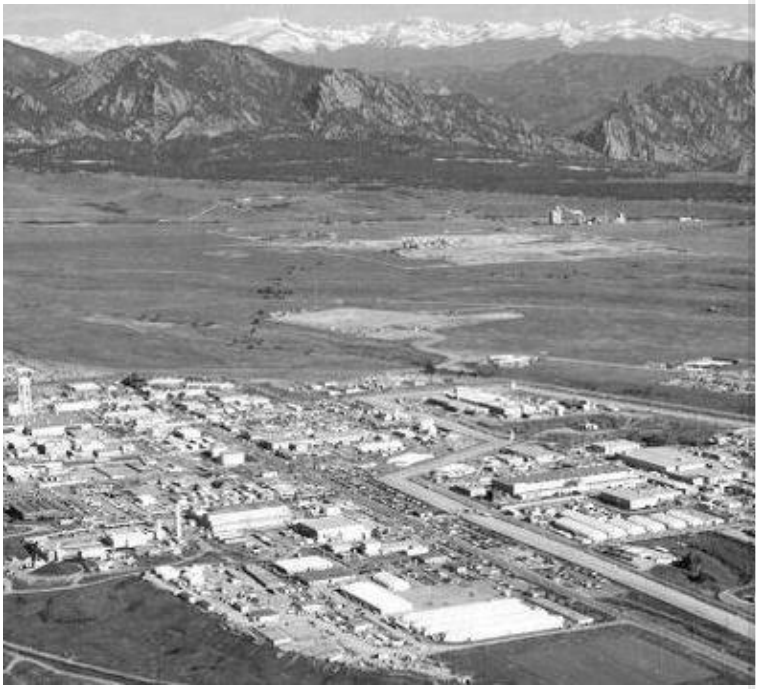
Rocky Flats Site 1995



Rocky Flats Site 2005

National Nuclear Security Administration

The United States Plutonium Balance, 1944 - 2009

An update of

Plutonium: The First 50 Years,
DOE/DP-0137, February 1996

June 2012

Preface

This report updates *Plutonium: The first 50 years* which was released by the U.S. Department of Energy (DOE) in 1996. The topic of both reports is plutonium, sometimes referred to as Pu-239, which is capable of sustaining a nuclear chain reaction and is used in nuclear weapons and for nuclear power production. The measures of plutonium are total element weight[1] in metric tons (MT)[2] and kilograms (kg). Neither Pu-238[3] nor Pu-242[4] are topics of this report. The plutonium discussed is owned by the DOE including that in the possession of the Department of Defense. Accordingly, plutonium in the civilian nuclear fuel cycle is not addressed unless it is owned by the DOE. Inventory refers to the plutonium maintained under nuclear material control and accountability, whereas waste estimates refer to plutonium tracked solely for environmental, safety, and health reasons.

[1] Element weight typically includes the isotopes 238, 239, 240, 241, and 242, with the predominate contributors being 239 and 240.
[2] One metric ton is 2,205 pounds, and one kilogram is approximately 2.2 pounds.
[3] Plutonium-238 has a Pu-238 content of greater than 10% by weight of total plutonium.
[4] Plutonium-242 has a Pu-242 content of greater than 20% by weight of total plutonium.

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1. Executive Summary

The Department of Energy's 1996 publication, *Plutonium: The First 50 Years*, DOE/DP-0137, related to the production, acquisition, and utilization of plutonium from the mid-1940s through 1994. The 1996 report was constructed from both original paper records dating back to the early 1940s and electronic data collected regularly since the late 1960s as part of the Nuclear Materials Management and Safeguards System (NMMSS). The 1996 report identified that:

- The combined DOE and DoD accountable 1994 plutonium inventory was 99.5 metric tons (MT), which included a pooled 66.1 MT for the Pantex Plant near Amarillo, Texas, and the U.S. nuclear weapons stockpile;
- The U.S. plutonium balance included 2.8 MT of inventory differences, equating to 2.5 percent of the total plutonium production;
- A total of 38.2 MT of accountable weapon-grade plutonium was declared surplus to defense needs and would never be used to build nuclear weapons; and,
- The amount of plutonium contained in waste was 3.9 MT located at nine different DOE sites.

This report updates 1994 data through 2009. The four most significant changes since 1994 include: (a) the completion of cleanup activities at the Rocky Flats Plant in 2005; (b) material consolidation and disposition activities, especially shipments from Hanford to the Savannah River Site; (c) the 2007 declaration of an additional 9.0 MT of weapons-grade plutonium to be surplus to defense needs in the coming decades; and (d) the opening of the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico in 1999.

These interrelated factors have not only resulted in decreases to total inventory and inventory differences but also increases in both surplus materials and materials written off the accountable inventory as waste. Figure 1 is a graphical summary of these interrelated factors spanning the fifteen years between the two reports.

This report also contains important revisions to previously reported data. The most significant revisions include increases in waste estimates for both Hanford and Idaho, based on improvements in waste characterization and reviews of historical records. These developments, especially the increases in waste, have led the DOE to prepare this update to the 1996 plutonium report. As a consequence, whereas waste was only an appendix in the 1996 report, it is one of the primary focuses of this update.

