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5.0 RESULTS AND CONCLUSIONS

5.1 EXPLANATION OF FLOW PATHS

5.1.1 FEMP

The flow of recycle uranium within the DOE complex was initiated as early as 1953, where uranium was recovered from the production of plutonium. The recovered uranium was then put back into the enrichment cycle and was hence referred to as recycled uranium. Recycle uranium was received at the Fernald site and then put through the blending and fabrication processes. The initial shipments of recycled uranium from the FEMP started as early as 1961. From 1961 through 1989 the FEMP has handled and blended recycled uranium.

The definition and interpretation of recycle uranium is different from site to site due to differences in handling and processing. At the FEMP uranium product materials were produced through the blending of streams to achieve specified limits. Blending streams with high constituent concentrations, such as the incinerator or tower ash, enabled the FEMP to meet product specifications while ensuring that uranium was not unnecessarily discarded or wasted. Because of FEMP specific activities the definition of recycle uranium necessarily included enriched, normal, and depleted streams across a wide range of constituent levels. Other facilities such as the source sites and the enrichment cascades were able to separate uranium streams by the constituent levels and thereby exclude uranium from the recycle definition when the concentrations of the constituents were below the deminimis levels (Appendix A Project Plan). Nearly all of the depleted uranium in the complex can be considered as deminimis since the constituent concentrations are all below the deminimis levels (refer to Appendix F for statistical analysis of constituent concentrations). In a similar manner the UF_6 can also be excluded from the definition of recycle since the diffusion process essentially cleans the uranium. The trace concentrations of transuranics in the uranium are removed and collected in the incinerator and tower ash, plates out on zero valence metal of cascade and storage cylinders. This material was then collected periodically and transferred to Fernald for recovery of the uranium.

Table 5-1 provides a succinct breakdown of the recycle uranium flow from Tier I, II, and III sites for the entire complex, excluding uranium quantities that were below the deminimis levels. Table 5-1 depicts shipments and receipts from the major facilities of recycle uranium after having taken into account material characteristics and constituent concentrations. The resultant quantities, therefore, represent the recycle uranium within the DOE complex since 1953. These quantities form the basis for determining the total quantities of plutonium, neptunium, and other trace constituents.

The total potential recycle uranium received by or shipped from Fernald differ significantly from the total uranium amounts, and from the complex-wide perspective as discussed above. The Fernald site received over 360,000 MTU of uranium over the life of the facility, however, only a little over 246,000 MTU was considered potentially recycled as discussed in detail for each of the four sites in Section 3. The definition of the potentially recycled uranium for Fernald used in this report considered all receipts and shipments after 1961. Table 5-2 below provides the shipments, receipts, and inventory for the Fernald uranium along with the constituent levels. The shipment and receipt data for each of the other three sites that comprise the Ohio Report are also provided. In section 5-5 the differences between the complex-wide rollup report and this site-specific report will be discussed.

TABLE 5-2A
FEMP SUMMARY OF CALCULATED CONSTITUENT MASSES
FOR RECEIPTS/SHIPMENTS/INVENTORY OF RECYCLED URANIUM

			Calculated Constituent Mass (Grams)		
Isotopic Range	Total U (MTU)	RU Quantity (MTU)	Pu-239	Np-237	Tc-99
Enriched – Receipts	64,939.4	60,180.7	*207.9*	*19,047.5*	*328,740.2*
Normal – Receipts	193,156.5	89,649.2	*4.1*	*3,025.9*	*1,197.4*
Depleted – Receipts	105,485.9	96,853.2	*5.7*	*3,668.7*	*2,060.5*
Total – Receipts	*363,581.8*	*246,683.1*	***217.7***	***25,742.1***	***331,998.1***
Enriched – Shipments	64,144.1	60,305.6	180.9	20,769.3	333,698.9
Normal – Shipments	***193,047.8***	***94,852.8***	7.7	5,683.8	2,249.3
Depleted – Shipments	***102,678.9***	***94,071.5***	2.4	424.8	1,541.3
Total – Shipments	*359,870.8*	*249,229.9*	**191.0**	**26,877.9**	**337,489.5**
Enriched – NM Inventory	***801.3***	***801.3***	14.4	531.1	1,858.4
Normal – NM Inventory	***193.4***	***193.4***	0.7	84.2	308.9
Depleted – NM Inventory	2,807.1	2,807.1	*<0.1*	*13.0*	*5.1*
Total – NM Inventory	**3,801.8**	**3,801.8**	***15.2***	***628.3***	***2,172.4***
Enriched – Waste Inventory	430.6	430.6	*7.3*	*345.1*	*1,870.2*
Normal – Waste Inventory	13.2	13.2	*<0.1*	*0.9*	*0.4*
Depleted – Waste Inventory	867	867	*0.1*	*13.7*	*50.3*
Total – Waste Inventory	**1,310.8**	**1,310.8**	***7.5***	***359.7***	***1,920.9***

