Cost-Benefit Analysis
For
Alternative Low-Emission Surface Preparation/ Depainting Technologies for Structural Steel

FINAL

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April 6, 2007

Prepared by
ITB, Inc.
Beavercreek, OH 45432

Submitted by
NASA Technology Evaluation for Environmental Risk Mitigation Principal Center

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PREFACE

This report was prepared by ITB, Inc., through the National Aeronautics and Space Administration (NASA) Technology Evaluation for Environmental Risk Mitigation Principal Center (TEERM) under Contract Number NAS10-03029. The structure, format, and depth of technical content of the report were determined by NASA TEERM, Government contractors, and other Government technical representatives in response to the specific needs of this project.

We wish to acknowledge the invaluable contributions provided by all the organizations involved in the creation of this document.

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EXECUTIVE SUMMARY

Stennis Space Center (SSC), Kennedy Space Center (KSC) and Air Force Space Command (AFSPC) identified particulate emissions and waste generated from the depainting process of steel structures as hazardous materials to be eliminated or reduced.

A Potential Alternatives Report, *Potential Alternatives Report for Validation of Alternative Low Emission Surface Preparation/Depainting Technologies for Structural Steel*, provided a technical analyses of identified alternatives to the current coating removal processes, criteria used to select alternatives for further analysis, and a list of those alternatives recommended for testing.

The initial coating removal alternatives list was compiled using literature searches and stakeholder recommendations. The involved project participants initially considered approximately 13 alternatives. In late 2003, core project members selected the following depainting processes to be further evaluated:

- Plastic Blast Media—Quickstrip®-A.
- Hard Abrasive—Steel-Magic®.
- Sponge Blasting—Sponge-Jet®.
- Liquid Nitrogen—NitroJet®.
- Mechanical Removal with Vacuum Attachment—DESCO and DCM *Clean-Air*
- Laser Coating Removal

Alternatives were tested in accordance with the *Joint Test Protocol for Validation of Alternative Low-Emission Surface Preparation/Depainting Technologies for Structural Steel*, and the *Field Evaluation Test Plan for Validation of Alternative Low-Emission Surface Preparation/Depainting Technologies for Structural Steel.* Results of the testing are documented in the Joint Test Report.

This Cost-Benefit Analysis (CBA) focuses on the three alternatives (Quickstrip®-A, Steel-Magic®, and Sponge-Jet®) that were considered viable alternatives for large area operations based on the results of the field demonstration and lab testing. This CBA was created to help participants determine if implementation of the candidate alternatives is economically justified.

Each of the alternatives examined reduced Environmental Activity (EA) Costs—those costs associated with complying with environmental regulations. One alternative, Steel-Magic®, also showed reduced Direct Costs and reduced total costs.

1.0 INTRODUCTION

Manned and unmanned space programs face the same challenges in corrosion control and compliance with federal, state and local environmental laws. Both are responsible for a number of facilities/structures with metallic structural and non-structural components in highly and moderately corrosive environments. Regardless of the corrosivity of the environment, all metals require periodic maintenance activity to guard against the insidious effects of corrosion and thus ensure that structures meet or exceed design or performance life. Environmentally preferable methods are needed to support space/launch/range operations while reducing hazardous materials usage and total ownership costs.

To help address these requirements, Air Force Space Command (AFSPC) and the National Aeronautics and Space Administration (NASA) have agreed to conduct joint projects to reduce total life cycle costs, eliminate duplication, and ensure best solution to support US Space civilian and military programs. Within NASA, the Technology Evaluation for Environmental Risk Mitigation Principal Center (TEERM), formerly the NASA Acquisition Pollution Prevention (AP2) Office, has Agency responsibility for coordinating intra- and inter-agency activities affecting pollution prevention issues identified during system and component acquisition and sustainment processes. The primary objectives of TEERM are to:

- Reduce or eliminate the use of hazardous materials or hazardous processes at manufacturing, remanufacturing, and sustainment locations.
- Avoid duplication of effort in actions required to reduce or eliminate Hazardous materials through joint center cooperation and technology sharing.

Within AFSPC, the Headquarters AFSPC Weapon Systems Pollution Prevention Program has an analogous role.

As part of the TEERM project methodology, the CBA is used as a tool for evaluating investments in environmental technologies that address compliance and pollution prevention issues. This CBA quantifies the estimated capital and process costs of the coating removal alternatives in relation to the current coating removal process.

This CBA is based on a number of assumptions and information gathered during the field demonstrations that occurred at SSC in Mississippi in 2004. The estimates in this CBA should not be used for any purpose beyond estimating the relative merits of the potential alternatives. The actual economic effects at any specific facility will depend on the alternative material or technology implemented, the number of actual applications converted, future workloads, and other factors.

1.1 Background

The conventional coating removal systems typically use abrasive blast media, which generate large quantities of hazardous waste subject to high disposal costs and scrutiny under environmental regulations, or chemicals that are high in volatile organic compounds and hazardous air pollutants, which are targeted for reduction/elimination by environmental regulations. This project focused on the use of abrasive blast media. Information regarding the types of hazardous materials used in the current processes, as well as the affected programs, applications, and substrates are listed in Table 1-1.

Table 1-1 Target Hazardous Materials Summary

Target HazMat	***Current Process***	***Applications***	***Current Specifications***	***Affected Programs***	***Candidate Parts/Substrates***
Airborne particulates and contaminated particulate matter	Dry Abrasive Blasting using materials such as coal slag	Maintenance of Test Stands, Ground Support Equipment, Shuttle Support Structures, Launch Pads, Towers and general structures.	SSPC-SP-5; SSPC-SP-10	Ground Support and Facilities Maintenance	A36 Carbon Steel; Aluminum Alloy 6061

1.2 Objectives and Scope of Work

The primary objective of the project was to demonstrate and validate alternatives to coating removal methods used across NASA and AFSPC. The focus was on large-area structural steel applications such as launch pads, test stands, and ground support equipment. This CBA is to help participants determine if implementation of the candidate alternatives is economically justified. Calculations are pertinent to the years 2005-2006.

1.3 Coating Removal Methods Overview

Since regulations have become more restrictive concerning the release of chlorinated solvent emissions and generation of hazardous waste, research efforts have been focused on developing innovative alternative technologies (e.g., environmentally acceptable chemical strippers, light-based technologies, and recyclable media) that would replace conventional coating removal processes (e.g., media blasting and chemical strippers) for large area coating removal.

This CBA is valid for areas that classified as "attainment" under the Clean Air Act, or "any area that meets the national primary or secondary ambient air quality standard for the pollutant." The pollutant in this study is particulate matter. Areas that are considered "non-attainment" and/or have more stringent local regulations call for additional study as their requirements may add additional costs that were not considered in this analysis.

2.0 TECHNICAL APPROACH

The methodology used to conduct this CBA is based on the Environmental Cost Analysis Methodology (ECAM^{SM}). The ECAM^{SM} was developed for the Department of Defense to provide a consistent means of quantifying and evaluating environmental costs and benefits. A copy of the ECAM^{SM} Handbook can be requested at http://www.ndcee.ctc.com/ecam/.

Information about each process was gathered including general process descriptions, process flow diagrams, process equipment, estimated material and energy usage, anticipated wastes and emissions and environmental factors and can be found in the *Potential Alternatives Report for Validation of Alternative Low-Emission Surface Preparation/Depainting Technologies for Structural Steel*.

Only those steps of each process that differed from the Baseline Process were examined. Costs were assigned to those steps of each process that changed and used to calculate the financial analysis metrics of Net Present Value and Payback Period.

2.1 General Assumptions

This CBA is based on a number of assumptions and information gathered during the field demonstrations that occurred at SSC. The estimates in this CBA should not be used for any purpose beyond estimating the relative merits of the potential alternatives. The actual economic effects at any specific facility will depend on the alternative material or technology implemented, the number of actual applications converted, future workloads, and other factors.

This cost analysis incorporates specific assumptions consistent with Office of Management and Budget (OMB) policies. Depreciation is not considered; after an investment has been made from the current year's budget, the value of that investment is not depreciated and modified in future years. Because NASA and the Air Force do not pay state, local, or federal income taxes, taxes are not included in this financial analysis.

This CBA uses a 10-year study period for evaluating the financial viability of the proposed investment. Analyzing the investment over such a length of time, which is generally longer than that used in traditional methods, allows organizations to evaluate the real costs and benefits of the proposed technology, as returns on pollution prevention investments are generally longer term.

The discount rate to be used is based on guidance offered by the OMB through OMB Circular A-94. Note that the OMB reference provides both *real* and *nominal* rates for specified time periods, or *maturities*: 3-, 5-, 7-, 10-, and 30-year periods. Real interest rates account for the effect of inflation when conducting financial analyses.

