POLLUTION PREVENTION OPPORTUNITY ASSESSMENT UNITED STATES ARMY CORPS OF ENGINEERS PITTSBURGH ENGINEER WAREHOUSE AND REPAIR STATION AND EMSWORTH LOCKS AND DAMS PITTSBURGH, PENNSYLVANIA

by

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FOREWORD

The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory is the Agency's center for investigation of technological and management approaches for reducing risks from threats to human health and the environment. The focus of the Laboratory's research program is on methods for the prevention and control of pollution to air, land, water and subsurface resources; protection of water quality in public water systems ; remediation of contaminated sites and ground water; and prevention and control of indoor air pollution. The goal of this research effort is to catalyze development and implementation of innovative, cost-effective environmental technologies; develop scientific and engineering information needed by EPA to support regulatory and policy decisions; and provide technical support and information transfer to ensure effective implementation of environmental regulations and strategies.

This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

E. Timothy Oppelt, Director
National Risk Management Research Laboratory

ABSTRACT

This report summarizes work conducted at the United States Army Corps of Engineers (USACE) Pittsburgh Engineering Warehouse and Repair Station (PEWARS) and Emsworth Locks and Dams in Pittsburgh, Pennsylvania under the U.S. Environmental Protection Agency's (EPA's) Waste Reduction Evaluations at Federal Sites (WREAFS) Program. This project was funded by EPA and the Strategic Environmental Research and Development Program (SERDP) and conducted in cooperation with USACE officials.

The purposes of the WREAFS Program are to identify new technologies and techniques for reducing wastes from process operations and other activities at Federal sites, and to enhance the implementation of pollution prevention/waste minimization through technology transfer. New techniques and technologies for reducing waste generation are identified through waste minimization opportunity assessments and may be further evaluated through joint research, development, and demonstration projects.

A pollution prevention opportunity assessment (PPOA) was performed during June 1994 which identified areas for waste reduction at PEWARS and the Emsworth Locks and Dams maintenance activities. The study followed procedures outlined in EPA's Facility Pollution Prevention Guide. Although the repair station was efficiently designed and employees have established numerous onsite procedures resulting in the reduction of waste generation, opportunities were identified for further action. This report identifies potential procedural initiatives as well as technology options to achieve further pollution prevention progress.

All waste generating processes were initially screened during a site visit. Opportunities to reduce wastes in each area were identified and evaluated.

This report was submitted in fulfillment of Contract Number 68-D2-0181 by TRC Environmental Corporation, under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period from 1 March to 30 September 1994; work was completed as of 30 September 1994.

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SECTION 1
INTRODUCTION

1.1 PURPOSE

The purpose of this project was to conduct a Pollution Prevention Opportunity Assessment (PPOA) of the United States Army Corps of Engineers (USACE) Pittsburgh Engineering Warehouse and Repair Station (PEWARS) and operations at the Emsworth Locks and Dams in Pittsburgh, Pennsylvania. The assessment was conducted under the Waste Reduction Evaluations at Federal Sites (WREAFS) Program, which is administered by the Pollution Prevention Research Branch of the National Risk Management Research Laboratory (NRMRL) of EPA. The study was conducted in accordance with the EPA manual, Facility Pollution Prevention Guide (EPA/600/R-92/088), which describes procedures for collecting and analyzing information using detailed worksheets to characterize waste streams and pollution prevention alternatives.

Pollution prevention in environmental management requires the development of a comprehensive program which continually seeks opportunities to implement cost-effective strategies to reduce waste generation. PPOAs provide detailed assessments of waste streams, options for preventing pollution, and analyses of alternative operating practices which generate less waste. Figure 1 identifies the key elements of a pollution prevention program showing the interrelationship of the PPOA to the program. The elements of the pollution prevention program are discussed in detail in the Facility Pollution Prevention Guide.

The approach for conducting the PPOA at PEWARS and Emsworth Locks and Dams is described in this section. Section 2 describes both of the facilities. Section 3 describes activities identified that generate waste at the two facilities. Possible alternative practices to minimize these wastes are discussed in Section 4. Recommendations for potential follow-up activities are also included in Section 4. The PPOA worksheets used during the site visit are included in Appendix A.

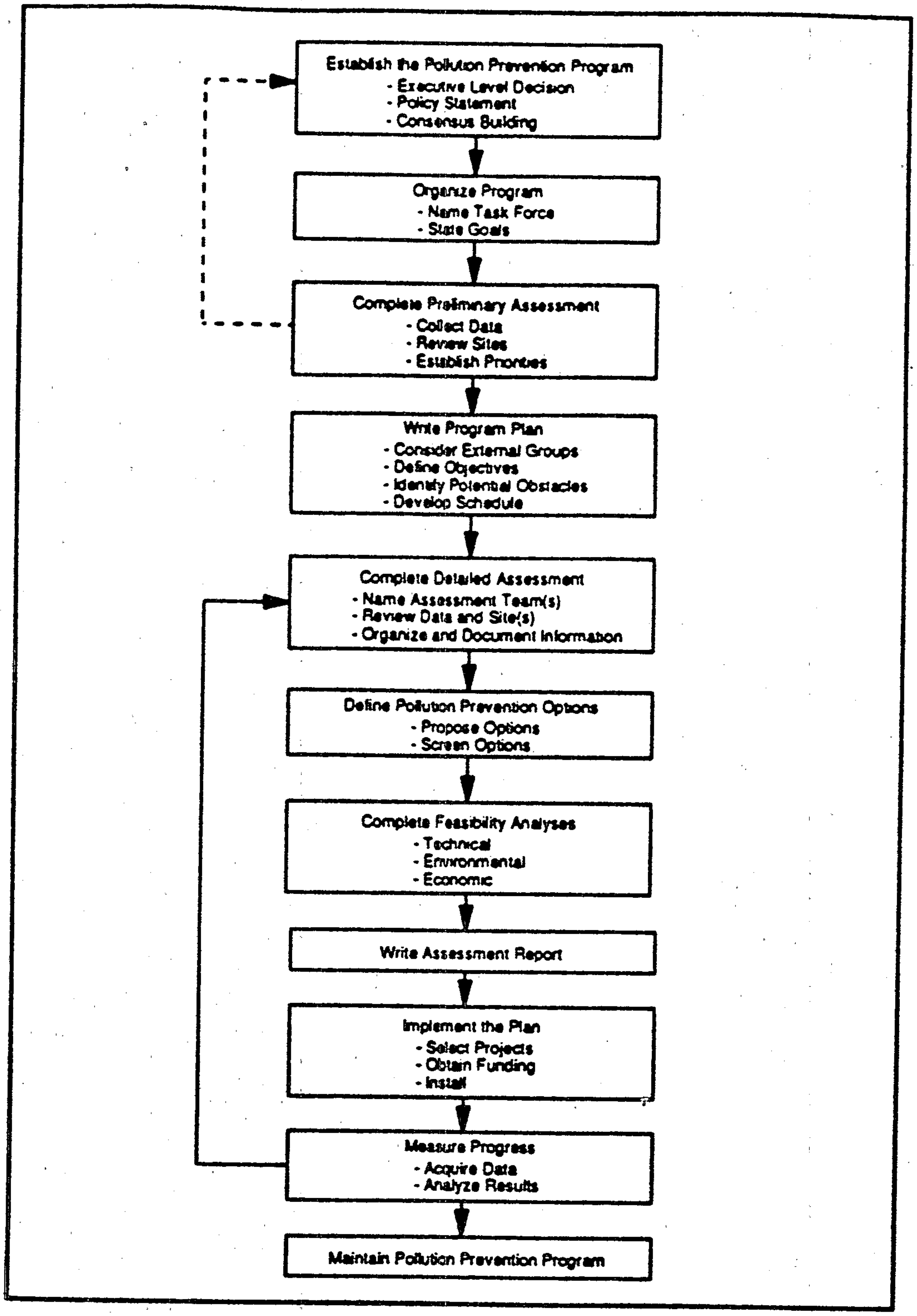

Figure 1. Pollution prevention program overview.

1.2 APPROACH

1.2.1 Report Structure

This report summarizes the PPOA efforts conducted at the Emsworth Locks and Dams System and PEWARS. A general description of the facilities is presented in Section 2, and the facility maintenance operations are described in Section 3. As apparent in these two sections, 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. Normal operations are quite different at the two facilities. Emsworth personnel have the chief responsibility for controlling lock and dam operations at their facility. PEWARS maintains a large warehouse, which is used to store materials and repair equipment for all of the USACE Pittsburgh District sites. PEWARS also maintains a floating barge which is used to perform maintenance activities and travels to various Pittsburgh District sites.

The facilities generally operate separately; therefore, their operations are discussed in separate subsections of this report. Activities discussed in detail about one facility that are relevant to the other are referenced in the applicable section, in order to avoid redundancy.

1.2.2 Objectives of this PPOA

To allow for navigation of major rivers in the United States, it is necessary to maintain lock and dam operations. The most significant environmental disturbances from locks and dams occur during initial construction of these projects, which can permanently alter the local ecosystems. Generally, the environmental impact during normal, continuing operations of the projects is much less significant. Minimal air and water pollution are generated by lock and dam systems, and generally few natural resources are consumed during normal operations. However, during the assessment of PEWARS and Emsworth, areas were identified for both of the facilities that appear to be candidates for waste reductions. The following areas were identified as having the greatest potential reduction in waste generation:

- Bearings, chains, gears and other components in the lock and dam system needing lubrication
- The current hydraulic system which transfers lubricating oils
- Depainting methods

- Painting types and application methods
- Inventory control practices

These significant areas are described in detail in Section 3 of this report. Potential waste-saving measures are discussed in Section 4.

During the site visit conducted in connection with this PPOA, all areas of waste generation and potential reduction were discussed to promote understanding of all facets of the operations and barriers to potential waste-reduction initiatives. Research conducted subsequent to the site visit explored pollution prevention issues that affect these facilities and similar systems throughout the United States. This PPOA report attempts to provide specific pollution prevention initiatives applicable to PEWARS and Emsworth, while maintaining a broader perspective on the potential for similar measures at other facilities.

SECTION 2
SITE DESCRIPTIONS

2.1 EMSWORTH LOCKS AND DAMS

2.1.1 General Activity Description

The Ohio River is separated into two channels by Neville Island, east of the town of Emsworth, Pennsylvania. The Emsworth Locks and Dams System is located on both of these channels. The lock and dam system consists of two separate water control systems on the two channels. The main portion of the project consisting of two locks and a gated dam, is located on the main channel near the town of Emsworth, 6.2 miles downstream from Pittsburgh, where the confluence of the Allegheny and Monongahela Rivers form the Ohio River. The second portion, which consists of a single gated dam, is located on the back channel of the river across Neville Island, 6.8 miles downstream of Pittsburgh. The location plan for Emsworth is illustrated in Figure 2.

Emsworth Locks and Damss (main channel dam and backwater channel dam) were originally constructed on the main channel between 1919 and 1922. Operations commenced on September 1, 1921. The dams were reconstructed between 1935 and 1938 to install movable gates and to increase the water level upstream by seven feet. Major rehabilitation of the Emsworth lock and dams was performed by USACE between February 1980 and August 1984.

The Emsworth locks enable boats (commercial and recreational) travelling on the river to be raised or lowered to the water levels created by the Emsworth dam. The typical differential in water level on the two sides of the dam is approximately 18 feet. The locks operate by permitting boats to enter on one side of the dam through open lock gates ("miter gates," so called because they come together at an angle). The hydraulically operated miter gates then close, sealing the boat into the lock. The water level in the lock chamber is then either raised (for a boat traveling upstream) or lowered (for downstream travel) by means of water-carrying culverts located on either side of the lock chamber. Hydraulically operated butterfly valves located in the culverts are opened or closed to allow water flow. The miter gates on the opposite side of the llock chamber are then opened,