5.1.2 RMI

Most of the material shipped to the RMI site was from Fernald. Table 5-2B delineates the quantities of potentially recycle material along with the constituent concentrations. The majority of the material received at RMI was metal as discussed in Section 2 and had low concentrations of constituents as discussed in Appendix F. The summary of constituent quantities included in Table 5-2B reflect the flow of material and the constituent concentrations determined by the analytical results presented previously.

TABLE 5-2B
RMI SUMMARY OF CALCULATED CONSTITUENT MASSES FOR RECEIPTS/SHIPMENTS/INVENTORY

Isotopic Range	Total U (MTU)	RU Quantity (MTU)	Calculated Constituent Mass (Grams) Pu-239	Np-237	Tc-99
Enriched – Receipts	*25,327.4*	*25,327.4*	108.8	9,422.6	178,542.0
Normal – Receipts	*5,236.0*	*5,236.0*	0.5	351.3	139.0
Depleted – Receipts	*46,158.5*	*46,158.5*	*0.3*	*117.2*	*421.0*
Total – Receipts	**76,721.9**	**76,721.9**	***109.6***	***9,891.1***	***179.102.0***
Enriched – Shipments	25,269.8	25,269.8	108.6	9,401.1	178,135.9
Normal – Shipments	5,181.8	5,181.8	0.5	347.6	137.6
Depleted – Shipments	45,722.7	45,722.7	0.1	25.0	89.9
Total – Shipments	**76,174.3**	**76,174.3**	**109.2**	**9,773.7**	**178,363.4**
Total – NM Inventory	--	--	--	--	--
Total – Waste Inventory	--	--	--	--	--

5.1.3 WVDP

The WVDP site did not receive recycle material and only shipped a small quantity. The majority of what was shipped went to the Fernald site. Table 5-2B delineates the quantities of potentially recycle material along with the constituent concentrations that WVDP shipped. The majority of the material received at the WVDP had low concentrations of constituents as discussed in Appendix F. The summary of constituent quantities included in Table 5-2B reflect the flow of material and the constituent concentrations determined by the analytical results presented previously.

TABLE 5-2C
WVDP SUMMARY OF CALCULATED CONSTITUENT MASSES FOR RECEIPTS/SHIPMENTS/INVENTORY

Isotopic Range	Total U (MTU)	RU Quantity (MTU)	Calculated Constituent Mass (Grams) Pu-239	Np-237	Tc-99
Enriched – Receipts	--	--	--	--	--
Normal – Receipts	--	--	--	--	--
Depleted – Receipts	--	--	--	--	--
Total – Receipts	--	--	--	--	--
Enriched – Shipments	464.6	464.6	1.8	64.6	1,465.2
Normal – Shipments	13.0	13.0	0.1	1.8	40.7
Depleted – Shipments	142.1	142.1	0.6	19.8	*448.3*
Total – Shipments	***619.7***	***619.7***	***2.5***	***86.2***	***1,954.2***
Total – NM Inventory	--	--	--	--	--
Total – Waste Inventory	--	--	--	--	--

5.1.4 WSSRAP

Most of the material shipped to the WSSRAP site was from Fernald. Table 5-2B delineates the quantities of potentially recycle material along with the constituent concentrations. The material received at WSSRAP included metal, UF_4, and UO_3 as discussed in Section 2 and had low concentrations of constituents as discussed in Appendix F. The summary of constituent quantities included in Table 5-2B reflect the flow of material and the constituent concentrations determined by the analytical results presented previously.

