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Project Summary

Pollution Prevention Opportunity Assessments of U.S. Army Corps of Engineers Civil Works Facilities

The Pollution Prevention Opportunity Assessments (PPOA) summarized here were conducted at the following representative U.S. Army Corps of Engineers (USACE) Civil Works facilities: Pittsburgh Engineering Warehouse and Repair Station (PEWARS) and Emsworth Locks and Dams in Pittsburgh, PA; Garrison Dam Hydroelectric Powerplant in Riverdale, ND; and John H. Kerr Dam and Reservoir in Boydton, VA. The PPOAs were conducted under the U.S. Environmental Protection Agency (EPA) Waste Reduction Evaluations At Federal Sites (WREAFS) Program and were funded by the Department of Defense Strategic Environmental Research and Development Program (SERDP).

Although the facilities studied were efficiently designed and employees have established numerous on-site procedures resulting in the reduction of waste generation, opportunities were identified for further action. The PPOA reports identify and discuss the economic and technical feasibility of potential source reduction and recycling opportunities at the facilities studied. The alternatives presented in the reports have application to similar Federal, non-Federal and private sector facilities.

This Project Summary was developed by EPA's National Risk Management Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in three separate reports (see Project Report ordering information at back).

Introduction

This project summary describes three Pollution Prevention Opportunity Assessments conducted at U.S. Army Corps of Engineers Civil Works facilities under the Waste Reduction Evaluations At Federal Sites (WREAFS) Program. The purposes of the WREAFS Program are to identify new technologies and techniques for reducing wastes from industrial processes at Federal sites, and to enhance the implementation of pollution prevention through technology transfer. New techniques and technologies for reducing waste generation are identified through pollution prevention opportunity assessments (PPOA) and may be further evaluated through joint research, development, and demonstration projects.

The assessments were conducted using the procedures outlined in EPA's *Facility Pollution Prevention Guide* (EPA/600/R-92/088). The assessments had two major phases. The first phase quantified waste generation and management practices. The second phase identified and evaluated the feasibility of opportunities and techniques to eliminate, reduce, or recycle wastes.

The facilities studied in the PPOAs were: a navigation lock and dam; a warehouse and a maintenance and repair facility; a hydroelectric power plant; and a flood control dam and reservoir with associated public recreation areas. Other Federal agencies, such as the Bureau of Reclamation and the Tennessee Valley Authority have similar functions and facilities, as do states and the private sector. Thus, the results of the PPOAs described in the three full reports have applicability to a broad audience.

Results and Discussion

Garrison Dam Hydroelectric Power Plant

The Garrison Dam Hydroelectric Power Plant (GDHP) is located on the Missouri River 55 miles northwest of Bismarck, ND. For the most part the GDHP can serve as a model for a well-run, clean industrial facility, but there are two areas in which the GDHP can potentially reduce waste generation: (1) wicket gate lubrication; and (2) antifreeze and bubbler system operations. In addition, there are several less significant areas of potential improvement, such as oil sampling, parts cleaning, and recycling.

Wicket Gate Lubrication

The GDHP has five turbines, each located in a penstock and powering a generator. In the normal operation of a turbine, the wicket gates, which are inside the penstock directly above the turbines, control water flow passing from the penstock to the turbine. The bronze-coated wicket gate bearings, on which the wicket gates pivot, must be continuously lubricated.

The GDHP uses approximately 3,200 lb/yr of a grease called Multifak EP2 to lubricate its wicket gate bearings. Essentially all of this grease escapes into the water flowing past the wicket gates.

Synthetic bearing systems have been installed in powerplant wicket gate bearings, as well as turbine main bearings and other bearings in turbine/wicket gate system. One system studied uses a bronzed bearing with a coating of a material called Thordon, which functions as a lubricant-impregnated spongelike matrix. Thordon systems have been used since the early 1970s, and appear to have an excellent reliability record. Most of the installations have been in Canadian facilities; however, similar systems have also been installed in one of the wicket gate systems at Tim's Ford Hydroelectric Powerplant, a Tennessee Valley Authority (TVA) facility.