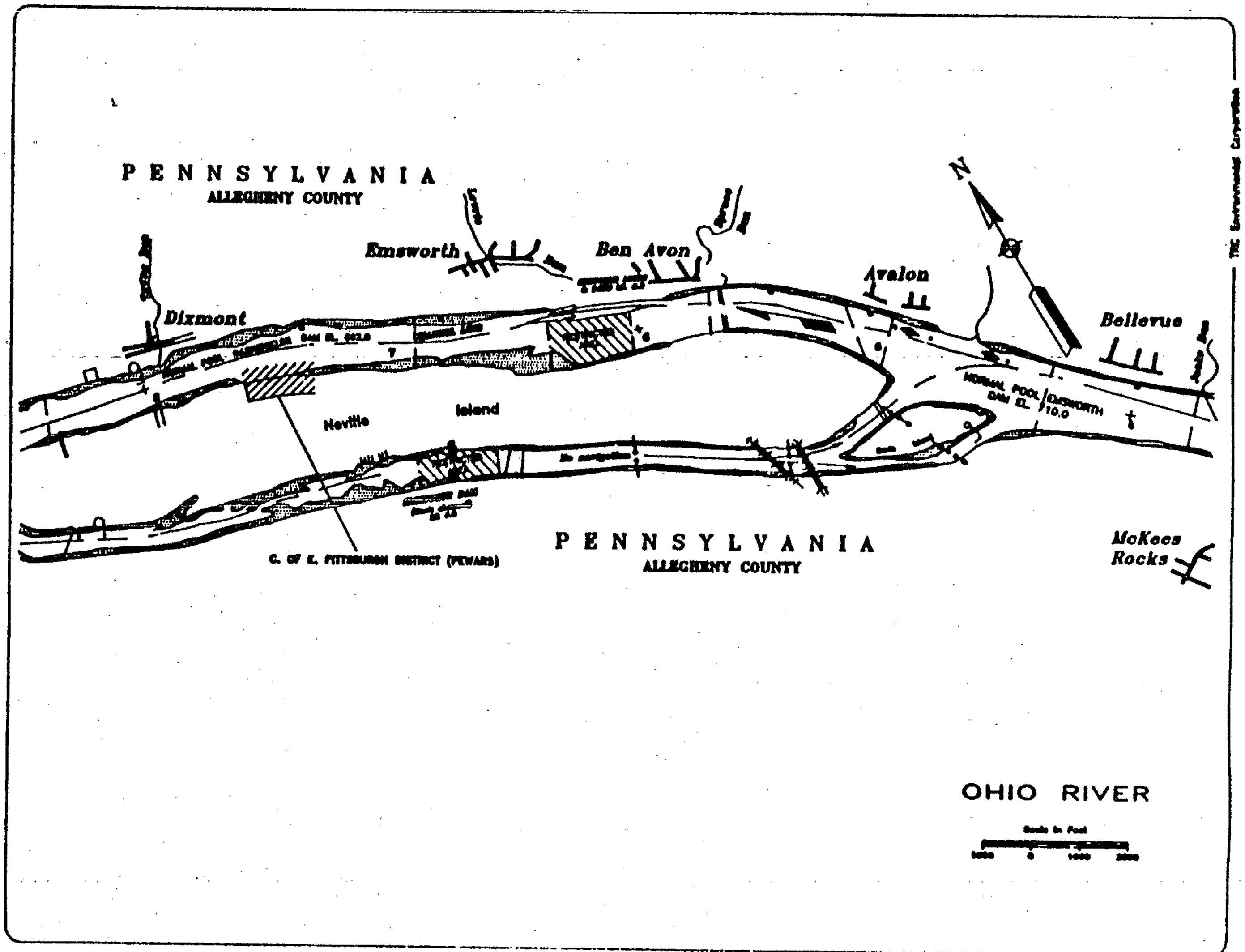

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Figure 2. Location Plan, Emsworth Locks, Dams and PEWARS.

allowing the boat to pass. The system consists of two locks which are different sizes, the landward lock being 600 feet long by 110 feet wide, and the riverward lock measuring 360 feet by 54 feet.

River water impounded behind the dam is called the "pool." Pool levels can be controlled by movable tainter gates built into the dam. The gates are normally in the lowered position, but can be raised to allow increased water flow downstream (thus decreasing the pool level upstream). Pool elevation on the upstream side of the dams is normally 710.0 feet above mean sea level (MSL), while the pool elevation on the downstream side is normally 692.0 feet above MSL.

Most lock and dam operations for the main channel are controlled from the operations building, located on the middle wall of the locks. The upstream lock gates for the smaller lock are operated from the control station at the upstream gate bay. Dam operations for the back channel are located in the back channel control building. Three hydraulic oil pumps which provide oil to the lock gate butterfly valves are located on the second floor of the operations building. Routine maintenance activities are conducted at scheduled intervals. In addition, major maintenance activities, consisting of lock gate repair or replacement, hydraulic system repair, repair or replacement of lock chamber equipment, and dredging of chambers and approaches, are scheduled periodically throughout the life of the system.

2.2 PITTSBURGH ENGINEERING 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. The tract of land currently occupied by PEWARS was originally part of a much larger facility built by the Dravo Corporation in conjunction with the United States Navy, which constructed landing craft, destroyers, and other vessels for use in World War II combat. At that time, the buildings housed fabrication shops, warehouses, laboratories, carpentry shops, steam generation facilities, offices, and locker rooms. The yard areas of the facility were used for steel fabrication and storage activities.

In 1947, ownership of the property reverted back to the United States government and was then transferred to the USACE. The USACE transferred the Pittsburgh District's Repair Station from Charleroi, Pennsylvania to Neville Island. The property then became known as PEWARS. PEWARS now operates to fulfill the following five objectives:

- Act as a central receiving agent for the Pittsburgh District's 27 navigation and flood control projects

- Store spare parts critical to the operation and maintenance of the District's navigation and flood control projects

- Repair and fabricate critical parts for the District's navigation and flood control projects

- Respond to and support any emergency situations that adversely affect the District's navigation and flood control responsibilities

- Perform all major maintenance on the District's navigation and flood control projects

The main building of PEWARS is the 90,000 square foot maintenance warehouse, which houses machine, welding, electrical, and carpentry shops. Generally, 30 to 40 people are employed at the Repair Station. In addition to maintenance operations, the warehouse contains a supply storage area for the Pittsburgh District. Consumable materials such as paint, antifreeze, degreaser compounds, lubricating oils, paper products, and other miscellaneous items are purchased by PEWARS and are stored at and distributed from the warehouse. In addition, the warehouse serves as a storage facility for surplus property generated throughout the Pittsburgh District prior to relocation or disposal.

PEWARS operates a floating maintenance barge which travels on the Ohio River system and performs repairs at various Pittsburgh District projects. The barge also performs maintenance operations at the PEWARS facility. The barge measures 52 feet wide by 150 feet long. Typically, 40 to 50 people are employed both on the floating barge and in the field operations sections of PEWARS. The barge is capable of supplying electrical power, compressed air and fuel, and can provide the following services:

- Steel fabrication, machining, carpentry, and masonry operations
- Heavy mobile equipment, tool, and other equipment repair
- Sewage treatment
- Storage for both hazardous and nonhazardous waste
- Sandblasting and painting activities
- Diving operations

- Sanitation support

The warehouse and floating maintenance barge together enable PEWARS to conduct several repair operations simultaneously. Routine daily maintenance operations conducted at both the warehouse and barge include lubricating and greasing gears, chains, and bearings in the lock mechanisms; repairing parts and equipment; and checking hydraulic systems for any leaks or breaks. These maintenance operations are required at the Emsworth Locks and Dams, and much of this work is performed by PEWARS using the warehouse and floating maintenance barge.

In addition to routine maintenance, major maintenance and repairs are conducted by the PEWARS floating barge, field sections, and outside contractors at each of the sites within the Pittsburgh District. Major maintenance and repair activities, which often require complete dewatering of lock chambers, include installation of new lock miter gates, repair of hydraulic crossovers, repair or replacement of lock chamber parts and equipment, and dredging of chambers and approaches.

SECTION 3
SITE ACTIVITIES DESCRIPTION

3.1 EMSWORTH LOCKS AND DAMS

3.1.1 Equipment Inspection, Lubrication, and Routine Maintenance

3.1.1.1 Description--

Equipment inspection, lubrication, and routine maintenance is performed on all Emsworth equipment at the regularly scheduled intervals suggested by equipment manufacturers and specified in USACE guidelines. Routine maintenance may include adjusting, lubricating, or cleaning equipment as required. Some of this maintenance is performed by Emsworth personnel and other maintenance is performed by PEWARS personnel. However, this maintenance will only be discussed in the Emsworth sections in order to avoid redundancy in this report. Information pertaining to maintenance is stored on Preventative Maintenance Cards, USACE Form 1852, which are kept on file at Emsworth. Information recorded on the maintenance cards includes the following:

- Inspection frequency
- Type of equipment
- Location of equipment
- List of required inspections
- Date of inspection
- Name of inspector
- Item number inspected
- Descriptions of any repair performed (recorded as "Remarks")

Table 1 provides a summary of the maintenance schedules for lock-operating equipment, as well as the preferred brand of lubricant used. The 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. All parts requiring lubrication are, at a minimum, lubricated every six months and cleaned every two years. Cleaning involves washing with

TABLE 1. LUBRICATION CHART FOR LOCK-OPERATING EQUIPMENT

Item of Equipment	Frequency of Lubrication	Lubricant
Lock Gates		
Pintle bushings	weekly	Fiske-Lubriplate No. 630AA®
Gudgeon pins	weekly	Fiske-Lubriplate No. 630AA®
Strut pins	weekly	Fiske-Lubriplate No. 630AA®
Gate Anchorages	6 months	Fiske-Lubriplate No. 630AA®
Roller bushing pins of the mitering devices	weekly	Fiske-Lubriplate No. 630AA®
Turnbuckles	6 months	Fiske-Lubriplate No. 630AA®
Latching device turnbuckles	weekly	S.A.E. 20 or 30 Motor Oil
Lock Gate Operating Machinery		
Sector pin	weekly	Fiske-Lubriplate No. 630AA®
Strut pin at sector arm	weekly	Fiske-Lubriplate No. 630AA®
Horizontal roller pins	weekly	Fiske-Lubriplate No. 630AA®
Vertical roller pins	monthly	Fiske-Lubriplate No. 630AA®
Gate end casting	monthly	Fiske-Lubriplate No. 630AA®
Rack teeth	monthly	Never Seez®
Sector teeth	monthly	Never Seez®
Guide shoe and back of rack	monthly	Fiske-Lubriplate No. 630AA®

kerosene, which functions as a solvent to remove spent lubricant, flushing with a light oil to remove any remaining lubricant or other impurities, and applying a fresh supply of lubricant.

Dam gate inspections are performed every six months. Table 2 provides a summary of the frequency of lubrication and lubricant of choice for the dam-operating equipment. During this inspection, idler sprockets and guide bearings on each gate are lubricated. All gear and pinion teeth are surveyed for misalignment, and are then lubricated after the correct alignment is ensured. Gate chains are lubricated and protected with a high grade chain dressing. The bulkhead hoisting cranes require periodic maintenance, which includes lubricating all gear boxes with high-grade light oil. In addition, all bearings and gears, including the gears on the driving wheels of the crane, must be properly lubricated. The proper amount of hydraulic oil must be maintained in the crane hoist mechanism.

As mentioned, the major component of routine maintenance performed at the Emsworth lock and dam is the addition of lubrication to the lock and dam bearings, gears, chains, and other equipment. This equipment usually deteriorates due to two factors. First, the equipment components are exposed to high pressure during operation, causing them to vibrate. If uncontrolled, the vibration will heat or begin to cause fractures in the components, eventually causing the components to fail. This type of failure could be immediate if the equipment is under great stress, or could take many months or years to occur.

The second type of component failure is due to contamination entering the joint. As air or water passes by the joint, movement of the joint will inevitably allow some particles to enter. This particulate material can scour the surfaces within component joints, eventually causing failure. Failure due to scouring generally occurs over a relatively long period of time, usually many months or years, and is most common in joints operating in water containing high levels of particulates. When this type of failure occurs, the equipment typically must be replaced.

TABLE 2. LUBRICATION CHART FOR MAIN CHANNEL AND BACK CHANNEL DAM-OPERATING EQUIPMENT

Item of Equipment	Frequency of Lubrication	Lubricant
Gate Hoist Mechanism		
Motors	6 months	Fiske-Lubriplate No. 630AA®
Ball Bearings	6 months	Fiske-Lubriplate No. 630AA®
Pressure Grease Fittings	6 months	Fiske-Lubriplate No. 630AA®
Enclosed worm gear reducers	check monthly	S.A.E. 90 Transmission Oil
Open spur gears and pinions	6 months	Never Seez®
Main lift chains and sprockets, chaindressing sprocket bearings, pressure grease fittings	6 months	Fiske-Lubriplate No. 630AA®
Gate guide wheels bearings - plain, pressure grease fittings	not specified	not specified
Exposed portions of shafting	not specified	Fiske-Lubriplate No. 630AA®
Bulkhead Hoisting Crane Hoist Motion		
Motors - ball bearings, pressure grease fittings	6 months	Fiske-Lubriplate No. 630AA®
Spur gear reducers - enclosed both lubricated	check monthly	S.A.E. 90 Transmission Oil
Open spur gear and pinion, gear dressing plain bearings	6 months	Never Seez®
Pressure grease fittings	6 months	Fiske-Lubriplate No. 630AA®
Drum bearings, pressure grease fittings	6 months	Fiske-Lubriplate No. 630AA®
Wire rope dressing	6 months	Never Seez®
Travel Motion		
Motor - ball bearing, pressure grease fittings	6 months	Fiske-Lubriplate No. 630AA®
Enclosed worm gear reducer	check monthly	S.A.E. 90 Transmission Oil
Open gear and pinion gear dressing	6 months	Never Seez®
Plain bearings, pressure grease fittings	6 months	Fiske-Lubriplate No. 630AA®
Wheel bearings, plain bearings, pressure grease fittings	6 months	Fiske-Lubriplate No. 630AA®

Operation of the hydraulic pumps is conducted from the control stations on the middle wall of the lock. The hydraulic system which controls the gates is supplied by two of the three pumps at any given time. The pumps are arranged and interconnected for pump rotation so that combinations of two of the three pumps may be used to control the gates. The selected pump combinations are regulated from the control center and are changed weekly so that all pumps receive equal use.

Each hydraulic pump is equipped with a filter capable of passing 60 gpm of hydraulic oil through 149-micrometer filter elements with a pressure drop of three psi. An additional filter is located in the return line which allows for six-micron filtration. The filters are periodically changed out and disposed of during preventative maintenance operations at the facility.

The hydraulic piping system consists of primary and secondary lines. Primary lines consist of dedicated pressure or return lines in which the oil always flows in one direction. The primary lines connect the three oil pumps to four-way control valves, which are controlled from the operations building. The secondary lines connect the four-way control valves to cylinders which actuate the hydraulically controlled units. Secondary lines serve as both pressure and return lines, depending on the direction of gate movement. All of the hydraulic lines are welded into continuous lengths, with the exception of locations that require assembly and disassembly of valves and equipment. Many of the hydraulic lines are located beneath the facility floor, and are inaccessible for prompt service or repair.