This report documents that as of September 30, 2009:

- The plutonium inventory, maintained under nuclear material control and accountability, is 95.4 MT, a 4.1 MT (4 %) decrease to the 1994 inventory. The 95.4 MT total includes a combined Pantex and nuclear weapons stockpile of 67.7 MT. The most important factor for the reduction in inventory was the reclassification of process residues originally set aside for plutonium recovery as waste. Of the 4.1 MT reduction, 3.5 MT (85 %) came from Rocky Flats residues sent to WIPP for disposition;

- The cumulative inventory difference for accountable plutonium is 2.4 MT, a 0.4 MT (14 %) decrease to the 2.8 MT made public in the 1996 plutonium report. The 0.4 MT decrease in the cumulative inventory difference is attributed to materials recovered during de-inventorying and closure activities at Rocky Flats (0.3 MT) and Hanford (0.1 MT). Of the current 2.4 MT of inventory difference, 1.1 MT (46%) is at Hanford and 0.9 MT (38%) at Rocky Flats. A large portion of the remaining 2.4 MT cumulative inventory difference appears to be explained by understated removals from inventory to waste;

- Plutonium surplus to defense needs is now 43.4 MT, a 5.2 MT (14 %) increase to the 1994 declaration; and

- The plutonium estimated in waste estimate is 9.7 MT, a 5.8 MT (149%) increase to the 1994 inventory of 3.9 MT. The 5.8 MT increase is attributed to: 4.4 MT (76%) in new discards from the accountable inventory; 0.8 MT (330%) increase in Rocky Flats solid waste generated prior to 1970; 0.4 MT (84%) increase in

Hanford high level waste tank estimates; 0.1 MT in solid waste at a commercial low-level radioactive disposal facility not included in the 1996 report,[5] and 0.1 MT from other sites.

The information contained herein is current as of September 2009 and is based on the best available information. There remain uncertainties about how much plutonium was actually produced, processed, and discarded to waste, especially for the period from the mid-1940s to 1970 before advances in nuclear material measurement systems and computer-aided tools to assist in the analysis of nuclear material accounting data. These uncertainties are reflected in the 2.4 MT cumulative inventory difference. This uncertainty applies especially to waste estimates, where quantities will continue to change and evolve as waste processing and characterization are performed as part of environmental cleanup activities. Consequently, information contained herein is subject to change as additional data become available during facility cleanout and waste operations.

[5] The 1996 plutonium history report included only the plutonium in waste that the DOE manages at its facilities; wastes at commercially operated facilities on leased DOE land were not included.