TABLE 5-2D
WSSRAP SUMMARY OF CALCULATED CONSTITUENT MASSES FOR RECEIPTS/SHIPMENTS/INVENTORY

Isotopic Range	Total U (MTU)	RU Quantity (MTU)	Calculated Constituent Mass (Grams) Pu-239	Np-237	Tc-99
Enriched – Receipts	842.6	*842.6*	2.4	327.7	7,206.1
Normal (Natural) – Receipts	122,015.9	*70,538.4*	--	--	--
Depleted – Receipts	167.8	*32.0*	*0*	*0.1*	*0.3*
Total – Receipts	*123,026.3*	*71,413.0*	**2.4**	**327.8**	**7,206.4**
Enriched – Shipments	***833.9***	833.9	2.4	324.4	7,131.7
Normal (Natural)– Shipments	***121,901.2***	73,878.4	--	--	--
Depleted – Shipments	***167.8***	92.3	0	0.2	0.8
Total – Shipments	*122,902.9*	***74,804.6***	***2.4***	***324.6***	***7,132.5***
Total – NM Inventory	--	--	--	--	--
Total – Waste Inventory	--	--	--	--	--

5.2 IDENTIFICATION AND EVALUATION OF PROCESSES/FACILITIES THAT INVOLVED POTENTIAL WORKER EXPOSURE TO RECYCLED URANIUM CONSTITUENTS

5.2.1 FEMP

Since recycled uranium was utilized in all aspects of production after 1961, all workers employed at the FEMP after that time can be considered potentially exposed. The operations with the highest potential for exposure to recycled uranium and its constituents would be those involving manual introduction of uranium compounds into processes (commonly called dumping operations), and packaging of uranium compounds resulting from processes. The handling of metallic uranium would represent little potential exposure to recycled uranium constituents, although machining operations could generate some airborne contaminants, and thus some increasing the potential exposure to recycled uranium and its constituents.

For most recycled uranium, constituent levels were sufficiently low upon receipt that they represented a trivial risk beyond normal uranium exposure risks, e.g. <10 percent additional of the uranium inhalation dose threshold. However, certain processes may have concentrated constituent levels with respect to uranium content as described in section 2.4. Typically these processes purified the uranium product, meaning that constituent-to-uranium ratios were increased in the production byproducts. The uranium in these byproducts was often recovered, so these materials were handled at various processes and facilities at the FEMP and to a lesser degree at the other sites addressed in this report.

FEMP processes where byproducts were recovered included:

- Plant 8 - kilns, furnaces, and filters
- Building 55 - MgF_2 handling after metal production in Plant 5
- Plant 2/3 - Slag leach (uranium was recovered from MgF_2)
- Plant 6 and 9 - Recovery of metal turnings in pickling operations (because impurities tended to concentrate on the surface of cast uranium)
- Plant 1 – Slag milling

In addition, dust collectors from thermally hot processes tended to concentrate technetium, relative to uranium content.

Furthermore, historical operations data indicate that the FEMP received a number of special shipments of

high constituent level recycled uranium, primarily from the GDPs located at Paducah, Portsmouth, and Oak Ridge (K-25). These special shipments included fluorination tower ash from Paducah and Oak Ridge (K-25); barrier and cylinder decontamination residues from Paducah, Portsmouth, and Oak Ridge; scraps and residues from Paducah, Portsmouth, and Oak Ridge; and incinerator ash from Paducah and Oak Ridge. The processing of these materials at the FEMP represent a higher potential source of exposure to recycled uranium and its constituents for the FEMP workforce. A more thorough discussion of these non-routine processing campaigns is presented in Appendix E.

These descriptions provide some insight into relative potential for exposure to recycled uranium and its constituents at various process locations. However, due to the wide variation in constituent concentration in various recycle materials (e.g., the Paducah fluorination tower ash) evaluation of the potential exposure of individuals to recycled uranium can only be made on a case-by-case basis. The exposure of workers to recycled uranium and its constituents would also have to take into consideration the individuals work histories to ascertain whether or not it would have coincided with the handling of the high-constituent materials.

Personnel Radiation Exposure Monitoring

The potential ramifications of transuranic and fission product constituents in recycle uranium had been recognized as early as 1986 and the FEMP site radiation protection practices were adjusted to account for the trace constituent levels within the framework of the DOE radiation protection standards in effect at that time. Prior to 1986, radiation protection practices addressed recycle uranium without consideration of the presence of radiological impurities. Therefore, it may be assumed that only monitoring data prior 1986 need be considered in evaluating consequences of the constituents of concern in recycled uranium.