A hydraulic oil storage tank for the gate system is located on the second floor of the middle wall control center. The tank provides storage for any oil not immediately needed to fill the hydraulic lines and cylinders. When oil is lost from the system, it will automatically be replenished by the storage tank. The tank has a maximum storage capacity of 400 gallons. A cleanout opening is located at each end of the tank, and a drain cock is located at tank bottom. The tank is equipped with a site level gauge which is used to maintain the established volume of oil in the system. If the volume of hydraulic oil decreases below the acceptable level, an oil-level monitoring system will sound an alarm and shut down the pumps.

An additional hydraulic system is used to operate the tow haulage and retriever system. This system serves to move boats which are operating without power through the lock chamber. The hydraulic system consists of a hydraulic motor, hydrostatic power drive unit with oil reservoir, variable displacement pump, and an electric motor. Unlike the hydraulic system used to operate the gates, this system utilizes a localized hydraulic oil reservoir and does not have long lines connecting the oil storage tank to the equipment. This system operates independently of the gate hydraulic system.

3.1.2.2 Pollution Prevention Issues--

Waste hydraulic oils are generated from the hydraulic systems through breaks in hydraulic lines and leaks in seals and fittings. If a break occurs in one of the hydraulic lines, a significant spill could occur in a short period of time. Since the system is interconnected with feed and return lines, a break in a line will continue to drain the oil in the system until hydraulic pressure decreases or the leak is sealed. According to onsite personnel, a major break in the main system is likely to result in the loss of 200 to 500 gallons of hydraulic oil. PEWARS personnel estimate that a break of this magnitude occurs every 5-10 years at one of the Pittsburgh district facilities. Many of the hydraulic lines at Emsworth are located in culverts or encased in concrete, making access for repairs extremely difficult and time-consuming.

Routine maintenance of the central hydraulic system includes periodic additions of fresh oil to the tank. Generally, the hydraulic fluid is not routinely changed; instead, oil is added as necessary to maintain the proper fluid level in the tank. According to site personnel, approximately 50 gallons of hydraulic oil are added to the system each year. Much of the loss is attributable to leaks around loose fittings. Although there is no planned schedule for changing the hydraulic oil in the system, site personnel indicated that the oil is drained and replaced approximately every 10 to 20 years.

The main hydraulic oil system has functioned properly since its installation over 30 years ago, and there are no plans for replacing it. However, if it is replaced in the future, 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. This option is further discussed in Section 4.2.2.

3.1.3 <u>Painting and Depainting</u>

All gate depainting and painting is conducted by work crews located at PEWARS. These operations are discussed in Sections 3.2.1 and 3.2.2.

3.2 PEWARS

3.2.1 Depainting

3.2.1.1 Description--

Routine maintenance on lock gates within the Pittsburgh District includes renewing existing coating systems (such as removing rust and paint from the gates and repainting), performing structural repairs, renewing cathodic protection systems, and repairing various gate operating components. The lock gates in the District come in a variety of sizes and designs. The Pittsburgh district has 25 lock chambers with widths of 56 feet, 84 feet, and 110 feet. These lock chambers incorporate ten different gate heights, depending on the head differential. Gate heights range from 21 feet 7 inches to 43 feet, 1 inch. The District possesses at least one spate set of each size of the 56 foot lock changer gates which are stored at PEWARS. The primary gate rehabilitation work that is performed at the PEWARS is on these 56-foot changer lock gates. Nearly all other gate rehabilitation work on the 84-foot and 110 foot lock gates is performed in the field by the PEWARS repair party. Many of the gates int eh district were originally coated with a lead based primer and/or a lead-based or vinyl top coat. Approximately four years ago, PEWARS converted its coating standard to a two-part epoxy system. Vinyl paints are still used but only rarely in touch-up applications. Lead-based coatings are no longer applied at amy of the facilities in the District.

Gate rehabilitation, which includes depainting and repainting, is performed on different schedules depending on the size of the lock gate, the location, and the water conditions. In general, 56-foot lock gates are rehabilitated on a 10-year cycle. The larger gate rehabilitation cycle is longer due to a number of factors including original coating system integrity, delays to navigation (since locks are closed during rehabilitation work), difficulty of work due to the larger gate sizes, and the unavailability of spare gates.

3.2.1.2 Pollution Prevention Issues--

Because of the non-routine painting schedule for the large gates, there are a number of gates with lead-based paint currently in operation. Lead-based paint waste can constitute a hazardous waste, depending on the lead concentration, and must be managed and disposed of accordingly. PEWARS personnel estimate that it will take 15 or more years before all lead-based paint on Pittsburgh District equipment is removed and disposed of.

The blasting material currently used by PEWARS is a coal by-product, trade name Black Beauty®. Due to its hardness and angularity, this slag abrasive has been the most effective paint removing abrasive used at PEWARS. PEWARS has estimated that approximately ten pounds of Black Beauty® are used to remove one square foot of paint from a gate. However, this amount can vary depending on the gate condition, sandblasting equipment and media condition, or operator experience.

PEWARS utilizes a vacuum conveyor system to collect and contain spent blast media. The spent sandblasting material and paint are collected by a vacuum feed system and sent to a cyclone. The cyclone extracts the spent material from the air. Cyclone waste is then collected in a dumpster, and the waste is tested for lead content.. If the lead concentration is greater than 5 parts per million (ppm), it is considered a hazardous waste and disposed of accordingly. The cost of disposing of this material as a hazardous waste is $200 per ton. If the lead content is below 5 parts per million, it is considered non-hazardous and disposed of in an appropriately licensed landfill at a cost of $60 per ton. Generally, on coating systems containing a moderate porportion of lead, through th enormal abrasive blasting process, a large volume of spent abrasive is mixed with the hazardoous paint partiles such that the resulting residual waste mixture contains less than 5 ppm lead and can be disposed of as a less than hazardous material.

A number of alternatives were identified for depainting operations which could reduce solid waste volumes generated in the depainting process. These options are discussed in Section 4.3.1.

3.2.2 Painting

3.2.2.1 General--

As described above, the routine maintenance performed at PEWARS includes periodically stripping paint from lock gates and repainting them. The paint system used to repaint the gates consists of a primer base and a paint coating recommended by USACE. Both the primer and paint are similar two-part epoxies, although the primer is enriched with zinc to reduce biological fouling. The primer and paint are thinned with T-10 Thinner®, which consists of a combination of solvents (*i.e.*, 40 percent xylene, 40 percent n-butyl alcohol, and 20 percent methyl n-amyl ketone). This solvent combination is added at a ratio of one unit volume of solvent for every ten unit volumes of primer or paint. Standard operating procedure is that no more primer or paint is mixed than can be used in one workday. An advantage of the epoxy system over previous types of paint used at PEWARS is that once mixed, the unused portion can be allowed to harden, and then can be disposed of as a non-hazardous waste. However, this hardening allows the remaining solvents in the paint to escape to the atmosphere.

The two-part epoxy paint is applied by an airless spray gun. First, the primer coat is applied, followed by an application of the epoxy paint. Then a second primer coat is applied, followed by a second epoxy paint coat. On average, a 56-foot lock gate will require a total of 40 gallons of paint to complete the coating system to a thickness of 14 to 16 mils. The gates are generally painted at PEWARS, within a recently constructed metal building which serves as a depainting and painting booth. Occasionally, gates may be painted while in place at a lock and dam. The facility estimates that 2 to 4 gates are depainted and repainted at PEWARS facility annually. Every few years, depainting and repainting activities will be conducted at a lock and dam facility with the assistance of the floating barge.

3.2.2.2 Pollution Prevention Issues--

PEWARS has already undertaken major steps to reduce pollution generated by painting. The use of an airless spray system with epoxy paint complies with EPA requirements for VOC levels in paints, which must contain less than 2.8 pounds of VOC per gallon of paint. This system is also easily applied and has shown reasonable durability. However, there are alternative systems that are being developed which may prove to be reliable and reduce waste generation. These alternative paint systems are discussed in Section 4.4.

PEWARS currently uses T-10 Thinner® to clean the paint guns after use. This waste is sprayed into an open drum at which time some of the thinner is vaporized. Any remaining waste liquid is placed into a closed drum for proper disposal as a hazardous waste. Further pollution prevention might be achieved by the use of alternate products for paint gun cleaning. Products such as Citrabake® and EP921®, which are manufactured by Inland Technology Inc., represent biodegradable alternatives which would reduce the usage of hazardous materials and the volume of VOC emissions generated during cleanup. However, cleaning waste would still have to be disposed of as a hazardous waste, so there would be little to no financial savings in a conversion to alternative cleaning products.

3.2.3 Major Lock and Dam Maintenance and Repair

3.2.3.1 General--

Major maintenance and repair often requires complete dewatering of a lock chamber, and may include the following activities: installation of new lock gates, repair of hydraulic systems, repair or replacement of lock chamber parts and equipment, and dredging of chambers and approaches. Most of these activities involve construction such as removal and replacement of concrete, lumber, and steel structures. The waste streams generated from these activities typically include scrap metal, lumber, and concrete.

3.2.3.2 Pollution Prevention Issues--

Scrap metal is accumulated at the PEWARS. Carbon, stainless and brass metals are separated and sold for recycling. Lumber is collected in dumpsters which also are used for the accumulation of typical construction waste. These materials are disposed of off-site at a licensed landfill. Used oil is generally collected in 55-gallon drums and tested by independent laboratories for disposal classification. Currently, all used oils are transported off-site by an independent certified disposing agent, and are used as an alternate fuel source.

PEWARS has taken a proactive approach to handling the wastes generated during major maintenance and repair. Whenever feasible, wastes are recycled. Oil wastes are recovered for use as an alternative energy source if possible. Few pollution prevention opportunities exist for these activities, as recycling and reuse measures have already been implemented. Methods of source reduction could be considered; however, such as reducing the amount of metal or lumber needed to complete the work.

3.2.4 Storage and Inventory

3.2.4.1 General--

As stated earlier, one of the missions of PEWARS is to provide storage for equipment, parts, raw materials, and waste generated by the Pittsburgh District's operation. In the past, PEWARS purchased materials in bulk quantities to save money. However, this resulted in the expiration of some materials before their use. As a result, expired supplies often were disposed of.

3.2.4.2 Pollution Prevention Issues--

In the last few years, PEWARS has been able to reduce its waste production by 50 percent through adjustments in its supply management methods. PEWARS no longer purchases in bulk, and describes its purchasing practices as "just-in-time." According to PEWARS personnel, this system has helped to minimize the potential for expiration of on-site materials before their use.

Currently, PEWARS conducts major purchases for the District sites. Each of the sites within the District purchases small quantities of raw materials for their own use. This may lead to higher levels of waste generation than necessary, as one site may purchase chemicals that could be available from and are no longer required at another site. These chemicals may expire even though they could have been consumed elsewhere in the District. A further discussion of PEWARS supply management system is presented in Section 4.5.

SECTION 4
OPPORTUNITY ASSESSMENT

4.1 GENERAL

During the site visit at PEWARS and Emsworth Locks and Dams, the assessment team observed efforts by personnel at both facilities to reduce wastes. However, additional opportunities for further progress in waste reduction were identified. This section discusses the ongoing successes as well as additional options which can be considered for reducing wastes for both Emsworth Locks and Dams and PEWARS.

4.2 EMSWORTH LOCKS AND DAMS ROUTINE OPERATIONS AND MAINTENANCE

4.2.1 Use of Conventional Lubricants

4.2.1.1 Current Practices--

As previously discussed, there are a number of components in the lock operating system which must be lubricated, including bearings, gears, and chains. These lubrication requirements were discussed in Section 3.1. Emsworth uses a grease called Lubriplate to lubricate the majority of these items. The grease protects the components in the equipment from environmental contaminants and allows movement of the various joints in the units. Spent grease is slowly released to the environment and must be replenished. The components are also cleaned periodically. The schedule for lubrication and cleaning is provided in Table 1.

The vast majority of locks and dams currently operating were constructed with components that require grease lubrication. These systems require the consumption of grease and allow greases to enter the surrounding water. However, there are alternatives to these systems which do not require greasing. These alternatives are summarized in Section 4.2.1.2.

4.2.1.2 Alternative Lubricant Materials--

There are a number of manufacturers that make non-grease lubricated materials for use in applications like locks and dams. Specifically, seven manufacturers of such materials were located during the research for this report. These companies are Thordon Bearings Incorporated, Oiles, Orkot, Capralon, Deva Corporation, Lubron Bearing Systems, and Voist-Alpine. All of the systems manufactured by these companies are composed of synthetic materials. Most rely on some form of asbestos, nylon, or teflon as a coating for the joints where they are placed. Some use a synthetic material bonded to metal, but even in these systems, the synthetic material is the exposed portion in the joint.

The makeup of each of the systems investigated for this report is proprietary. However, there are three general classes of alternative materials that are commonly found among the non-grease lubricated systems. These classes are as follows:

- Materials having a layer of a synthetic shock-absorbing material, such as teflon, nylon, or asbestos, with a permanent coating of lubricant, like molybdenum disulfide or graphite.
- Materials like teflon, nylon or asbestos with an infusion of lubricant. Small pellets or pockets of lubricant are injected or otherwise inserted into and/or beneath the matrix of the synthetic material. These systems may also have a coating of lubricant on their surface.
- The synthetic material (*e.g.*, teflon, nylon, or asbestos) has a porous nature, and is impregnated throughout its volume with lubricant. These systems are conceptually similar to a lubricant-soaked sponge. These systems could be manufactured with a coating of lubricant on their surface.

The first of these classes may be appropriate for the relatively low-pressure environments found in lock and dam systems. However, they do not function well in environments with high contaminant loads, as they are susceptible to damage by contaminating undissolved solids. If solid particles scour the surface of this class of synthetic material, the lubricant will be lost, and the material will not allow easy rotation of the joint. It is likely that the submerged joints containing this class of material which are exposed to waterborne contaminants would not function well in a lock and dam setup. The second and third types of materials appear to be applicable for use in high pressure, heavy particulate-load environments, as they can be scoured to some degree and still maintain lubrication.