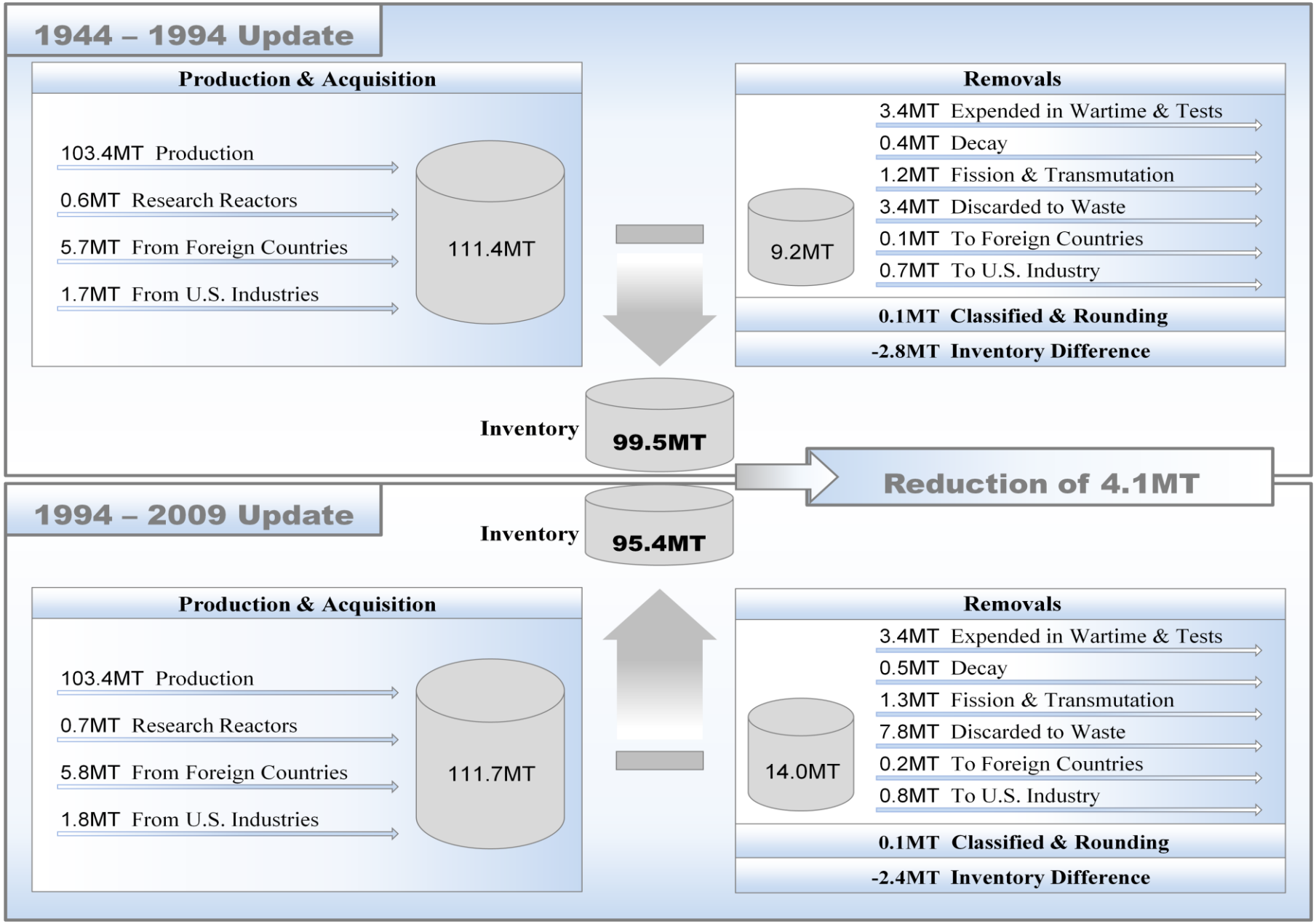

Figure 1 U.S. Plutonium: Where it Came From and Current Balance Statement

2. Introduction

In February of 1996 the Department of Energy released the report *Plutonium: The First 50 Years*. Commonly referred to as either the plutonium history report or the 1994 declaration, the 1996 report summarized U.S. plutonium production, acquisition, and utilization from the beginning of activities in 1944 through 1994. The report was produced at the request of the Secretary of Energy to support President Clinton's goal for greater openness and transparency in government.

The philosophy behind the release of the plutonium history report recognized that transparency is essential to public accountability and trust. It was believed that the report would aid discussions of plutonium storage, safety, and security with stakeholders as well as encourage other nations to declassify and release similar information. The data in the plutonium history report offered stakeholders increased opportunities to participate in policymaking by providing the benefits of their collective expertise and information to governmental leadership. Most importantly, the goal of increased governmental openness was realized without either compromising national security or aiding nuclear proliferation.

The 1994 declaration is now more than 16 years old. Since the release of the 1996 report, significant changes in both location and quantity of U.S. plutonium have occurred. Changes in location include closure of the Rocky Flats Plant in 2005 and the consolidation of plutonium stocks to the Savannah River Site in South Carolina from the Hanford Site and the Lawrence Livermore and Los Alamos National Laboratories. At the same time, significant quantities of plutonium, originally set aside for future recovery, were deemed surplus and made available for disposal in 2000 at the then newly opened Waste Isolation Pilot Plant in New Mexico.

After more than a decade and a half, significant interest in this topic remains. The aim of this publication is to provide, in a transparent manner, comprehensive and up-to-date data

to regulators, public interest organizations, and the general public. Knowledge of the current U.S. plutonium balance and the locations of these materials is needed to understand the Department's plutonium storage, safety, and security strategies. The information contained in this report updates the 1994 data through 2009.

Over the 65-year history of the U.S. nuclear program, there have been many different organizations and facilities involved in producing, processing, utilizing, and regulating[6] nuclear materials. From the beginning of the nuclear program in the 1940s through 1954, the U.S. effort was primarily military in character. During this period, all special nuclear material[7] was government property held by contractors operating government-owned facilities. In 1954, the Atomic Energy Act of 1946 was amended to allow civilian peaceful use, though not ownership, of special nuclear material.

It was not until the mid-1960s that private ownership of special nuclear material was permitted, with a further amendment to the Atomic Energy Act. The Energy Reorganization Act of 1974 created the Nuclear Regulatory Commission (NRC). The NRC began operations in 1975 to regulate several important areas involving privately-owned nuclear materials, including nuclear material control and accountability, reactor safety, plant siting, and environmental protection.

In the U.S., plutonium was both produced and expended in nuclear reactors. It was separated/recovered in processing facilities from irradiated reactor fuel and then blended into fuel elements as new reactor fuel or utilized in many different forms for energy, medical, and national defense purposes. Residues from these operations were processed, and the plutonium recovered and recycled. Plutonium wastes that were either economically or technically unrecoverable were stored for future disposal. It was not

[6] The regulating organizations were the U.S. Army Corps of Engineers Manhattan Engineering District (1940-1947), the Atomic Energy Commission (1947-1975), the Energy Research and Development Administration (1975-1977), and DOE (1977 to present).
[7] Special nuclear material is defined by the Atomic Energy Act and includes plutonium and uranium enriched in the U-235 isotope or the U-233 isotope.

until 1999 that the U.S. opened a facility to permanently dispose of transuranic waste[8] including plutonium waste from the research on and production of nuclear weapons.

The facilities discussed in this update are shown in Figure 2. Included in the figure is background information for nine principal facilities including mission, location, size, operating dates, status, plutonium inventory, and waste estimates.

[8] Radioactive waste that contains more than 100 nCi/g of alpha-emitting isotopes with atomic numbers greater than 92 and half-lives greater than 20 years.

