Assessing Inventories of Past Radioactive Waste Arisings at Chalk River Laboratories

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ABSTRACT

Internationally, a great deal of progress has been made in improving the management of currently accumulating and anticipated future radioactive wastes. Progress includes improved waste collection, segregation, characterization and documentation in support of disposal facility licensing and operation.

These improvements are not often very helpful for assessing the hazards of wastes collected prior to their implementation, since, internationally, historic radioactive wastes were not managed and documented according to today's methods. This paper provides an overview of Atomic Energy of Canada Limited's (AECL) unique approach to managing its currently accumulating, low-level radioactive wastes at Chalk River Laboratories (CRL) and it describes the novel method AECL-CRL has developed to assess its historic radioactive wastes.

Instead of estimating the characteristics of current radioactive wastes on a package-by-package basis, process knowledge is used to infer the average characteristics of most wastes. This approach defers, and potentially avoids, the use of expensive analytical technologies to characterize wastes until a reasonable certainty is gained about their ultimate disposition (Canada does not yet have a licensed radioactive waste disposal facility). Once the ultimate disposition is decided, performance assessments determine if inference characterization is adequate or if additional characterization is required. This process should result in significant cost savings to AECL since expensive, resource-intensive, up-front characterization may not be required for low-impact wastes. In addition, as technological improvements take place, the unit cost of characterization usually declines, making it less expensive to perform any additional characterization for current radioactive wastes.

The WIP-III data management system is used at CRL to "warehouse" the average characteristics of current radioactive wastes. This paper describes how this "warehouse of information" is used to support the management of currently accumulating radioactive wastes and how this same "warehouse of information" is the basis for the development of a novel way to assess historic waste inventories.

Records of waste emplaced into storage facilities at CRL since the mid 1940's are in a variety of formats and the quality of the data recorded is inconsistent. In addition, prior to recent improvements in waste management, wastes that should have been collected and handled separately (short-lived versus long-lived) were usually handled and stored together on the basis of external radiation field - not on their requirements for long-term management. As such, the challenge is to assess historic waste management records in the context of today's waste management practices.

Recent enhancements to the WIP-III application have provided the tools for this assessment. Historic records are entered into WIP-III "as-is". Next, using additional data entry screens, expert interpretation is used to identify historic wastes as similar to a current waste or similar to a mixture of current wastes. Next, the historic waste is assigned the characteristics of a current waste or of a mixture of current wastes, using the "warehouse of information".

The interpretation process improves the quality of historic waste inventory records, which will allow AECL-CRL to provide defensible estimates of the characteristics of its historic wastes.

This paper describes how the interpretation process can be generically applied to any waste site with historic wastes, independently of how those sites manage their current wastes. The paper is also an update of a presentation with the same title by G.W. Csullog et al. at Waste Management '98, 1- 5 March 1998, Tucson, Arizona, USA.

INTRODUCTION

Internationally, a variety of approaches have been taken for managing low-level radioactive wastes (LLW) and intermediate-level radioactive wastes (ILW). In addition, there is no international consensus on the definitions for LLW and ILW.

For example, solid LLW accepted at the Drigg facility in the United Kingdom is defined as having less than 4 GBq/tonne of alpha-emitting radionuclides and less than 12 GBq/tonne of beta- and gamma-emitting radionuclides [1]. ILW are defined as having radionuclide inventories above LLW and they do not include high-level radioactive wastes (HLW). HLW are defined as spent irradiated fuel or fuel reprocessing wastes that are heat generating.

In Canada, LLW are defined by exclusion [2]. LLW encompasses all forms of radioactive wastes except irradiated nuclear fuel (HLW) and uranium or thorium mining/milling operations wastes. As such, LLW encompasses what many other nations would define as ILW. However, even in Canada, the Federal Government's definition of LLW is not uniformly applied. Some organizations still use the terms LLW and ILW to define some of their wastes, while Atomic Energy of Canada Limited (AECL) uses only LLW and HLW to define its wastes.

At a recent international symposium [3], improvements in waste collection, segregation, characterization and documentation were profiled by representatives from more than 15 nations. However, the lack of an international consensus on definitions for LLW, ILW and HLW makes it difficult to compare the various national waste management programs that were presented.

In addition to the lack of a consensus on the management of currently accumulating wastes, it was clear from the symposium that there is even more uncertainty on how to come to grips with the issue of historic wastes since, internationally, historic radioactive wastes were not managed and documented according to today's methods. Questions were raised about how inventories of historic radioactive wastes could be assessed given that often these waste were not managed according to their long-term radiological hazards. Historic wastes were often segregated and managed according to parameters such as external radiation field, a short-term radiation protection factor.

The challenge, therefore, is to assess historic waste management records in the context of current waste management practices. Even though current practices vary internationally, AECL's Chalk River Laboratories (CRL) has implemented a novel approach to assessing historic waste inventories that should be readily applicable to any site with historic wastes regardless of the differences these sites have in managing their current wastes.

BACKGROUND TO THE CRL HISTORIC INVENTORY PROJECT

AECL has implemented a unique approach to managing its currently accumulating LLW at CRL. Instead of estimating the characteristics of current radioactive wastes on a package-by-package basis, the CRL Waste Identification (WI) Program uses process knowledge to infer the average characteristics of most waste from routine operations [4]. This approach defers, and potentially avoids, the use of expensive analytical technologies to characterize wastes until a reasonable certainty is gained about their ultimate disposition (Canada does not yet have a licensed radioactive waste disposal facility).

Once the ultimate disposition of waste is decided, performance assessments determine if inference characterization is adequate or if additional characterization is required [5]. This process should result in significant cost savings to AECL since expensive, resource-intensive, up-front characterization should not be required for low-impact wastes. In addition, as technological improvements take place, the unit cost of characterization usually declines, making it less expensive to perform any additional characterization of radioactive wastes from current operations.

