# Low-Level Legacy Waste Processing Experience at the West Valley Demonstration Project

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## ABSTRACT

This paper presents detailed results and lessons learned from the very challenging and highly successful 2005 low level radioactive waste sorting, packaging, and shipping campaign that removed over 95% of the available inventory of 350,000 $ft^3$ of legacy low level waste at the West Valley Demonstration Project near West Valley, New York. First some programmatic perspective and site history is provided to provide pertinent context for DOE's waste disposal mandates at the site. This is followed by a detailed description of the waste types, the storage locations, the containers, and the varied sorting and packaging facilities used to accomplish the campaign. The overall sorting and packaging protocols for this inventory of wastes are defined. This is followed by detailed sorting data and results concluding with lessons learned.

## INTRODUCTION

The West Valley Nuclear Fuel Reprocessing Plant is located in the western part of New York State (NYS) about 30 miles south of the city of Buffalo. It is the only commercial NRC-licensed spent fuel reprocessing plant to ever operate in the United States. It operated between 1966 and 1972, processing over 620 metric tons of varied irradiated fuel to recover uranium and plutonium product using the PUREX and THOREX chemical separation technologies. As a result of this reprocessing operation, the plant generated about 600,000 gallons of liquid high-level waste. Consistent with existing technology and standard practices at the time, this highly radioactive liquid waste was safely stored in underground tanks at the site. The plant closed in 1972 for modifications to increase production capacity and efficiency. Escalating costs, partly the result of more stringent regulatory requirements as well as other factors, led to the 1976 withdrawal of the plant's operator from the spent fuel reprocessing enterprise at West Valley. As a result of prior contractual agreements, the facility and the wastes fell to the full possession of NYS.

Recognizing that all other such high-level liquid waste in the U.S. was managed by the Federal government at sites primarily in the states of Washington, South Carolina and Idaho, as well as the substantive federal involvement and support in the original West Valley venture, Congress passed the West Valley Demonstration Project (WVDP) Act on October 1, 1980. This Act authorized the Department of Energy (DOE) to carry out a high-level liquid nuclear waste management demonstration project at the West Valley site for the purpose of demonstrating solidification techniques useful for preparing high-level liquid waste for permanent disposal.

DOE's operations at the West Valley site have been underway since February 1982 with joint funding support between DOE and NYS at a 90-10 split, respectively.

When passed by Congress in 1980, the WVDP Act recognized that DOE's solidification project activities at West Valley would also generate additional quantities of low level radioactive wastes. The WVDP Act included a mandate for DOE to dispose of such radioactive waste as part of the Project. A brief history pertinent to such disposal provides perspective and background to enhance the understanding of the waste activities discussed in this paper.

There are two radioactive waste burial areas at the West Valley site. One is about ¼ mile south-southeast of the site's main Process Plant and was licensed by the Atomic Energy Commission (AEC)/ Nuclear Regulatory Commission (NRC) for use as part of the reprocessing facility operations. The other is adjacent to and immediately to the south of this facility area and was licensed by New York State under their authority as an AEC/NRC Agreement State as a commercial low level radioactive waste burial area. When DOE arrived on-site in 1982, the on-site disposal area that was licensed by the AEC/NRC as a part of plant operations and used by the reprocessing plant operator from 1966 through 1980 was available to the Project for limited use. The adjacent state-licensed disposal area had been closed from all further use in 1976.

From 1982 to 1986 lower activity wastes collected as a result of DOE's Project activities were disposed in the NRC-licensed disposal area with agreement from NYS and the NRC. Certain higher activity wastes were stored on-site in engineered waste storage areas designed for such storage awaiting further processing and disposition decisions. The wastes buried in the on-site area were high volume very low activity solid wastes (about 40% by volume was lightly contaminated soil from on-site construction activities). For illustrative comparison, between 1982 and 1986 DOE disposed approximately 198,000 $ft^3$ of solid low level radioactive waste containing an estimated 1,200 Ci in this disposal area. Between 1966 and 1982 the site's plant operator disposed 165,000 $ft^3$ containing an estimated 298,000 Ci in the same area from licensed reprocessing operations. In 1986 DOE's on-site disposal of such waste was stopped in anticipation of both site-specific and Complex-wide decision-making in regard to the disposal of such wastes by DOE. Thus, from that point forward, radioactive wastes generated at the Project were packaged and safely stored on-site pending results from that decision-making process.

## WASTE INVENTORY OVERVIEW

The Project has generated a diverse inventory of low-level wastes as a result of project activities that have included the on-going management and maintenance of an aging reprocessing plant, associated support facilities and new facilities added by DOE as part of DOE's congressionally mandated solidification mission at West Valley. With the successful completion of the site's solidification mission in 2002, as well as related waste disposal DOE Records of Decision in 2000 (with respect to DOE's Waste Management Programmatic Environmental Impact Statement of 1997) and 2005 (with respect to DOE's WVDP Waste Management Environmental Impact Statement of 2003), the Project has in recent years shifted focus to the off-site disposal of this inventory of low level radioactive wastes.

By the end of 2004, the WVDP had a substantial inventory of low level legacy waste in safe on-site storage. As discussed earlier, some of this legacy waste had been packaged about 20 years earlier as a result of Project activities at the site. The legacy waste inventory can be viewed as being comprised of 4 general categories: Debris, Equipment, Contaminated Media, and Cement. This waste inventory was packaged and stored primarily in 8 on-site storage areas: Lag Storage Building (5%), Waste Storage Area (5%), Lag Storage Area 1 (7%), Lag Storage Area 3 (21%), Lag Storage Area 4 (22%), Drum Cell (32%), and uncovered hardstand areas (8%).

The total inventory includes about 200,000 $ft^3$ of cemented waste generated between 1988 and 1995 and stored in the Radwaste Treatment System Drum Cell. The Drum Cell contains about 20,000 square 71 gallon drums of cement low-level waste generated as a secondary waste stream as a result of DOE's solidification mission for the Project. This waste stream is a solid, monolithic form that is not subject to the type of sorting operations that are the primary topic of this discussion. In addition, about 100,000 $ft^3$ of the waste in inventory was determined to not have a clear path to disposal as a result of currently unresolved packaging, characterization, and waste form issues. Thus, 350,000 $ft^3$ of wastes are available from the inventory for sorting, characterization, and shipping to off-site disposal.