Synthetic bearing systems have been installed in hydroelectric power plant wicket gate bearings, turbine main bearings and other bearings in the turbine and wicket gate system, and in marine craft bearings. 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. It is likely that there are wide variations in performance of various manufacturers' synthetic materials. There is also variation in the proper application for the different types of materials. Before any system or material is installed, it must be studied and tested thoroughly to determine its applicability and durability. Several systems investigated for this report are discussed below.

One system studied for this report, the Lubron® system, manufactured by Lubron Bearing Systems in California, uses a teflon base in a bronze substrate. The teflon has lubricant in its matrix, and additional lubricant can be deposited in machined recesses in the bearings. This system appears to be a hybrid of the second and third synthetic systems listed. Lubron has experienced successful runs in several types of marine bearing systems, such as hydroelectric power plants and ship rudders. Lubron is currently being tested by USACE for use in gate applications. The USACE test, which is being conducted at the Carter Dam project in Georgia, should help determine the applicability of Lubron in other lock and dam assemblies throughout USACE.

Another system studied operates with a coating of a material called Thordon®. Thordon, which is manufactured by Thordon Bearings, Incorporated of Canada, appears to fall into the third category of lubricated synthetics listed. It functions as a lubricant-impregnated spongelike matrix. Unfortunately, officials at Marine Industries Corporation, which is the American distributor of Thordon, were unwilling to divulge information relating to any lock and dam facilities that may have implemented Thordon in their systems.

According to PEWARS personnel, it is their understanding that two attempts have been made in the District to use non-lubricated bushings in its larger machinery applications. The first was a graphite impregnated bushing in which small pockets of graphite were made into the bushing. This application was not successful, as dirt from the river water appeared to accummulate and combine with the graphite pockets. The mixture hardened and became an abrasive, rather than a lubricant. The second involved the Thordon product on valve machinery bushings. This product has not been in place long enough to determine its effectiveness.

4.2.1.3 Recommendations--

Table 3 contains a general comparison of the implementation of the grease lubrication system and the non-grease lubricated systems. While the greaseless systems have superior environmental

TABLE 3. COMPARISON OF GREASE AND NON-GREASE LUBRICATED BUSHINGS

Option for Wicket Gate Bearing System	Installation Requirements	Advantages	Disadvantages
Current greased systems	None; system currently in place	Proven long-term reliability; continued use of the systems is inexpensive in comparison to replacement	Release significant volumes of grease to the environment over time
Install non-grease lubricated bushings in the bearing system	Lock and dam systems requiring grease must be completely disassembled	Essentially no pollution produced; replacement can be performed when units are worn out, so facility loss is eliminated	Systems have been in operation for over twenty years, but reliability is still a question. Most systems have only been operating for less than 10 years. If replacement is to be performed before the units are worn out, unavailability of the lock and dam may prove unacceptable.

characteristics, the systems have no proven history of operations in lock and dam environments. Also, refurbishing a lock and dam with a greaseless system is a major undertaking. In addition to the time and expense required for refurbishment, the facility's lost availability while it is being refurbished must also be considered. If a facility requires refurbishment, it would be logical to install greaseless systems at that time. However, if a facility's systems are functioning well, it might be economically prohibitive to take the facility off line in order to implement a greaseless system.

Each case of potential refurbishing must be considered individually for its productivity loss and overhaul costs. The tests currently being conducted on the Lubron system by USACE should further indicate the applicability of greaseless systems in lock and dam operations. Certainly, if a lock and dam system relying on grease lubrication is to be refurbished, greaseless materials appear to be an environmentally preferable alternative.

4.2.2 Hydraulic Oil System

As previously discussed, the lock system at Emsworth contains gate and valve systems that are hydraulically operated. These systems are powered by three vane pumps which distribute oil from a centralized 400-gallon oil reservoir. The electrically powered pumps send hydraulic oil to the hydraulic units in the gates and valves throughout the locks and dams through a network of aboveground and underground lines. The pumps are only active when a unit is in use. Otherwise, the system remains shut down. According to onsite personnel, oil added to the reservoir each year averages approximately 50 gallons.

According to USACE personnel, there are occasional rapid oil losses from these systems. These losses are normally caused by a line failure, although occasionally a pump or hydraulic unit may develop a rapid leak. It is possible that during a rapid release, a significant amount of oil may leak out of the system. Facility personnel estimate that 200 to 500 gallons could be lost before the system could be shut down and line loss stopped. In addition to rapid losses, there are also slower losses due to wear in the lines, pumps, and units. These losses are very difficult to locate within the system because of the length and number of lines. Emsworth personnel estimate that 50 gallons a year of oil are added to the hydraulic oil system due to losses from the system.

The hydraulic system has functioned well over its lifetime. It does not appear that the system will require replacement in the near future. However, if the units are replaced, an alternative design for the system would likely reduce pollution by minimizing releases. The current system uses one oil reservoir and a network of oil lines to transmit oil to the various hydraulic mechanisms in the lock system. By localizing the units, the length of the oil transmission lines could be reduced drastically. Currently, a localized hydraulic unit powers the tow haulage and retriever system. This smaller system does not have long oil lines connecting the oil reservoir to the unit. This system has operated effectively at Emsworth for over 30 years.

In addition to localizing the units, placing the oil lines aboveground and ensuring that they are accessible would further improve their potential to reduce oil loss. The lines of the current system travel underground through concrete channels, making portions of the lines inaccessible, and greatly increasing the likelihood of slow losses not being located and having major breaks not easily repaired. Any future replacements for the hydraulic units should have accessible lines.

With smaller line lengths and accessible lines, both rapid and slow spills would be much easier to localize and remedy. In the event of a rapid spill, the smaller hydraulic oil tanks and line volume in the localized units would not contain as much oil as the current centralized tank, and therefore, could not leak as much oil at one time. A localized hydraulic oil system would appear to significantly reduce the potential for oil spillage over time.

Since the current hydraulic oil system is operating effectively, it would be difficult to justify removing and replacing it with a localized oil system. However, when Emsworth's system is at the end of its useful lifetime in the future, a localized hydraulic oil unit sending system appears to be environmentally preferable to the current centralized system. It is noted that on newer structures within the District, and when major rehabilitation work is performed on older structures, the District has eliminated the extensive runs of hydraulic line in favor of localized electro-hydraulic actuator units, thus reducing the potential for pollution from hydraulic oil spills.

4.3 PEWARS

4.3.1 <u>Depainting</u>

4.3.1.1 Alternative Methods--

As discussed in Section 3.2.1, PEWARS is responsible for depainting and painting operations for all 27 Pittsburgh District flood control and navigation sites. Depainting and painting are usually performed at the PEWARS warehouse depainting and painting booth. However, for large lock gates, depainting and painting may be performed in place. PEWARS utilizes a product called Black Beauty applied with a Chemco sandblaster for paint removal. Black Beauty is made up of bituminous coal. Once a gate is depainted, the blast material is tested for lead content. If the lead content is greater than 5 ppm, the waste is disposed of as hazardous waste.

The *Industrial Lead Paint Removal Handbook*[1] provides a list of 18 currently utilized methods for paint removal and surface preparation. These methods are listed in Table 4. The source material for this summary includes a number of publications by the Steel Structures Painting Council, which is a group formed by industries in the steel paint field, as well as a variety of other documents addressing state of the art and innovative technologies for removal of paint and surface preparation for steel structures. Chapter 5 of the *Handbook* provides a summary, rating, critique and discussion of each of these 18 methods. Each method is rated with respect to the following characteristics:

- Equipment required and expense
- Quality of surface preparation, (including effectiveness of removing paint and rust/mill scale from flat and irregular surfaces)
- Debris created and dust generated
- Type of containment used and containment requirements
- Productivity/production rate

Table 5 compares all 18 methods by numerical rankings given for each of these characteristics.

The current method used for depainting at PEWARS for both the maintenance shop and on-site operations is a modification of method 3, closed abrasive blast cleaning with vacuum. The modification to the method is the use of Black Beauty. The *Handbook* mentions only sand or slag as examples of expendable abrasives used in this application, and gives no specific information about the use of bituminous coal like the Black Beauty compound used for all depainting operations at PEWARS. However, this system's performance cost, and environmental characteristics appear similar to those of standard method 3. Note that if the Black Beauty compound is considered a slag and the vacuum is used recover the spent abrasive, but is not an inherent part of the depainting method, it could be said that PEWARS uses Method 1; however, the analysis of alternative methods would be the same in either case.

TABLE 4. LEAD PAINT REMOVAL METHODS

Method 1:	Open abrasive blast cleaning with expendable abrasives
Method 2:	Open abrasive blast cleaning with recyclable abrasives
Method 3:	Closed abrasive blast cleaning with vacuum
Method 4:	Wet abrasive blast cleaning
Method 5:	High pressure water jetting
Method 6:	High pressure water jetting with abrasive injection
Method 7:	Ultra-high pressure water jetting
Method 8:	Ultra-high pressure water jetting with abrasive injection
Method 9:	Hand tool cleaning
Method 10:	Power tool cleaning
Method 11:	Power tool cleaning with vacuum attachment
Method 12:	Power tool cleaning to bare metal
Method 13:	Power tool cleaning to bare metal with vacuum attachment
Method 14:	Chemical stripping
Method 15:	Sponge jetting
Method 16:	Sodium bicarbonate blast cleaning
Method 17:	Carbon dioxide blast cleaning
Method 18:	Combinations of removal methods

Lead-containing wastes generated from the open and closed abrasive cleaning methods (methods 1 through 3) can sometimes be disposed of as a nonhazardous waste, due to the large volume of blasting material that is consumed in these methods. Other methods which generate lead-containing wastes have a smaller volume of blasting material used, and therefore have a higher concentration of lead in the waste. All of the alternative methods discussed in this section are designed to reduce the overall volume of abrasive in the process waste stream, which will result in increased lead concentrations and possible increases in per-unit disposal costs for the operation.

Any pollution prevention effort for the depainting operation should significantly reduce the volume of debris generated from depainting without allowing unacceptable degradation of the quality

TABLE 5. COMPARISON OF PAINT REMOVAL METHODS

Method/Name	Equipment Investment(a)	Quality of Preparation: Paint Removal(b) Flat	Paint Removal(b) Irregular	Rust/MS Removal(b) Flat	Rust/MS Removal(b) Irregular	Quality for Painting(c)	Debris Created: Dust Generation(d)	Debris Created: Volume of Debris(d)	Containment Required(d)	Production Rate(e)
Method 1: Open Abrasive Blast Cleaning with Expendable Abrasive	2-4*	5	5	5	5	5	1	1	1-2	5
Method 2: Open Abrasive Blast Cleaning with Recyclable Abrasives	1	5	5	5	5	5	3	4	1	5
Method 3: Closed Abrasive Blast Cleaning with Vacuum	1	5	3-4	5	3-4	5	4-5	4	4	2
Method 4: Wet Abrasive Blast Cleaning	2-3*	5	5	5	5	4-5	4-5	1	2-3	4
Method 5: High Pressure Water Jetting	2	3-4	2-3	1	1	3-5	5	2-4	2-4	3
Method 6: High Pressure Water Jetting with Abrasive Injection	2	5	4-5	5	4-5	4-5	5	2-3	2-4	3-4
Method 7: Ultra-High Pressure Water Jetting	1	4-5	3-4	1	1	3-5	5	2-4	2-4	4
Method 8: Ultra-High Pressure Water Jetting with Abrasive Injection	1	5	4-5	5	4-5	4-5	5	2-3	2-4	4
Method 9: Hand Tool Cleaning	5	1-2	1-2	1	1	1-3	4-5	4	4	2
Method 10: Power Tool Cleaning	4	2-3	2	1-2	1-2	1-3	3-4	4	4	2
Method 11: Power Tool Cleaning with Vacuum Attachment	3	2-3	2	1-2	1-2	1-3	4-5	4	4-5	2
Method 12: Power Tool Cleaning to Bare Metal	4	4-5	2-3	4-5	2-3	4-5	3	4	3-4	1-2
Method 13: Power Tool Cleaning to Bare Metal with Vacuum Attachment	3	4-5	2-3	4-5	2-3	4-5	4-5	4	4-5	1-2
Method 14: Chemical Stripping	3-4	3-4	3	1	1	2-5	5	2-3	3-4	1
Method 15: Sponge Jetting	2-3	5	5	4-5	4-5	5	4	3-4	3-4	2-3
Method 16: Sodium Bicarbonate Blast Cleaning	2-3	3	2-3	1-2	1-2	3-4	4-5	2-4	2-4	2-3
Method 17: Carbon Dioxide Blast Cleaning	1	2-3	2-3	1	1	3-4	4-5	4	4	1-2
Method 18: Combinations of Removal Methods	Ratings dependent upon combinations of methods used.									

(a)
5: Very Inexpensive
4: Inexpensive
3: Moderately Expensive
2: Expensive
1: Very Expensive

(b)
5: Highly Effective
4: Effective
3: Moderately Effective
2: Poor
1: Very Poor (Ineffective)

(c)
5: Excellent
4: Good
3: Marginal
2: Poor
1: Very Poor

(d)
5: No/None
4: Little/Low
3: Moderate
2: Sizeable
1: Substantial

(e)
5: Very High
4: High
3: Moderate
2: Low
1: Very Low

*Most contractors already own much of this equipment. Therefore, even though the purchase price is high, little additional investment may be needed.

of surface preparation or the production rate. Differences in containment and disposal requirements should also be considered, as these can markedly effect the overall cost and pollution generation of the methods. The two open abrasive cleaning methods have the highest containment requirements; all other methods require substantially lower amounts of effort to control the removed paint and other debris. In many methods, particles are entrained in a vacuum or water as a primary part of the cleaning method. However, water contaminated with lead might comprise an additional disposal concern.