The WI Program at CRL is described in detail in a companion paper [4].

The natural consequence of the WI Program is the generation of large amounts of information and data associated with identifying and characterizing processes and wastes. Using a typical waste inventory database approach, AECL would have been faced with either the routine entry of large amounts of data that are recorded on waste data sheets ("manifests") or simply cross-referencing documentation that described waste characteristics (with the latter approach, running inventories of radionuclides and toxic hazardous inventories could not be effectively maintained for storage or disposal facilities).

Therefore, AECL's WIP-III data management system [6] was engineered to "warehouse" information collected from the WI Program and to pass this information from lookup lists to pre-populate "template" waste data sheets for generators to use. Figures 1A to 1D provide an overview of how WIP-III is used to manage WI Program data.

The "warehousing" of data has the following benefits:

- a high quality/quantity of characterization data can be entered with little effort and few staff,
- the waste receiver's staff expend less effort qualifying wastes for acceptance,
- characterization data are traceable, auditable and defensible, and
- change control is managed by the WIP-III database, as follows:
  - changes in WI reports result in changes to WIP-III lookup tables,
  - once lookup table changes are implemented and authorized, WIP-III generates new template data sheets and forces the use of the latest revision template (outdated templates submitted by generators cannot be used).

Together, the WI Program and the WIP-III data management system provide a very cost-effective administrative system that has minimized radioactive waste characterization costs and has provided an auditable, defensible "paper trail" that links waste from their point of generation to their final disposition point. The key feature of this administrative system is the integration of characterization data from WI reports into WIP-III to create template data sheets that describe a waste block's average characteristics.

While the administrative system described was developed and implemented to manage currently accumulating radioactive wastes in a very cost-effective manner, this same system has been extended to provide a novel and effective method for assessing the CRL inventory of historic radioactive wastes.

THE CRL HISTORICAL WASTE INVENTORY PROJECT

The "Waste Management Areas Historical Inventory Project", authorized in mid August 1997, has the following objectives:

1. enhance the WIP-III application to enter historic records of waste receipts,
2. enter historic records into WIP-III,
3. interpret historic records in the context of current waste management operations,
4. define the requirements for "validating" interpretations,
5. validate the interpretation of historic records, and
6. estimate the inventory of historic wastes in the CRL waste management areas (WMA).

Objective 2 involves transcribing hand written records from the daily WMA logbooks that were used to record waste emplacements. Objective 6 will take several years to achieve since it requires the entry and interpretation of about 50 years of historic records using the enhanced WIP-III application.

By the end of August 1997, a prototype "historic waste module" was added to WIP-III - see Figure 2.

The prototype module was used to enter "as-is" information from the WMA logbooks using the top half of the data entry screen shown in Figure 2. As logbook records were entered, supporting documentation, which provides additional detail about the wastes emplaced, was collected. Once a complete page of logbook entries was entered, a copy of the logbook page and all supporting documentation was passed to a waste management specialist.

The specialist then "interpreted" the historic logbook records in the context of current radioactive waste operations using the bottom half of the screen shown in Figure 2. The parameters in the bottom half of the screen, such as Location, Package Type, Waste Material and Waste Type were selected from the lookup lists that are used to identify currently accumulating radioactive wastes. The use of lookup lists forced the specialist to interpret free-format, historic records in terms of a prescribed list of definitions. The specialist also recorded all supporting documentation used in the interpretation (refer to the "Supporting Doc" tab in Figure 2).

The interpretation of historic records relies on the specialist identifying a historic waste as equal to or similar to a currently accumulating waste. If the current waste has a template, the template, and thus the current waste's estimated contaminant inventory, can be assigned to the historic waste.

Several issues were identified with the use of the prototype module:

1. The format of logbook pages has varied over the last 50 years. To enter logbook records "as-is", the WIP-III historic module needs to dynamically specify the format of logbook pages.
2. Single logbook records sometimes require multiple interpretations. For example, a single logbook record may refer to the transfer of multiple packages, with varying characteristics, to various waste storage locations. A separate interpretation would be required to record the characteristics and location of each package. The prototype module allowed only a single interpretation per logbook record.
3. Supporting documents should become an integral part of the WIP-III historic records. The prototype module only provided references to supporting documents.
4. Historic wastes were not segregated the same way as currently accumulating wastes. As such, some historic wastes are mixtures of current wastes. For example, each package of the current waste Block 101 contains 18 ion exchange columns from an isotope production facility. The current waste Block 121 (see Figure 3) contains cemented isotope production wastes. Historically, two ion exchange columns were placed into each package of cemented wastes. Therefore, the historic waste should be assigned $1/9^{th}$ of the contaminant inventory for Block 101 and all of the contaminant inventory for Block 121. The prototype module only allowed for the identification of one template for a single waste block (that is, only the inventory of a single, current waste could be associated with a historic waste).

The historic waste module was re-worked to address the issues identified above. Figure 4 illustrates how the structure of logbook pages can be dynamically defined. For each column on a logbook page, the data entry person creates a new data entry row on the "Log Book" entry screen. The defined structure remains in effect until the data entry person modifies the screen to reflect the current logbook page being processed.

Instead of the 1:1 relationship between logbook records entered and interpretations, per the top and bottom halves of Figure 2, the waste management specialist "tabs over" to an interpretation screen in the re-worked historic waste module. Initially, the specialist is presented with a list of all the interpretations for the current logbook record (the list is empty if no interpretations have been performed yet). The specialist can create new interpretations, update existing interpretations or delete existing interpretations. Figure 5 is a capture of the interpretation screen after the "update button" was clicked.

Figure 5 shows that a split screen interface (top/bottom) is used for the re-worked interpretation process, with "tabs" on each half of the screen to provide additional functions. If the "Log Book" tab is selected in the bottom half of the screen, the "as-is" logbook information is displayed for easy reference to facilitate the interpretation using the top half of the screen.