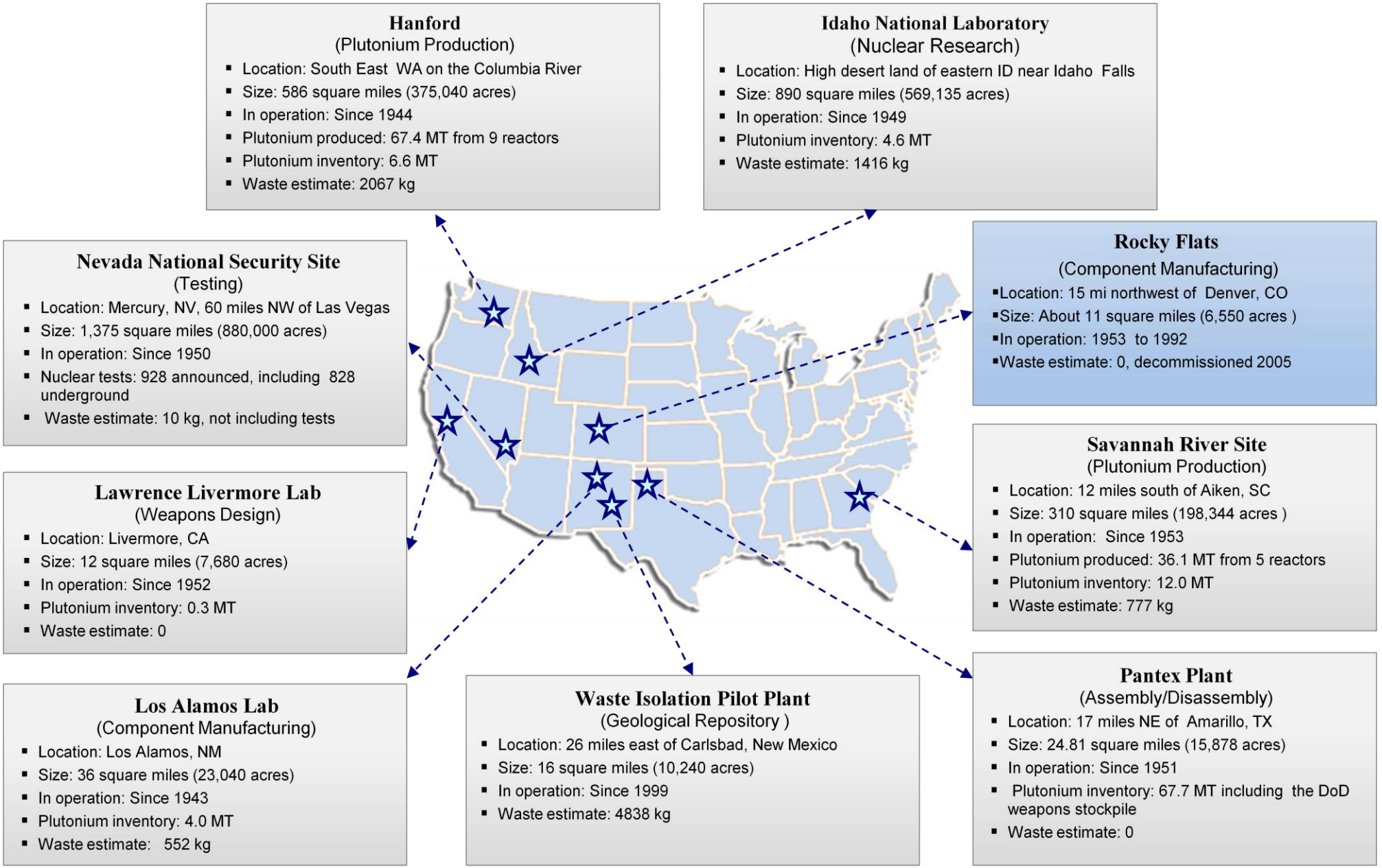

Figure 2 Plutonium Sites Referenced in this Report

3. Plutonium Inventory

The 1996 plutonium history report acknowledged that the September 30, 1994 DOE/DoD plutonium inventory was 99.5 MT (Table 1). At that time, the 99.5 MT was composed of 85.0 MT weapons grade (less than 7% Pu-240), 13.2 MT fuel grade (7 to less than 19% Pu-240), and 1.3 MT power reactor grade plutonium (19% and greater Pu-240). Table 1 also shows that the September 30, 2009 plutonium inventory was 95.4 MT, a 4.1 MT (4%) decrease to the 1994 inventory. The 95.4 MT was composed of 81.3 MT weapons grade, 12.7 MT fuel grade, and 1.4 MT power reactor grade plutonium.

Table 1 Location of the U.S. Plutonium Accountable Inventory (MT)

Location	1994	2009[9]	Change
DoD and Pantex Plant	66.1	67.7	1.6
Hanford Site	11.0	6.6	-4.4
Idaho Site[10]	4.5	4.6	0.1
Lawrence Livermore	0.3	0.3	0.0
Los Alamos	2.7	4.0	1.3
Rocky Flats Plant	12.7	0.0	-12.7
Savannah River Site	2.0	12.0	10.0
Other Sites	0.2	0.2	0.0
Total Inventory[11]	**99.5**	**95.4**	**-4.1**

The 4.1 MT reduction in inventory from 1994 to 2009 was primarily attributable to the closure in 2005 of the Rocky Flats Plant and material disposition activities, especially the removal of plutonium from the accountable inventory as waste and shipped to the WIPP. The majority of the government plutonium inventory (71% compared to 66% in 1994) still resides at DoD and Pantex.