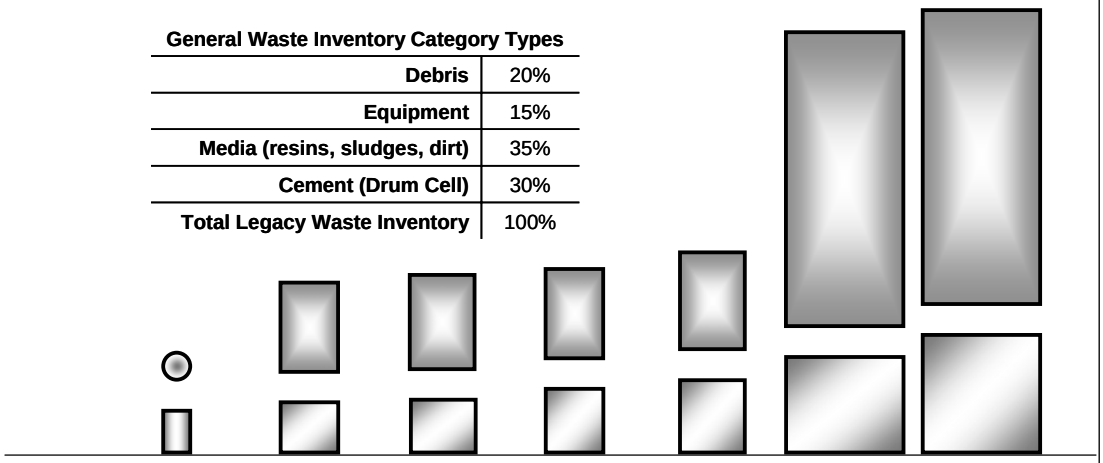
The low level waste containers employed at the West Valley Project run the gamut of standard and non-standard nuclear waste containers used within DOE and the nuclear industry. Examples of containers used at West Valley including their approximate size and volume are shown in Table I. The containers are shown as percentages with respect to two perspectives: by count and by volume. By count is a factor in evaluating such items as material handling, movement and repetitive functions. By volume considerations indicate which group of containers potentially represents the largest quantity of waste. Both are important factors in planning and designing systems and procedures for waste preparation for off-site disposal.

The seven container types shown in Table I represent over 95% by count of all the containers that comprise the 350,000 $ft^3$ inventory of waste at West Valley. The remaining 5% are special custom containers. There are about 80 such special containers in this waste inventory, custom built to meet special waste management needs, often waste size related, of specific projects. Although they vary in size, the average volume of such a container is 420 $ft^3$. About 1/3 of the waste containers by count are the standard B-25 box. The S-70 box and 55 gallon drums represent about 22% each of the total 350,000 $ft^3$ legacy waste inventory. These three container types represent over ¾ of the total container inventory by simple container count.

The seven container types shown in Table I represent over 80% by volume of the total volume of waste to be prepared for shipment to off-site disposal. The remaining 20% by volume are the special custom containers referred to earlier. The largest single percentage by volume, about 27% of the total inventory, is, again, contained in standard B-25 waste boxes. About 22% is contained in the large multi-purpose transport containers with just over 14% contained in the S-70 boxes. These container types represent about ⅔ of the total waste inventory by contained waste volume.

Table I. Common Waste Types and Containers in Use at West Valley

| General Waste Inventory Category Types | |
|---|---|
| Debris | 20% |
| Equipment | 15% |
| Media (resins, sludges, dirt) | 35% |
| Cement (Drum Cell) | 30% |
| Total Legacy Waste Inventory | 100% |



| | 55 g Drum | S-70 Box | "87" - Box | B-25 Box | OP Box | Intermodal | Sealand |
|---|---|---|---|---|---|---|---|
| Width (in.) | 22½ dia | 47 | 53 | 47 | 57 | 96 | 96 |
| Height (in.) | 34 | 41 | 43 | 52 | 68½ | 78 | 96 |
| Length (in.) | n/a | 73 | 77 | 73 | 87½ | 240 | 240 |
| $Vol_{INT}$ ($ft^3$) | 7.4 | 70 | 87 | 90 | 122 | 686 | 1,215 |
| % by Count | 21.8% | 22.3% | 6.4% | 32.8% | 9.8% | 0.7% | 1.6% |
| % by Volume | 1.5% | 14.4% | 5.1% | 27.2% | 11.0% | 4.6% | 17.6% |

The scope and breadth of the sorting and waste preparation process is complex. Consideration, coordination and integration skills need to be combined to address the movement and staging of wastes from 8 different storage locations, 7 standard waste package configurations, special size custom containers, all containing one of three major waste categories of low level waste.

## WASTE PROCESSING EXPERIENCE

In addition to the items discussed above there are other specific considerations with respect to the entire 350,000 $ft^3$ inventory of legacy low level waste. This inventory is comprised of three major subsets: 1) ready-to-ship, 2) packaged after September 2001, and 3) packaged before September 2001. This paper is focusing attention on subsets 2 and 3. The ready-to-ship containers are the most recently created packages of waste and are documented as fully compliant when generated. No sorting is necessary for this population of containers.

Major waste management packaging process and procedural changes occurred at West Valley in September 2001. As a result of these sweeping changes, all wastes packaged after this date have a high confidence of being in full compliance with shipping and off-site disposal requirements. As a result, such waste containers (except for the most recent containers as noted earlier) are opened and visually scanned for potential obvious prohibited items without physically removing and examining each item in its contents. If items are identified they are removed; if not the package is closed back up.

Waste containers packaged before September 2001 present a different challenge. Previous on-site experience at West Valley has demonstrated that in addition to the expected and allowable solid radioactive waste contained within these pre-September 2001 containers, there are occasionally other materials that are job-related wastes that may have also made their way into a waste container. Some of these other items are potentially prohibited as part of a disposal waste package.