The "Matching Interpretations" tab serves two purposes. First, if the specialist selects, for example, Package Type = CAN, Waste Material = CELL WASTE and Waste Type = ISOTOPE PRODUCTION in the top half of the screen, selects the "Matching Interpretations" tab in the bottom half and then clicks the FIND button, the screen will display all previous interpretations that contain these parameter values. As such, the specialist interpreting the current logbook record can quickly review how previous interpretations had been completed for similar cases. Second, the "COPY" button appears once the "Matching Interpretations" tab is selected. The specialist can select a previous interpretation then COPY the entire interpretation from the bottom half of the screen to the top half to speed up the process of completing interpretations.

In addition to referencing supporting documentation (the document identifier and the location of a physical copy are entered), the re-worked historic module uses BLOB fields (**B**inary **L**arge **OB**jects) to insert electronic copies of supporting documents into the WIP-III inventory database. Documents can be in native format, such as Microsoft^{tm} Word^{tm}, or scanned images in a variety of formats. Suites of documents in "zip" archives can also be entered as a single BLOB.

For logistical reasons, the re-worked historic waste module, like the prototype module, can only reference one waste block template. However, WIP-III has been modified to create "scaled" templates; see Figure 6.

With scaled templates, the waste management specialist selects one or more templates on which to base the creation of a new "historic template". The specialist enters (1) the ID number for the new template, (2) the ID number(s) of an existing template or templates and (3) the percentage(s) of the contaminant inventory for an existing template or templates. After parameters such as Package Type and Waste Material are defined for the new historic template, the new template's contaminant inventory is computed from the existing template(s). This process allows the simulation of historic waste packages that existed prior to recent changes in waste segregation for current wastes.

Figures 7 and 8 illustrate the result of historical record interpretation. Figure 7 summarizes the "as-is" inventory recorded on one page of a historical CRL waste management areas logbook page. Figure 8 summarizes the additional contaminants in the historical inventory after the "as-is" records were interpreted. Clearly, the interpreted records provide a richer description of the historical waste.

SUMMARY AND CONCLUSIONS

The historic waste inventory project at CRL is based on:

- identifying the routine operating radioactive wastes currently being generated (waste blocks),
- estimating the average characteristics of waste blocks,
- entering these average characteristics into lookup tables in the WIP-III data management system,
- entering historic waste emplacement records "as-is" into the historic waste module of WIP-III,
- interpreting these historic records in the context of current operations that generate waste, and
- identifying historic wastes as equal or similar to a currently accumulating waste or equal or similar to mixtures of currently accumulating wastes.

"Low quality", "as-is", historic records from hand-written logbooks are entered into WIP-III's historic waste module. A waste management specialist interprets these "as-is" records relying on a knowledge of currently accumulating wastes and any historic, supporting documentation that is related to the logbook records. For many historic wastes from routine operations, the specialist can identify this waste as equal or similar to a current routine waste or to a mixture of current routine wastes. Therefore, the contaminant inventory for these historic wastes can be inferred to be equal or similar to the inventory of currently accumulating waste(s). In effect, "low quality" historic records are interpreted to become "high quality" records of past waste arisings. These interpreted records will be used to estimate the characteristics of historic wastes currently stored in the waste management areas at CRL.

The WIP-III data management system includes algorithms to compare contaminant inventories of wastes with administrative limits established by performance assessments. These algorithms determine the impact any given waste would have upon various disposal facility options. This impact assessment will be used to determine if the inferred characteristics for any given waste, either currently accumulating or historic, is adequate for disposal purposes. This assessment process has the potential to minimize the cost and effort associated with characterizing wastes, either current or historic, beyond using inference methods.

The implementation of the historic waste module in WIP-III is a logical extension of how current wastes are managed at CRL. However, the approach taken for estimating the characteristics of historic waste inventories can be applied to other sites with historic wastes, independently of how these sites manage their current wastes. Generically, the following is required:

- identify the "components" of historic wastes (at CRL, these "components" are the currently accumulating waste blocks and "historic waste blocks"),
- establish the average characteristics of these "components" (at CRL, this is accomplished by the Waste Identification Program),
- enter the average characteristics of these "components" into a database (at CRL, this is accomplished by lookup tables in the WIP-III database),
- enter the records for historic waste emplacements for a waste management facility into a database (at CRL, this is accomplished by the historic waste module of WIP-III),
- interpret historic waste records as being equal or similar to a "component" or a "mixture of components" (at CRL, historic records are associated with a template for a current waste or with a "historic template" that represents mixtures of current wastes), and
- develop a reporting mechanism to compute the contaminant inventories in historic wastes within the waste management facility or within its sub-facilities.

REFERENCES

1. S Newstead, "**Regulatory Control of Radioactive Waste Disposal in the UK**", Third International Seminar on Radioactive Waste Products, 23-26 June 1997, Würzburg, Germany.
2. Energy Mines and Resources Canada, "**Federal Policy on the Management of Low-Level Radioactive Wastes**", 1986.
3. Third International Seminar on Radioactive Waste Products, 23-26 June 1997, Wurzburg, Germany.
4. G.W. Csullog, N.W. Edwards and M.A. terHuurne, "**Current Status of the Waste Identification Program at AECL's Chalk River Laboratories**", presented at the 19th Annual Conference of the Canadian Nuclear Society, 18 - 21 October 1998, Toronto, Ontario, Canada.
5. G.W. Csullog, "**The Link Between Performance Assessment and Quality of Data**", Second International Seminar on Radioactive Waste Products, 28 May-1 June 1990, Julich, Germany.
6. M.A. terHuurne, G.W. Csullog, S.M. Dunford, V.R. Hulley, J.D.M. Martin, M.T. Miller, "**WIP-III: The Waste Operations Data Management System at AECL's Chalk River Laboratories**", Waste Management 97, 2-6 March 1997, Tucson, Arizona, USA.