[9] Increases in inventory reflect consolidation of plutonium pits at Pantex and surplus non-pit plutonium at the Savannah River Site per record of decision for the storage and disposition of weapons-usable fissile materials final programmatic environmental impact statement.
[10] Idaho National Laboratory, which includes the Argonne National Laboratory-West.
[11] The quantities are element weight plutonium, which typically includes the isotopes 238, 239, 240, 241, and 242, with the predominant contributors being 239 and 240.

The largest inventory decrease occurred at Rocky Flats, where 3.5 MT of its 12.7 MT inventory was shipped to WIPP for disposition, and the remaining 9.2 MT was sent to other DOE facilities as part of shutdown and material consolidation activities. The largest increase in inventory (500%) was at Savannah River, reflecting the site's missions to: (a) store surplus plutonium from Hanford, Rocky Flats, Los Alamos National Laboratory, and Lawrence Livermore National Laboratory as part of the plutonium consolidation and disposition program, (b) convert surplus nuclear weapons components to commercial nuclear mixed oxide fuel, and (c) store irradiated nuclear fuel elements from foreign and domestic power and research reactors.

Quantities in Table 1 are owned by the DOE and include plutonium in the possession of the DoD. Plutonium in the civilian nuclear fuel cycle is not included in the totals unless the material is owned by the DOE. DOE-owned material in the civilian nuclear fuel cycle is included in the Other Sites category. Quantities in Table 1 comprise plutonium that is maintained under nuclear material control and accountability (i.e., the accountable inventory). The accountable inventory is tracked for safeguards and security reasons. It is important to note that the quantities in Table 1 do not include plutonium that has been removed from the accountable inventory as waste (for example, plutonium at WIPP). Waste estimates are tracked for environmental, safety, and health reasons and are discussed separately in Section 6 of this report.

4. Plutonium Mass Balance

From 1944 to 2009, DOE and its predecessor organizations produced and acquired a total of 111.7 MT of plutonium (Table 2). During the same period, 14.0 MT was removed from the inventory. Classified transactions and rounding account for a positive 0.1 MT, and the DOE cumulative inventory difference through 2009 was 2.4 MT. These four factors (total receipts, minus total removals, plus classified transactions and rounding, minus the cumulative inventory difference) yield a September 2009 inventory of 95.4 MT plutonium, a 4.1 MT reduction to the 1994 inventory of 99.5 MT.

Table 2 U.S. Plutonium: Acquisitions, Removals, and Inventory (MT)

	1994	2009	Change
Receipts			
Production	103.4	103.4	0.0
Research Reactors	0.6	0.7	0.1
From Foreign Countries	5.7	5.8	0.1
From U.S. Industry	1.7	1.8	0.1
Total Receipts	111.4	111.7	0.3
Removals			
Expended in Wartime & Tests	3.4	3.4	0.0
Decay	0.4	0.5	0.1
Fission & Transmutation	1.2	1.3	0.1
Discarded to Waste	3.4	7.8	4.4
To Foreign Countries	0.1	0.2	0.1
To U.S. Industry	0.7	0.8	0.1
Total Removals	9.2	14.0	4.8
Classified & Rounding[12]	0.1	0.1	0.0
Inventory Difference	-2.8	-2.4	0.4
Ending Inventory[13]	99.5	95.4	-4.1

[12] Classified transactions and rounding to the nearest tenth of a metric ton.
[13] Total receipts, minus total removals, plus adjustment for classified transactions and rounding, minus the cumulative inventory difference.

As shown in Table 2, the principal changes to the 1994 plutonium mass balance were increases in discards to waste and reductions in inventory difference.

- The 4.4 MT increase in discards to waste occurred primarily at four sites (Figure 3): Rocky Flats Plant (78%), Hanford (9%), Savannah River (8%) and Los Alamos National Laboratory (5%). The reason for these discards was the reclassification of process residues originally set aside for plutonium recovery as waste.