Assumptions that apply to individual processes are included in their respective sections such as the amount of labor required, which is dependent upon the coating strip rate of each technology.

- The amount of primary waste per job was calculated by multiplying the surface area to be depainted times the coating thickness (assumed to be 6 mils):

$$\mathbf{25{,}000\ ft^2 \times 6\ mils = 12.5\ ft^3 \approx 80\ gal}$$

- The amount of secondary waste for each alternative was calculated by dividing the amount of media required for the job by its density and converting to gallons (dry).
- The number of 55-gallon drums required for waste disposal was calculated by adding the amounts of primary and secondary wastes and dividing by 55 gallons (the volume of the container) and rounding up to the nearest whole number.

2.2 Unit Costs

Unit costs were calculated for the current and proposed depainting technologies. The unit cost incorporates the direct and indirect costs associated with the depainting operations. A brief description of the cost input parameters for Direct Costs and Environmental Activity Costs are provided in its respective section.

3. DIRECT COSTS

The following subsections look at the Direct Costs (conventional costs associated with a process) for the Baseline Process and candidate alternatives.

The unit costs for Direct Costs are based on the surface area, labor costs, material costs, and equipment costs. A brief description of the cost input parameters is provided in Table 3-1.

Table 3-1 Unit Cost Calculation Elements for Direct Costs

Item	*Assumption*
Work Load	A "job" shall be defined as a surface area of 25,000 ft^2.
Labor Hours	The number of worker hours required to perform the depainting activity are calculated using the average coating strip rate per worker.
Labor Costs for Depainting Activities	A labor rate of $19.75 per hour plus $8.50 in fringe benefits was used to determine a total labor rate of $28.25. The labor rate was multiplied by 2.5 to represent a burdened labor rate of $70.63 that includes the overhead costs associated with depainting activities. The burdened labor rate was multiplied by the number of labor hours and the number of laborers to perform the depainting operation to get the total labor costs for the depainting activities.
Material Costs	The material costs are based on the number of pounds of media required to complete the depainting activity. The material costs are based on the material required to meet the SSPC specifications for the selected coatings (including recycling the media if acceptable).
Equipment Costs	Equipment costs are included if there was a change in equipment required by the selected technology.

3.1 Black Beauty® Direct Costs

Figure 3-1 shows a Process Flow Diagram for the Black Beauty® process including inputs (such as labor and materials) and outputs (such as emissions and waste).

Based on the process flow diagram and information gathered, Table 3-2 was created to quantify activity costs for the Black Beauty® Abrasive process.

Assumptions used are:

1. Black Beauty® Utility BB1040 Abrasive will be used.
2. Cost of material: $ 99 / ton (cost for bulk purchase less than 21 tons).
3. Coating strip rate: 1.7 ft^2 / min.
4. Material Consumption: 1 ton / 1,000 ft^2 = 50,000 lb / 25,000 ft^2.

Table 3-2 Direct Costs for Black Beauty® Process

Resource	*Quantities Used*	*Cost Factors*	*Cost*
Labor (to depaint)	245 hrs	$70.63 per hr	$17,311
Black Beauty® Material	25 tons	$99.00 per ton	$2,475
		Total Direct Costs Per Job	**$19,786**
		Total Direct Costs Per Year	**$197,863**

*NOTE: Direct costs do not include Environmental Activity Costs

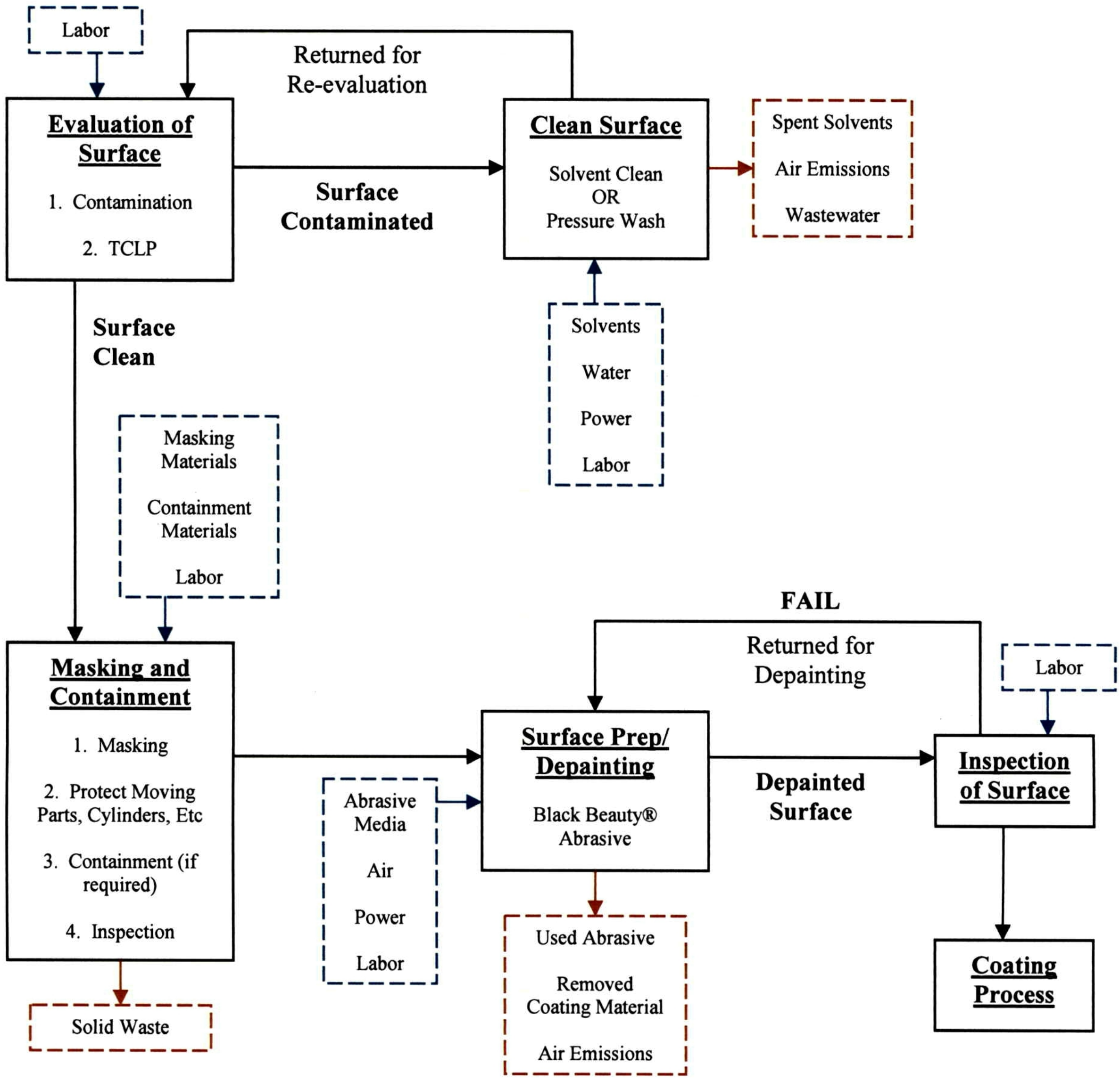

Figure 3-1 Process Flow Diagram for Black Beauty® Process

3.2 Quickstrip®-A Direct Costs

Quickstrip®-A is a clean, safe, easy-to-use and fast process for efficient coatings removal, deflashing, surface preparation, mold cleaning and nearly every other industrial cleaning application. It effectively removes coatings from steel, plastics, aluminum, fiberglass, brass and a variety of other materials in a wide range of industries. Quickstrip®-A replaces chemical stripping, sand blasting and other hard abrasive blast operations and also avoids damage to delicate substrates.

Figure 3-2 shows a Process Flow Diagram for the Quickstrip®-A process including inputs (such as labor and materials) and outputs (such as emissions and waste). Quickstrip®-A media is recyclable thus reducing the amount of material needed. US Technology Corporation collects and recycles all used media and collected debris resulting in zero waste from the actual surface preparation/depainting step. However, containment is required to ensure capture of all used media for recycling and capture of all waste and debris for returning to the manufacturer.