West Valley's Standard Operating Procedure for Contact Handled Low Level Waste Processing contains a list of prohibited items based directly on the specific disposal site requirements or extrapolations from such specific requirements. These prohibited items include:

- Batteries
- Lead
- Penetrants
- Chelating/Complexing Agents
- Lubricants
- Pesticides
- Corrosives
- Mercury Vapor Lamps
- Refrigerants
- Fluorescent Light Bulbs
- Oil Filters
- Solvent products
- Gas Cylinders
- Wet paint
- Unknown Chemicals
- Items Containing Mercury (Thermostats, Mercury Switches, etc.)
- Aerosol Containers Containing Hazardous Material or Propellant
- Wastes Generated from Clean-up of Hazardous Waste Spills
- Items Containing Asbestos

This detailed working list of prohibited items responds to disposal site waste acceptance requirements with regard to contained hazardous materials, compressed gasses, corrosive chemicals, flammable items, pyrophoric items, and chemical compatibility.

For the population of waste containers packaged between ~1986 and 2001 there are a number of concerns. One stems from the less than adequate waste separation rigor used in the packaging operations at the time. Another stems from the potential specific content of hazardous elements prevalent in various products available to and in use in the industry at that time. For example, the mercury content in alkaline batteries has dramatically decreased from voluntary efforts by the battery industry between late-1989 and early-1991 to today. Federal legislation to restrict mercury use in batteries went into effect in May 1996. Thus, it is possible that discarded alkaline batteries that may be present in older waste containers may pre-date the low or non-mercury batteries that are essentially the standard today. As another example, an average standard 4 foot fluorescent lamp bulb contained 46 milligrams of mercury in 1990. This was down to 23

milligrams in 1995 and is even lower today, with such 4 foot bulbs available with less than 10 milligrams of mercury. With an industry average life of about 4 years for such a bulb, it is possible that some higher constituent bulbs could be present in the waste inventory. Although mercury is used in this example, lead and cadmium are other elements of concern in such bulbs and other waste items as well. Older ballasts used in fluorescent light fixtures were known to contain PCBs unlike today's PCB-free units.

Mercury switches, thermostats, thermometers, manometers and other similar elemental mercury containing devices can end up as waste during decontamination, reclamation and dismantlement operations such as those that have occurred at West Valley after it is determined that their original use or function in an area is no longer required. A standard thermostat may contain 3 grams of elemental mercury. One of the more common items found in older waste packages are aerosol cans. The concern for aerosol cans is two-fold. If aerosol cans are pressurized they are considered reactive hazardous waste due simply to the pressure; they may also be determined to be hazardous due to the remaining products within the can.

As a point of practical reference to provide some perspective to the sorting issue being addressed here, for an average 2,000 pound box of low level radioactive waste, with limits equal to 20 times the toxicity characteristic value from Table I of 40 CFR Part 261, toxicity limits for mercury would likely be exceeded by any one of the following: 4 old generation D alkaline batteries, 1 old generation lantern alkaline battery, 2 standard thermostats, and exceeded for lead by a cube larger than about ¾ inches square.

## SORTING FACILITIES

To accomplish the waste sorting, characterization and processing campaign for disposal in an efficient and targeted manner, the Project has established a suite of facilities and areas for that purpose. The areas range from smaller one-at-a-time sorting and processing to larger scale operations. In addition to being able to match the varied waste types and characteristics to a particular sorting area and its capabilities, the existence of multiple facilities allows sorting operations at multiple locations to occur at the same time. The available facilities are discussed below:

### Waste Reduction and Packaging Area (WRPA)

Set up in a reclaimed area of the original West Valley Process Plant (at the Product Packing and Shipping area near the tail end of the original product material flow path where purified reprocessing product was packaged for shipment) the WRPA was decontaminated and reclaimed for use by DOE as a low-level waste compaction area. It was equipped with a 50-ton hydraulic trash compactor for compacting compressible, low dose rate, radioactively contaminated materials. Compaction ratios of between three-to-one and four-to-one were achieved. The Waste Reduction and Packaging Area is being used to compact low-level non-hazardous radioactive waste that has been confirmed to contain no prohibited items in metal box containers.

**Container Sorting and Packaging Facility (CSPF)**
Located just inside and adjacent to one of the roll-up doors inside Lag Storage Area 4 is the Container Sorting and Packaging Facility (CSPF). This engineered area was completed in September 1995 for contact sorting of previously packaged wastes. This facility was designed for smaller capacity sorting and has one box tipper to enable easy operator access into the contents of standard waste boxes of various sizes. The tipper interfaces with an L-shaped stainless steel sorting table. The walls and ceiling of this 40 ft (n-s) by 28 ft (e-w) area are made of prefabricated, modular 22 gage stainless steel panels. The sorting area is 12 ft tall and the personnel and package airlocks are 8 ft tall. A stand-alone blower room (10 ft (e-w) x 12 ft (n-s) x 8'-6" tall) contains ventilation and support system equipment for the CSPF exhausting to a monitored stack just outside LSA-4.

**FRS and Load Out (FRS et al)**
The east end of the original Fuel Receiving and Storage (FRS) area consists of a 40 foot by 55 foot flat reinforced concrete floor area where spent fuel shipping casks were originally staged and prepared for movement into and out of the adjacent spent fuel pool. The pool has been subsequently decontaminated and emptied of fuel and water making this area available for sorting operations. There is roadway and rail access into the FRS enclosure building through a tall powered door. This area is serviced by a 100 ton crane, is ventilated and indoors and is particularly well-suited for sorting and processing operations on the larger multi-purpose shipping containers. On the other side of the original process plant from the FRS, the Load Out area was built on the front of the Equipment Decontamination Room of the original reprocessing plant in preparation for the eventual load out of the canisters of vitrified high level waste made by DOE as the primary mandate of the WVDP. This Load Out area presents available open floor space serviced by an overhead crane with roadway access from the north, west and south. Similar to the FRS area, this area is particularly well-suited for sorting and processing operations on the larger multi-purpose shipping containers.

**Shipping Depot Waste Sorting Area (Depot)**
Attached onto Lag Storage Area 4 is a 69 ft by 91 ft enclosed shipping depot with two roll-up doors and an adjoining office area (16 ft x 91 ft) to enhance WVDP's ability to ship wastes to off-site disposal. Located within this depot is a waste sorting area. The pre-existing containment enclosure (59' x 35') was upgraded to provide similar processing capabilities as the Waste Packaging Area discussed below. Additional viewing windows were installed. The containment is ventilated by three 2,000 scfm Portable Ventilation Units. Breathing air was supplied from a portable air compressor with attached filtration and monitoring equipment. Outfitting included the installation of two tipping fixtures, tooling, and accessories identical to those provided at the WPA.