The following discussion describes key differences between the methods listed in Table 4. A more complete assessment of potential feasibility of specific methods would require testing of several alternatives on-site at PEWARS to determine their effectiveness in the desired applications.

4.3.1.2 Evaluation of the Methods--

The following observations can be made with respect to the potential applicability of the methods listed in Table 4 for PEWARS depainting operations. These observations are grouped into categories of similar methods, and are compared to Method 3 (or Method 1), which is currently used in modified form at PEWARS. These preliminary assessments may be confirmed or contradicted by on-site testing. An attempt has been made to address costs involved with changes in technology or blasting media. However, it is likely that only field testing would generate accurate cost estimates for the various methods.

Methods 1 and 2: Method 1, open abrasive blast cleaning with expendable abrasives, is the oldest and least expensive method of depainting large steel structures, and is one of the best-performing methods. Method 1 is one of three methods with universally high rankings for the quality of surface preparation provided. Method 2, open blasting with recyclable abrasives, and method 4, wet abrasive blasting (which is described in the next method group), rank equally high. The two open abrasive cleaning methods, methods 1 and 2, are also the only methods which have "very high" production rates. However, method 1 results in a larger volume of debris created and more dust generation than almost any other paint removal method. Only method 4, wet abrasive blast cleaning, is also ranked as producing "substantial" debris.

Method 2, open abrasive blast cleaning with recyclable abrasives, would reduce the amount of debris and dust in comparison to the levels generated with expendable abrasives, with the least overall impact on other performance criteria. According to the *Handbook* rankings, essentially no change would be expected in performance or production rate but equipment investment would be significant.

Method 4 :

Wet abrasive blast cleaning would result in marginal improvements in quality, production and containment requirements, and would reduce dust generation significantly, but would actually increase waste-related concerns due to the introduction of water into the process. Clean-up of the wet slurry and wastewater generated by the method itself may be considered hazardous waste if contamination levels are high. Method 4 is classified as producing "substantial" debris, which is more than all methods except method 1.

Methods 5 through 8:

The four high and ultra-high pressure water jetting methods, methods 5 through 8, have similar benefits and drawbacks to those described for Method 4, except that debris volume would not be as large. The quality of surface preparation would likely be unacceptable for method 5, high pressure jetting without abrasive, but the use of abrasive injection and/or ultra-high pressure in methods 6 through 8 would likely prove adequate for most PEWARS applications. However, plain water jetting at either pressure provides little capability for rust removal from any type of surface.

Methods 9 through 17:

Hand tool cleaning and power tool cleaning of all types, methods 9 through 13, would not provide the quality of surface preparation and production rate required at PEWARS. This is also true of three of the other final four methods (*i.e.*, chemical stripping, sodium bicarbonate and carbon dioxide blast cleaning). Sponge jetting appears to have adequate surface preparation and debris reduction properties, but has a low to moderate production rate, which, although above the rates of these other methods, is probably not adequate for the volume of work and time constraints involved in the PEWARS operation.

Method 18: The application of Method 18 would likely entail cleaning the surface with hand tools and power tools combined with blast or jet cleaning. While various combinations of Methods 1 through 17 might provide certain advantages in performance, the complication of using two different sets of equipment in production-scale cleaning operations would likely be prohibitive.

Based on this evaluation, the possible substitutes for the current depainting method at PEWARS are:

- Method 2, open abrasive blast cleaning with recyclable abrasives
- Method 6, high pressure water jetting with abrasives
- Method 8, ultra-high pressure water jetting with abrasives.

Table 6 contains a direct comparison of these three methods.

4.3.2 Painting

4.3.2.1 Current Practices--

The most significant pollution prevention alternative in the area of painting is the use of alternative paints. Alternative paints could reduce the emissions of VOCs to the atmosphere. Alternative paints that could be used in lock and dam maintenance will be discussed in this section.

The lock gates in the Pittsburgh District system were originally painted with a lead-based paint. Due to health concerns, the USACE switched to two-part epoxy paints in the late 1980's and vinyl resin paints for touch up applications. Vinyl resin paints have proven to be extremely durable, with life expectancies of 20 to 40 years. These paints cure in less than one day and cost approximately $1.00 per square foot as applied. However, due to their high VOC content, they may be in limited use by USACE. The two-part epoxy which has been used by PEWARS since the late 1980's has displayed reasonable durability, although not close to the levels of vinyl resin paints because of its sensitivity to abrasion impacts. The life expectancy of the two-part epoxy paint is typically 15 to 20 years. However, if the gate is subjected to water with high particulate content, the life expectancy may be reduced to 3 to 5 years.

TABLE 6. COMPARISON OF RECOMMENDED ALTERNATIVE PAINT REMOVAL METHODS

Method Number	Method Name	Equipment Investment	Removal Efficacy	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

The two-part epoxy paint used by PEWARS has application difficulties, as it is sensitive to temperature during application and may require up to seven days to cure. The epoxy paint costs approximately $1.60 per square foot of paint applied. Also, the two-part epoxy tends to chalk when exposed to long periods of direct sunlight. In some cases, the paint can lose up to 1 mil per year due to chalking, reducing the average life expectancy to 12 to 14 years. Chalking can be prevented with the application of a urethane top coat, although this substantially increases the cost and complication of the coating operation.

Advantages to the epoxy paint systems include the fact that they can be applied at temperatures well below 40 degrees, which is important in the maintenance function at PEWARS. In addition, with the advent of epoxy PRE-PRIME coatings, surface preparation requirements are becoming somewhat more forgiving than for vinyl systems.

4.3.2.2 Requirements of Alternative Systems--

When analyzing alternative paints for the lock and dam it is important to have an understanding of the following two characteristics of the paint:

- abrasion resistance
- level of corrosion resistance
- resistance to fouling by microorganisms in the water

The paint must perform well in all of these areas in order to function properly in a lock and dam operation. In addition, it is important to determine the conditions to which the paint will normally be exposed. In a lock and dam, the gate may be completely submerged at all times or submerged at times and exposed to the atmosphere at times. Certain paint formulations have better durability characteristics for atmospheric exposure than water exposure and vice versa.[2]

In addition to having preferable environmental characteristics, it is important that the paint application be an effective and environmentally acceptable method. Certain paint application methods produce high volumes of paint overspray, thus wasting paint and generating excessive waste. Alternative painting methods will be discussed in Section 4.3.2.3, while alternative paints will be discussed in Section 4.3.2.4. This is followed by a summary of painting options in Section 4.3.2.5.

4.3.2.3 Alternate Painting Application Methods--

Currently, there are five methods for applying paint to a surface: brush, paint pads, roller, mitt, and spray. For large structures, such as the gates on a lock or dam, spray methods have proven to be the most cost efficient and expedient method. There are many types of spray equipment used in paint application. This discussion will focus on four of these methods, three of which have been proven effective in steel structure painting, and one of which is an emerging technology that may prove applicable in the future. The three currently applicable methods are air spray, airless spray, and high-volume, low-pressure (HVLP) spray. Electrostatic spray is an additional, unproven method. Currently, PEWARS utilizes an airless spray system.

Air spray was the method originally developed for paint spray application. In this method, air is supplied by a compressor to a spray gun which atomizes the paint and projects it onto the structure or part. This method causes a large amount of overspray and paint loss, up to 40 percent in some applications. This method is no longer frequently used because of the volume of overspray, and concern for worker safety due to the atomized paint deposited in the ambient air.

Airless spray allows for a reduction of overspray while continuing high product throughput. This method utilizes hydraulic pressure of 1,000 to 6,000 pounds per square inch to force paint through a gun. The gun is designed to separate the paint into small streams, causing atomization of the paint as it exits and is projected onto the structure or part. This method is faster, cleaner, less expensive, and easier to use than the conventional air spray system. In addition, paint lost due to overspray is 10 to 15 percent less than in air spray systems.

The HVLP spray method uses a turbine to generate a high volume of air that atomizes the paint at a low pressure and projects the paint on to the structure or part at a low velocity. This method has proven successful with high solid coatings. The paint loss to overspray is minimal and the system is easy to clean. However, there are several drawbacks to this method. The capital and maintenance costs for the HVLP equipment are high. Because of the low velocity at which the coating is applied, the speed of application is much lower than the airless spray method. In addition, no currently utilized high solids coatings researched for this report are suited for use in lock and dam environments.

An additional method that has not been adapted to large steel structures, such as lock and dam gates, is electrostatic spraying. In this method an electrostatic charge is generated between the applicator and surface, which allows for distribution of an electrically charged paint spray to all exposed conductive areas. This method has the lowest overspray potential of all spraying methods developed to date, as it ensures that the paint is actively attracted to the surface being painted. However, the method has only been used on small parts, and may not prove applicable for large structures like lock gates. Also, in current applications the method is expensive, has a slow throughput, and paint can only be applied in thin coats.

Based on the information gathered on paint application technologies, the airless spray gun currently utilized at PEWARS appears to be the most effective and efficient process for large scale painting operations. As discussed above, none of the other technologies presented are currently technically feasible for use at PEWARS. However, the HVLP method could be used if a suitable high- solids paint formulation is developed and the application speed proves acceptable. In addition, ongoing research may generate advances in the electrostatic spray method. In the future, this may prove to be an environmentally preferable and functionally effective alternative to the airless system.

4.3.2.4 Alternative Paints--

Table 7 contains a comparison of paints and their properties. Alternative paints are discussed in the remainder of this section.

Air-cured urethane paints, which must be applied in a relatively thick coating, are being tested by the U.S. Army Corps of Engineers Construction Engineering Research Laboratory (CERL). Results to date have shown a limited life expectancy, generally less than five years. In addition, because of the increased thickness of the coating, the cost can be two to three times the cost of vinyl resin paint.[3]

Another type of two-part epoxy paint that is currently undergoing development is a coal-tar epoxy. The performance levels of these paints are not currently available, as they are still being developed. However, due to their potential toxicity and concern for worker safety, these paints may not prove viable.[3,4] According to PEWARS personnel, an existing type of coal-tar epoxy, which as been used in the Pittsburgh District is known to have shown breakdown when continually submerged in water.

Another class of paint that is being tested by CERL is an air-cured urethane. There are several different formulations of this type of paint which contain varying levels of zinc and iron oxide in the formulation. These paints typically cure in less than one day and require less significant surface preparation than either vinyl resins or epoxies. CERL is currently testing these paints to

TABLE 7. COMPARISON OF PAINT METHODS

Paint	Life Expectancy	Cost ($/ft^2)	Preferred Application Method	VOC Content	Advantages	Disadvantages
Vinyl resins	20-40 years	$1.00	brush, roll, spray	70-75 percent by weight	short cure, easy to apply, excellent durability	large source of VOC emissions, significant surface preparation
2-part epoxy	15-20 years	$1.60	spray	<2.8 pounds per gallon	easy to apply, good durability	long cure, temperature sensitive, abrasion sensitive, chalking in sunlight
Coal tar epoxy	15-20 years	NA*	spray	20-30 percent by weight	excellent durability, less significant surface preparation	toxicity
Air-cured urethanes	<5 years	$2.00-$3.00	NA*	<2.8 pounds per gallon	low VOC emissions, not sensitive to sunlight	current life expectancy not high
Moisture-cured urethanes	currently under testing by USACE	NA*	NA*	<2.8 pounds per gallon	short cure, less significant surface preparation	moisture sensitive during application
100 percent solids	currently under testing by USACE	NA*	spray	none	no VOC emissions	difficult to apply, not water resistant
Powder coatings	<5 years	NA*	spray	none	no VOC emissions	very sensitive to abrasion, poor durability

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

determine life expectancy and performance levels.

The application of moisture-cured urethane paints can be very difficult, especially if paint is applied to the gate while it is still in place on the lock or dam. This is because the moisture from the water flowing near the gate could cause the paint to prematurely cure. There may be limitations to application methods in the Pittsburgh District, depending on the relative humidity. If the humidity is low, the curing process may proceed slowly. However, during periods of high humidity, application may prove difficult due to premature curing. Currently, CERL is completing testing to determine the life expectancy and performance levels of these paints.[3,4]

CERL has completed preliminary testing of 100 percent solids paint in both one-component and multicomponent formulations. These paints do not contain or emit VOCs. However, the one-component system does not perform well when immersed in water for long periods of time. The paint will blister and peel off, reducing the life expectancy. The multicomponent system is also difficult to apply. Further testing is necessary to definitively determine its life expectancy.[3] However, performance limitations in the current formulations make the systems unacceptable at this time.

Another paint that emits no VOCs is powder coatings. These coatings are difficult and time consuming to apply. In addition, they are very sensitive to abrasion. CERL tests have determined that even in quiet immersion, with little or no abrasion caused by the water, the paint detaches from the surface, exposing the metal within five years.[3]

4.3.2.5 Painting Summary--

At this time, it is premature for PEWARS to consider converting to an alternate paint or application method. The two-part epoxy currently in use complies with the EPA requirement for products with VOC content of less than 2.8 pounds per gallon. However, non-VOC containing paint formulations are continuing to be developed and tested, such as the 100 percent solids, powder coatings, and organic antifouling paints. Advances in the paint development area could result in effective, environmentally preferable paints.

Although none of the coatings discussed above are currently ready for industrial use, PEWARS might prove an ideal test site for the evaluation of these alternatives.

4.4.3 Storage and Inventory Control

As discussed in Section 3.2.4, PEWARS has been successful in changing their methods of procurement to help prevent oversupply of raw materials that would normally result in solid or hazardous waste. By purchasing on an "as needed" basis, PEWARS has estimated that they have reduced their waste generation by 50 percent.