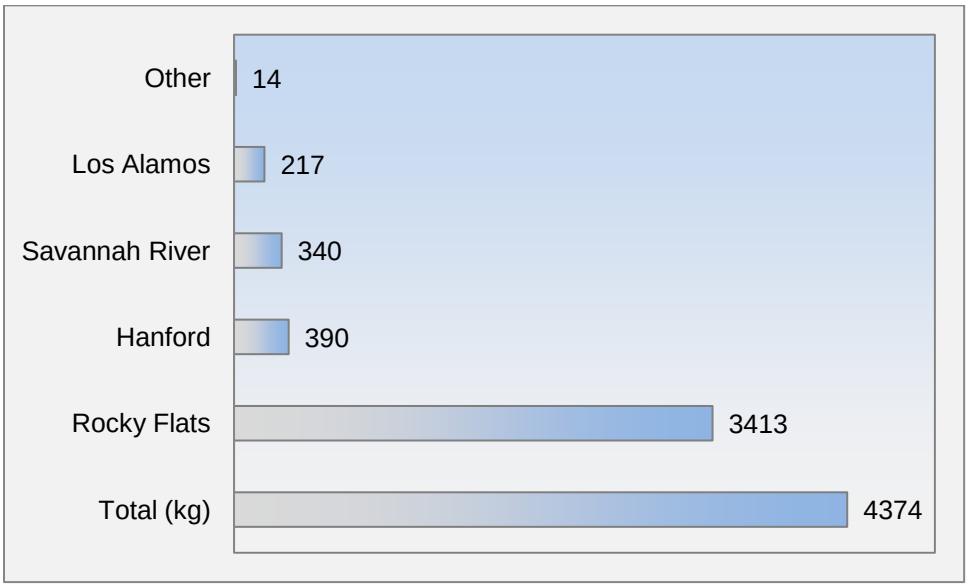

Figure 3 Discards to Waste 1995 through 2009 (Kg)

- The 0.4 MT decrease in the cumulative inventory difference is attributable to materials recovered during de-inventorying and closure activities at Rocky Flats (0.3 MT) and Hanford (0.1 MT). Of the remaining 2.4 MT of inventory difference, 0.9 MT is attributed to Rocky Flats. Of the 0.9 MT Rocky Flats difference, 0.8 MT is attributed to waste shipments from Rocky Flats to Idaho during the mid-1950s and 1960s. More details are provided in Section 6.

Other differences shown in Table 2 include, receipts from U.S. industry and receipts from and removals to foreign countries.

- The 0.1 MT receipts from U.S. industry included unwanted plutonium sources recovered and secured from the public sector by the Global Threat Reduction Initiative Offsite Source Recover Project (GTRI/OSRP). Since 1999, GTRI/OSRP has recovered approximately 800 sources containing more than 14 kg of plutonium from approximately 200 industrial, educational, government, and other facilities across the U.S. The recovered sources were sent from Los Alamos to WIPP for final disposition.

- The removals to foreign countries, receipts from foreign countries, and removals to U.S. industry reflect the 2004 shipment from Los Alamos National Laboratory of purified plutonium oxide for use in fabrication of mixed oxide (MOX) assemblies in France and the return of those assemblies for insertion into a commercial U.S. power reactor for testing.

5. Excess Determinations

Plutonium surplus to defense needs on September 30, 2009, was 43.4 MT, a 5.2 MT (14%) increase to the 1994 declaration, reflecting an additional 9.0 MT of weapon-grade plutonium to be removed from weapons use, minus the disposition of 3.8 MT of the 1994 surplus material to WIPP (Table 3).

Table 3 Excess Weapon-Grade Plutonium (MT)

Location	1994	2009	Change
Pantex/future dismantlement	21.3	23.4	2.1
Hanford Site	1.7	0.3	-1.4
Idaho Site	0.4	0.0	-0.4
Los Alamos	1.5	1.2	-0.3
Rocky Flats	11.9	0.0	-11.9
Savannah River Site	1.3	8.8	7.5
Other Sites	0.1	0.7	0.6
Excess Subtotal	38.2	34.4	-3.8[14]
Additional Declaration		9.0	9.0
Total	**38.2**	**43.4**	**5.2**

The added declaration was made by Secretary of Energy Samuel W. Bodman speaking before the International Atomic Energy Agency's annual general conference on September 17, 2007, when he announced that the U.S. would remove an additional 9 MT of plutonium from further use as fissile material in U.S. nuclear weapons, thereby increasing the original 38.2 MT to 47.2 MT. Signifying the Bush Administration's ongoing commitment to nonproliferation, Secretary Bodman stated that,

> *The United States is leading by example and furthering our commitment to nonproliferation and the Nuclear Nonproliferation Treaty by safely reducing the amount of weapons-usable nuclear material in the world. As the United States continues to reduce the size of its nuclear weapons stockpile, we will be able to*

[14] The reduction of 3.8MT weapon-grade plutonium to the 1994 excess is the result of material removed from the accountable inventory and shipped to WIPP

dispose of even more nuclear material while increasing energy and national security.

Secretary Bodman stated that the additional 9 MT of excess plutonium would be removed in the coming decades from retired, dismantled nuclear weapons and eliminated by fabrication into mixed-oxide fuel that can be burned in commercial nuclear reactors to produce electricity.

The original 38.2 MT became available with the end of the Cold War and resulting diminished strategic military threat to our national security. The declaration of excess was part of President Clinton's commitment to further demonstrate our commitment to the goals of the Nuclear Nonproliferation Treaty. In a March 1, 1995 speech at the Nixon Center for Peace and Freedom, President Clinton stated, "I have ordered that 200 tons [which included 38.2 MT of plutonium] of fissile material—enough for thousands of nuclear weapons—be permanently withdrawn from the United States nuclear stockpile. It will never again be used to build a nuclear weapon."

6. Waste Estimates

The plutonium estimated in waste is 9.7 MT, a 5.8 MT (150%) increase to the 1994 inventory of 3.9 MT. The 5.8 MT increase is attributed to: 4.4 MT (76%) in new discards from the accountable inventory; 0.8 MT (330%) increase in Rocky Flats solid waste generated prior to 1970; 0.4 MT (84%) increase in Hanford high level waste tank estimates; 0.1 MT in solid waste at a commercial low-level radioactive disposal facility not included in the 1996 report,[15] and 0.1 MT from other sites (see Table 4).