**Waste Packaging Area (WPA)**
Located inside the Lag Storage Area 4 building is a new tent-like enclosure (56' x 35') erected for the direct purpose of supporting of this sorting and shipment campaign. This tent has numerous large viewing windows, two personnel airlocks and load-in and load-out vestibules. The tent is ventilated with three 2,000 scfm Portable Ventilation Units. Breathing air is supplied by a compressor/filter/dryer skid. Radiation protection instruments (Continuous Air Monitors,

and Personal Contamination Monitors) were installed to monitor conditions during processing. Designed and fabricated special handling equipment including two large drum/box tippers (capable of handling B-25 boxes, overpack boxes and special boxes with weights up to 12,000 lb), integral conveyor systems, and equipment and tools for picking up or otherwise manipulating the waste pieces, a drum crusher and special dedicated walk-behind fork truck. A special pass through port was installed for handling smear samples and small equipment transfers.

## SORTING OPERATION RESULTS

The waste sorting and processing campaign targeting the 350,000 $ft^3$ inventory of legacy low level radioactive wastes at the West Valley Demonstration Project has been on-going since February 2005. This section presents representative details from an 11 week period of sorting from the end of July 2005 through mid October 2005. This data in Table II is associated with the Waste Packaging Area located within Lag Storage Area 4 and the inventory of wastes packaged before September 2001. This data illustrates the number and types of items related to the detailed sorting operations applied to this inventory of waste containers.

Table II. Potentially Prohibited Items Found in Example 11 Week Period

| | | Total Containers | | | Prohibited items found | | | % of Containers with prohibited items |
|---|---|---|---|---|---|---|---|---|
| Period | wk | No. | cu-ft | lbs | Containers | cu-ft | items | |
| 7-27 to 8-2 | **1** | 17 | 1,530 | 12,762 | 7 | 630 | 10 | 41.2% |
| 8-3 to 8-9 | **2** | 16 | 1,350 | 7,314 | 4 | 360 | 8 | 25.0% |
| 8-10 to 8-16 | **3** | 35 | 2,730 | 3,744 | 1 | 90 | 1 | 2.9% |
| 8-17 to 8-23 | **4** | 39 | 3,090 | 2,815 | 2 | 180 | 3 | 5.1% |
| 8-24 to 8-30 | **5** | 35 | 2,850 | 5,773 | 3 | 250 | 8 | 8.6% |
| 8-31 to 9-6 | **6** | 18 | 1,580 | 8,201 | 5 | 450 | 10 | 27.8% |
| 9-7 to 9-13 | **7** | 39 | 3,020 | 8,249 | 4 | 340 | 8 | 10.3% |
| 9-14 to 9-20 | **8** | 40 | 3,260 | 11,048 | 5 | 430 | 7 | 12.5% |
| 9-21 to 9-27 | **9** | 2 | 212 | 5,991 | 2 | 212 | 6 | 100.0% |
| 9-28 to 10-4 | **10** | 42 | 4,112 | 6,327 | 1 | 90 | 1 | 2.4% |
| 10-5 to 10-11 | **11** | 69 | 507 | 944 | 8 | 59 | 10 | 11.6% |
| | | 352 | 24,241 | 73,168 | 42 | 3,091 | 72 | 11.9% |
| | | | | | 11.9% | 12.8% | | |

From the end of July through mid-October the WPA has processed 367 containers. Of these, 41 contained potentially prohibited items. In these 41 containers, 72 such items were identified. This works out to be: one container out of 9 had ~2 prohibited items. About half of the potentially prohibited items segregated out by sorting are commercial chemical products, split about 50/50 aerosol/non-aerosol. The other half of the items is mostly readily identifiable, standard or common items and equipment. As shown in Table III, these include batteries, switches, shielding, and fluorescent light ballasts and bulbs. There are a small number of special miscellaneous items that needed some further examination. These include unidentified liquids, a microwave oven, and a dead bat in an old can of paint.

It is to be noted that these sorting operations involved on-the-spot decisions between the waste operators doing the physical sorting and the waste characterization engineers observing the

overall process. If the operators found a questionable or potentially prohibited item that the waste characterization engineer identified from past experience to not be prohibited the item was not removed for separate evaluation and disposal. In addition, more aerosol cans were found than indicated on the log list reproduced in this paper but because they were previously analyzed acceptable window cleaner, they were simply pierced on-the-spot to relieve the internal pressure and returned to the waste container. Some of the items required product and content research that identified no hazardous constituents. Once thus researched and confirmed, if such an item or product was encountered again, it was simply returned to the waste container. If the same type of item but from a different manufacturer or supplier was found, the item was segregated and individual research was performed. Thus the list of potentially prohibited items simply indicates what item was set aside until it could be determined whether it was actually prohibited or not. Many of the items on this list ended up as being not prohibited and were returned to a low-level waste package. Others were segregated for alternate disposal.

By December 2005, the WVDP had safely completed the manifesting of over 335,000 $ft^3$ of low-level waste for off-site disposal. This consisted of about 2,600 containers containing 13M pounds of radioactive low-level wastes. The waste processing took place in nine indoor and several outdoor locations during the year, logging 130,000 safe work hours, over 302 work days with a Total Recordable Case rate of zero. As a result of these safe efforts the site's available inventory of legacy waste was reduced over 95% in a single year.

