio;
- ❑ CSF Humic Filter Media, a leaf-based compost product manufactured by Stormwater Management of Portland, Ore., and,
- ❑ MultiSorb 100, a peat-based compost product manufactured by Peat Technologies Corp. of Cook, Minn.

(For contact information on these companies, refer to ***Appendix A****.)*

The study's preliminary conclusions indicated that enhanced filtration media demonstrated good removal of dissolved heavy metals at relatively low costs. In the long-term test, all three filter media removed close to 100 percent of dissolved zinc early in the test. Removal of total suspended solids, however, was lower than expected.

Four treatment arrangements were evaluated in the joint AKART analysis for cost-effectiveness and feasibility. The first two processes employed the three tested enhanced filtration media, while the last two employed conventional treatment methods. The four treatment arrangements were:

- ❑ Individual catch basin filtration
- ❑ "End of pipe" collection sumps connecting a series of catch basins
- ❑ "End of pipe" sand filtration
- ❑ "End of pipe" sand filtration/chemical pre-treatment

Issues

Three issues arose in followup discussion:

- ❑ Managing stormwater to avoid unnecessary treatment
- ❑ Concentrating treatment on a storm's "first flush" of water
- ❑ Keeping shipyard discharges in perspective with other pollution sources

Managing Storm Water. Storing stormwater was suggested as a technique for reducing the amount of stormwater requiring treatment and ensuring that only stormwater from work areas are treated. Runoff from parking lots and rooftops is not considered industrial waste for purposes of meeting Clean Water Act requirements. Naval shipyards in California have established systems to catch process area runoff and allow heavy contaminants to settle, which is then followed by monitoring to determine whether the water requires treatment or if it can be discharged to Publicly Owned Treatment Works (POTW).

While stormwater storage may be viable for large shipyards, small yards may not have sufficient space on their properties to build storage facilities. Through the AKART process, Washington shipyards may evaluate and recommend runoff storage.

First Flush Treatment. Meeting participants questioned whether the AKART process can produce a time-sensitive characterization of pollutant concentrations. The questions were based on the theory that the "first flush" of runoff generated by a storm will have the highest pollutant concentrations. The Department of Ecology's view is that data do not support the "first flush" theory. In Western Washington, the six-month, 24-hour storm is the design event that is used to size appropriate stormwater treatment works.

Putting Shipyard Discharges into Perspective. Stormwater permits are required by the Clean Water Act. The Department of Ecology is working with shipyards, through the AKART process, to identify solutions that incorporate water quality protections and are economically feasible. Meeting participants raised concerns that the AKART process will result in technology-based requirements that are excessively stringent, considering shipyards' share of pollutant discharges into Puget Sound.

Shipyards face a practical problem, in that implementing a Department of Ecology-approved stormwater plan developed through the AKART process may not necessarily bring them into compliance with water quality standards, leaving shipyards open to citizen lawsuits. One of the reasons for this problem is complexities associated with stormwater regulation. There are two kinds of effluent limits that govern discharges to receiving waters: water quality-based limits and technology-based limits. Water quality-based limits are designed to protect aquatic life and require permittees to comply with numerical limits for specific pollutants such as heavy metals. There are two sets of standards: one for fresh water, the other for salt water, and they include acute and chronic exposure limits.

Technology-based limits are based on the performance of treatment technologies. The stricter of the two types of limits must be applied as permit conditions, but the point of contention is that the technology-based limits cannot exceed economic reasonableness. Conversely, the water quality-based limits do not have an economic reasonableness component.

An alternative approach would be setting a Total Maximum Daily Load (TMDL), a carrying capacity for each pollutant in a body of water, then allocating each permittee a share of that capacity. TMDLs are required by the Clean Water Act for any body of water that does not meet water quality standards.

Total Cost Assessment

Total Cost Assessment (TCA) is an economic analysis tool for comparing all the costs and benefits of two or more environmental investment alternatives. TCA exposes "hidden" costs that conventional economic analysis often overlooks and which can be reduced or avoided through pollution prevention. Among the tangible "hidden" costs are permitting fees, environmental testing, hazard and workers' compensation insurance, workplace injury, future liability and remedial action. Intangible "hidden" costs include employee relations and corporate image. Using the time value of money, TCA extends the horizon of the analysis in order to account for the longer-term savings typical of pollution prevention investments. TCA can be carried out by hand or by using *P2/Finance* software developed by the Tellus Institute.

*(To obtain a free copy of P2/Finance, contact PPRC or Rob Reuter at the Department of Ecology, listed in **Appendix A**.)*

Alternatives to Abrasive Dry Grit Blasting

Abrasive dry grit used in sandblasting operations to remove paint from ship hulls is a significant source of pollutants entering waterways from shipyards' stormwater. Spent sandblast grit is contaminated with hull paint, which contains toxic heavy metals, such as copper and zinc, that are used as anti-fouling agents.