External Radiation Exposure Monitoring

Personnel monitoring, for external radiation exposure, has been performed effectively throughout site operations, starting in 1952 and continuing to the present. Early monitoring was performed via film badges, thermoluminescent dosimeters (TLDs) have been used since 1984. Provided that external monitoring devices respond appropriately to various types of radiation, external radiation measurements are not dependent on the radionuclide that gives rise to the radiation. Consequently, external radiation

exposures are contained in individual exposure monitoring records for all current and former employees, since 1952 and for all subcontractors and visitors since about 1986.

Internal Radiation Exposure Monitoring

Internal radiation exposure monitoring has been performed since the 1950's using urinalysis, and since 1968 using in vivo lung monitoring. In vivo monitoring was performed using the Mobile In Vivo Radiation Monitoring Laboratory from Oak Ridge Y-12 Plant from 1968 until 1989. An onsite in vivo facility was constructed at the FEMP and has operated since 1989. However, prior to the effective date of DOE Order 5480.11 in 1989, internal monitoring data was not routinely used to estimate intake quantities and subsequent radiation doses. Rather, action levels were established for internal monitoring results that would prompt additional follow-up monitoring, evaluation of work practices and workplace conditions, and reassignment of employees to jobs with low exposure potential. Results above some threshold prompted entries of lung doses on the site's Radiation Exposure Report in the form of annual lung dose. Committed lung doses and committed effective dose equivalents were not calculated until DOE Order 5480.11 became effective.

Urinalysis

The analytical technique for uranium analysis at the FEMP, formerly the FMPC, has always been a chemical analysis for uranium, rather than a radiometric analysis. Consequently, intakes of uranium with dosimetrically significant quantities of transuranics or other impurities would not be viewed any differently than an intake of pure uranium. For that reason, urinalysis derived internal monitoring results likely understate actual radiological intakes when materials being handled had transuranic levels in excess of the deminimis level. Because of the variability of transuranic constituent levels, with respect to location in the plant and between processing campaigns within the recycled uranium, it is not possible to develop a standard value for the amount of dose contribution that would result from the presence of transuranic constituents.

In order to determine internal doses resulting from transuranic constituents in recycle uranium, each individual's exposure record would have to be considered on a case-by-case basis. Urinalysis results could be utilized in conjunction with knowledge of work assignments, and transuranic concentrations in recycle uranium handled at those locations to develop an estimate of the total radiological intakes and resulting internal doses. For all data prior to 1989 (it is important to note that Radiation Protection

programs are believed to have adequately accounted for impurities and transuranics in recycle uranium since 1986) internal doses have not been calculated. Therefore any investigation of doses due to transuranics in recycle uranium would require a complete dose assessment, evaluating doses from uranium as well as transuranic constituents, utilizing internal monitoring results and information about the individual's workplace assignments.

In Vivo

Although in vivo measurements are radiometric measurements, the measuring technology in the Mobile In Vivo Radiation Monitoring Laboratory was not adequate to detect transuranics at levels that could have occurred at occupational exposure. Consequently, just as is the case for urinalysis results, in vivo monitoring results for uranium would have to be used along with knowledge of work assignments and transuranic levels of the material within those locations and facilities in order to estimate the total intake.

The information relative to internal radiation dose estimation contained within the Deminimis Report provides an acceptable approach to identify those product/waste streams which may require additional evaluation or bioassay measurements. The deminimis approach provides an effective method for screening materials, however, the method should not be used to calculate actual dose.

The method described is based on comparison of derived air concentration values (DACs) which do not provide sufficient detail for assigning internal dose. For transuranic constituents in uranium that method generally overestimates the dose contribution from the transuranics, due to the convention used in determining the DAC value. For that reason, during investigations and development of special bioassay programs at the FEMP, appropriate dose conversion factors derived from ICRP 30 and ICRP 48 methods are used to determine bioassay requirements or to calculate individual dose to employees resulting from intakes of impurities contained within the waste/product material.

A comparison between the method provided in the Deminimis report and methods used at the FEMP to calculate CEDE resulted in a factor of 2 difference between the methods, with the Deminimis report being more conservative.

5.1.2 RMI

Since recycled uranium was utilized in all aspects of production after 1961, all workers employed at the RMI after that time can be considered potentially exposed. The handling of metallic uranium would

represent little potential exposure to recycled uranium constituents, although machining operations could generate some airborne contaminants, and thus some increasing the potential exposure to recycled uranium and its constituents.