The quantities in Table 4 (and also 6) are displayed in kilogram quantities to reflect how they were reported by the associated waste management organization and to be consistent with the 1996 report for comparison purposes. However, some values are based on calculations and assumptions and may be stated to a greater accuracy than the underlying measurement technologies support. Therefore, the quantities in the table should be considered to have a wide margin of uncertainty associated with them.

Table 4 Plutonium in Waste Estimates (Kg)

Location	1994	2009	Change
Hanford Site	1,522	2,067	545
Idaho Site	1,108	1,416	308
Los Alamos	610	552	-58
Nevada Site	16	10	-6
Oak Ridge	41	25	-16
Rocky Flats Plant	47	0	-47
Savannah River Site	575	777	202
Waste Isolation Pilot Plant	0	4,838	4,838
Total (kg)	**3,919**	**9,685**	**5,766**

The 4.4 MT of post-1994 discards came mainly from four sites: Rocky Flats (3.4 MT), Hanford (0.4 MT), Savannah River (0.3 MT), and Los Alamos National Laboratory (0.2

[15] The 1996 plutonium history report included only the plutonium in waste that the DOE manages at its facilities; wastes at commercially operated facilities on leased DOE land were not included.

MT). Most of the post-1994 discards were attributed to reclassification of process residues originally set aside for plutonium recovery as waste.

Approximately half of the plutonium waste (4.8 MT) in 2009 was located at WIPP. WIPP is sited in the Chihuahuan Desert, approximately 26 miles east of Carlsbad, New Mexico (Figure 1). WIPP disposal operations began in March 1999 and are expected to continue until 2070. By 2009, the facility had already processed more than 7,800 shipments of waste from more than 9 different sites. As shown in Table 5, the 4.8 MT plutonium received at WIPP came mostly from five different sites: Rocky Flats (3.5 MT), Hanford (0.5 MT), Idaho (0.5 MT), Los Alamos National Laboratory (0.3 MT), and Savannah River (0.1 MT).

Table 5 Plutonium Disposed at WIPP (Kg)

Shipped From	Shipments	Kg
Hanford Site	432	481
Idaho Site	3,674	466
Lawrence Livermore	18	9
Los Alamos	537	275
Nevada Test Site	48	7
Oak Ridge	14	<1
Rocky Flats Plant	2,045	3,460
Savannah River Site	1,047	138
Other Sites	46	2
Total	**7,861**	**4,838**

Site-specific changes to the 2009 estimates include new discards from the accountable inventory, minus shipments to WIPP (Table 5), and increases to the 1994 data due to redetermination of pre-1970 discards quantities. The 2009 Idaho and Hanford waste estimates shown in Table 4 include increases to the 1994 data. The increase at Idaho was 769 kg (increasing the 1994 estimate from 1108 kg to 1877 kg), and the increase at Hanford was 545 kg (increasing the 1994 estimate from 1522 to 2067 kg). The

adjustments to the 1994 data were based on redetermination of waste quantities generated from the mid-1940s to 1970, before advances in nuclear material measurement systems and computer-aided tools to assist in the analysis of nuclear material accounting data.

The 769 kg increase at Idaho was attributed to solid waste received from Rocky Flats during the period 1954 to 1970 and disposed of at the subsurface disposal area. The primary explanation for the differences was significant limitations for measuring the radionuclide content of the waste containers during the 1950s and 1960s. Another 0.8 MT of the remaining Rocky Flats cumulative inventory difference of 0.9 MT is expected to be recovered from understated waste shipments from Rocky Flats to Idaho during the mid-1950s and 1960s. The new plutonium values are based both on information provided by Rocky Flats and subsequent Idaho calculations to establish the best estimates for the amount of plutonium buried at Idaho[16] (Figure 4). The new annual quantities are shown in Table 6 in the appendix.

In the plutonium mass balance shown in Table 2, the 769 kg increase in waste at Idaho would be offset with a corresponding 769 kg decrease in the 0.9 MT Rocky Flats inventory difference included in the 2.4 MT total inventory difference.

[16] Idaho Historical Data Task, INEL-95/0310, Appendix C, Table C-2, August 1995.