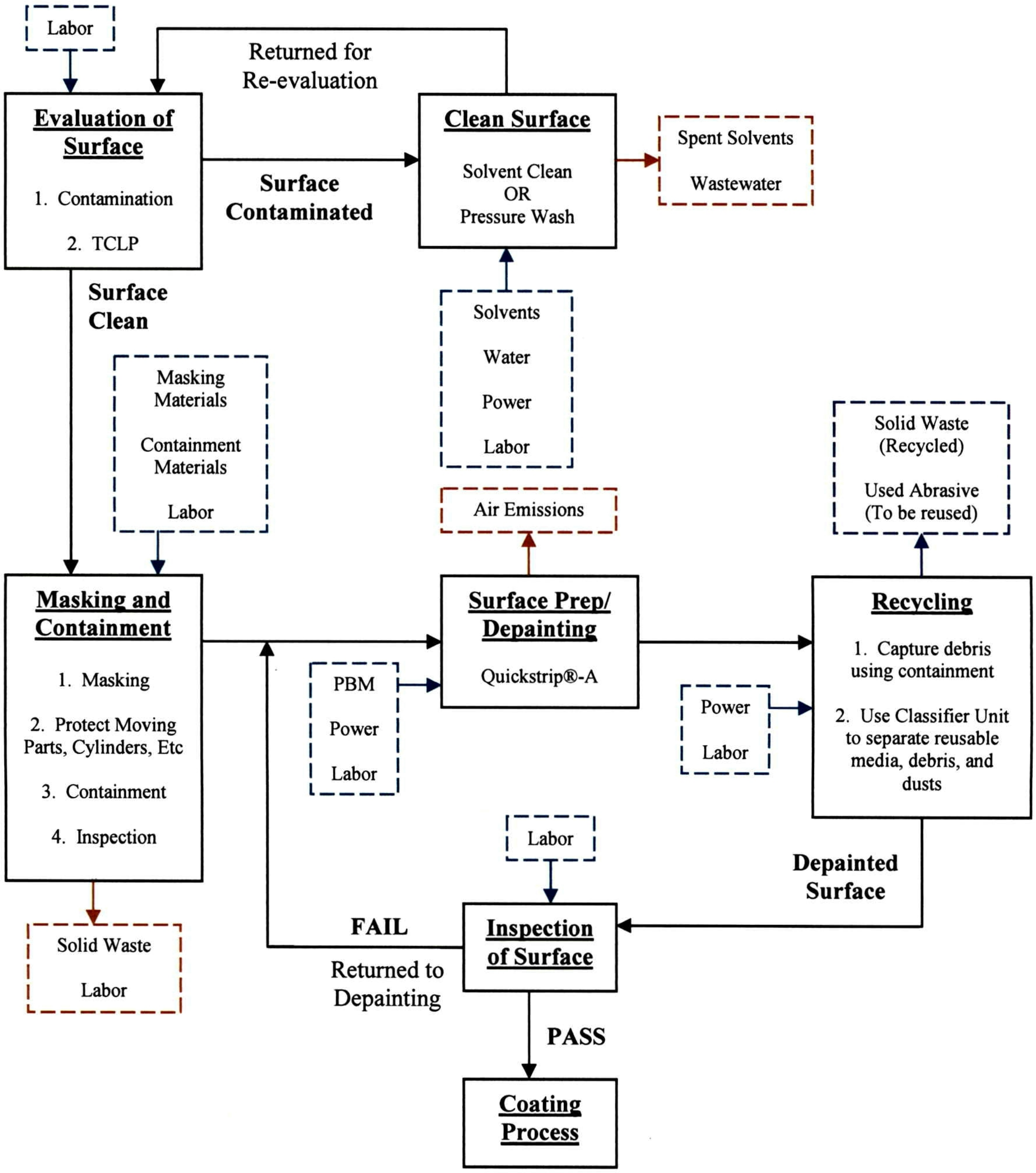

Figure 3-2 Process Flow Diagram for Quickstrip®-A Process

Based on the Process Flow Diagram and information gathered, Table 3-3 was created to quantify activity costs for the Quickstrip®-A process.

Assumptions used are:

1. Quickstrip®-A 10-20 abrasive will be used
2. Cost of material: $ 2.25 / lb
3. Coating strip rate: 3.2 ft^2 / min
4. Material Consumption*: 17,000 lb / 25,000 ft^2

***NOTE**: Material usage includes recycling the media with a 25% loss of the media for each time the material is recycled due to worn out media and media that is not captured for recycling. There will be recycled media left over each refurbishment (assumed to be 25%) for subsequent work thus reducing the amount of new material required over time. This additional media is considered further in the life-cycle cost analysis.

Table 3-3 Direct Costs for Quickstrip®-A Process

Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (to depaint)	181 hrs	$70.63 per hr	$12,795
Quickstrip®-A Material	17000 lb	$2.25 per lb	$38,250
		Total Direct Costs Per Job	**$51,045**
		Total Direct Costs Per Year	**$510,453**

*NOTE: Direct costs do not include Environmental Activity Costs

3.3 Steel-Magic® Direct Costs

Steel-Magic® is a clean, safe, easy-to-use and fast process for efficient coatings removal, deflashing, surface preparation, mold cleaning and nearly every other industrial cleaning application. It effectively removes coatings from steel, plastics, aluminum, fiberglass, brass and a variety of other materials in a wide range of industries. Hard abrasive media replaces chemical stripping, sand blasting and other hard abrasive blast operations. The media can also be recycled resulting in less material required for depainting and less waste.

Figure 3-3 shows a Process Flow Diagram for the Steel-Magic® process including inputs (such as labor and materials) and outputs (such as emissions and waste). Steel-Magic® media is recyclable thus reducing the amount of material needed. US Technology Corporation collects and recycles all used media and collected debris resulting in zero waste from the actual surface preparation/depainting step. However, containment is required to ensure capture of all used media for recycling and capture of all waste and debris for returning to the manufacturer.

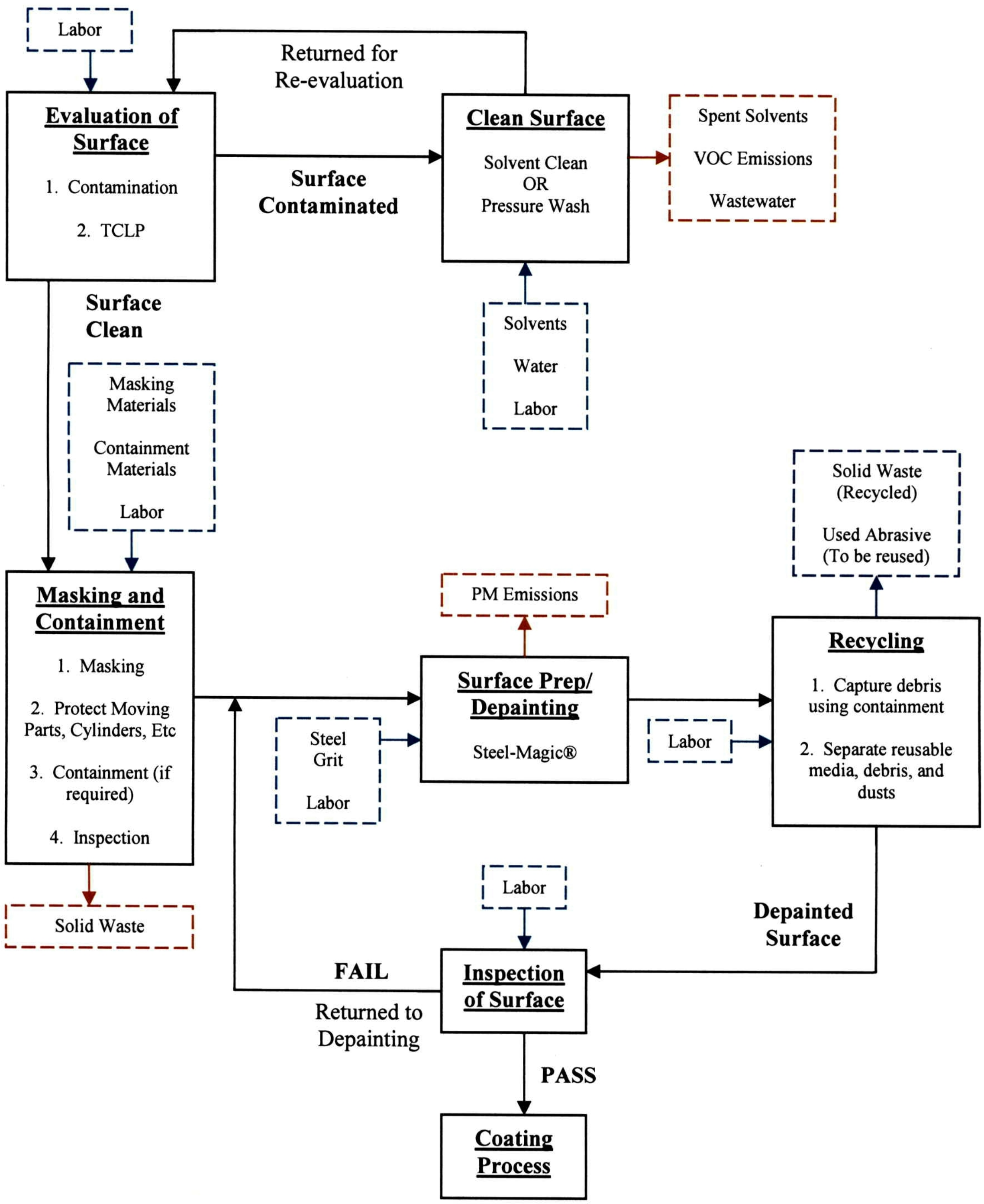

Figure 3-3 Process Flow Diagram for Steel-Magic® Process

Based on the Process Flow Diagram and information gathered, Table 3-4 was created to quantify activity costs for a single refurbishment for the Steel-Magic® process.