Additional reductions in waste generation may be achieved through further centralizing purchasing responsibilities. This would require further reduction of individual site's supply purchases. This would help prevent purchasing duplicate materials, and therefore reduce shelf-life losses. In addition, a centralized tracking system should be developed to keep an inventory of all materials purchased, storage location, quantities available, and shelf lives. Before any facility considered a purchase, they should be required to check the database for applicable products. Any oversupply could be made available to the Pittsburgh District sites. By tracking materials and expiration dates, and ensuring that all facilities have access to chemicals stored throughout the district, PEWARS should be able to greatly reduce the losses due to shelf life exceedance and purchasing redundancy.

4.4 POTENTIAL DEMONSTRATION PROJECTS AND SUMMARY

Both Emsworth Locks and Dams and PEWARS have areas of their operations that could benefit from the addition of 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
2. Replacement of the current centralized hydraulic system with localized units incorporating accessible oil flow lines
3. Substitution of the current depainting method with a lower-waste generating alternative
4. Substitution of the current paint and application method with a lower VOC-emitting system
5. Further implementing the centralization of and tracking system for the inventory control process

Numbers 1 and 2 were described under the Emsworth sections of this report. However, they are applicable to any lock and dam site. Numbers 3 through 5 were described under the PEWARS sections of this report. These initiatives would apply to any facility that performs major maintenance or storage.

Of the five initiatives listed above, initiative 3 appears to be an excellent candidate for a demonstration projects. The most promising demonstration projects are:

- Method 2, open abrasive blast cleaning with recyclable abrasives
- Method 6, high-pressure water jetting with abrasives
- Method 8, ultra-high pressure water jetting with abrasives

Any of these three methods would produce significantly less solid waste than the current operations at PEWARS.

Initiative 4 could also prove beneficial if powder or 100 percent solid coatings progress to the point where they are suitable for conditions such as those found at PEWARS and Emsworth Locks and Dams.

Table 8 provides a list of wastestreams generated at Emsworth and PEWARS, and options recommended for those wastestreams.

TABLE 8. SUMMARY OF SIGNIFICANT WASTESTREAMS GENERATED BY EMSWORTH AND PEWARS AND RECOMMENDED OPTIONS FOR WASTESTREAM REDUCTION OR MODIFICATION

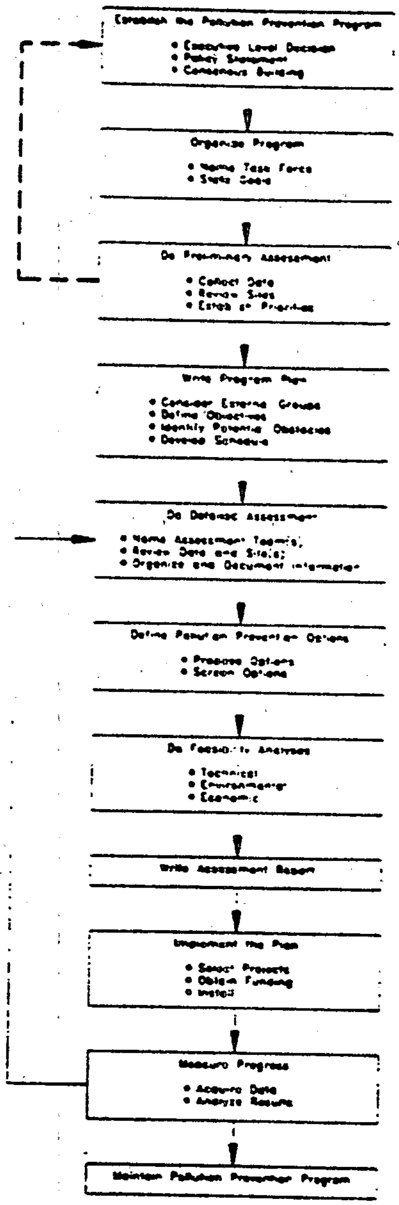
Wastes Generated	Source of Waste Generation	Environmental Disadvantages	Recommended Options	Advantages	Disadvantages	Recommendations
Emsworth						
Lubriplate, Never Seez®, transmission and engine oil	Lubrication of lock and dam equipment	Lubricants eventually escape into environment	Installation of 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
PEWARS						
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

APPENDIX A
PPOA WORKSHEETS

Firm USACE	**Pollution Prevention Assessment Worksheets**	Prepared By Vitas
Site Pittsburgh, Pennsylvania		Checked By J. Smith
Date September 30, 1994	Proj. No. 01645-0111-00003	Sheet 1 of 1 Page __ of __

WORKSHEET 1

EMSWORTH LOCK AND DAM



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WORKSHEET 2

SITE DESCRIPTION

Firm: U.S. Army Corps of Engineers

Plant: Emsworth Lock and Dam

Department:

Area:

Street Address: 3500 Grand Avenue, Neville Island

City: Pittsburgh

State/Zip Code: Pennsylvania 15225-1584

Telephone: (412) 644-4184

Major Products: None

SIC Codes:

EPA Generator Number:

Major Unit:

Product or Service:

Operations: Provide access to Ohio and Mongahela Rivers to boat traffic, minor maintenance and repair to lock and dam area

Facilities/Equipment Age: Dams originally constructed between 1919 and 1922. Reconstructed between 1935 and 1938 and major rehabilitation was completed in 1984.

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WORKSHEET 3

PROCESS INFORMATION

Process Unit/Operation: Equipment Inspection, Lubrication, and Routine Maintenance

Operation Type: ☐ Continuous ☐ Discrete ☐ Batch or Semi-Batch ☐ Other ______

Document	Status					
	Complete? (Y/N)	Current? (Y/N)	Last Revision	Used in this Report (Y/N)	Document Number	Location
Process Flow Diagram	N					
Material/Energy Balance						
Design						
Operating						
Flow/Amount Measurements						
Stream						
Analyses/Assays	N					
Stream						
Process Description	Y					
Operating Manuals	Y	Y	1988	Y		
Equipment List	N					
Equipment Specifications	N					
Piping and Instrument Diagrams	N					
Plot and Evaluation Plan(s)	N					
Work Flow Diagrams	N					
Hazardous Waste Manifests	N					
Emission Inventories	N					
Annual/Biennial Reports	N					
Environmental Audit Reports	N					
Permit/Permit Applications	N					
Batch Sheet(s)	N					
Materials Applications Diagrams	N					
Product Composition Sheets	N					
Material Safety Data Sheets	Y	Y		Y		
Inventory Records	N					
Operator Logs	N					
Production Schedules	N					

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WORKSHEET 3

PROCESS INFORMATION

Process Unit/Operation: Hydraulic Oil System

Operation Type: ☐ Continuous ☐ Discrete ☐ Batch or Semi-Batch ☐ Other ______

Document	Status					
	Complete? (Y/N)	Current? (Y/N)	Last Revision	Used in this Report (Y/N)	Document Number	Location
Process Flow Diagram	N					
Material/Energy Balance						
Design						
Operating						
Flow/Amount Measurements						
Stream						
Analyses/Assays	N					
Stream						
Process Description	Y					
Operating Manuals	Y	Y	1988	Y		
Equipment List	N					
Equipment Specifications	N					
Piping and Instrument Diagrams	N					
Plot and Evaluation Plan(s)	N					
Work Flow Diagrams	N					
Hazardous Waste Manifests	N					
Emission Inventories	N					
Annual/Biennial Reports	N					
Environmental Audit Reports	N					
Permit/Permit Applications	N					
Batch Sheet(s)	N					
Materials Applications Diagrams	N					
Product Composition Sheets	N					
Material Safety Data Sheets	Y	Y		Y		
Inventory Records	N					
Operator Logs	N					
Production Schedules	N					

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WORKSHEET
4

INPUT MATERIALS SUMMARY

SEE SECTION 2 OF PPOA

Attribute	Description		
	Stream No.____	Stream No.____	Stream No.____
Name/ID			
Source/Supplier			
Component/Attribute of Concern			
Annual Consumption Rate			
Overall			
Component(s) of Concern			
Purchase Price, $ per ______			
Overall Annual Cost			
Delivery Mode[1]			
Shipping Container Size & type[2]			
Storage Mode[3]			
Transfer Mode[4]			
Empty Container Disposal Management[5]			
Shelf Life			
Supplier Would			
- accept expired material? (Y/N)			
- accept shipping containers: (Y/N)			
- revise expiration date? (Y/N)			
Acceptable Substitute(s), if any			
Alternate Supplier(s)			

Notes:
1. e.g., pipeline, tank car, 100 bbl tank truck, truck, etc.
2. e.g., 55 gal drum 100 lb paper bag, tank, etc.
3. e.g., outdoor, warehouse, underground, aboveground, etc.
4. e.g., pump, forklift, pneumatic transport, conveyor, etc.
5. e.g., crush and landfill, clean and recycle, return to supplier, etc.

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WORKSHEET 5

INPUT MATERIALS SUMMARY

NO PRODUCTS FROM OPERATION

Attribute	Description		
	Stream No.____	Stream No.____	Stream No.____
Name/ID			
Component/Attribute of Concern			
Annual Consumption Rate			
Overall			
Component(s) of Concern			
Annual Revenues, $____			
Shipping Mode			
Shipping Container Size & type			
Onsite Storage Mode			
Containers Returnable (Y/N)			
Shelf Life			
Rework Possible (Y/N)			
Customer Would			
- relax specification (Y/N)			
- accept larger containers (Y/N)			

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WORKSHEET 6

WASTE STREAM SUMMARY

Equipment Inspection, Lubrication, and Routine Maintenance

Attribute	Description		
	Stream No. 1	Stream No.__	Stream No.__
Waste ID/Name:	Used Lubricant		
Source/Origin	Maintenance		
Component or Property of Concern	Lock/Dam Gates		
Annual Generation Rate (units____)	Unknown		
Overall			
Component(s) of Concern			
Cost of Disposal			
Unit Cost ($ per:___)			
Overall (per year)			
Method of Management[1]	Landfill		
Containers Returnable (Y/N)			

Priority Rating Criteria[2]	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-product Recovery							
Sum of Priority Rating Scores		$\Sigma(R \times W)$		$\Sigma(R \times W)$		$\Sigma(R \times W)$	
Priority Rank							

Notes: 1. For example, sanitary landfill, hazardous waste landfill, on-site recycle, incineration, combustion with heat recovery, distillation, dewatering, etc.
2. Rate each stream in each category on a scale from 0 (none) to 10 (high).

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WORKSHEET 6

WASTE STREAM SUMMARY

Hydraulic Oil System

Attribute	Description		
	Stream No. 2	Stream No.__	Stream No.__
Waste ID/Name:	Used Oil		
Source/Origin	Maintenance		
Component or Property of Concern	Lock/Dam Gates		
Annual Generation Rate (units____)	Unknown		
Overall			
Component(s) of Concern			
Cost of Disposal			
Unit Cost ($ per:___)			
Overall (per year)			
Method of Management[1]	Off site energy recovery		
Containers Returnable (Y/N)			

Priority Rating Criteria[2]	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-product Recovery							
Sum of Priority Rating Scores		$\Sigma(RxW)$		$\Sigma(RxW)$		$\Sigma(RxW)$	
Priority Rank							

Notes:
1. For example, sanitary landfill, hazardous waste landfill, on-site recycle, incineration, combustion with heat recovery, distillation, dewatering, etc.
2. Rate each stream in each category on a scale from 0 (none) to 10 (high).

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WORKSHEET 7

OPTION GENERATION

Meeting format (e.g., brainstorming, nominal group technique) Brainstorming

Meeting Coordinator J. Smith

Meeting Participants D. Bowman, J. Vitas, S. Walata

List Suggestion Options	Rationale/Remarks on Option
SEE ATTACHED	

EMSWORTH LOCK AND DAM
PITTSBURGH, PENNSYLVANIA
PPOA BRAINSTORMING SESSION

I. OPPORTUNITIES TO REDUCE WASTE GENERATION

A. INPUT MATERIALS

- Identify areas that appear to be candidates for reduction or alteration of current practices to reduce input materials
- Investigate use of alternative materials which are environmentally preferable
- Reduce consumption rates where feasible

B. WASTE MANAGEMENT

- Segregate wastes and attempt to retain value of components
- Recycle and reuse materials where possible
- Use care when handling materials, especially when transferring and applying paints, oils and greases

C. AWARENESS

- Communicate environmental information and objectives to employees
- Periodic "friendly" inspections of areas to assess environmental status
- Ensure employees understand environmental impacts of all processes and materials
- Allow employees latitude to find environmentally preferable methods to performing business

III. INVESTIGATION BY PROCESS

A. USE OF CONVENTIONAL LUBRICANTS

- Evaluate current lock and dam systems and grease and oil consumption requirements
- Identify materials that could be implemented in locks and dams that would not require conventional lubrication
- Determine applicability in current and future lock and dam systems

B. HYDRAULIC OIL SYSTEM

- Evaluate current hydraulic oil control system for lock gates and butterfly valves
- Examine alternative systems that would reduce the possibility for chronic and rapid oil releases
- Determine applicability in current and future lock and dam systems

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WORKSHEET 8

OPTION DESCRIPTION

Option Name Installation of localized above ground hydraulic oil system

Briefly describe the option: Replace current centralized hydraulic oil system with a system that is localized for each of the locks and dams at Emsworth, making the lines shorter. In addition, place the lines of the system above ground for easy access to repair leaks that may currently go undetected.