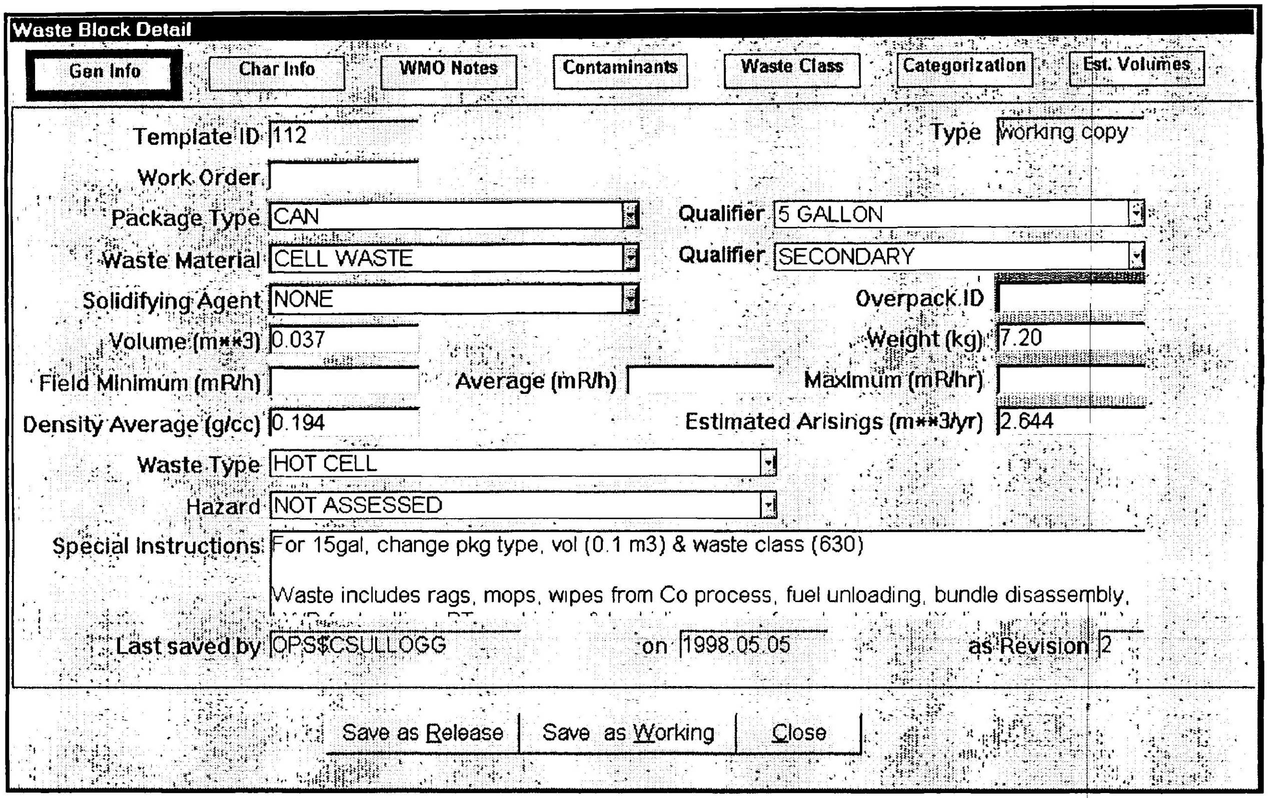

Figure 1A: First of four computer "screens" illustrating how WI Program information is "warehoused" in CRL's WIP-III data management system