A second system, the Lubron system, manufactured by Lubron Bearing Systems, uses a teflon base in a bronze substrate. The Teflon has lubrication in its matrix, and additional lubricant can be deposited in machined recesses in the bearings. Lubron is being used at the Tim's Ford TVA plant in the shift ring for the wicket gate arms. The Lubron system was installed at the same time as the Thordon bearings, and has likewise performed without problems.

A general comparison of the bronze greased lubrication bearing system and the non-grease lubricated systems is included in the report.

Chemical Antifreeze Use

Ice formation on the spillway tainter gates prevents their proper working in case of an emergency discharge, and might damage the gates or cause them to fail. To keep ice formation from reaching the gates, the GDHP spillway was built with an underwater bubbler system. To supplement the bubbler system and clear the bubbler lines of ice, the GDHP employs chemical antifreeze treatment in the bubbler lines. Vaporized Frosto (mostly methanol) is injected into the compressed air bubbler lines running near the tainter gates.

Table 1 contains a summary of the possible alternative methods of reducing pollution from tainter gate deicing.

Table 2 contains a summary of the most significant waste streams generated by

Table 1. *Options to Reduce Methanol Use at the Tainter Gates*

Option to Reduce Methanol Use	*Requirements for Introducing Option*	*Estimated Costs*	*Advantages*	*Disadvantages*
Bubbler system repair	*Dredge lake bottom; stabilize lake banks; overhaul bubbler system*	*$1.5 million*	*The repair would allow bubbler to operate effectively; would reduce erosion of banks ensuring future operation of bubbler*	*Very expensive repair; chemical use might not be markedly decreased*
Operational readiness evaluation	*Internal evaluation by the USACE*	*Facilities would bear no direct costs if a USACE research group performed the evaluation*	*No additional equipment or chemicals required; only procedural changes*	*Evaluation may take time; USACE may feel operational readiness can not be compromised*
Physical ice reduction options (heater system, water mixer)	*Evaluation of the tainter gates preceded by installation of system*	*Equipment cost is about $20,000 per gate; electricity costs are hard to predict, but costs would likely be around $4,000 per gate*	*Once installed, units would generate little pollution and allow less antifreeze to be consumed*	*Data on systems only from 1991 forward, so reliability is not confirmed; increased electricity consumption*
Alternate chemical use	*Assessment of applicability in current system; might require extensive equipment modifications*	*Equipment modification costs are not predictable—they could be minimal or run into many thousands of dollars; chemical costs would be similar to current chemical costs*	*Toxicity of chemicals introduced to the environment would be reduced*	*Total chemical consumption might not markedly change; feasibility of modifying equipment must be assessed*
Pulse rate reduction	*Determine lowest reasonable level of chemical injection; make minor equipment modifications*	*Total costs would likely not exceed $1,000 per unit; some units allow pulse reduction by simply changing their settings*	*Simple, low cost pollution prevention measure*	*If chemicals are reduced too much, ice might form at tainter gates*

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Table 2. Summary of Significant Waste Streams Generated by the GDHP and Recommended Options for the Waste Stream Reduction or Modification

Waste(s) Generated	Source of Waste Generation	Amount of Waste Generation	Recommended Options
Frosto (mostly methanol)	Bubbler system operation	Approximately 1,650 gal/yr	1. Repair bubbler system 2. Add heating elements 3. Use alternate antifreeze 4. Lower antifreeze injection pulse rate to bubbler 5. Reassess need for fully operational spillway year-round
Multifak EP2	Wicket gate lubrication	Approximately 1,500 gal/yr	Install non-grease lubricated bearings in wicket gate system
Lubricant, transformer, and OCB oil	Oil testing	Approximately 30 gal/yr	1. Reduce sampling volumes to lowest levels possible 2. Reduce sampling frequency to lowest reasonable levels
Lubricant, transformer, and OCB oil; filters; oil sludge	Oil transfer and recycling	Less than 20 gal/yr oil; less than 100 lb of filter waste; less than 30 gal/yr sludge	1. Use caution during transfers 2. Reduce recycling frequencies if feasible
Mineral Spirits	Parts washing	Approximately 55 gal/yr	1. Use ultrasonic cleaners instead of solvent bath 2. Locate acceptable alternate solvent with preferable environmental characteristics

the GDHP, and options recommended for those streams.