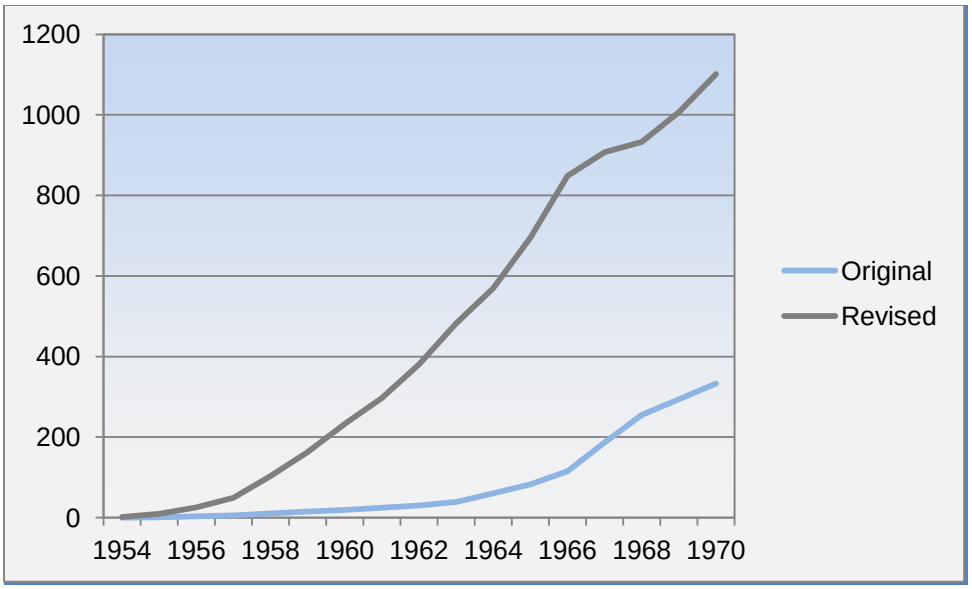

Figure 4 Revised Estimates of Plutonium Shipped to Idaho from Rocky Flats (Kg)

The increase in the amount of estimated plutonium in waste at Hanford is attributable to four primary causes: (a) current inventories in Hanford's high-level waste tanks were established based on improved characterization data and modeling of specific types of tank waste performed between 1994 to September 2009 (380 kg increase), (b) previously reported production values discarded to waste as "approved write-offs" and normal operating losses (390 kg), (c) inclusion of plutonium disposed in waste at a commercial low-level radioactive waste disposal facility on-site (143 kg)[17], and (d) revised inventories in solid and liquid waste residues based on on-going characterization and cleanup operations (110 kg).

A total of 481 kg of plutonium was removed from Hanford waste accounts in off-site shipments to WIPP. The results of these transactions are shown in Table 6.

[17] NMMSS records indicate that 22 kg of the 143 kg total are from government origin.

Table 6 Hanford Waste Estimates 2009 (Kg)

Waste Type	2009
High level tank waste	836
Liquid wastes	229
Pre-1970 waste and ERDF[18]	366
US Ecology[19]	143
Solid Waste Operating complex (SWOC)[20]	346
Remaining Retrievably Stored Waste (RSW)[21]	101
Facility Residuals	46
Total	**2,067**

The net difference in Hanford's plutonium waste quantities totals (545 kg) will continue to change as additional plutonium discards are made, and waste processing and characterization associated with environmental cleanup activities are performed. In general, the quantity of plutonium declared as waste at any particular time will be subject to variation from previously reported waste values based on estimate and measurement uncertainty of the plutonium amounts at the time of original discard. The cause of these fluctuations is likely interrelated to the cumulative plutonium inventory differences created through Hanford's production history.

Reductions in Hanford's cumulative plutonium inventory difference for the 65-year period from 1944 to 2009 (1,134 kg, a 132 kg decrease since 1994) may be reviewed

[18] Hanford's ERDF in the center of the Hanford Site is a massive landfill regulated by the U.S. Environmental Protection Agency. Built in 1996, ERDF accepts low-level radioactive, hazardous, and mixed wastes that are generated during the cleanup activities at the Site. It does not accept any non-Hanford waste.

[19] Commercial Low-Level Radioactive Waste (LLRW) facility that operates on the federal Hanford Nuclear Reservation. This facility was not included in the 1996 report because it disposes LLRW primarily from commercial sources.

[20] SWOC is comprised of the Hanford Site Low Level Burial Grounds (LLBG), the Central Waste Complex (CWC), the T-Plant Complex, and the Waste Receiving and Processing Facility (WRAP).

[21] RSW is waste that is or was believed to meet the TRU waste criteria when it was placed in burial ground trenches after May 6, 1970.

further to account for corresponding increases in the plutonium written off the accountable inventory as waste.

Appendix

Table 7 updates on an annual basis the plutonium discarded by Rocky Flats to waste (i.e., normal operating losses) for the period 1954 to 1970. Waste quantities from 1971 to 1994 remain unchanged. The 1994 quantities were originally published in Table 9 of the 1996 plutonium history report. Revisions to waste quantities are based on a 1995 joint Rocky Flats and Idaho Study.[22] The Rocky Flats waste identified in Table 7 was subsequently shipped to Idaho and buried at the Idaho Subsurface Disposal Area.

Table 7 Revisions to Rocky Flats Plutonium in Waste (Kg)

Fiscal Year	1994	2009	Change
1954	0.1	1.6	1.5
1955	0.5	8.0	7.5
1956	2.6	16.1	13.5
1957	2.3	23.3	21.0
1958	4.5	54.1	49.6
1959	4.7	59.4	54.7
1960	4.4	70.3	65.9
1961	5.4	64.3	58.9
1962	6.0	83.7	77.7
1963	8.6	101.8	93.2
1964	21.2	87.3	66.1
1965	22.6	125.5	102.9
1966	31.9	153.2	121.3
1967	72.0	58.9	-13.1
1968	68.1	25.5	-42.6
1969	38.9	74.0	35.1
1970	38.7	94.2	55.5
Total (kg)	**332.5**	**1101.2**	**768.7**

[22] Idaho Historical Data Task, INEL-95/0310, Appendix C, Table C-2, August 1995.