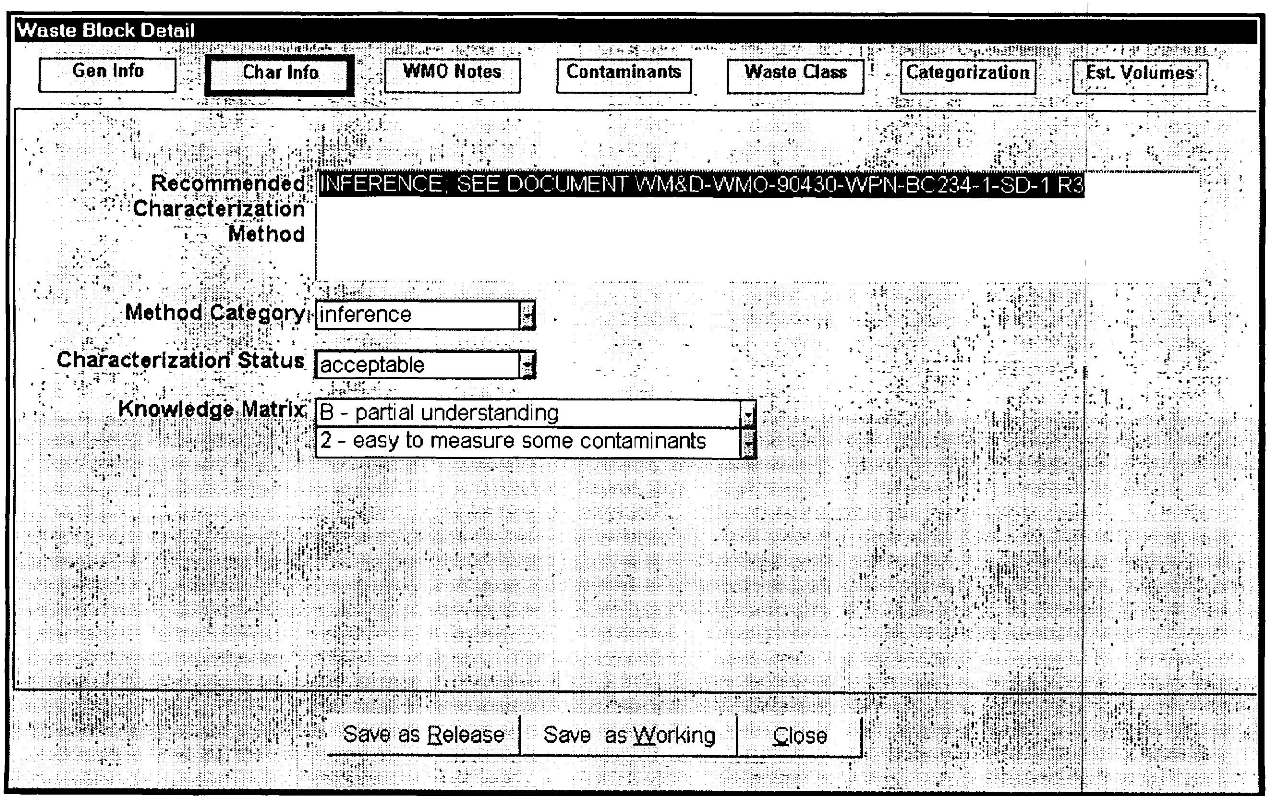

Figure 1B: Second of four computer "screens" illustrating how WI Program information is "warehoused" in CRL's WIP-III data management system

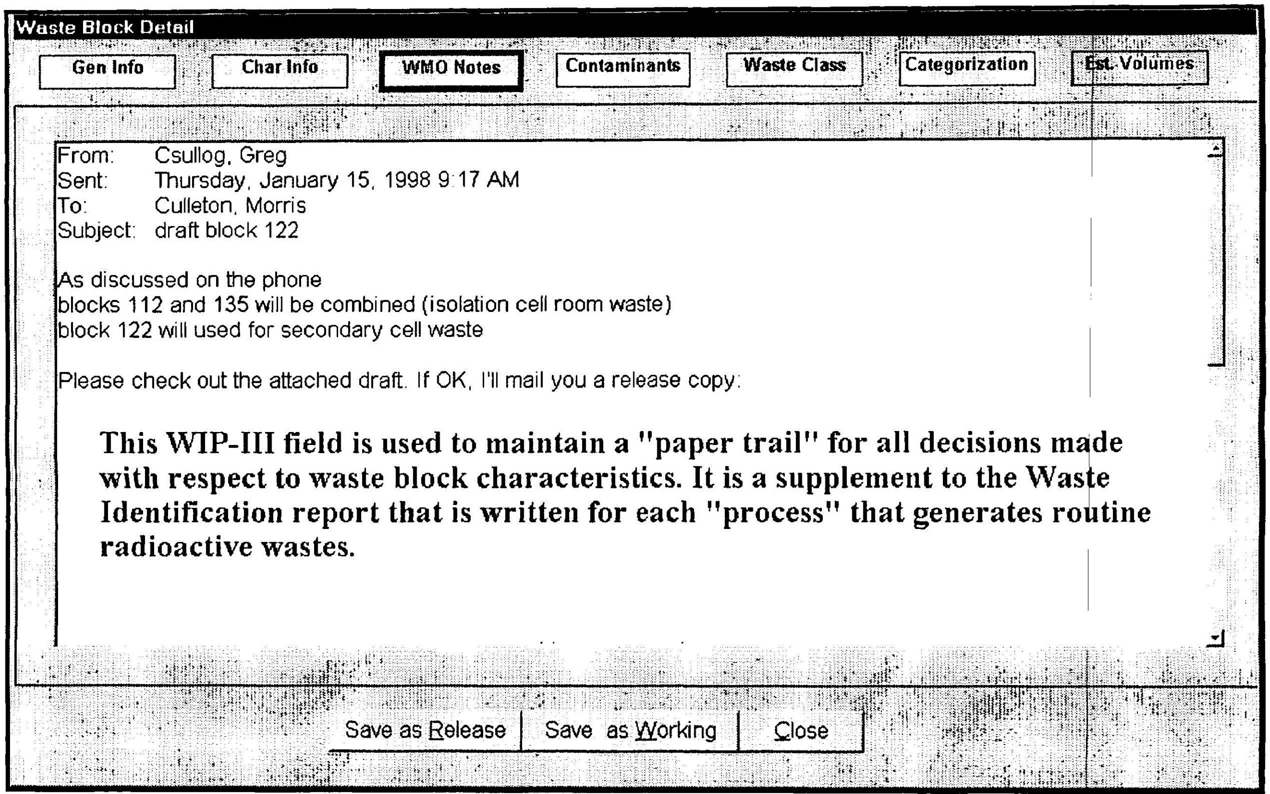

Figure 1C: Third of four computer "screens" illustrating how WI Program information is "warehoused" in CRL's WIP-III data management system