Assumptions used are:

1. Steel-Magic® Coarse abrasive will be used
2. Cost of material: $1.25 / lb
3. Coating strip rate: 4.3 ft^2 / min
4. Material Consumption*: 14,000 lb / 25,000 ft^2

***NOTE**: Material usage includes recycling the media with a 25% loss of the media for each time the material is recycled due to worn out media and media that is not captured for recycling. There will be recycled media left over each refurbishment (assumed to be 25%) for subsequent work thus reducing the amount of new material required over time. This additional media is considered further in the life-cycle cost analysis.

Table 3-4 Direct Costs for Steel-Magic® Process

Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (to depaint)	97 hrs	$70.63 per hr	$6,844
Steel-Magic® Material	14000 lb	$1.25 per lb	$17,500
		Total Direct Costs Per Job	**$24,344**
		Total Direct Costs Per Year	**$243,440**

*NOTE: Direct costs do not include Environmental Activity Costs

3.4 Sponge-Jet® Direct Costs

Sponge blasting systems incorporate various grades of water-based urethane-foam cleaning media in order to clean and prepare surfaces. The foam cleaning media is absorptive and can be used either dry or wetted with various cleaning agents and surfactants to capture, absorb and remove a variety of surface contaminants such as oils, greases, lead compounds, chemicals, and radionuclides. Using the foam media wetted also provides for dust control without excess dampening of the surface being cleaned.

The media can also be recycled resulting in less material required for depainting and less waste. However, containment is required to ensure capture of all used media for recycling.

Figure 3-4 shows a Process Flow Diagram for the Sponge-Jet® process including inputs (such as labor and materials) and outputs (such as emissions and waste). Sponge-Jet® media is recyclable thus reducing the amount of material needed.

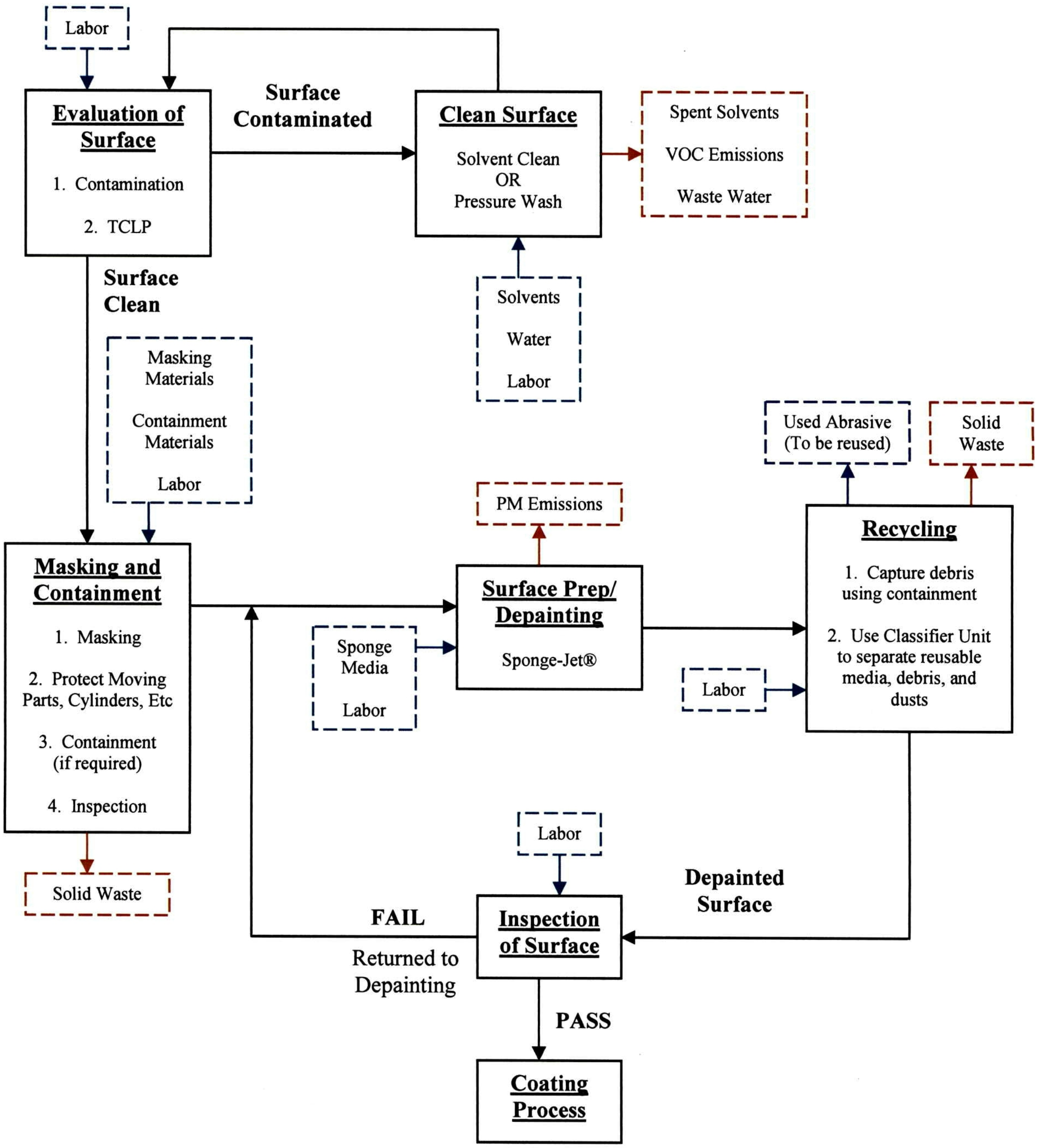

Figure 3-4 Process Flow Diagram for Sponge-Jet® Process

Based on the Process Flow Diagram and information gathered, Table 3-5 was created to quantify activity costs for the Sponge-Jet® process.

Assumptions used are:

1. Sponge-Jet® Silver 30 Abrasive will be used
2. Cost of material: $75 per 40 lb bag
3. Coating strip rate: 2.7 ft^2 / min
4. Material Consumption*: 15,000 lb / 25,000 ft^2

***NOTE**: Material usage includes recycling the media with a 25% loss of the media for each time the material is recycled due to worn out media and media that is not captured for recycling. There will be recycled media left over each refurbishment (assumed to be 25%) for subsequent work thus reducing the amount of new material required over time. This additional media is considered further in the life-cycle cost analysis.

Table 3-5 Direct Costs for Sponge-Jet® Process

Resource	*Quantities Used*	*Cost Factors*	*Cost*
Labor (to depaint)	154 hrs	$70.63 per hr	$10,900
Sponge-Jet® Material	15000 lb	$1.88 per lb	$28,200
		Total Direct Costs Per Job	**$39,100**
		Total Direct Costs Per Year	**$390,997**

*NOTE: Direct costs do not include Environmental Activity Costs

3.5 Summary of Direct Costs

Table 3-6 provides a summary of the Direct Costs for the Baseline and alternative processes.

None of the alternatives provide cost savings in terms of Direct Costs. Although the 'Labor Costs' are all lower due to faster strip rates, those savings are off-set by the cost of the media. Even when the media is recycled, its overall cost is more when examined for both the initial and subsequent jobs.

The Steel-Magic® is the lowest priced alternative when considering Direct Costs, costing only $6,202/yr more than the Baseline process.

Table 3-6 Summary of Direct Costs

Depainting Process	Media Cost per Pound	Media Required per Job (lbs)	Media Cost for Initial Job	Media Left for Next Job (lbs) [1]	Media Required per Year [2]	Media Cost per Year	Media Strip Rate [3]	Direct Labor Cost per Job [4]	Direct Labor Cost per Year	Total Direct Costs for Initial Job	Total Direct Costs per Year	Direct Cost Savings per Year
Black Beauty®	$0.05	50,000	$2,475	0	500,000	$24,750	1.7	$17,311	$173,110	$19,786	$197,863	**$0**
Quickstrip®-A	$2.25	17,000	$38,250	4,250	131,750	$296,438	2.3	$12,795	$127,950	$51,045	$424,390	**($226,528)**
Steel-Magic®	$1.25	14,000	$17,500	3,500	108,500	$135,625	4.2	$6,844	$68,440	$24,344	$204,065	**($6,202)**
Sponge-Jet®	$1.88	15,000	$28,200	3,750	116,250	$218,550	2.7	$10,900	$109,000	$39,100	$327,547	**($129,684)**

(#####) = negative number

[1] Based on an average rate of 25% of initial starting amount of media.