Waste Stream(s) Affected: Number 2

Input Material(s) Affected: Hydraulic oil

Product(s) Affected:

Indicate Type: ☐ **Source Reduction**

- x **Equipment-Related Change**
- __ **Personnel/Procedure-Related Change**
- __ **Materials-Related Change**

☐ **Recycling/Reuse**

- __ **Onsite**
- __ **Offsite**
- __ **Material reused for original purpose**
- __ **Material used for a lower-quality purpose**
- __ **Material sold**

Originally proposed by: TRC **Date:** 6/20/94

Reviewed by TRC **Date:**

Approved for study? x yes __ no **By:** TRC

Reason for Acceptance or Rejection Reduction of a significant waste stream

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WORKSHEET
8

OPTION DESCRIPTION

Option Name Installation of alternative bearing materials

Briefly describe the option: Remove current grease-lubricated parts from lock and dam gates and refurbish units with a non-grease lubricated system.

Waste Stream(s) Affected: Number 1

Input Material(s) Affected: Grease lubricants

Product(s) Affected: ____

Indicate Type:

- ☐ **Source Reduction**
  - ___ **Equipment-Related Change**
  - ___ **Personnel/Procedure-Related Change**
  - x **Materials-Related Change**
- ☐ **Recycling/Reuse**
  - ___ **Onsite**
  - ___ **Offsite**
  - ___ **Material reused for original purpose**
  - ___ **Material used for a lower-quality purpose**
  - ___ **Material sold**

Originally proposed by: TRC **Date:** 6/20/94

Reviewed by TRC **Date:** ____

Approved for study? x **yes** ___ **no** **By:** TRC

Reason for Acceptance or Rejection Reduction of a significant waste stream

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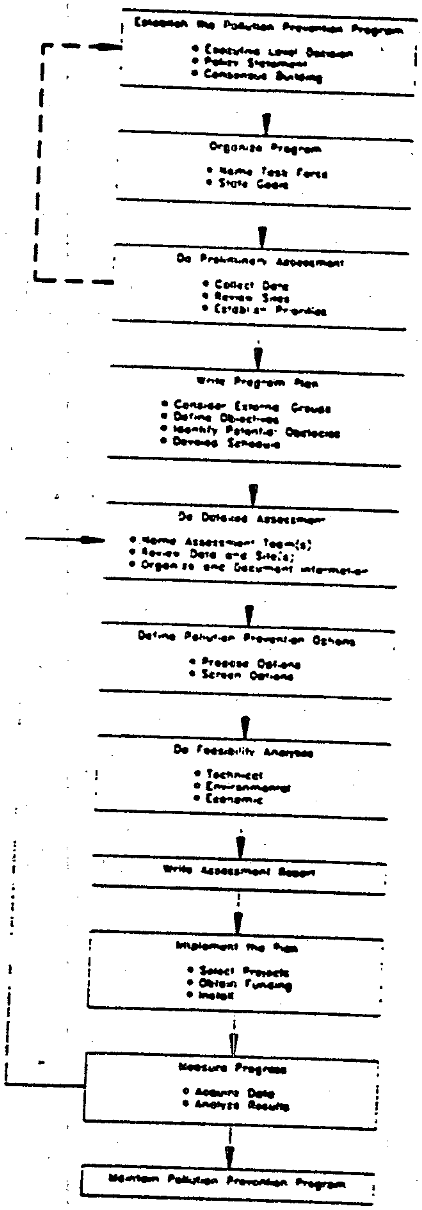
WORKSHEET 1

PEWARS



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WORKSHEET 2

SITE DESCRIPTION

Firm: U.S. Army Corps of Engineers

Plant: Pittsburgh Engineer Warehouse and Repair Shops

Department:

Area:

Street Address: 3500 Grand Avenue, Neville Island

City: Pittsburgh

State/Zip Code: Pennsylvania 15225-1584

Telephone: (412) 644-4184

Major Products: Maintenance operations for the locks and dams in the Pittsburgh District.

SIC Codes:

EPA Generator Number: PA6960010050

Major Unit:

Product or Service:

Operations: Maintenance facility and warehouse for 27 sites within the Pittsburgh District

Facilities/Equipment Age: Facility built in 1943 as part of U.S. Navy's effort to support World War II. Facility was transferred to the U.S. Army Corps of Engineers in 1947 to provide maintenance services to the District. Floating maintenance barge commissioned in 1989.

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WORKSHEET 3

PROCESS INFORMATION

Process Unit/Operation: Major Maintenance - PEWARS and Floating Barge

Operation Type: ☐ Continuous ☐ Discrete ☐ Batch or Semi-Batch ☐ Other ____

Document	Status					
	Complete? (Y/N)	Current? (Y/N)	Last Revision	Used in this Report (Y/N)	Document Number	Location
Process Flow Diagram	N					
Material/Energy Balance						
Design						
Operating						
Flow/Amount Measurements						
Stream						
Analyses/Assays	N					
Stream						
Process Description	Y					
Operating Manuals	Y	Y	1988	Y		
Equipment List	N					
Equipment Specifications	N					
Piping and Instrument Diagrams	N					
Plot and Evaluation Plan(s)	N					
Work Flow Diagrams	N					
Hazardous Waste Manifests	Y		1993	Y		
Emission Inventories	N					
Annual/Biennial Reports	N					
Environmental Audit Reports	N					
Permit/Permit Applications	N					
Batch Sheet(s)	N					
Materials Applications Diagrams	N					
Product Composition Sheets	N					
Material Safety Data Sheets	Y	Y		Y		
Inventory Records	N					
Operator Logs	N					
Production Schedules	N					

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WORKSHEET
3

PROCESS INFORMATION

Process Unit/Operation: Depainting Operations - PEWARS and Floating Barge

Operation Type: ☐ Continuous ☐ Batch or Semi-Batch ☐ Discrete ☐ Other ________

Document	Status					
	Complete? (Y/N)	Current? (Y/N)	Last Revision	Used in this Report (Y/N)	Document Number	Location
Process Flow Diagram	N					
Material/Energy Balance						
Design						
Operating						
Flow/Amount Measurements						
Stream						
Analyses/Assays	N					
Stream						
Process Description	Y					
Operating Manuals	N					
Equipment List	N					
Equipment Specifications	N					
Piping and Instrument Diagrams	N					
Plot and Evaluation Plan(s)	N					
Work Flow Diagrams	N					
Hazardous Waste Manifests	Y		1993	Y		
Emission Inventories	N					
Annual/Biennial Reports	N					
Environmental Audit Reports	N					
Permit/Permit Applications	N					
Batch Sheet(s)	N					
Materials Applications Diagrams	N					
Product Composition Sheets	N					
Material Safety Data Sheets	N					
Inventory Records	N					
Operator Logs	N					
Production Schedules	N					

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WORKSHEET
3

PROCESS INFORMATION

Process Unit/Operation: Painting Operations - PEWARS and Floating Barge

Operation Type: ☐ Continuous ☐ Discrete ☐ Batch or Semi-Batch ☐ Other ________

Document	Status					
	Complete? (Y/N)	Current? (Y/N)	Last Revision	Used in this Report (Y/N)	Document Number	Location
Process Flow Diagram	N					
Material/Energy Balance						
Design						
Operating						
Flow/Amount Measurements						
Stream						
Analyses/Assays	N					
Stream						
Process Description	Y					
Operating Manuals	N					
Equipment List	Y	Y		Y		
Equipment Specifications	N					
Piping and Instrument Diagrams	N					
Plot and Evaluation Plan(s)	N					
Work Flow Diagrams	N					
Hazardous Waste Manifests	Y		1993	Y		
Emission Inventories	N					
Annual/Biennial Reports	N					
Environmental Audit Reports	N					
Permit/Permit Applications	N					
Batch Sheet(s)	N					
Materials Applications Diagrams	N					
Product Composition Sheets	N					
Material Safety Data Sheets	N					
Inventory Records	N					
Operator Logs	N					
Production Schedules	N					

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WORKSHEET 3

PROCESS INFORMATION

Process Unit/Operation: Storage and Inventory Control - PEWARS

Operation Type: ☐ Continuous ☐ Discrete ☐ Batch or Semi-Batch ☐ Other ______

Document	Status					
	Complete? (Y/N)	Current? (Y/N)	Last Revision	Used in this Report (Y/N)	Document Number	Location
Process Flow Diagram	N					
Material/Energy Balance						
Design						
Operating						
Flow/Amount Measurements						
Stream						
Analyses/Assays	N					
Stream						
Process Description	N					
Operating Manuals	N					
Equipment List	N					
Equipment Specifications	N					
Piping and Instrument Diagrams	N					
Plot and Evaluation Plan(s)	N					
Work Flow Diagrams	N					
Hazardous Waste Manifests	Y		1993	Y		
Emission Inventories	N					
Annual/Biennial Reports	N					
Environmental Audit Reports	N					
Permit/Permit Applications	N					
Batch Sheet(s)	N					
Materials Applications Diagrams	N					
Product Composition Sheets	N					
Material Safety Data Sheets	N					
Inventory Records	N					
Operator Logs	N					
Production Schedules	N					

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WORKSHEET 4

INPUT MATERIALS SUMMARY

SEE SECTION 2 OF PPOA

Attribute	Description		
	Stream No.____	Stream No.____	Stream No.____
Name/ID			
Source/Supplier			
Component/Attribute of Concern			
Annual Consumption Rate			
Overall			
Component(s) of Concern			
Purchase Price, $ per ______			
Overall Annual Cost			
Delivery Mode[1]			
Shipping Container Size & type[2]			
Storage Mode[3]			
Transfer Mode[4]			
Empty Container Disposal Management[5]			
Shelf Life			
Supplier Would			
- accept expired material? (Y/N)			
- accept shipping containers: (Y/N)			
- revise expiration date? (Y/N)			
Acceptable Substitute(s), if any			
Alternate Supplier(s)			

Notes:
1. e.g., pipeline, tank car, 100 bbl tank truck, truck, etc.
2. e.g., 55 gal drum 100 lb paper bag, tank, etc.
3. e.g., outdoor, warehouse, underground, aboveground, etc.
4. e.g., pump, forklift, pneumatic transport, conveyor, etc.
5. e.g., crush and landfill, clean and recycle, return to supplier, etc.

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WORKSHEET
5

INPUT MATERIALS SUMMARY

NO PRODUCTS FROM OPERATION

Attribute	Description		
	Stream No.____	Stream No.____	Stream No.____
Name/ID			
Component/Attribute of Concern			
Annual Consumption Rate			
Overall			
Component(s) of Concern			
Annual Revenues, $____			
Shipping Mode			
Shipping Container Size & type			
Onsite Storage Mode			
Containers Returnable (Y/N)			
Shelf Life			
Rework Possible (Y/N)			
Customer Would			
- relax specification (Y/N)			
- accept larger containers (Y/N)			

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WORKSHEET 6

WASTE STREAM SUMMARY

Major Maintenance - PEWARS and Floating Maintenance Barge

Attribute	Description		
	Stream No. 1	Stream No. 2	Stream No. 3
Waste ID/Name:	Scrap Metal	Scrap Lumber	Scrap Concrete
Source/Origin	Repair/Replace	Repair/Replace	Repair/Replace
Component or Property of Concern	Lock/Dam Gates	Lock/Dam Gates	Lock/Dam Gates
Annual Generation Rate (units ____)	Unknown	Unknown	Unknown
Overall			
Component(s) of Concern	Carbon, stainless,		
	and brass can be		
	recycled		
Cost of Disposal			
Unit Cost ($ per: ___)			
Overall (per year)			
Method of Management[1]	Landfill	Landfill	Landfill
Containers Returnable (Y/N)			

Priority Rating Criteria[2]	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-product Recovery							
Sum of Priority Rating Scores		$\Sigma(R x W)$		$\Sigma(R x W)$		$\Sigma(R x W)$	
Priority Rank							

Notes: 1. For example, sanitary landfill, hazardous waste landfill, on-site recycle, incineration, combustion with heat recovery, distillation, dewatering, etc.
2. Rate each stream in each category on a scale from 0 (none) to 10 (high).

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WORKSHEET 6

WASTE STREAM SUMMARY

Major Maintenance - PEWARS and Floating Maintenance Barge

Attribute	Description		
	Stream No. 4	Stream No.___	Stream No.___
Waste ID/Name:	Used Oil		
Source/Origin	Repair/Replace		
Component or Property of Concern	Lock/Dam Gates		
Annual Generation Rate (units_____)	Unknown		
Overall			
Component(s) of Concern			
Cost of Disposal			
Unit Cost ($ per:___)			
Overall (per year)			
Method of Management[1]	Off site energy recovery		
Containers Returnable (Y/N)			

Priority Rating Criteria[2]	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-product Recovery							
Sum of Priority Rating Scores		$\Sigma(R \times W)$		$\Sigma(R \times W)$		$\Sigma(R \times W)$	
Priority Rank							

Notes: 1. For example, sanitary landfill, hazardous waste landfill, on-site recycle, incineration, combustion with heat recovery, distillation, dewatering, etc.
2. Rate each stream in each category on a scale from 0 (none) to 10 (high).