5.1.3 WVDP

Difficulties exist trying to quantify the amount of recycled material that might have been shipped from the WVDP. However, since WVDP's primary mission was to process irradiated uranium from commercial, experimental and government reactors, the site's worker protection program would have been designed to address transuranics and fission products and therefore should have been adequate to address recycled uranium constituents.

5.1.4 WSSRAP

Historical data are inconclusive regarding the receipt of recycled uranium by the Weldon Spring site and the Mallinckrodt Chemical Works, a thorough analysis of the quantities of recycled uranium processed at these facilities is impractical. However, FEMP records indicated that approximately 437 MTU of enriched uranium was shipped from the FEMP to Weldon Spring in the early 1960s. Therefore, it must be concluded that the potential existed for Weldon Spring workers during this time period could have been exposed to recycled uranium and its constituents.

5.3 IDENTIFICATION AND EVALUATION OF PROCESSES/FACILITIES THAT INVOLVED POTENTIAL ENVIRONMENTAL CONTAMINATION

5.3.1 FEMP

Section 2 and Appendix F of this report addressed the activities that lead to the release of recycled uranium that contained trace constituents. Uranium residues and wastes were periodically placed in waste pits on site. In addition, even though filters were in place low concentrations of uranium were released through roof stacks and vents of various facilities over time. Over the life of the facility it is estimated that as much as 170 MTU were released to the environment with approximately 2 grams of plutonium. Table 5-3 presents the estimated environmental releases from the FEMP over the life of the facility.

5.3.2 RMI

The RMI facility received uranium metal from Fernald and then performed extrusions and other metal handling activities including pickling the metal and chemical processing that was limited to the oxidation of uranium fines for recovery. The oxidation of the uranium could have lead to environmental releases.

During the RCRA Facility Investigation (RFI) required by the Ohio environmental Protection Agency uranium and technetium were detected along with specific organic compounds used at the site. No specific data are available to estimate the quantity of recycled uranium that may have been released to the environment.

5.3.3 WVDP

The WVDP handled primarily source materials that are out of scope of the recycle uranium report. The processing and other activities involving uranium at the WVDP did not contribute to releases of "recycle" uranium and therefore the potential environmental impacts are essentially zero. These conclusions are represented in Table 5-3 for the WVDP site.

5.3.4 WSSRAP

Section 2 and Appendix F of this report addressed the activities that lead to the release of recycled uranium which contained trace constituent levels. Uranium residues and wastes were periodically generated and managed on site. Low concentrations of uranium were released through roof stacks and vents of various facilities over time. Over the life of the facility it is estimated that as much as 228 MTU were released to the environment, however, since the primary material handled was deminimis there was essentially no measurable plutonium released. Table 5-3 presents the estimated environmental releases from the WSSRAP over the life of the facility.

Table 5-3: Estimated and Calculated Recycle Uranium Environmental Releases FEMP

Site	Environmental Release	Chemical Form(s)	Quantity of RU, MTU	Constituent Values ppb			Calculate Constitue Mass Grams	
				Pu-239	Np-237	Tc-99	Pu-239	Np-237
FEMP (Routine)	Dust Collectors	Metal, Compounds	19.4	2.884	388.97	8,552.33	0.1	7.5
FEMP (Routine)	Wet Scrubbers	Various	21.6	2.884	388.97	8,552.33	0.1	8.4
FEMP (Routine)	Gulping Operations	UNH	25.7	2.884	388.97	8,552.33	0.1	10.0
FEMP (Routine)	Other	UF6	6.4	2.884	388.97	8,552.33	0.0	2.5
FEMP (Non-Routine)	Pilot Plant UF6	UF6	1.5	0.502	54.90	201.61	0.0	0.1
FEMP (Non-Routine)	Plant 2/3	UO3,U3O8, UO2	22.6	23.969	1,045.29	2,789.56	0.5	23.6
FEMP (Non-Routine)	Other Non-Routine Production	Metal, Compounds	2.1	2.884	388.97	8,552.33	0.0	0.8
FEMP (Non-Production)	FEMP Incinerators	U3O8, UO2	3.1	23.969	1,045.29	2,789.56	0.1	3.2
FEMP (Non-Production)	FEMP Storage	Metal, Compounds	1.0	84.817	3,999.32	4,110.05	0.1	4.0
FEMP (Non-Production)	Other Airborne Emissions	UO2, U3O8	0.3	16.035	1,328.11	2,399.22	0.0	0.4
FEMP (Liquid)	Liquid Effluents	Metal, Compounds	66.5	16.035	1,328.11	2,399.22	1.1	88.3
Total FEMP Releases			**170.2**				**2.0**	**148.9**
West Valley	Airborne Releases	UNH	0.0	3.947	139.00	3,155.10	0.0	0.0
West Valley	Liquid Effluents	UNH	0.0	3.947	139.00	3,155.10	0.0	0.0
Total WV Releases			**0.0**				**0.0**	**0.0**
Weldon Spring	Airborne Releases	Metal, Compounds, UF6	45.0	0.091	67.09	26.55	0.0	3.0
Weldon Spring	Liquid Effluents	Metal, Compounds	183.0	0.091	67.09	26.55	0.0	12.3
Total WSSRAP Releases			**228.0**				**0.0**	**15.3**