[2] Based on the amount of original material and reusable media from all jobs that year (assuming 10 total).

[3] Based on DFT of 6 mils.

[4] Assumes 25,000 sq ft of surface area per job with a labor rate of $70.63/hr.

4.0 CAPITAL COSTS

Capital costs are the capital equipment costs of the proposed technology. The Baseline Process was not evaluated for Capital Costs since new equipment will not be required to be purchased.

4.1 Quickstrip®-A Capital Costs

The Vacu-Blast® Blast and Recovery System (BRS) is the recommended unit for blasting and recycling. Either the 2.0 cu. ft. or the 3.5 cu. ft. systems are suitable for the type of operations performed and are available in both pneumatic and electric versions and portable or skid mount. The unit can blast and vacuum simultaneously thus eliminating dust clouds and poor visibility; or independently.

Quickstrip®-A can also be used in a standard blast pot such as one currently used by the Baseline process. If used with existing Baseline equipment, the equipment that must be purchased includes a vacuum for collecting recyclable media and a recycling unit.

Equipment		*Cost*
Vacu-Blast BRS (includes blast pot and recycler)		$ 22,000
Dual head (3" work head with 50 ft of hose)		$ 700
	TOTAL	**$ 22,700**

Or

Equipment		*Cost*
70-P Pneumatic Recycler (capable of serving two blast pots)		$ 15,000
55-Gallon Drum Vacuum		$ 3,000
	TOTAL	**$ 18,000**

The total cost of purchasing the Vacu-Blast® BRS ($22,000) will be used for this analysis. The Vacu-Blast® BRS system was chosen over using the existing equipment and purchasing a vacuum and recycler because of only a small difference in cost and the expected benefits of the Vacu-Blast® BRS system such as the simultaneous blasting and vacuuming feature.

4.2 Steel-Magic® Capital Costs

The Vacu-Blast® Blast and Recovery System (BRS) is the recommended unit for blasting and recycling. Either the 2.0 cu. ft. or the 3.5 cu. ft. systems are suitable for the type of operations performed and are available in both pneumatic and electric versions and portable or skid mount. The unit can blast and vacuum simultaneously thus eliminating dust clouds and poor visibility; or independently.

Steel-Magic® can also be used in a standard blast pot such as one currently used by the Baseline process. If used with existing Baseline equipment, the equipment that must be purchased includes a vacuum for collecting recyclable media and a recycling unit.

Equipment		*Cost*
Vacu-Blast BRS (includes blast pot and recycler)		$ 22,000
Dual head (3" work head with 50 ft of hose)		$ 700
	TOTAL	**$ 22,700**

Or

Equipment		*Cost*
70-P Pneumatic Recycler (capable of serving two blast pots)		$ 15,000
55-Gallon Drum Vacuum		$ 3,000
	TOTAL	**$ 18,000**

The total cost of purchasing the Vacu-Blast® BRS ($22,000) will be used for this analysis. The Vacu-Blast® BRS system was chosen over using the existing equipment and purchasing a vacuum and recycler because of only a small difference in cost and the expected benefits of the Vacu-Blast® BRS system such as the simultaneous blasting and vacuuming feature.

4.3 Sponge-Jet® Capital Costs

The equipment required consists of two specially designed transportable modules, which include the Feed Unit and the Classifier Unit. A standard blast pot cannot be used due to the properties of the media. The identified equipment is specially designed to prevent the material from clumping.

The Feed Unit is pneumatically powered for propelling the foam cleaning media. The unit is portable and is produced in several sizes (depending on the capacity required). A 100 horsepower (hp) unit is available for small to medium projects and has increased mobility; the typical unit for large operations is 400 hp. A hopper, mounted at the top of the unit, holds the foam media. The media is fed into a metering chamber that mixes the foam cleaning media with compressed air. By varying the feed unit air pressure and type of cleaning media used, sponge blasting can remove a range of coatings from soot on wallpaper to high-performance protective coatings on steel and concrete surfaces.

The Classifier Unit or Recycler (which can be pneumatic or electric) is used to remove large debris and powdery residues from the foam media after each use. The pneumatic unit requires a minimum 100 cubic feet per minute at 30 pounds per square inch. The electric recyclers require a minimum 30 amps, 115 volt, single-phase, 60 hertz power source. The used media is collected and placed into an electrically powered sifter. The vibrating sifter classifies the used media with a stack of progressively finer screens. Large contaminants, such as paint flakes, rust particles, etc., are collected on the coarsest screens. The reusable foam media are collected on the corresponding screen size. The dust and finer particles fall through the sifter and are collected for disposal. After classifying, the reclaimed foam media can be reused immediately in the Feed Unit.

Costs for the equipment depends on whether a completely self-contained unit (includes blast pot, vacuum, and classifier) is purchased or if each module is purchased separately.

Equipment	*Cost*
Self-Contained Unit (B-Vac Pro 2 unit includes all modules)	**$ 70,000**

Or

Equipment	*Cost*
400-HP Feed Unit (suitable for most applications)	$ 19,000
70-P Pneumatic Recycler (capable of serving two blast pots)	$ 15,000
55-Gallon Drum Vacuum	$ 3,000
TOTAL	**$ 37,000**

The lower cost of $37,000 for purchasing the modules separately will be used for this analysis.

5.0 ENVIRONMENTAL ACTIVITY COSTS

The following subsections look at the EA Costs associated with the baseline process and candidate alternatives. Environmental Activities that differ from the baseline process and are included in this analysis are:

- Sampling waste streams to be tested/analyzed.
- Testing/analysis of waste streams: A Toxicity Characteristic Leaching Procedure (TCLP) is used to determine whether any the waste contains any hazardous constituents.
- Transportation of wastes on site.
- Hazardous waste manifest preparation and container labeling.
- Record-keeping associated with hazardous waste.

The unit costs for EA Costs are based on the surface area, labor costs, and material costs. The number of worker hours required to perform the environmental activity is based on information gathered. A brief description of the EA cost input parameters is provided in Table 5-1.

Table 5-1 Unit Cost Calculation Elements for EA Costs

Item	*Assumption*
Labor Costs Associated with Waste	A labor rate of \$24.75 per hour plus \$10.50 in fringe benefits was used to determine a total labor rate of \$35.25. The labor rate was multiplied by 2.5 to represent a burdened labor rate of \$88.13 that includes the overhead costs associated with EA activities. Cost associated with sample taking for testing/analysis of waste stream: Estimated to be 1 hour. Cost associated with time to transport wastes: Estimated to be 5 minutes per drum for loading, unloading, transport. Cost associated with time to prepare HW manifest and label drums: Estimated to be 10 minutes per drum. Cost associated with record-keeping of hazardous waste: Estimated to be ½ hour per drum.
Waste Disposal Costs	Cost of 55-gallon drum: \$50 per drum Cost of hazardous waste disposal: \$75 per drum Cost of TCLP = \$250

5.1 Black Beauty® EA Costs

Based on the Process Flow Diagram and information gathered, Table 5-2 was created to quantify EA costs for the Black Beauty® (Baseline) process.

Assumptions used are:

1. Black Beauty® Utility BB1040 Abrasive Density ≈ 169 lb/ft^3.
2. Secondary waste = Lbs of media used / density = 50,000 lbs / 169 lb/ft^3 = 296 ft^3 = 1902 gal (dry).

Table 5-2 EA Costs for Black Beauty® Process

Resource	*Quantities Used*	*Cost Factors*	*Cost*
Labor (Sample waste stream)	1 hrs	$44.07 per hr	$44
TCLP	1 TCLP	$250.00 per TCLP	$250
Labor (Transport wastes on-site)	3.1 hrs	$44.07 per hr	$136
Labor (HW manifest/labeling)	6.2 hrs	$44.07 per hr	$272
Labor (Record keeping)	18.5 hrs	$44.07 per hr	$816
55-gal drums required	37 drums	$50.00 per drum	$1,852
Disposal of drums	37 drums	$75.00 per drum	$2,778
		Total EA Costs Per Job	**$4,630**
		Total EA Costs Per Year	**$46,295**

5.2 Quickstrip®-A EA Costs

Based on the Process Flow Diagram and information gathered, Table 5-3 was created to quantify EA costs for the Quickstrip®-A process.

Assumptions used are:

1. Cost of Quickstrip®-A material includes:
    a. Freight from manufacturer to jobsite
    b. Freight from jobsite to manufacturer
    c. Recycling of spent material
    d. Drums
    e. Shipping Labels
2. Since all waste is gathered and returned to the manufacturer for recycling, no waste is generated to be drummed, shipped, or tracked.