Pittsburgh Engineer Warehouse and Repair Station (PEWARS) and Emsworth Locks and Dams

The Pittsburgh Engineer Warehouse and Repair Station (PEWARS) is located on Neville Island between the main and back channels of the Ohio River near the town of Emsworth, PA. Operations performed at the two facilities are related, in that PEWARS performs painting, depainting, storage, and routine and major maintenance operations for all flood control and navigation projects in the USACE Pittsburgh District, including Emsworth; however, normal operations are quite different at the two facilities.

The Emsworth Locks and Dams System is located on the Ohio River, 6.2 miles downstream of Pittsburgh, PA. The main portion of the project consisting of two locks and a gated dam, located on the main channel. The second portion, which consists of a single gated dam, is located on the back channel of the river. The dams are created to maintain a channel depth that will accommodate large vessels, such as commercial barges. The locks enable vessels to be raised or lowered to the water levels created by the dams.

Both Emsworth Locks and Dams and PEWARS have areas of operations that could benefit from the following pollution prevention initiatives.

1. **Installation of non-grease lubricated bearings, chains, gears, and other components in the lock and dam system where possible.** A major task involved during routine maintenance activities conducted on the lock-operating machinery is ensuring that a proper amount of lubricant is present on all bearings and other parts requiring lubrication. Synthetic systems have been used in water containing relatively high concentrations of undissolved solids, as might be found in lock and dam systems; however, there is no proven history of the application of synthetic materials in lock and dam systems. Its use in this situation could be studied and demonstrated.
2. **Replacement of the current centralized hydraulic system with localized units incorporating accessible oil flow lines.** Hydraulic pressure is used in the daily operation of the Emsworth Locks and Dams to open and close the lock gates and butterfly valves in the lock system. If a break occurs in one of the hydraulic lines, a significant spill could occur in a short period of time. It would be environmentally preferable to install a system with localized hydraulic oil units, like the system currently used at Emsworth to operate the tow haulage and retriever system.
3. **Substitution of the current depainting method with a lower-waste generating alternative.** PEWARS utilizes a product called Black Beauty (made up of bituminous coal) applied with a Chemco sandblaster for paint removal. Once a gate is depainted, the blast material is tested for lead content. If the lead content is greater than 5 ppm, the waste must be disposed of as hazardous waste. The possible substitutes for the current depainting method at PEWARS are: (1) open abrasive blast cleaning with recyclable abrasives; (2) high pressure water jetting with abrasives; and (3) ultra-high pressure water jetting with abrasives. Table 3 contains a direct comparison of these three methods.
4. **Substitution of the current paint and application method with a lower VOC-emitting system.** PEWARS has already undertaken major steps to reduce pollution generated by painting. The use of an airless spray system with epoxy paint complies with requirements for VOC levels in paints, which must

Table 3. Comparison of Recommended Alternative Paint Removal Methods

Method Number	Method Name	Equipment INvestment	Removal Efficiency	Production Speed	Environmental Advantages	Environmental Disadvantages
2	Open abrasive blast cleaning with recyclable abrasive	Very expensive	Excellent in all areas	Very high	Recycling of abrasive results in lowest volume of waste generation of tested methods	Waste may be hazardous due to potential for increased lead concentrations
6	High pressure water jetting with abrasive injection	Expensive	Good to excellent in all areas	Moderate to high	Much less debris than current method	More debris than method 2; waste may be hazardous due to potential for increased lead concentrations
8	Ultra-high pressure water jetting with abrasive injection	Very expensive	Good to excellent in all areas	High	Much less debris than current method	More debris than method 2; waste may be hazardous due to potential for increased lead concentrations

contain less than 2.8 lb/gal. This system is also easily applied and has shown reasonable durability. However, there are alternative systems being developed which may prove to be reliable and reduce waste generation. These alternatives are shown in Table 4. Any of these three methods would produce significantly less solid waste than the current operations at PEWARS.