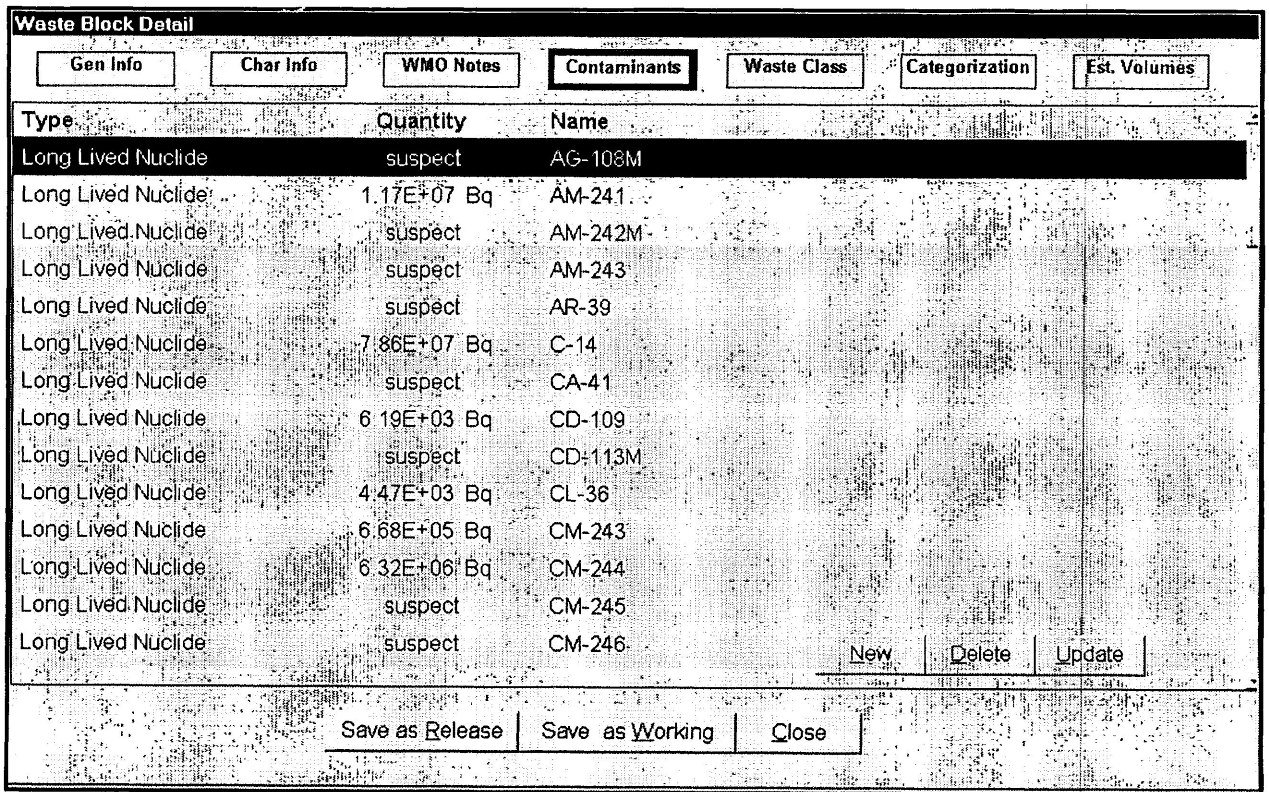

Figure 1D: Fourth of four computer "screens" illustrating how WI Program information is "warehoused" in CRL's WIP-III data management system.

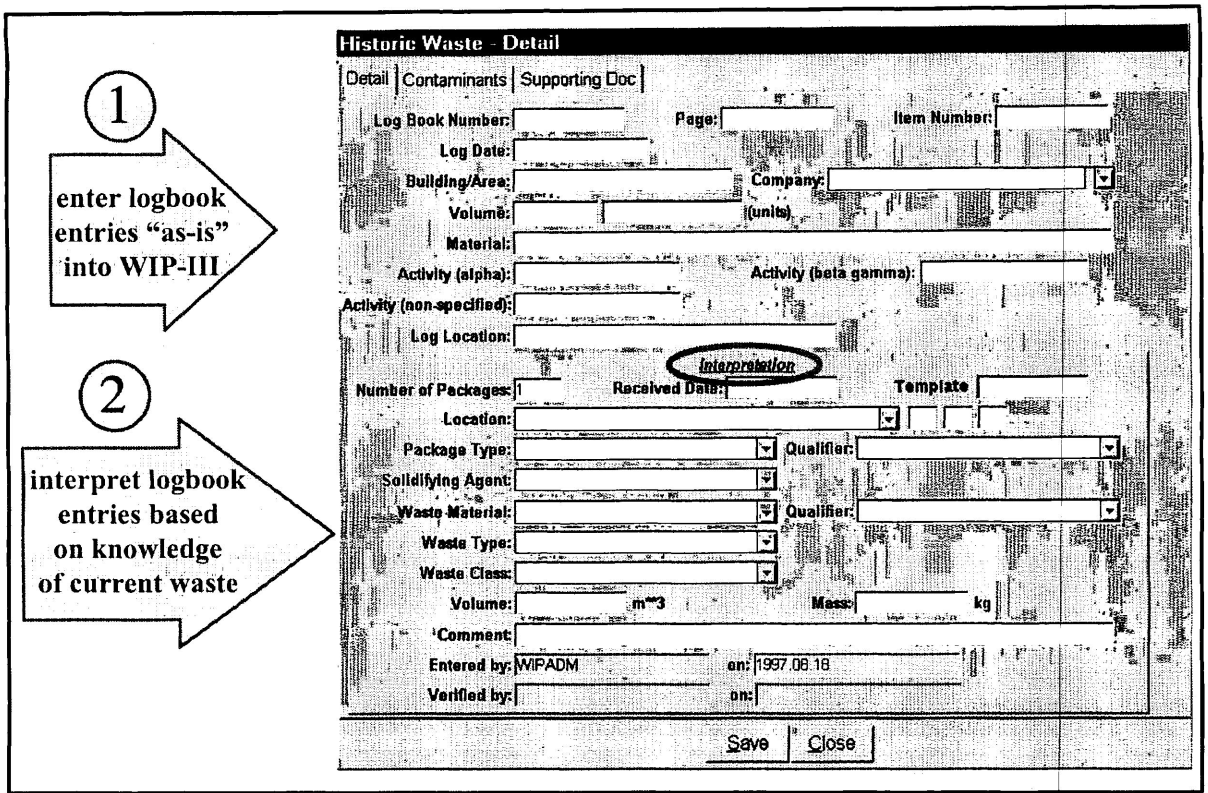

Figure 2: Prototype historical module in the WIP-III data management system

AECL - On-Site Data Sheet

Template ID 121 Revision 1

Listing of Contaminants

Contaminants identified in Waste Identification Program:

Type	Contaminant	Average Qty	Type	Contaminant	Average Qty
Long Lived Nuclide	CD-113M	1.09E+09 Bq	*Long Lived Nuclide*	CS-134	2.42E+11 Bq
Long Lived Nuclide	CS-135	1.09E+07 Bq	*Long Lived Nuclide*	CS-137	1.99E+13 Bq
Long Lived Nuclide	EU-154	3.45E+10 Bq	*Long Lived Nuclide*	EU-155	4.61E+11 Bq
Long Lived Nuclide	H-3	6.32E+10 Bq	*Long Lived Nuclide*	I-129	1.13E+10 Bq
Long Lived Nuclide	KR-85	1.26E+10 Bq	*Long Lived Nuclide*	NP-237	5.31E+10 Bq
Long Lived Nuclide	PM-147	2.34E+13 Bq	*Long Lived Nuclide*	PU-239	2.45E+08 Bq
Long Lived Nuclide	PU-240	2.33E+07 Bq	*Long Lived Nuclide*	PU-241	2.48E+08 Bq
Long Lived Nuclide	RU-106	3.81E+13 Bq	*Long Lived Nuclide*	SB-125	7.34E+11 Bq
Long Lived Nuclide	SE-79	6.71E+07 Bq	*Long Lived Nuclide*	SM-151	2.04E+11 Bq
Long Lived Nuclide	SN-126	5.32E+07 Bq	*Long Lived Nuclide*	SR-90	1.90E+13 Bq
Long Lived Nuclide	TC-99	9.48E+08 Bq	*Long Lived Nuclide*	U-234	7.43E+09 Bq
Long Lived Nuclide	U-235	1.47E+08 Bq	*Long Lived Nuclide*	U-238	1.45E+06 Bq
Long Lived Nuclide	ZR-93	3.94E+08 Bq	*Short Lived Nuclide*	CE-141	5.56E+15 Bq
Short Lived Nuclide	CE-144	6.69E+14 Bq	*Short Lived Nuclide*	I-131	7.27E+15 Bq
Short Lived Nuclide	MO-99	1.21E+16 Bq	*Short Lived Nuclide*	NB-95	3.67E+14 Bq
Short Lived Nuclide	RU-103	2.47E+15 Bq	*Short Lived Nuclide*	TE-129	2.11E+14 Bq
Short Lived Nuclide	XE-133	1.13E+14 Bq	*Short Lived Nuclide*	XE-135	4.82E+13 Bq
Short Lived Nuclide	ZR-95	3.36E+15 Bq	*Toxic Substance*	ALUMINUM	1.24E+01 grams
Toxic Substance	MERCURY	3.11E+00 grams	*Toxic Substance*	NITRIC ACID	1.24E+02 grams

Contaminants in the table above are reported in concentration units. Bq/m3 for nuclides, kPa for pressurized gases, and g/kg for other contaminants. Total quantities (Bq or g) will be calculated based on the volume and mass of waste.

Figure 3: Back page of a template data sheet showing the estimated contaminant inventory

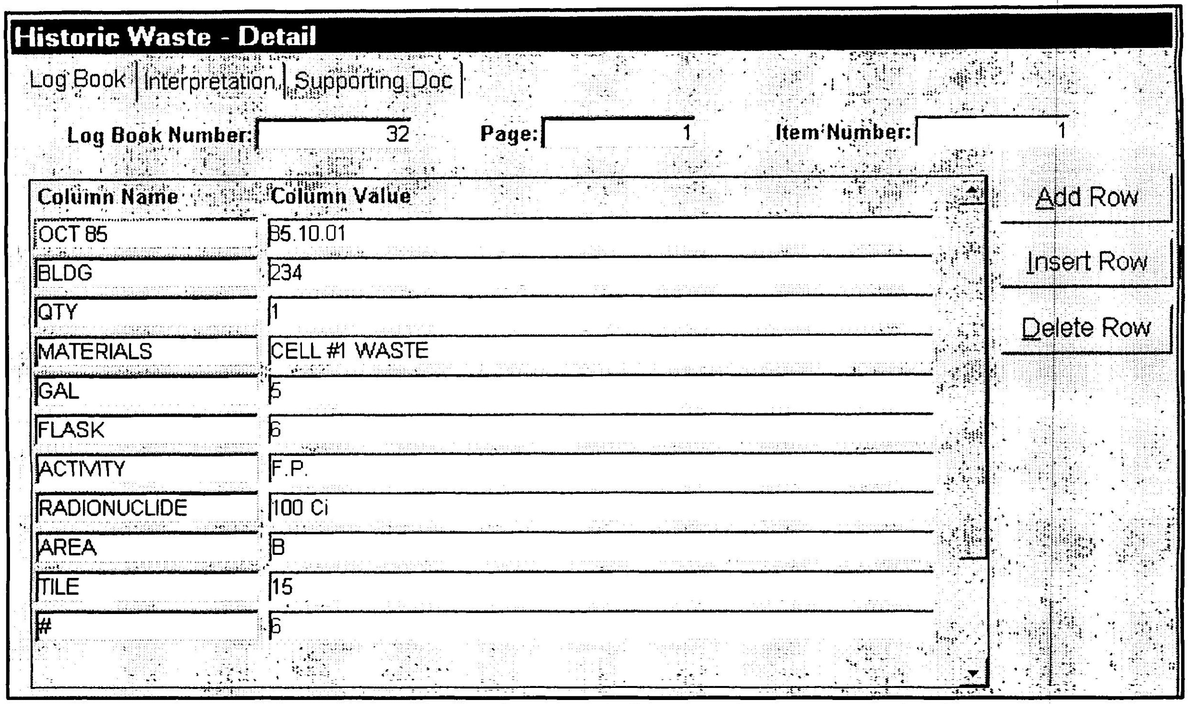

Figure 4: Revised historic module - dynamic definition of historical logbook page structure