Table 5-3 EA Costs for Quickstrip®-A Process

Resource	*Quantities Used*	*Cost Factors*	*Cost*
Labor (Sample waste stream)	0 hrs	$44.07 per hr	$0
TCLP	0 TCLP	$250.00 per TCLP	$0
Labor (Transport wastes on-site)	0 hrs	$44.07 per hr	$0
Labor (HW manifest/labeling)	0 hrs	$44.07 per hr	$0
Labor (Record keeping)	0 hrs	$44.07 per hr	$0
55-gal drums required	0 drums	$50.00 per drum	$0
Disposal of drums	0 drums	$75.00 per drum	$0
		Total EA Costs Per Job	**$0**
		Total EA Costs Per Year	**$0**

5.3 Steel-Magic® EA Costs

Based on the Process Flow Diagram and information gathered, Table 5-4 was created to quantify EA costs for the Steel-Magic® process.

Assumptions used are:

1. Cost of Steel-Magic® material includes:
    a. Freight from manufacturer to jobsite
    b. Freight from jobsite to manufacturer
    c. Recycling of spent material
    d. Drums
    e. Shipping Labels
2. Since all waste is gathered and returned to the manufacturer for recycling, no waste is generated to be drummed, shipped, or tracked.

Table 5-4 EA Costs for Steel-Magic® Process

Resource	*Quantities Used*	*Cost Factors*	*Cost*
Labor (Sample waste stream)	0 hrs	$44.07 per hr	$0
TCLP	0 TCLP	$250.00 per TCLP	$0
Labor (Transport wastes on-site)	0 hrs	$44.07 per hr	$0
Labor (HW manifest/labeling)	0 hrs	$44.07 per hr	$0
Labor (Record keeping)	0 hrs	$44.07 per hr	$0
55-gal drums required	0 drums	$50.00 per drum	$0
Disposal of drums	0 drums	$75.00 per drum	$0
		Total EA Costs Per Job	**$0**
		Total EA Costs Per Year	**$0**

5.4 Sponge-Jet® EA Costs

Based on the Process Flow Diagram and information gathered, Table 5-5 was created to quantify EA costs for the Sponge-Jet® process.

Assumptions used are:

1. Sponge-Jet® Silver 30 Abrasive Density ≈ 46.8 lb/ft^3
2. Secondary waste = Lbs of media that cannot be recycled / density = 11,250 lbs / 46.8 lb/ft^3 = 240 ft^3 = 1,546 gal (dry).

Table 5-5 EA Costs for Sponge-Jet® Process

Resource	*Quantities Used*		*Cost Factors*		*Cost*
Labor (Sample waste stream)	1	hrs	$44.07	per hr	$44
TCLP	1	TCLP	$250.00	per TCLP	$250
Labor (Transport wastes on-site)	2.5	hrs	$44.07	per hr	$108
Labor (HW manifest/labeling)	4.9	hrs	$44.07	per hr	$217
Labor (Record keeping)	14.8	hrs	$44.07	per hr	$651
55-gal drums required	30	drums	$50.00	per drum	$1,478
Disposal of drums	30	drums	$75.00	per drum	$2,217
			Total EA Costs Per Job		**$3,695**
			Total EA Costs Per Year		**$36,955**

5.5 Summary of EA Costs

Table 5-6 provides a summary of the EA Costs for the Baseline and alternative processes.

All of the alternatives provide cost savings in terms of EA Costs. The Quickstrip®-A and Steel-Magic® provide the largest EA Cost savings with $61,478/yr, completely eliminating EA Costs. Sponge-Jet® also provides EA Cost savings of $11,811/yr over the Baseline process.

Table 5-6 Summary of EA Costs						
Depainting Process	***Testing Costs Associated with Waste per Job***	***Waste Disposal Costs per Job (Drums and Disposal)*** [1]	***EA Labor Costs per Job***	***Total EA Costs per Job***	***Total EA Costs per Year***	***EA Cost Savings per Year***
Black Beauty®	$250	$4,630	$1,268	$6,148	$61,478	**$0**
Quickstrip®-A	$0	$0	$0	$0	$0	**$61,478**
Steel-Magic®	$0	$0	$0	$0	$0	**$61,478**
Sponge-Jet®	$250	$3,695	$1,021	$4,967	$49,667	**$11,811**

[1] Based on primary waste calculated at 80 gal/job plus secondary waste based on media used

6.0 LIFE-CYCLE COST ANALYSIS

Once costs are assigned to the process, environmental investment alternatives are evaluated on the basis of their relative cost or benefit to the organization. The CBA includes Capital Costs, Direct Costs and Environmental Activity Costs. Financial performance indicators calculated were net present value (NPV) and payback period.

6.1 Net Present Value

NPV is the difference between the present value of cash inflows and the present value of cash outflows. Future cash flows are discounted using the discount rate in Office of Management and Budget (OMB) Circular A-94. The nominal discount rate for 10 years is 5% (valid for calendar year 2007).

After discounting cash flows, the initial investment is subtracted to determine the project's NPV. A positive NPV means an acceptable return. If comparing multiple proposals, the highest NPV provides the highest value. Additional information and details of this analysis can be found in the Appendix.

6.2 Payback Period

The Payback Period is the time required to recover 100% of the investment from future savings. It is calculated by dividing the total project investment by the annual net savings of the project. This is the first indicator to use when evaluating the viability of a proposed investment. It provides an initial view of the project's costs and benefits. The shortest payback period shows which alternative has the fastest investment recoup and lowest risk.

6.3 Summary of Life-Cycle Cost Analysis

Table 6-1 shows a summary of the financial analysis for the baseline process and each of the alternatives. Additional information and details of this analysis can be found in the Appendix.

Only Steel-Magic® produces cost savings over the Baseline process with a payback period of less than 1 year. There may be additional EA Costs, however, for other locations that were not considered in this analysis and which may make the other alternatives more cost effective as well. There are also subjective benefits that each of the alternatives offer that are difficult to include in a financial analysis such as a reduction in the Personal Protective Equipment required and increased worker visibility which may increase production.

Table 6-1 Summary of Life-Cycle Cost Analysis

Depainting Process	Total Costs for Initial Job (Direct + EA Costs)	Total Cost Savings for Initial Job	Total Annual Costs (Direct + EA Costs)	Capital Costs (one-time cost)	Initial Year Costs	Initial Year Cost Savings [1]	Annual Cost Savings After Initial Year [2]	10-Year NPV	Payback Period (Years)
Black Beauty®	$25,934	$0	$259,340	$0	$259,340	$0	$0	($259,340.00)	0
Quickstrip®-A	$51,045	($25,111)	$424,390	$22,700	$447,090	($187,750)	($165,050)	($1,297,172.35)	NA [3]
Steel-Magic®	$24,344	$1,590	$204,065	$22,700	$226,765	$32,575	$55,275	$404,118.90	< 1
Sponge-Jet®	$44,066	($18,132)	$377,214	$37,000	$414,214	($154,873)	($117,873)	($947,184.06)	NA [3]

(#####) = Negative number

[1] 'Initial Year Cost Savings' is the difference between the Baseline Annual Cost and the Alternative Annual Cost which includes the 'Capital Costs' for purchasing the required equipment.

[2] 'Annual Cost Savings after Initial Year' is the difference between the Baseline Annual Cost and the Alternative Annual Cost not including the 'Capital Costs' for purchasing the equipment since it was previously purchased.

[3] The Sponge-Jet® and Quickstrip®-A processes do not reduce the overall costs and therefore do not have a payback period.

7.0 CONCLUSIONS

For this project, three alternatives met the basic performance requirements as compared to the Baseline. When considering the full implication of implementing alternatives, both Direct and EA Costs should be considered along with environmental benefits. Even though an alternative may have higher costs, that difference can sometimes be justified as required to comply with government regulations.

Although the 'Labor Costs' of all of the alternatives are lower due to faster strip rates, those savings are off-set by the cost of the media. Even when the media is recycled, each alternative's annual Direct Costs are more than the Baseline. The Steel-Magic® is the lowest priced alternative when considering Direct Costs, costing only $6,202/yr more than the Baseline process.

Each of the alternatives have lower EA Costs than the Baseline primarily due to reduced wastes from recycling the media. Lower EA Costs also reflect a reduced environmental impact of operations. Two alternatives, Quickstrip®-A and Steel-Magic®, eliminate EA Costs altogether, saving over $61K/year.

There may be additional EA Costs not considered in this analysis, however, based on another location's uniqueness which may make the other alternatives more cost effective as well. There are also subjective benefits that each of the alternatives offer that are difficult to include in a financial analysis such as a reduction in the Personal Protective Equipment required during operations and increased worker visibility which may increase production.