5.4 DISCUSSION OF DATA SOURCES (CONFIDENCE, UNCERTAINTY)

The sources of data for the evaluation of the recycled uranium flows and constituent mass balance for all of the sites in this report included historical documents, records of shipments and receipts, former site workers with key process knowledge expertise, and an abundance of analytical data covering a wide range of uranium streams and isotopic ranges (Appendix C). There is inherent uncertainty in each of these sources of information. The critical element in developing this report was to extract the facts from the information and then shape the interpretations and perceptions of the information within the framework of the facts. The uncertainty in the analytical data can be measured and quantified as is the case with the records of uranium shipments and receipts. Processes, activities, and conditions at the sites as perceived by former site workers also have inherent uncertainties. These uncertainties are less quantifiable, yet can be bounded. Historical documents and records are also by nature limited by uncertainties, however, here too the data, results, and conclusions of past studies can be examined in light of the conditions at the time of the study, the level of detail expected, and the current use of the historical information.

Ultimately the question of uncertainty leads directly to the question of how much confidence is there in the results and conclusions reached. The relationship between the uncertainty and the confidence in any conclusions can be established thorough the coupling of the available information. This report represents a fairly comprehensive evaluation of both the available information and the gaps in the knowledge base. Records associated with receipts and shipments for the WSSRAP as an example were not available, however, by thoroughly examining the records for shipments and receipts from the other sites across the complex a relatively accurate picture of the WSSRAP was possible. Likewise, the analytical data representing the concentrations of the constituents in recycled uranium was not available in significant amounts at many of the sites, there were, however, more than 3,000 data points collected at the Fernald site. Appendix F of this report presents the statistical and process knowledge interpretations generated from the available analytical data.

Clearly the available data do not cover the entire range of operating history or all of the uranium streams with the same level of detail. A majority of the constituent data was obtained between the mid 1980's through the 1990's and therefore is representative of the later processes rather than from the early years. This is significant in that the early processing years involving recycled uranium contained lesser quantities of the transuranic constituents. The lower constituent concentrations in the early processing years is a direct consequence of the fact that Fernald had not started the blending using the uranium recovered from the Paducah ash. In the early years the average concentration of plutonium in the

recycled uranium going back to Hanford was well below the 5 ppb level, where as after the recovery of uranium from the ash the average Pu levels increased to over 5 ppb. Taking into account the process history, the available analytical data and the time frame over which the data were collected the range and the representative value for each of the key constituents can be estimated for nearly all of the recycled uranium in the complex. The extrapolation of the analytical data backward in time provides both a conservative estimate as well as an accurate upper bound on the constituent levels. Knowing that there is an upper bound allows for the constituent mass balance to be carried forward for the entire complex.

As a consequence of the evaluation of the inherent uncertainties in the available information there is high confidence in the conclusions reached as to the quantity of recycled uranium shipped and received at each of the four sites with this report. In addition, there is also a high degree of confidence in the representative values of the concentrations for each of the three primary constituents and the corresponding estimated constituent masses. The overall plutonium, neptunium, and technetium contained in the recycled uranium received at or shipped from each of the four sites is well within the expected bounds and constitutes a basis for performing a constituent mass balance for the complex.