Table III. List of Typical Potential Non-conforming/Prohibited Items Removed from Wastes 7-13-05 to 10-13-05

| | Date | Cont # | Gen date | OAW (lbs) | TW (lbs) | WW (lbs) | Description | other items per cont. | Comment/Concern |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 7/27/2005 | 12-1247 | 10/23/1986 | 1,460 | 640 | 820 | aerosol can spray paint | X | comml prod -aerosol |
| 2 | 7/28/2005 | 12-1285 | 6/11/1985 | 1,923 | 640 | 1,283 | (2) aerosol spray paint cans | X | comml prod -aerosol |
| 3 | 8/2/2005 | 12-1452 | 9/9/1987 | 1,753 | 640 | 1,113 | aerosol can spray paint | X X | comml prod -aerosol |
| 4 | 8/2/2005 | 12-1502 | 1/21/1988 | 1,309 | 640 | 669 | sample insulation | X X X | comml prod -aerosol |
| 5 | 8/3/2005 | 12-1368 | 11/2/1987 | 1,635 | 640 | 995 | aerosol can penetrating oil | X | comml prod -aerosol |
| 6 | 8/23/2005 | 12-1402 | 7/18/1987 | 1,434 | 640 | 794 | aerosol can penetrating oil | X X | comml prod -aerosol |
| 7 | 8/24/2005 | 70-2243 | 7/27/1999 | 2,086 | 700 | 1,386 | aerosol can spray paint | X X X | comml prod -aerosol |
| 8 | 8/25/2005 | 12-772 | 9/6/1985 | 1,408 | 640 | 768 | oven cleaner | X X | comml prod -aerosol |
| 9 | 9/1/2005 | 12-820 | 12/5/1985 | 1,530 | 640 | 890 | (4) cans of penetrating oil | X | comml prod -aerosol |
| 10 | 9/6/2005 | 12-834 | 11/13/1985 | 1,148 | 640 | 508 | aerosol can spray paint | X | comml prod -aerosol |
| 11 | 9/6/2005 | 12-775 | 3/4/1986 | 1,589 | 640 | 949 | small can of propane | X X X | comml prod -aerosol |
| 12 | 9/6/2005 | 12-775 | 3/4/1986 | 1,589 | 640 | 949 | aerosol can spray paint | X X X | comml prod -aerosol |
| 13 | 9/7/2005 | 12-2588 | 12/3/1996 | 1,817 | 805 | 1,012 | engine starting fluid | X | comml prod -aerosol |
| 14 | 9/12/2005 | 12-928 | 2/2/1986 | 1,692 | 640 | 1,052 | aerosol can spray paint | X X | comml prod -aerosol |
| 15 | 9/14/2005 | 12-1198 | 7/30/1987 | 1,451 | 640 | 811 | aerosol can greaseless lubricant | X X X | comml prod -aerosol |
| 16 | 9/14/2005 | 12-1198 | 7/30/1987 | 1,451 | 640 | 811 | aerosol can leak check | X X X | comml prod -aerosol |
| 17 | 9/14/2005 | 12-1198 | 7/30/1987 | 1,451 | 640 | 811 | aerosol can galvanizing compound | X X X | comml prod -aerosol |
| 18 | 9/26/2005 | OP-005 | 2/18/1987 | 2,957 | 990 | 1,967 | aerosol can penetrating oil | X X X | comml prod -aerosol |
| 19 | 10/11/2005 | 14102 | 10/28/1991 | 88 | 55 | 33 | (2) aerosol spray paint cans | X X | comml prod -aerosol |
| 20 | 10/12/2005 | 15985 | 2/5/1998 | 164 | 55 | 109 | (2) aerosol spray paint cans | X | comml prod -aerosol |
| 1 | 8/2/2005 | 12-1502 | 1/21/1988 | 1,309 | 640 | 669 | leak check coating material | X X X | comml prod - non aerosol |
| 2 | 8/2/2005 | 12-1502 | 1/21/1988 | 1,309 | 640 | 669 | pipe joint compound | X X X | comml prod - non aerosol |
| 3 | 8/8/2005 | 12-1277 | 1/8/1987 | 1,582 | 640 | 942 | smoke tube | X X | comml prod - non aerosol |
| 4 | 8/9/2005 | 12-2843 | 8/17/1999 | 3,006 | 805 | 2,201 | bottle of liquid | X X X X | comml prod - non aerosol |
| 5 | 8/24/2005 | 70-2243 | 7/27/1999 | 2,086 | 700 | 1,386 | pipe joint compound | X X X | comml prod - non aerosol |
| 6 | 8/24/2005 | 12-974 | 5/15/1986 | 2,279 | 640 | 1,639 | insecticide | X X X | comml prod - non aerosol |
| 7 | 8/24/2005 | 12-974 | 5/15/1986 | 2,279 | 640 | 1,639 | pipe joint compound | X X X | comml prod - non aerosol |
| 8 | 8/25/2005 | 12-772 | 9/6/1985 | 1,408 | 640 | 768 | decontamination compound | X X | comml prod - non aerosol |
| 9 | 8/31/2005 | 12-1721 | 1/9/1990 | 2,947 | 640 | 2,307 | leak check coating material | X X X X | comml prod - non aerosol |
| 10 | 8/31/2005 | 12-1721 | 1/9/1990 | 2,947 | 640 | 2,307 | pipe joint compound | X X X X | comml prod - non aerosol |
| 11 | 8/31/2005 | 12-1721 | 1/9/1990 | 2,947 | 640 | 2,307 | soldering paste | X X X X | comml prod - non aerosol |
| 12 | 9/6/2005 | 12-775 | 3/4/1986 | 1,589 | 640 | 949 | pipe joint compound | X X X | comml prod - non aerosol |
| 13 | 9/8/2005 | 70-1801 | 6/26/1995 | 2,776 | 700 | 2,076 | (2) pipe joint compound | X X X X | comml prod - non aerosol |
| 14 | 9/8/2005 | 70-1801 | 6/26/1995 | 2,776 | 700 | 2,076 | soldering paste | X X X X | comml prod - non aerosol |
| 15 | 9/8/2005 | 70-1801 | 6/26/1995 | 2,776 | 700 | 2,076 | lubricant product | X X X X | comml prod - non aerosol |