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WORKSHEET 6

WASTE STREAM SUMMARY

Depainting - PEWARS and Floating Maintenance Barge

Attribute		Description					
		Stream No. 5		Stream No. __		Stream No. __	
Waste ID/Name:		Spent Blasting Material					
Source/Origin		Depainting					
Component or Property of Concern		Lock/Dam Gates					
Annual Generation Rate (units __)		Unknown					
Overall							
Component(s) of Concern							
Cost of Disposal							
Unit Cost ($ per: ton)		$200 (hazardous) $60 (non-hazardous)					
Overall (per year)							
Method of Management[1]		Landfill or Off site energy recovery					
Containers Returnable (Y/N)							
Priority Rating Criteria[2]	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-product Recovery							
Sum of Priority Rating Scores		$\Sigma(RxW)$		$\Sigma(RxW)$		$\Sigma(RxW)$	
Priority Rank							

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WORKSHEET 6

WASTE STREAM SUMMARY

Painting - PEWARS and Floating Maintenance Barge

Attribute	Description		
	Stream No. 6	Stream No. 7	Stream No. 8
Waste ID/Name:	Unused Paint	Spent Thinner	Paint brushes, rollers
Source/Origin	Painting	Cleaning	Painting
Component or Property of Concern	Lock/Dam Gates	Spray Guns	Lock/Dam Gates
Annual Generation Rate (units ____)	Unknown	Unknown	Unknown
Overall			
Component(s) of Concern			
Cost of Disposal			
Unit Cost ($ per: ton)			
Overall (per year)			
Method of Management[1]	Landfill	Off site energy recovery	Landfill
Containers Returnable (Y/N)			

Priority Rating Criteria[2]	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-product Recovery							
Sum of Priority Rating Scores		Σ(RxW)		Σ(RxW)		Σ(RxW)	
Priority Rank							

Notes: 1. For example, sanitary landfill, hazardous waste landfill, on-site recycle, incineration, combustion with heat recovery, distillation, dewatering, etc.
2. Rate each stream in each category on a scale from 0 (none) to 10 (high).

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WORKSHEET 6

WASTE STREAM SUMMARY

Storage and Inventory - PEWARS and Floating Maintenance Barge

Attribute		Description					
		Stream No. 9		Stream No. ___		Stream No. ___	
Waste ID/Name:							
Source/Origin							
Component or Property of Concern							
Annual Generation Rate (units ___)							
Overall							
Component(s) of Concern							
Cost of Disposal							
Unit Cost ($ per ton)							
Overall (per year)							
Method of Management[1]		Landfill					
Containers Returnable (Y/N)							
Priority Rating Criteria[2]	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-product Recovery							
Sum of Priority Rating Scores		Σ(RxW)		Σ(RxW)		Σ(RxW)	
Priority Rank							

Notes: 1. For example, sanitary landfill, hazardous waste landfill, on-site recycle, incineration, combustion with heat recovery, distillation, dewatering, etc.
2. Rate each stream in each category on a scale from 0 (none) to 10 (high).

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WORKSHEET 7

OPTION GENERATION

Meeting format (e.g., brainstorming, nominal group technique) Brainstorming

Meeting Coordinator J. Smith

Meeting Participants D. Bowman, J. Vitas, S. Walata

List Suggestion Options	Rationale/Remarks on Option
SEE ATTACHED	

PEWARS
PITTSBURGH, PENNSYLVANIA
PPOA BRAINSTORMING SESSION

I. OPPORTUNITIES TO REDUCE WASTE GENERATION

A. INPUT MATERIALS

- Identify areas that appear to be candidates for reduction or alteration of current practices to reduce input materials
- Investigate use of alternative materials which are environmentally preferable
- Reduce consumption rates where feasible
- Ensure products are purchased in volumes that prevent waste from expiration of shelf life

B. WASTE MANAGEMENT

- Segregate wastes and attempt to retain value of components
- Recycle and reuse materials where possible
- Use care when handling materials, especially when transferring and applying paints, oils and greases

C. AWARENESS

- Communicate environmental information and objectives to employees
- Periodic "friendly" inspections of areas to assess environmental status
- Ensure employees understand environmental impacts of all processes and materials
- Allow employees latitude to find environmentally preferable methods to performing business

II. INVESTIGATION BY PROCESS

A. DEPAINTING

- Evaluate current method of depainting lock gates
- Investigate alternative depainting methods that generate less waste than current system and operate effectively
- Evaulate methods for feasiblity, cost and environmental factors
- Recommend potential alternative methods

B. PAINTING

- Evaluate current paint and method of paint application
- Investigate alternative paints and painting methods that are environmentally preferable to the current vinyl system
- Evaulate methods for feasiblity, cost and environmental factors
- Recommend potential alternative methods and paints

C. STORAGE AND INVENTORY CONTROL

- Evaluate current methods of inventory control, purchasing, and distribution
- Further centralize purchasing to reduce redundant purchases
- Track material use and expiration dates
- Make leftover chemicals available to all Pittsburgh District sites

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WORKSHEET 8

OPTION DESCRIPTION

Option Name Open abrasive blast cleaning with recyclable abrasives

Briefly describe the option: Use a recyclable abrasive to replace the bituminous coal currently used.

Waste Stream(s) Affected: Number 5

Input Material(s) Affected: Bituminous coal

Product(s) Affected:

Indicate Type: ☐ **Source Reduction**

- ___ Equipment-Related Change
- _x_ Personnel/Procedure-Related Change
- _x_ Materials-Related Change

☐ **Recycling/Reuse**

- ___ Onsite
- ___ Offsite
- ___ Material reused for original purpose
- ___ Material used for a lower-quality purpose
- ___ Material sold

Originally proposed by: TRC **Date:** 6/20/94

Reviewed by TRC **Date:**

Approved for study? _x_ yes ___ no By: TRC

Reason for Acceptance or Rejection May substantially reduce the amount of waste generated by the depainting process

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WORKSHEET 8

OPTION DESCRIPTION

Option Name Wet abrasive blast cleaning

Briefly describe the option: Use water to assist the abrasive in removing the paint from the lock gate.

Waste Stream(s) Affected: Number 5

Input Material(s) Affected: Bituminous coal

Product(s) Affected:

Indicate Type: ☐ Source Reduction

x Equipment-Related Change
x Personnel/Procedure-Related Change
x Materials-Related Change

☐ Recycling/Reuse

__ Onsite
__ Offsite

__ Material reused for original purpose
__ Material used for a lower-quality purpose
__ Material sold

Originally proposed by: TRC **Date:** 6/20/94

Reviewed by TRC **Date:**

Approved for study? x yes __ no **By:** TRC

Reason for Acceptance or Rejection May reduce the amount of abrasive that needs to be used per square foot of paint removed

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WORKSHEET 8

OPTION DESCRIPTION

Option Name Ultra high pressure water jetting without abrasive

Briefly describe the option: Use pressurized water (20,000 to 40,000 psi) to remove paint from the lock gate.

Waste Stream(s) Affected: Number 5

Input Material(s) Affected: Bituminous coal

Product(s) Affected:

Indicate Type: ☐ **Source Reduction**

- x Equipment-Related Change
- x Personnel/Procedure-Related Change
- x Materials-Related Change

☐ **Recycling/Reuse**

- __ Onsite
- __ Offsite
- __ Material reused for original purpose
- __ Material used for a lower-quality purpose
- __ Material sold

Originally proposed by: TRC **Date:** 6/20/94

Reviewed by TRC **Date:**

Approved for study? x yes __ no **By:** TRC

Reason for Acceptance or Rejection May increase paint removal efficiency, reduces the amount of dust created during depainting

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WORKSHEET 8

OPTION DESCRIPTION

Option Name Ultra high pressure water jetting with abrasive

Briefly describe the option: Use pressurized water (20,000 to 40,000 psi) with abrasive to remove paint from the lock gate.

Waste Stream(s) Affected: Number 5

Input Material(s) Affected: Bituminous coal

Product(s) Affected: ______

Indicate Type: ☐ Source Reduction

- x Equipment-Related Change
- x Personnel/Procedure-Related Change
- x Materials-Related Change

☐ Recycling/Reuse

- ___ Onsite
- ___ Offsite
- ___ Material reused for original purpose
- ___ Material used for a lower-quality purpose
- ___ Material sold

Originally proposed by: TRC **Date:** 6/20/94

Reviewed by TRC **Date:** ______

Approved for study? x yes ___ no **By:** TRC

Reason for Acceptance or Rejection May increase paint removal efficiency, reduces the amount of dust created during depainting

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WORKSHEET 8

OPTION DESCRIPTION

Option Name Air-cured urethane paint

Briefly describe the option: Replace 2-part epoxy paint system with an air-cured urethane paint.

Waste Stream(s) Affected: Number 9

Input Material(s) Affected: 2-part epoxy paint

Product(s) Affected:

Indicate Type: ☐ **Source Reduction**

- __ Equipment-Related Change
- __ Personnel/Procedure-Related Change
- x Materials-Related Change

☐ **Recycling/Reuse**

- __ Onsite
- __ Offsite
- __ Material reused for original purpose
- __ Material used for a lower-quality purpose
- __ Material sold

Originally proposed by: TRC **Date:** 6/20/94

Reviewed by TRC **Date:**

Approved for study? x yes __ no **By:** TRC

Reason for Acceptance or Rejection May reduce VOC emissions

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WORKSHEET 8

OPTION DESCRIPTION

Option Name Moisture-cured urethane paint

Briefly describe the option: Replace 2-part epoxy paint system with a moisture-cured urethane paint.

Waste Stream(s) Affected: Number 9

Input Material(s) Affected: 2-part epoxy paint

Product(s) Affected:

Indicate Type: ☐ **Source Reduction**

- __ Equipment-Related Change
- __ Personnel/Procedure-Related Change
- x Materials-Related Change

☐ **Recycling/Reuse**

- __ Onsite
- __ Offsite
- __ Material reused for original purpose
- __ Material used for a lower-quality purpose
- __ Material sold

Originally proposed by: TRC **Date:** 6/20/94

Reviewed by TRC **Date:**

Approved for study? x yes __ no **By:** TRC

Reason for Acceptance or Rejection May reduce VOC emissions

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WORKSHEET 8

OPTION DESCRIPTION

Option Name 100 percent solid paint

Briefly describe the option: Replace 2-part epoxy paint system with a 100 percent solid paint.

Waste Stream(s) Affected: Number 9

Input Material(s) Affected: 2-part epoxy paint

Product(s) Affected:

Indicate Type: ☐ Source Reduction

- ___ Equipment-Related Change
- ___ Personnel/Procedure-Related Change
- x Materials-Related Change

☐ Recycling/Reuse

- ___ Onsite
- ___ Offsite
- ___ Material reused for original purpose
- ___ Material used for a lower-quality purpose
- ___ Material sold

Originally proposed by: TRC Date: 6/20/94

Reviewed by TRC Date:

Approved for study? x yes ___ no By: TRC

Reason for Acceptance or Rejection May reduce VOC emissions

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WORKSHEET 8 | **OPTION DESCRIPTION**

Option Name Powder coating

Briefly describe the option: Replace 2-part epoxy paint system with a powder coating.

Waste Stream(s) Affected: Number 9

Input Material(s) Affected: 2-part epoxy paint

Product(s) Affected: ______

Indicate Type: ☐ **Source Reduction**

- ___ Equipment-Related Change
- ___ Personnel/Procedure-Related Change
- x Materials-Related Change

☐ **Recycling/Reuse**

- ___ Onsite
- ___ Offsite
- ___ Material reused for original purpose
- ___ Material used for a lower-quality purpose
- ___ Material sold

Originally proposed by: TRC **Date:** 6/20/94

Reviewed by TRC **Date:** ______

Approved for study? x yes ___ no **By:** TRC

Reason for Acceptance or Rejection May reduce VOC emissions

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WORKSHEET
8

OPTION DESCRIPTION

Option Name High-volume, low-pressure spray application

Briefly describe the option: Equipment that atomizes paint at a low pressure by subjecting it to high volumes of air.

Waste Stream(s) Affected: Number 9

Input Material(s) Affected: 2-part epoxy paint

Product(s) Affected: ______

Indicate Type:
- ☐ Source Reduction
  - x Equipment-Related Change
  - x Personnel/Procedure-Related Change
  - __ Materials-Related Change
- ☐ Recycling/Reuse
  - __ Onsite
  - __ Offsite
  - __ Material reused for original purpose
  - __ Material used for a lower-quality purpose
  - __ Material sold

Originally proposed by: TRC Date: 9/05/94

Reviewed by TRC Date: ______

Approved for study? x yes __ no By: TRC

Reason for Acceptance or Rejection May reduce overspraying of paint, therefore reducing VOC emissions during the painting operation

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WORKSHEET 8

OPTION DESCRIPTION

Option Name Electrostatic spray application

Briefly describe the option: Equipment generates a large electrostatic charge which causes the paint to coat all exposed conductive areas. This method has not yet been proven for large steel structures.

Waste Stream(s) Affected: Number 9

Input Material(s) Affected: 2-part epoxy paint

Product(s) Affected: ____

Indicate Type: ☐ **Source Reduction**

x Equipment-Related Change
x Personnel/Procedure-Related Change
__ Materials-Related Change

☐ **Recycling/Reuse**

__ Onsite __ Material reused for original purpose
__ Offsite __ Material used for a lower-quality purpose
__ Material sold

Originally proposed by: TRC **Date:** 9/05/94

Reviewed by TRC **Date:** ____

Approved for study? x yes ____ no **By:** TRC

Reason for Acceptance or Rejection May reduce overspraying of paint, therefore reducing VOC emissions during the painting operation

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WORKSHEET 8

OPTION DESCRIPTION

Option Name Centralized purchasing

Briefly describe the option: Require that all sites within the Pittsburgh District purchase materials through PEWARS. Store all materials at PEWARS.

Waste Stream(s) Affected: Number 10

Input Material(s) Affected: All raw materials purchased

Product(s) Affected: Various

Indicate Type: ☐ **Source Reduction**

- ___ **Equipment-Related Change**
- _x_ **Personnel/Procedure-Related Change**
- _x_ **Materials-Related Change**

☐ **Recycling/Reuse**

- ___ **Onsite**
- ___ **Offsite**
- ___ **Material reused for original purpose**
- ___ **Material used for a lower-quality purpose**
- ___ **Material sold**

Originally proposed by: TRC **Date:** 9/05/94

Reviewed by TRC **Date:** ______

Approved for study? _x_ **yes** ___ **no** **By:** TRC

Reason for Acceptance or Rejection May further reduce losses due to expired materials, also may reduce duplication of purchases