Three Puget Sound shipyards—Todd Pacific Shipyard Corporation, Puget Sound Naval Shipyard and Trident Refit Facility—gave presentations on alternatives to abrasive dry grit blasting they are using to strip paint from hulls. The alternatives are:

- ❑ Ultra-high-pressure water blasting with hand-held units, used by Todd Pacific;
- ❑ High-pressure water blasting with a robotically driven unit, used by Puget Sound Naval Shipyard;
- ❑ Wetted grit blasting with an additive to chemically bind lead to silica particles, used by Trident Refit Facility.

Ultra High-Pressure Water Blasting With Hand-Held Units

How the Operation Works. Operators use hand-held units to blast water at a pressure of 40,000 pounds per square inch. The hand-held units are connected to a central control mechanism. Water used for paint removal is collected for treatment and disposal.

Pollution Prevention Benefits. The use of water rather than dry grit for paint removal avoids dust emissions and the need to dispose of large quantities of spent grit contaminated with paint particles containing heavy metals.

Technical and Cost Issues. Wastewater can be filtered with media such as diatomaceous earth, then disposed of in Publicly Owned Treatment Works. Paint chips can be gathered with a wet vacuum for disposal as hazardous waste.

Ultra high-pressure water blasting projects do not require the complex containment necessary for dry grit blasting. Elimination of dust emissions also permits more flexible scheduling of maintenance projects on dust-sensitive components, such as propeller shafts and hydraulic equipment. Operating costs are comparable to dry grit blasting. While the "production rate" (square feet of painted surface stripped per hour) is lower with ultra high-pressure blasting, containment and cleanup costs are lower. For gummy coatings such as vinyl, the production rate for ultra high-pressure water blasting exceeds that of dry grit blasting.

Coating manufacturers have developed paints that can be applied to surfaces prepared with ultra high-pressure water blasting. Paint can be applied directly over "flash rust"—surface areas which rust when bare metal is exposed to the elements between removal of old coating and application of new coating.

Safety is a concern. Water blasted at 40,000 pounds per square inch can sever operators' limbs.

Another operational issue is the strenuous nature of the work. Frequent rotation of workers is necessary to prevent fatigue.

High-Pressure Water Blasting with Robotically Driven Unit

How the Operation Works. A robotically driven unit applies water under high pressure to the ship hull, and filters and reuses the water in a closed loop.

Pollution Prevention Benefits. The use of water rather than dry grit for paint removal avoids dust emissions and the need to dispose of large quantities of spent grit contaminated with paint particles containing heavy metals. Because water is reused in a closed loop, there is little danger of heavy metals being released via wastewater.

Technical and Cost Issues. The complex containment required for dry grit blasting is avoided with robotically driven, high-pressure water blasting. Scheduling other overhaul jobs, such as propeller shaft maintenance, is more flexible, because there is no danger of blasting grit contaminating dust-sensitive equipment. Blast jobs can be carried out in drydock or over water.

The unit's production rate of 240 square feet per hour exceeds that of dry grit blasting by 60 percent. The cost of the unit, manufactured by Pratt & Whitney, is $1.4 million. The estimated operating costs are half the costs of dry grit blasting, when avoided cleanup costs are taken into account.

Wetted Grit Blasting

How the Operation Works. A garnet grit is mixed with water inside the pressure chamber of an air-driven blasting unit. The wetted grit is then mixed with Blastox, an additive which bonds with lead and copper to form silicates. Hand-held spray guns are used to blast the wetted grit.

Pollution Prevention Benefits. Worker and environmental exposure to lead and copper is prevented, because bonding the metals into silicates formed through the Blastox process makes the metals biologically unavailable. Spent grit falls dry after blasting and is collected for use in cement kilns or sent to a landfill. Wetting the grit avoids dust emissions.

Technical and Cost Issues. Reduction in dust emissions lessens the amount of containment required and there are no hazardous waste disposal costs. The system has saved the Trident Refit Facility $50,000 in hazardous waste disposal costs and 1,200 person-days of labor per vessel. The facility has worked on three ships with the process, and four more jobs are scheduled during the next three years.

The blasting units are available for demonstration at Puget Sound-area shipyards. The units cost $35,000 each.

Best Management Practices

Best Management Practices (BMPs) are maintenance, housekeeping and materials management practices that prevent or reduce pollution. Other benefits of BMPs include reduced costs and reduced workplace exposure to hazardous materials. The concluding discussion explored opportunities for implementing BMPs and barriers to implementation.

BMP Opportunities

Roundtable participants discussed issues associated with a number of the BMPs that can prevent or reduce pollution from shipyards. Discussions for three of the opportunities are described below. *(For a list of shipyard BMPs, refer to **Appendix C**.)*

Materials Management. Instituting controls over the purchase, storage and distribution of work chemicals is a recommended source reduction method for minimizing waste, reducing workplace exposure to hazardous materials, and cutting costs. Trident Refit Facility routinely uses 2,000 chemicals in 66 shop buildings, one drydock and two piers for its submarine maintenance and overhaul projects. Before each shift, each shop receives a job box with measured quantities of chemicals for the shift's work. Unused materials are picked up at the end of the shifts. The controls were implemented to better manage hazardous wastes and reduce workers' compensation costs. Estimated savings: $250,000 per year.