5.5 OTHER CONCLUSIONS

In Section 5.1 above the differences in the definition of recycled uranium between the various source sites, enrichment facilities and processing plants was discussed. The results of the different definitions changes the amount of recycled uranium significantly, however, the total constituent masses does not change appreciably. In each of the following sub-sections the complex-wide rollup for recycled uranium is presented along with the total uranium quantities.

5.5.1 FEMP

A comparison of the constituent masses for the complex-wide rollup report and the potential recycled uranium as contained in this report shows that the majority of the constituents are contained in a relatively small mass of uranium. In Table 5-2A the total quantity of plutonium contained in nearly 246,000 MTU was estimated to be approximately 217 grams. In Table 5-4A below the total quantity of plutonium has only decreased by 16 grams and yet nearly 190,000 MTU of uranium has been removed from that considered as recycle for the complex. The majority of the nearly 190,000 MTU is either UF6 or depleted uranium with average plutonium concentrations below 0.01 ppb. The remaining 55,000 MTU of enriched uranium considered recycled from the complex-wide perspective has average plutonium concentrations near 3 ppb which is 300 times greater.

Removing the low concentration or deminimis uranium streams from the complex-wide rollup does not adversely impact the ability to quantify the total constituent masses.

TABLE 5-4A: COMPLEX-WIDE ROLLUP SUMMARY OF FEMP CONSTITUENT MASSES FOR RECEIPTS / SHIPMENTS / INVENTORY OF RECYCLED URANIUM

	Total U (MTU)	RU Quantity (MTU)	Calculated Constituent Mass (Grams)		
			Pu-239	Np-237	Tc-99
Total – Receipts	*363,581.8*	**55,419**	***201***	***18,378***	***328,981***
Total – Shipments	*359,870.8*	**63,863**	***183***	***21,013***	***335,442***
Total – NM Inventory	3,801.8	**2,273**	***15.1***	***612***	***2,155***
Total – Waste Inventory	1,310.8	**651**	***7.4***	***357***	***1,915***

5.5.2 RMI

In a similar manner the total recycled uranium received at the RMI facility was reduced in the complex-wide rollup without a significant decrease in the total quantity of the trace constituents. The results of removing uranium from the potentially recycled inventory on the constituent masses is illustrated in Table 5-4B below.

TABLE 5-4B: COMPLEX-WIDE ROLLUP SUMMARY OF RMI CONSTITUENT MASSES FOR RECEIPTS / SHIPMENTS / INVENTORY OF RECYCLED URANIUM

	Total U (MTU)	RU Quantity (MTU)	Calculated Constituent Mass (Grams)		
			Pu-239	Np-237	Tc-99
Total – Receipts	**76,721.9**	**25,328**	***109***	***9,423***	***178,542***
Total – Shipments	**76,174.3**	**25,270**	***109***	***9,401***	***178,136***

5.5.3 WVDP

The WVDP only shipped uranium that was considered recycle and there was little or no change in either the constituent levels or the quantity of recycled uranium estimates. The very minor differences are noted in Table 5-4C below.

TABLE 5-4C: COMPLEX-WIDE ROLLUP SUMMARY OF WVDP CONSTITUENT MASSES FOR RECEIPTS / SHIPMENTS / INVENTORY OF RECYCLED URANIUM

	Total U (MTU)	RU Quantity (MTU)	Calculated Constituent Mass (Grams)		
			Pu-239	Np-237	Tc-99
Total – Receipts	--	--	--	--	--
Total – Shipments	***619.7***	***619.7***	***2.5***	***86.2***	***1,954.2***

5.5.4 WSSRAP

In correlating the potential recycled material in this report with the complex-wide rollup for the WSSRAP site there were essentially no changes to either the quantity of recycled uranium or the calcualted constituent masses. These results are illustrated in Table 5-4D below.

TABLE 5-4D: COMPLEX-WIDE ROLLUP SUMMARY OF WSSRAP CONSTITUENT MASSES FOR RECEIPTS / SHIPMENTS / INVENTORY OF RECYCLED URANIUM

	Total U (MTU)	RU Quantity (MTU)	Calculated Constituent Mass (Grams)		
			Pu-239	Np-237	Tc-99
Total – Receipts	*123,026.3*	***843***	***2.4***	***328***	***7,206***
Total – Shipments	*122,902.9*	**926.2**	***2.4***	***325***	***7,133***