| 16 | 9/26/2005 | OP-005 | 2/18/1987 | 2,957 | 990 | 1,967 | lubricant product | X X X | comml prod - non aerosol |
| 17 | 10/6/2005 | 13651-B | 1/7/1993 | 103 | 50 | 53 | lubricant product | X X | comml prod - non aerosol |
| 18 | 10/9/2005 | 14124 | 6/18/1992 | 85 | 55 | 30 | lubricant product | X | comml prod - non aerosol |
| 19 | 10/9/2005 | 14187 | 6/19/1992 | 121 | 55 | 66 | lubricant product | X | comml prod - non aerosol |
| 20 | 10/13/2005 | 70-1090-B | 2/8/1994 | 1,403 | 700 | 703 | lubricant product | X X X | comml prod - non aerosol |
| 21 | 10/13/2005 | 70-1090-B | 2/8/1994 | 1,403 | 700 | 703 | lubricant product | X X X | comml prod - non aerosol |
| 22 | 10/13/2005 | 70-1090-B | 2/8/1994 | 1,403 | 700 | 703 | lubricant product | X X X | comml prod - non aerosol |
| 1 | 8/3/2005 | 12-1452 | 9/9/1987 | 1,753 | 640 | 1,113 | alkaline flashlight (D) battery | X X | battery (pre 1996 Hg, Cd) |
| 2 | 8/8/2005 | 12-1319 | 12/12/1986 | 1,091 | 640 | 451 | (2) alkaline flashlight (D) battery | X | battery (pre 1996 Hg, Cd) |
| 3 | 8/22/2005 | 12-2713 | 9/2/1998 | 1,381 | 805 | 576 | alkaline batteries | X | battery (pre 1996 Hg, Cd) |
| 4 | 8/24/2005 | 70-2243 | 7/27/1999 | 2,086 | 700 | 1,386 | alkaline batteries | X X X | battery (pre 1996 Hg, Cd) |
| 5 | 9/8/2005 | 70-1801 | 6/26/1995 | 2,776 | 700 | 2,076 | lantern battery | X X X X | battery (pre 1996 Hg, Cd) |
| 6 | 9/8/2005 | 12-1823-B | 12/1/1999 | 1,964 | 805 | 1,159 | alkaline batteries | X | battery (pre 1996 Hg, Cd) |
| 7 | 9/19/2005 | 12-1749 | 5/25/1995 | 3,060 | 640 | 2,420 | (3) alkaline flashlight (D) battery | X | battery (pre 1996 Hg, Cd) |
| 8 | 9/21/2005 | 12-1467 | 4/3/1990 | 3,034 | 640 | 2,394 | lantern battery | X X X | battery (pre 1996 Hg, Cd) |
| 9 | 9/21/2005 | 12-1467 | 4/3/1990 | 3,034 | 640 | 2,394 | (2) alkaline flashlight (D) battery | X X X | battery (pre 1996 Hg, Cd) |
| 10 | 9/27/2005 | OP-005 | 2/18/1987 | 2,957 | 990 | 1,967 | (2) alkaline flashlight (D) battery | X X X | battery (pre 1996 Hg, Cd) |
| 11 | 10/3/2005 | 12-2371 | 8/16/1990 | 6,327 | 805 | 5,522 | alkaline flashlight (D) battery | X | battery (pre 1996 Hg, Cd) |
| 12 | 10/11/2005 | 14102 | 10/28/1991 | 88 | 22 | 66 | lantern battery | X X | battery (pre 1996 Hg, Cd) |
| 13 | 9/14/2005 | 12-994 | 4/23/1986 | 1,757 | 640 | 1,117 | mercury thermostat | X | Hg |
| 14 | 10/6/2005 | 13651-B | 1/7/1993 | 103 | 50 | 53 | mercury containing switch or bulb | X X | Hg |
| 15 | 8/1/2005 | 12-1300 | 3/11/1987 | 2,934 | 640 | 2,294 | lead shot | X | Pb |
| 16 | 8/1/2005 | 12-1132 | 8/22/1986 | 1,415 | 640 | 775 | lead shot | X | Pb |
| 17 | 8/8/2005 | 12-1277 | 1/8/1987 | 1,582 | 640 | 942 | lead shot | X X | Pb |
| 18 | 8/9/2005 | 12-2843 | 8/17/1999 | 3,006 | 805 | 2,201 | lead brick | X X X X | Pb |
| 19 | 9/21/2005 | 12-1467 | 4/3/1990 | 3,034 | 640 | 2,394 | lead brick | X X X | Pb |
| 20 | 10/6/2005 | 15486-C | 12/10/1997 | 157 | 55 | 102 | lead paint chips | X | Pb |
| 21 | 10/10/2005 | 13965 | 5/21/1991 | 140 | 55 | 85 | piece of lead | X | Pb |
| 22 | 8/9/2005 | 12-2843 | 8/17/1999 | 3,006 | 805 | 2,201 | fluorescent light ballast | X X X X | possible PCB |
| 23 | 8/30/2005 | 12-1721 | 1/9/1990 | 2,947 | 640 | 2,307 | fluorescent light ballast | X X X X | possible PCB |
| 24 | 9/12/2005 | 12-928 | 2/2/1986 | 1,692 | 640 | 1,052 | fluorescent light ballast | X X | possible PCB |
| 25 | 10/5/2005 | 5046-B | 5/26/1998 | 135 | 50 | 85 | motor oil and oil filter | X | oil |
| 26 | 8/23/2005 | 12-1402 | 7/18/1987 | 1,434 | 640 | 794 | asbestos | X X | ACM |
| 27 | 7/27/2005 | 12-1205-B | 8/25/1992 | 1,968 | 640 | 1,328 | fluorescent light bulb | X | bulbs (Hg, Cd) |
| 28 | 8/10/2005 | 12-2389 | 11/14/1991 | 3,744 | 805 | 2,939 | broken fluorescent light bulb(s) | X | bulbs (Hg, Cd) |
| 29 | 10/10/2005 | P-112 | 4/15/1992 | 115 | 60 | 55 | fluorescent light bulb | X | bulbs (Hg, Cd) |
| 30 | 9/19/2005 | 70-2439 | 11/19/1999 | 2,186 | 700 | 1,486 | microwave oven | X | Hg, Cd in electronics |
| 1 | 8/31/2005 | 12-864 | 11/26/1985 | 987 | 640 | 347 | 1 bat contained in paint can | X | biological |
| 1 | 8/9/2005 | 12-2843 | 8/17/1999 | 3,006 | 805 | 2,201 | ion exchange resin | X X X X | liquid, unknown prop. |
| 2 | 8/24/2005 | 12-974 | 5/15/1986 | 2,279 | 640 | 1,639 | 1L bottle green liquid | X X X | liquid, unknown prop. |
| 3 | 9/20/2005 | 12-2606-B | 12/6/1995 | 2,594 | 655 | 1,939 | unknown vials | X | liquid, unknown prop. |