Alternative Coating Materials and Tools. The use of alternative anti-fouling coatings can reduce the release of copper and other toxic heavy metals. The use of alternative coatings with few or no volatile solvents can reduce generation of hazardous wastes and emissions of VOCs and hazardous air pollutants. Using alternative coating materials can help a facility avoid the more complex Clean Air Act compliance requirements for emissions of hazardous air pollutants that exceed certain thresholds. Alternative spray guns can reduce paint waste by increasing “transfer efficiency,” the ratio of paint deposited on a work surface to the total amount of paint sprayed.

Longer-lasting coatings reduce the frequency that ships need to be stripped and repainted, as long as the coatings are applied with high quality control, such as avoiding painting in wet weather. Concerns were raised about the performance of alternative anti-foulants and spray guns with high transfer efficiency. Trident Refit Facility is experimenting with a high-solids coating that does not contain solvents.

Work Area Cleanup. In a test, the Puget Sound Naval Shipyard compared the results of sweeping versus vacuuming drydock work areas. The test area was first swept, then vacuumed. The result was that the vacuuming picked up a significant quantity of copper-laden paint chips that sweeping had failed to remove. A concern was raised about the labor costs of vacuuming.

Barriers to Implementation

Roundtable participants discussed financial, institutional and information barriers to implementing BMPs that prevent or reduce pollution. Discussions for four of the barriers are described below.

Costs. Many shipyard representatives, both commercial and military, said financial pressures preclude investment in pollution prevention technologies and practices. For example, the commercial fishing fleet is suffering revenue losses as a result of declining catches and stricter harvest regulations. As a result, fishing vessel owners are reducing their spending on vessel maintenance, which in return reduces shipyard revenues.

Cooperative projects, such as the joint sponsorship of the AKART analysis discussed above, were suggested as a means of encouraging implementation of pollution prevention. Economic analysis tools that provide a more complete picture of the costs and benefits of alternative prevention and treatment strategies would lead to better-informed decision-making. *(For details on Total Cost Assessment, refer to **Page 4**.)*

Customer Specifications. Shipyards often are required by their customers to use paint stripping methods and coatings that generate pollution. A solution is specifications that are less prescriptive and more performance-based. The U.S. Department of Defense is examining contract policies that will reduce hazardous wastes by employing commercial instead of traditional military specifications.

Policing Work Practices. Among the more vexing issues raised at the roundtable was policing work practices at shipyards where docks are rented and work is performed either by subcontractors or by ship crews themselves. While the owners of such shipyards ultimately are responsible for activities performed at their facilities, they lack the ability to monitor customers continuously. Even more problematic is communicating pollution concerns with foreign ship personnel and/or subcontractor employees who do not understand English.

Regulatory Requirements. Concerns were raised that the prospect of citizen lawsuits could force shipyards into end-of-pipe pollution treatment rather than long-term pollution prevention strategies. One suggested solution would be setting pollution caps that allow facilities operational flexibility in their work practices and processes, as long as their releases stay below the caps. This approach would avoid the regulatory burden of re-opening permits whenever a process change is planned.

Recommendations

As part of all industry roundtables, PPRC identifies projects or activities that could address needs or problems identified during the roundtable discussions. As a result of the shipyards roundtable, possible follow-up activities with the potential to help the industry in future pollution prevention and compliance efforts were identified by PPRC. They include:

❑ Provide cost assessments of shipyard pollution prevention projects and make them available to the industry

Because industry funds are limited, especially on the commercial side, it is important to show decision-makers at shipyards the true costs and benefits of potential pollution prevention projects. This will help encourage investment in projects that might otherwise be overlooked. A good candidate for a Total Cost Assessment (TCA) demonstration would be one of the alternative technologies that replace dry grit blasting. Several roundtable participants expressed an interest in a TCA demonstration. One possible way to make such a project happen would be to have a volunteer shipyard perform the analysis by using free consulting services provided by the University of Washington Environmental MBA program. Students from the program perform consulting projects with local companies each spring as part of their graduation requirements. Application to participate in the program could be done by an individual shipyard, the American Waterways Operators, PPRC, or others.

❑ Facilitate technology transfer between the military and commercial shipyards

It was clear during the roundtable that many of the lessons the military shipyards learned from their testing and evaluation of alternative technologies are very useful to the commercial yards as well. The reason the Navy and commercial yards have not had contact on environmental issues very often is because the commercial yards are regulated by the state, while the military yards are regulated by the federal government. While it is true that some of the projects the Navy implements are not feasible for the commercial yards because of their high capital cost, many others have potential transferability.

❑ Continue good-faith efforts to ensure that water quality standards are met with due consideration for economic impacts

As discussed earlier, shipyards face a practical problem in implementing stormwater prevention and treatment projects that may not necessarily bring them into compliance with water quality standards. Shipyards and the Department of Ecology should continue working together in good faith to:

- ❑ Characterize the extent and nature of stormwater-related water quality problems,
- ❑ Identify prevention and treatment projects that will incorporate water quality protections into stormwater permits with due consideration for economic impacts.