When considering life-cycle cost for this specific example, however, only the Steel-Magic® produced annual cost savings over the Baseline process. Steel-Magic® also has a payback period of less than 1 year.

Table 7-1 CBA Summary Table

	Black Beauty®	***Quickstrip®-A***	***Steel-Magic®***	***Sponge-Jet®***
Direct Costs				
Capital Investment Cost	$0	$22,700	$22,700	$37,000
Media Cost (per lb)	$0.05	$2.25	$1.25	$1.88
Media Req per Year (lb)	500,000	131,750	108,500	116,250
Media Cost per Year	$24,750	$296,438	$135,625	$218,550
Media Strip Rate (ft^2/min)	1.7	2.3	4.2	2.7
Labor Hours per Job	245	181	97	154
Labor Cost per Job	$17,311	$12,795	$6,844	$10,900
Labor Cost per Year	$173,113	$127,953	$68,440	$108,997
Total Direct Cost per Year	$197,863	$424,390	$204,065	$327,547
EA Costs				
Testing Cost per Job	$250	$0	$0	$250
Waste Disposal Cost per Job	$4,630	$0	$0	$3,695
EA Labor Cost per Job	$1,268	$0	$0	$1,021
Total EA Cost per Job	$6,148	$0	$0	$4,967
Total EA Cost per Year	$61,478	$0	$0	$49,667
Life-Cycle Cost Analysis				
Total Cost for Initial Year	$259,340	$447,090	$226,765	$414,214
Total Cost per Year	$259,340	$424,390	$204,065	$377,214
Annual Cost Savings	$0	($165,050)	$55,275	($117,873)
NPV	($259,340)	($1,297,172)	$404,119	($947,184)
Payback Period	0	NA*	< 1	NA*

($XXX,XXX) = Negative number

*The Sponge-Jet® and Quickstrip®-A do not reduce the overall costs and therefore do not have a payback period.

APPENDIX

Life-Cycle Cost Analysis

Cost-Benefit Analysis

Direct Costs

Depainting Process	Jobs per Year	Media Cost per Pound	Media Required per Job (lbs)	Media Cost for Initial Job	Media Remaining for Subsequent Jobs (lbs)[1]	Media Required per Year[2]	Media Cost per Year	Media Strip Rate[3]	Direct Labor Hours per Job	Direct Labor Cost per Job[4]	Direct Labor Cost per Year	Total Direct Costs for Initial Job (Media + Labor)	Total Direct Costs per Year (Media + Labor)	Direct Cost Savings per Year
Black Beauty (baseline)	10	$0.05	50,000	$2,475.00	0	500,000	$24,750	1.7	245	$17,311	$173,113	$19,786	$197,863	$0
Quickstrip-A	10	$2.25	17,000	$38,250.00	4,250	131,750	$296,438	2.3	181	$12,795	$127,953	$51,045	$424,390	($226,528)
Steel-Magic	10	$1.25	14,000	$17,500.00	3,500	108,500	$135,625	4.2	97	$6,844	$68,440	$24,344	$204,065	($6,202)
Sponge-Jet	10	$1.88	15,000	$28,200.00	3,750	116,250	$218,550	2.7	154	$10,900	$108,997	$39,100	$327,547	($129,684)

EA Costs

Depainting Process	Testing Costs Associated with Waste per Job	Waste Disposal Costs per Job (Drums and Disposal)[5]	EA Labor Costs per Job	Total EA Costs per Job	Total EA Costs per Year	EA Cost Savings per Year
Black Beauty (baseline)	$250	$4,630	$1,268	$6,148	$61,478	$0
Quickstrip-A	$0	$0	$0	$0	$0	$61,478
Steel-Magic	$0	$0	$0	$0	$0	$61,478
Sponge-Jet	$250	$3,695	$1,021	$4,967	$49,667	$11,811

Life Cycle Costs/Analysis

Depainting Process	Total Costs for Initial Job (Direct + EA)	Total Cost Savings for Initial Job	Total Annual Costs (Direct + EA)	Capital Costs (one-time cost)	Initial Year Costs	Initial Year Cost Savings	Annual Cost Savings After Initial Year	10-Year NPV	Payback Period (Years)
Black Beauty (baseline)	$25,934	$0	$259,340	$0	$259,340	$0	$0	($259,340.00)	0
Quickstrip-A	$51,045	($25,111)	$424,390	$22,700	$447,090	($187,750)	($165,050)	($1,297,172.35)	NA
Steel-Magic	$24,344	$1,590	$204,065	$22,700	$226,765	$32,575	$55,275	$404,118.90	<1
Sponge-Jet	$44,066	($18,132)	$377,214	$37,000	$414,214	($154,873)	($117,873)	($947,184.06)	NA

(#####) = Negative number

1 Based on an average rate of 25% of initial starting amount of media

2 Based on the amount of original material and reusable media from all jobs that year (10 total)

3 Based on coating DTF of 6 mil

4 Assumes 25,000 sq. ft. per job with a labor rate of $70.63/hr

5 Based on primary waste calculated at 80 gal/job plus secondary waste based on media used

6 The Sponge-Jet® and Quickstrip®-A do not reduce the overall costs and therefore do not have a payback period.

Direct Costs for Black Beauty® (Baseline) Process			
Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (to depaint)	245 hrs	$70.63 per hr	$17,311
Black Beauty® Material	25 tons	$99.00 per ton	$2,475
		Total Direct Costs Per Job	**$19,786**
		Total Direct Costs Per Year	**$197,863**

Assumptions used are:

1. Surface area to be depainted: 25,000 ft^2
2. Cost of material: $ 99 / ton = $ 99 / 2000 lb
3. Coating strip rate: 1.7 ft^2 / min
4. Material Consumption: 1 ton / 1000 ft^2 = 50,000 lb

EA Costs for Black Beauty® (Baseline) Process			
Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (sample waste stream)	1 hrs	$44.07 per hr	$44
TCLP	1 TCLP	$250.00 per TCLP	$250
Labor (transport wastes on-site)	3.1 hrs	$44.07 per hr	$136
Labor (HW manifest/labeling)	6.2 hrs	$44.07 per hr	$272
Labor (record-keeping)	18.5 hrs	$44.07 per hr	$816
55-gal drums required	37 drums	$50.00 per drum	$1,852
Disposal of drums	37 drums	$75.00 per drum	$2,778
		Total EACosts Per Job	**$4,630**
		Total EACosts Per Year	**$46,295**

Assumptions used are:

1. Time to sample waste stream for testing is estimated to be 1 hr
2. Cost of TCLP is estimated to be $250
3. Time to transport wastes on site is estimated = number of drums / 5 min/drum (loading, unloading, transport)
4. Time to prepare HW manifest and label drums = number of drums / 10 min/drum
5. Time for record-keeping is estimated to be 1/2 hour per drum
6. Number of 55-gal drums required to hold waste = volume of primary and secondary waste divided by 55 gallons
7. Primary waste = Surface area x coating thickness = 25000 sq ft x 6 mils = 12.5 cu ft = 80 gal
8. Secondary waste = Lbs of media required / density = 50000 lbs / 169 lb/cu ft = 296 cu ft = 1902 gal

Direct Costs for Quickstrip®-A Process			
Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (to depaint)	181 hrs	$70.63 per hr	$12,795
Quickstrip®-A Material	17000 lb	$2.25 per lb	$38,250
		Total Direct Costs Per Job	**$51,045**
		Total Direct Costs Per Year	**$510,453**

Assumptions used are:

1. Surface area to be depainted: 25,000 ft^2
2. Cost of material: $ 2.25 / lb
3. Coating strip rate: 2.3 ft^2 / min
4. Material Consumption: 17000 lb / 25000 ft^2

NOTE: Material usage includes recycling the media with a 25% loss of the media for each time the material is recycled due to worn out media and media that is not captured for recycling. There will be recycled media left over each refurbishment (assumed to be 25%) for subsequent work thus reducing the amount of new material required over time. This additional media is considered further in the life-cycle cost analysis.

EA Costs for Quickstrip®-A Process			
Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (sample waste stream)	0 hrs	$44.07 per hr	$0
TCLP	0 TCLP	$250.00 per TCLP	$0
Labor (transport wastes on-site)	0 hrs	$44.07 per hr	$0
Labor (HW manifest/labeling)	0 hrs	$44.07 per hr	$0
Labor (record-keeping)	0 hrs	$44.07 per hr	$0
55-gal drums required	0 drums	$50.00 per drum	$0
Disposal of drums	0 drums	$75.00 per drum	$0
		Total EACosts Per Job	**$0**
		Total EACosts Per Year	**$0**

Assumptions used are:

The price of the Quickstrip®-A material includes:

1. Freight from manufacturer to jobsite
2. Freight from jobsite to manufacturer
3. Recycling of spent material
4. Drums
5. Shipping Labels

All waste is gathered and returned to the manufacturer for recycling in the shipping container, so no drums are required and no waste is generated to be drummed, shipped, or tracked. Therefore, there are no EA costs associated with the use of the Quickstrip®-A.