The results from the overall sorting campaign are shown in Table IV on a week-by-week basis for each of the key sorting areas that were used in this campaign. These results begin on January 5 2005 (week 1) and are summarized through November 1, 2005 (week 43). It is noted that the ready-to-ship wastes contribute an additional 52,000 $ft^3$ to the total processed waste inventory.

Table IV. Weekly Waste Processing Summary

| | Waste Sorting and Processing Areas | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Depot et al | | CSPF | | WPA | | FRS et al | | WRPA | | Rdy to Shp | | Sorting Total | | Srtg Cum Sum | | Grand Total | | Grnd Cum Sum | |
| | $ft^3$ | No. | $ft^3$ | No. | $ft^3$ | No. | $ft^3$ | No. | $ft^3$ | No. | $ft^3$ | No. | $ft^3$ | No. | $ft^3$ | No. | $ft^3$ | No. | $ft^3$ | No. |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | | | | |
| 2 | 0 | 0 | 0 | 0 | 7 | 1 | 0 | 0 | 287 | 39 | | | 294 | 40 | 294 | 40 | | | | |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 294 | 40 | | | | |
| 4 | 0 | 0 | 7 | 1 | 90 | 1 | 0 | 0 | 0 | 0 | | | 97 | 2 | 391 | 42 | | | | |
| 5 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 391 | 42 | | | | |
| 6 | 0 | 0 | 70 | 1 | | | 0 | 0 | 0 | 0 | | | 70 | 1 | 461 | 43 | | | | |
| 7 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | 6,324 | 90 | 0 | 0 | 461 | 43 | 6,785 | 133 | 6,785 | 133 |
| 8 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 461 | 43 | 0 | 0 | 6,785 | 133 |
| 9 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 461 | 43 | 0 | 0 | 6,785 | 133 |
| 10 | 0 | 0 | 29 | 4 | | | 0 | 0 | 0 | 0 | 1,207 | 15 | 29 | 4 | 491 | 47 | 1,236 | 19 | 8,021 | 152 |
| 11 | 1,920 | 24 | 144 | 4 | | | 0 | 0 | 0 | 0 | 0 | | 2,064 | 28 | 2,555 | 75 | 2,064 | 28 | 10,085 | 180 |
| 12 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 2,555 | 75 | 0 | 0 | 10,085 | 180 |
| 13 | 910 | 13 | 0 | 0 | | | 0 | 0 | 918 | 11 | 2,279 | 33 | 1,828 | 24 | 4,383 | 99 | 4,107 | 57 | 14,192 | 237 |
| 14 | 2,570 | 33 | 0 | 0 | | | 0 | 0 | 982 | 12 | 2,048 | 29 | 3,552 | 45 | 7,935 | 144 | 5,600 | 74 | 19,792 | 311 |
| 15 | 1,310 | 15 | 164 | 2 | | | 0 | 0 | 905 | 12 | 0 | | 2,379 | 29 | 10,314 | 173 | 2,379 | 29 | 22,171 | 340 |
| 16 | 3,622 | 49 | 0 | 0 | | | 1,460 | 18 | 1,120 | 16 | 0 | | 6,202 | 83 | 16,516 | 256 | 6,202 | 83 | 28,373 | 423 |
| 17 | 4,252 | 72 | 0 | 0 | | | 2,117 | 20 | 420 | 6 | 1,478 | 13 | 6,789 | 98 | 23,305 | 354 | 8,267 | 111 | 36,640 | 534 |
| 18 | 4,078 | 59 | 0 | 0 | | | 254 | 1 | 360 | 4 | 1,978 | 35 | 4,692 | 64 | 27,997 | 418 | 6,670 | 99 | 43,310 | 633 |
| 19 | 3,136 | 31 | 140 | 2 | | | 1,524 | 6 | 0 | 0 | 0 | | 4,800 | 39 | 32,797 | 457 | 4,800 | 39 | 48,110 | 672 |
| 20 | 0 | 0 | 1,808 | 9 | | | 0 | 0 | 270 | 3 | 0 | | 2,078 | 12 | 34,875 | 469 | 2,078 | 12 | 50,188 | 684 |
| 21 | 0 | 0 | 0 | 0 | | | 257 | 1 | 360 | 4 | 0 | | 617 | 5 | 35,492 | 474 | 617 | 5 | 50,805 | 689 |
| 22 | 6,271 | 674 | 90 | 1 | | | 1,687 | 13 | 230 | 3 | 0 | | 8,278 | 691 | 43,770 | 1,165 | 8,278 | 691 | 59,083 | 1,380 |
| 23 | 4,687 | 63 | 0 | 0 | | | 3,340 | 40 | 0 | 0 | 12,530 | 161 | 8,027 | 103 | 51,797 | 1,268 | 20,557 | 264 | 79,640 | 1,644 |
| 24 | 4,502 | 63 | 174 | 2 | | | 1,788 | 84 | 0 | 0 | 497 | 12 | 6,464 | 149 | 58,261 | 1,417 | 6,961 | 161 | 86,601 | 1,805 |
| 25 | 2,358 | 23 | 0 | 0 | | | 1,798 | 49 | 0 | 0 | 1,524 | 27 | 4,156 | 72 | 62,418 | 1,489 | 5,680 | 99 | 92,281 | 1,904 |
| 26 | 1,279 | 23 | 0 | 0 | | | 671 | 11 | 90 | 1 | 0 | | 2,040 | 35 | 64,457 | 1,524 | 2,040 | 35 | 94,321 | 1,939 |
| 27 | 4,544 | 52 | 0 | 0 | | | 180 | 2 | 0 | 0 | 0 | | 4,724 | 54 | 69,181 | 1,578 | 4,724 | 54 | 99,045 | 1,993 |
| 28 | 4,862 | 59 | 141 | 8 | 540 | 6 | 734 | 2 | 0 | 0 | 160 | 2 | 6,277 | 75 | 75,459 | 1,653 | 6,437 | 77 | 105,482 | 2,070 |
| 29 | 5,746 | 63 | 0 | 0 | 450 | 5 | 1,236 | 3 | 0 | 0 | 0 | | 7,432 | 71 | 82,891 | 1,724 | 7,432 | 71 | 112,914 | 2,141 |
| 30 | 3,706 | 70 | 180 | 2 | 1,530 | 17 | 3,304 | 4 | 0 | 0 | 452 | 5 | 8,720 | 93 | 91,611 | 1,817 | 9,172 | 98 | 122,086 | 2,239 |
| 31 | 4,508 | 60 | 140 | 2 | 1,347 | 15 | 2,430 | 2 | 3,150 | 35 | 271 | 3 | 11,575 | 114 | 103,186 | 1,931 | 11,846 | 117 | 133,932 | 2,356 |
| 32 | 2,917 | 25 | 0 | 0 | 2,730 | 35 | 6,075 | 5 | 0 | 0 | 0 | | 11,722 | 65 | 114,908 | 1,996 | 11,722 | 65 | 145,654 | 2,421 |
| 33 | 5,036 | 120 | 0 | 0 | 3,090 | 39 | 4,860 | 4 | 0 | 0 | 470 | 6 | 12,986 | 163 | 127,894 | 2,159 | 13,456 | 169 | 159,110 | 2,590 |
| 34 | 1,699 | 47 | 0 | 0 | 2,670 | 33 | 6,075 | 5 | 0 | 0 | 1,527 | 13 | 10,444 | 85 | 138,338 | 2,244 | 11,971 | 98 | 171,081 | 2,688 |
| 35 | 6,239 | 54 | 0 | 0 | 1,400 | 16 | 4,860 | 4 | 0 | 0 | 0 | | 12,499 | 74 | 150,836 | 2,318 | 12,499 | 74 | 183,579 | 2,762 |
| 36 | 5,404 | 27 | 0 | 0 | 3,180 | 40 | 4,045 | 4 | 0 | 0 | 0 | | 12,629 | 71 | 163,465 | 2,389 | 12,629 | 71 | 196,208 | 2,833 |
| 37 | 1,828 | 6 | 0 | 0 | 3,280 | 40 | 254 | 1 | 0 | 0 | 3,971 | 57 | 5,362 | 47 | 168,827 | 2,436 | 9,333 | 104 | 205,541 | 2,937 |
| 38 | 4,025 | 30 | 270 | 3 | 90 | 1 | 600 | 3 | 0 | 0 | 4,797 | 68 | 4,985 | 37 | 173,812 | 2,473 | 9,782 | 105 | 215,323 | 3,042 |
| 39 | 1,966 | 19 | 180 | 2 | 4,322 | 45 | 2,854 | 6 | 0 | 0 | 0 | | 9,322 | 72 | 183,134 | 2,545 | 9,322 | 72 | 224,645 | 3,114 |
| 40 | 4,986 | 103 | 90 | 1 | 715 | 86 | 986 | 2 | 0 | 0 | 3,740 | 54 | 6,776 | 192 | 189,910 | 2,737 | 10,516 | 246 | 235,161 | 3,360 |
| 41 | 2,370 | 27 | 0 | 0 | 1,468 | 59 | 1,378 | 3 | 0 | 0 | 3,782 | 55 | 5,216 | 89 | 195,126 | 2,826 | 8,998 | 144 | 244,159 | 3,504 |
| 42 | 552 | 6 | 0 | 0 | 2,521 | 37 | 719 | 3 | 0 | 0 | 2,865 | 42 | 3,792 | 46 | 198,918 | 2,872 | 6,657 | 88 | 250,816 | 3,592 |
| 43 | 1,131 | 13 | 0 | 0 | 2,270 | 27 | 2,831 | 5 | 0 | 0 | 134 | 2 | 6,232 | 45 | 205,150 | 2,917 | 6,366 | 47 | 257,182 | 3,639 |
| | 102,414 | 1,923 | 3,628 | 44 | 31,700 | 503 | 58,316 | 301 | 9,092 | 146 | 52,033 | 722 | 205,150 | 2,917 | | | | | | |
| | 49.9% | 65.9% | 1.8% | 1.5% | 15.5% | 17.2% | 28.4% | 10.3% | 4.4% | 5.0% | - | - | 100.0% | 100.0% | | | | | | |
| | | | | | | | | | | | | | | | | | 257,182 | 3,639 | | |
| | 39.8% | 52.8% | 1.4% | 1.2% | 12.3% | 13.8% | 22.7% | 8.3% | 3.5% | 4.0% | 20.2% | 19.8% | | | | | 100.0% | 100.0% | | |