5. **Further implementing the centralization of and tracking system for the inventory control process.** This would help prevent purchasing duplicate materials, and therefore reduce shelf-life losses.

Of the five initiatives given above, Numbers 1 and 2 are applicable to any lock and dam site. Numbers 3, 4 and 5 would apply to any facility that performs major maintenance or storage. Number 3 appears to be an excellent candidate for a demonstration project. Initiative 4 could also prove beneficial if powder or 100% solid coatings progress to the point where they are suitable for conditions such as those found at PEWARS and Emsworth Locks and Dams.

Table 5 provides a list of waste streams generated at Emsworth and PEWARS, and options recommended for those waste streams.

John H. Kerr Dam and Reservoir

The John H. Kerr Dam and Reservoir is located on the Roanoke River 55 miles north of Raleigh, NC and 100 miles southwest of Richmond, VA. The project was authorized by the Flood Control Act of 1944, and was constructed for flood control and aquatic recreation needs. Additional purposes of the project include domestic water supply, water supply for hydroelectric power generation, water quality control, wildlife management, and navigation.

The facilities discussed in the full report are: (1) North Bend Park maintenance facility, spray irrigation water treatment system, marina, and campground, all operated by USACE; (2) Longwood Park, operated by USACE; (3) the pump station at Island Creek Dam, operated by USACE; (4) Satterwhite Point State Park maintenance facility and wastewater treatment system, operated under lease by the State of North Carolina Department of Parks and Recreation; and (5) the Clarksville Marina, a privately owned concession under lease.

There has been substantial cooperation between these Federal, state, local, and private organizations. However, several specific areas were identified which could benefit from pollution prevention efforts. These areas are summarized in Table 6.

Conclusion

For the most part, the majority of environmental effects from USACE Civil Works facilities occur during construction. Less pollution is generated as a result of the operation, maintenance, replacement or repair of these facilities; however, several areas can be targeted for pollution reduction. At Garrison Dam Hydroelectric Powerplant, the six areas identified for the greatest potential reduction in waste generations were wicket gate lubrication, tainter gate maintenance, oil sampling and recycling, parts washing, consumer product recycling, and inventory control. The greatest potential for pollution reduction at PEWARS and Emsworth Locks and Dams were lubrication and the hydraulic system used to transport the oils; painting and depainting, and inventory control practices. At John H. Kerr Dam and Reservoir, the areas of greatest pollution prevention potential were expanding the use of recycled plastic timbers instead of creosoted railroad ties, oily rag generation, antifreeze for toilets and piping, parts washing and degreasing, solid waste separation and recycling, and inventory control.

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Table 4. Comparison of Paint Methods

Paint	Life Expectancy	Cost ($/ft²)	Preferred Application Method	VOC Content	Advantages	Disadvantages
Vinyl resins	20-40 yr	$1.00	brush, roll, spray	70-75% by weight	Short cure, easy to apply, excellent durability	Large source of VOC emissions, significant surface preparation
2-part epoxy	15-20 yr	$1.60	spray	<2.8 lb/gal	Easy to apply, good durability	Long cure, temperature sensitive, abrasion sensitive, chalking in sunlight
Coal tar epoxy	15-20 yr	NA*	spray	20-30 % by weight	Excellent durability, less significant surface preparation	Toxicity
Air-cured urethanes	<5 yr	$2.00-$3.00	NA*	<2.8 lb/gal	Low VOC emissions, not sensitive to sunlight	Current life expectancy not high
Moisture-cured urethanes	Currently under testing by USACE	NA*	NA*	<2.8 lb/gal	Short cure, less significant surface preparation	Moisture sensitive during application
100 % solids	Currently under testing by USACE	NA*	spray	none	No VOC emissions	Difficult to apply, not water resistant
Powder coatings	<5 yr	NA*	spray	none	No VOC emissions	Very sensitive to abrasion, poor durability