Direct Costs for Steel-Magic® Process			
Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (to depaint)	97 hrs	$70.63 per hr	$6,844
Steel-Magic® Material	14000 lb	$1.25 per lb	$17,500
		Total Direct Costs Per Job	**$24,344**
		Total Direct Costs Per Year	**$243,440**

Assumptions used are:

1. Surface area to be depainted: 25,000 ft^2
2. Cost of material: $ 1.25 / lb
3. Coating strip rate: 4.3 ft^2 / min
4. Material Consumption: 14000 lb / 25000 ft^2

NOTE: Material usage includes recycling the media with a 25% loss of the media for each time the material is recycled due to worn out media and media that is not captured for recycling. There will be recycled media left over each refurbishment (assumed to be 25%) for subsequent work thus reducing the amount of new material required over time. This additional media is considered further in the life-cycle cost analysis.

EA Costs for Steel-Magic® Process			
Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (sample waste stream)	0 hrs	$44.07 per hr	$0
TCLP	0 TCLP	$250.00 per TCLP	$0
Labor (transport wastes on-site)	0 hrs	$44.07 per hr	$0
Labor (HW manifest/labeling)	0 hrs	$44.07 per hr	$0
Labor (record-keeping)	0 hrs	$44.07 per hr	$0
55-gal drums required	0 drums	$50.00 per drum	$0
Disposal of drums	0 drums	$75.00 per drum	$0
		Total EACosts Per Job	**$0**
		Total EACosts Per Year	**$0**

Assumptions used are:

The price of the Steel-Magic® material includes:

1. Freight from manufacturer to jobsite
2. Freight from jobsite to manufacturer
3. Recycling of spent material
4. Drums
5. Shipping Labels

All waste is gathered and returned to the manufacturer for recycling in the shipping container, so no drums are required and no waste is generated to be drummed, shipped, or tracked. Therefore, there are no EA costs associated with the use of the Steel-Magic®.

Direct Costs for Sponge-Jet® Process			
Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (to depaint)	154 hrs	$70.63 per hr	$10,900
Sponge-Jet® Material	15000 lb	$1.88 per lb	$28,200
		Total Direct Costs Per Job	**$39,100**
		Total Direct Costs Per Year	**$390,997**

Assumptions used are:

1. Surface area to be depainted: 25,000 ft^2
2. Cost of material: $ 1.88 / lb
3. Coating strip rate: 2.7 ft^2 / min
4. Material Consumption: 15000 lb / 25000 ft^2

NOTE: Material usage includes recycling the media with a 25% loss of the media for each time the material is recycled due to worn out media and media that is not captured for recycling. There will be recycled media left over each refurbishment (assumed to be 25%) for subsequent work thus reducing the amount of new material required over time. This additional media is considered further in the life-cycle cost analysis.

EA Costs for Sponge-Jet® Process			
Resource	***Quantities Used***	***Cost Factors***	***Cost***
Labor (sample waste stream)	1 hrs	$44.07 per hr	$44
TCLP	1 TCLP	$250.00 per TCLP	$250
Labor (transport wastes on-site)	2.5 hrs	$44.07 per hr	$109
Labor (HW manifest/labeling)	4.9 hrs	$44.07 per hr	$217
Labor (record-keeping)	14.8 hrs	$44.07 per hr	$651
55-gal drums required	30 drums	$50.00 per drum	$1,478
Disposal of drums	30 drums	$75.00 per drum	$2,217
		Total EACosts Per Job	**$3,695**
		Total EACosts Per Year	**$36,955**

Assumptions used are:

1. Time to sample waste stream for testing is estimated to be 1 hr
2. Cost of TCLP is estimated to be $250
3. Time to transport wastes on site is estimated = number of drums / 5 min/drum (loading, unloading, transport)
4. Time to prepare HW manifest and label drums = number of drums / 10 min/drum
5. Time for record-keeping is estimated to be 1/2 hour per drum
6. Number of 55-gal drums required to hold waste = volume of primary and secondary waste divided by 55 gallons
7. Primary waste = Surface area x coating thickness = 25000 sq ft x 6 mils = 12.5 cu ft = 80 gal
8. Secondary waste = Lbs of media that cannot be recycled / density = 11250 lbs / 46.8 lb/cu ft = 240 cu ft = 1546 gal

Black Beauty® (Baseline) Net Present Value calculated using NPV calculator at http://www.investopedia.com/calculator/NetPresentValue.aspx

The "Initial Cost" is the Initial Year Costs and includes the cost of Capital Equipment, Labor, and Materials for the alternative.

The "Cash flow" is the difference between the Baseline Process annual costs and the annual costs of the alternative. A positive value means that the alternative costs less annually, while a negative value means that the alternative costs more annually.

Discount Rate:	5	%
Life of Project:	10	years
Initial Cost:	-259340.00	
Cash flow 1:	0.00	per year
Cash flow 2:	0.00	per year
Cash flow 3:	0.00	per year
Cash flow 4:	0.00	per year
Cash flow 5:	0.00	per year
Cash flow 6:	0.00	per year
Cash flow 7:	0.00	per year
Cash flow 8:	0.00	per year
Cash flow 9:	0.00	per year
Cash flow 10:	0.00	per year

Calculate Reset

Net Present Value: **-$259,340.00**

PV of Expected Cash flows: **$0.00**

Quickstrip®-A Net Present Value calculated using NPV calculator at http://www.investopedia.com/calculator/NetPresentValue.aspx

The "Initial Cost" is the Initial Year Costs and includes the cost of Capital Equipment, Labor, and Materials for the alternative.

The "Cash flow" is the difference between the Baseline Process annual costs and the annual costs of the alternative. A positive value means that the alternative costs less annually, while a negative value means that the alternative costs more annually.

Discount Rate:	5	%
Life of Project:	10	years
Initial Cost:	-22700.00	
Cash flow 1:	-165050.00	per year
Cash flow 2:	-165050.00	per year
Cash flow 3:	-165050.00	per year
Cash flow 4:	-165050.00	per year
Cash flow 5:	-165050.00	per year
Cash flow 6:	-165050.00	per year
Cash flow 7:	-165050.00	per year
Cash flow 8:	-165050.00	per year
Cash flow 9:	-165050.00	per year
Cash flow 10:	-165050.00	per year

Calculate Reset

Net Present Value: **-$1,297,172.35**

PV of Expected Cash flows: **-$1,274,472.35**

Steel-Magic® Net Present Value calculated using NPV calculator at
http://www.investopedia.com/calculator/NetPresentValue.aspx

The "Initial Cost" is the Initial Year Costs and includes the cost of Capital Equipment, Labor, and Materials for the alternative.

The "Cash flow" is the difference between the Baseline Process annual costs and the annual costs of the alternative. A positive value means that the alternative costs less annually, while a negative value means that the alternative costs more annually.

Discount Rate:	5	%
Life of Project:	10	years
Initial Cost:	-22700.00	
Cash flow 1:	55275.00	per year
Cash flow 2:	55275.00	per year
Cash flow 3:	55275.00	per year
Cash flow 4:	55275.00	per year
Cash flow 5:	55275.00	per year
Cash flow 6:	55275.00	per year
Cash flow 7:	55275.00	per year
Cash flow 8:	55275.00	per year
Cash flow 9:	55275.00	per year
Cash flow 10:	55275.00	per year

Calculate Reset

Net Present Value: **$404,118.90**

PV of Expected Cash flows: **$426,818.90**

Sponge-Jet® Net Present Value calculated using NPV calculator at
http://www.investopedia.com/calculator/NetPresentValue.aspx

The "Initial Cost" is the Initial Year Costs and includes the cost of Capital Equipment, Labor, and Materials for the alternative.

The "Cash flow" is the difference between the Baseline Process annual costs and the annual costs of the alternative. A positive value means that the alternative costs less annually, while a negative value means that the alternative costs more annually.

Discount Rate:	5	%
Life of Project:	10	years
Initial Cost:	-37000.00	
Cash flow 1:	-117873.00	per year
Cash flow 2:	-117873.00	per year
Cash flow 3:	-117873.00	per year
Cash flow 4:	-117873.00	per year
Cash flow 5:	-117873.00	per year
Cash flow 6:	-117873.00	per year
Cash flow 7:	-117873.00	per year
Cash flow 8:	-117873.00	per year
Cash flow 9:	-117873.00	per year
Cash flow 10:	-117873.00	per year

Calculate Reset

Net Present Value: **-$947,184.06**

PV of Expected Cash flows: **-$910,184.06**