This data indicates that about 66% by count and 50% by volume of the waste sorting and processing was accomplished in the Depot attached to Lag Storage Area 4. This high throughput is due to the fact that this waste was mostly waste packaged after September 2001 and thus did not require the item-by-item search of the waste processed in the WPA. The next highest volume of waste processed (28%) was in the FRS. This is attributed to the fact that this area processed the majority of the large multi-purpose transport containers. The WPA was used almost exclusively for the waste inventory that packaged prior to September 2001 and processed more containers but less volume than the FRS. Overall sorting and processing of the inventory shown in Table IV was accomplished primarily over a 31 week period at an average rate of approximately 110 containers per week and 8,300 $ft^3$ per week.

## LESSONS LEARNED

As with any campaign of this complexity, magnitude and duration there are on-going and evolving improvements and enhancements that are developed and employed. Some of these lessons learned include the following:

- ensuring that wastes are originally packaged without prohibited items avoids having to reevaluate and revisit the waste packages prior to shipping for disposal
- long-handled tools were provided to waste operators working in the sorting areas to improve retrieval of items from the boxes
- step-up platforms were added to provide enhanced ergonomics for the waste operators while removing items from boxes
- special rigging equipment for heavy materials were added to assist in removing items too heavy to load onto the conveyors
- having operators cross-trained such that they can work in any of the waste sorting areas and facilities maximizes the use and shifting of resources to match sorting and processing needs
- visual interface with waste and characterization engineers during sorting operations provided on-the-spot decision-making to maintain effective sorting schedules
- additional air supply for cooling air vests was provided to handle the extra heat inside the sorting containment areas during summer months
- additional breathing air supply was provided for backup to minimize down-time during maintenance of installed system
- closed circuit TV system was added to easily monitor and record waste box loading activities
- a hard-wired intercom system was added as battery-operated radios were troublesome, unreliable, and difficult to use
- separate load-in and load-out airlocks improve processing rates (WPA only)