* NA - not available, paint and application method is currently under development.

Table 5. Summary of Significant Waste Streams Generated by Emsworth and PEWARS and Recommended Options for Waste Stream Reduction or Modification

Wastes Generated	Source of Waste Generation	Environmental Disadvantages	Recommended Options	Advantages	Disadvantages	Recommendations
<u>Emsworth</u> Lubriplate, Never Seez®, transmission and engine oil	Lubrication of lock and dam equipment	Lubricants eventually escape into environment	Installation of non-grease lubricated systems	No grease allowed to escape into environment	Cost can be very high due to loss of operation	Installation should only be considered during necessary overhaul
Hydraulic oil	Main hydraulic system leaks and line breaks	Oil escapes into environment	Installation of localized oil-sending units with accessible lines	Reduced chance of oil leakage to environment	Cost would be high	Installation should only be considered during necessary overhaul
<u>PEWARS</u> Depainting wastes	Paint removal from lock gates with expendable abrasives	High waste volumes generated using current process	Alternative, lower waste volume methods	Drastic reduction in solid waste volume generation	Disposal costs may go up, equipment investment would be costly	Alternative methods would be excellent demonstration projects
Painting waste and VOCs	Painting of lock gates using epoxy paint and spray system	VOCs are increasingly regulated, spray system has fairly large overspray	Powder or 100-percent solids paints and HVLP system	No VOC and low paint waste generation	Paint and application system still under development	Alternative method would be excellent demonstration project
Various chemicals and other materials	Excess purchases	Materials that could be used at other District facilities could expire	Further centralizing purchasing; accessible, updated inventory of materials	Reduced waste	Purchasing system must be updated and personnel must make effort to follow system	Continue centralization and inventory control

Table 6. Summary of Pollution Prevention Recommendations for John H. Kerr Dam and Reservoir Areas

Site for Implementation	Activity Description	Current Practice	Recommended Alternative Practice	Benefits of Alternative
All locations	Railroad tie replacement	Wood, creosote, and recycled plastic tie replacements	Use recycled plastic ties as much as possible	Reduces use of virgin materials
North Bend State Park-Maintenance Facilities	Oily rag generation from car oil changes	Disposal in 55-gal drums	Wringer system to recover oil and allow reuse of rags	Reduces amount of oil and rags consumed
North Bend State Park-Maintenance Facilities, Satterwhite Point State Park	Antifreeze for toilets and piping	Ethylene glycol used as an antifreeze	Use of propylene glycol instead of ethylene glycol	Much lower toxicity
North Bend State Park-Maintenance Facilities, Clarksville Marina	Parts washing and degreasing	Mineral spirits used in parts washer	Alternative solvent, such as various DuPont® solvents	Reduced VOC emissions
North Bend State Park, Satterwhite Point State Park	Solid waste separation	Many recyclable materials are disposed of as solid waste	Encourage recycling, allow civic groups to collect recyclables, provide bins	Reduced solid waste generation
Island Creek Dam and Pump Station	Inventory control	Materials are not always accounted for and can be allowed to expire	Ensure adequate recordkeeping, allow unneeded chemicals to be distributed	Reduced solid and hazardous waste generation
Clarksville Marina and other marinas	Human waste disposal	Boaters must haul wastes up hill and pay fee	Put sewer hookups near boats, recoup fee in a less direct method	Reduce unsanitary waste disposal