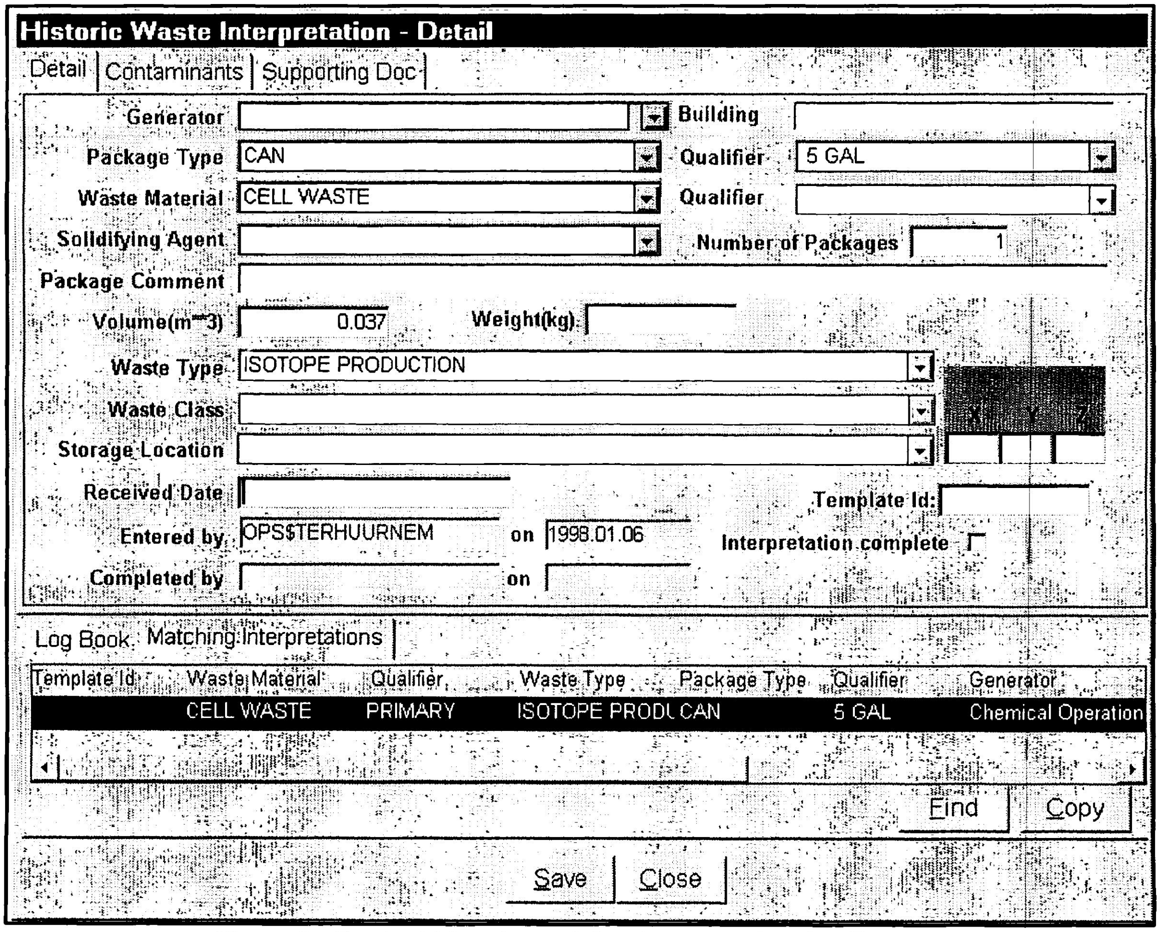

Figure 5: Revised historic module - interpretation detail screen

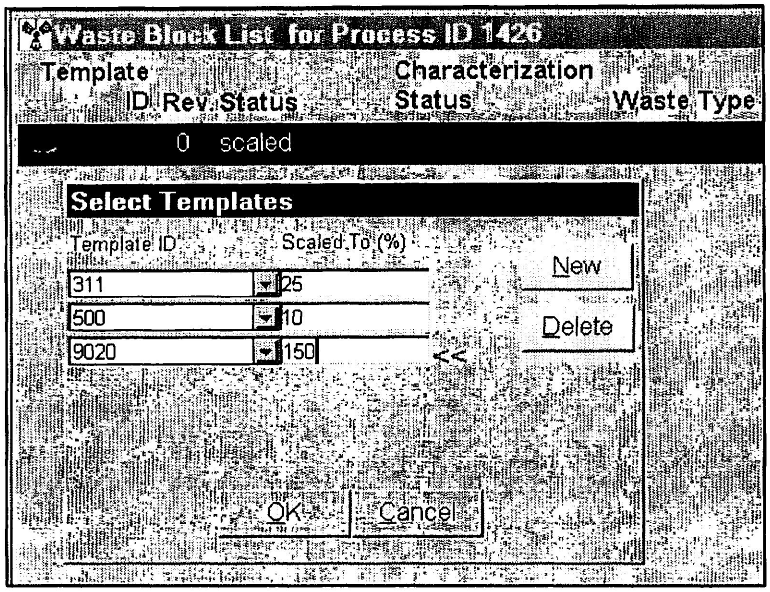

Figure 6: Revised historic module - implementation of 'scaled' data sheet templates

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Reported Contaminants (based on historic records)

Long Lived Nuclide		
C-14	3.70E+09 Bq	
CO-60	1.16E+12 Bq	
CS-137		undetermined quantity
ENR-U	5.32E+04 grams	
EU-154		undetermined quantity
IR-192	3.55E+13 Bq	
PU	6.38E+02 grams	
U-233	9.65E+02 grams	
U-235	3.36E+02 grams	
Short Lived Nuclide		
MO-99	9.25E+12 Bq	
Unidentified		
ACTIVATION PRODUCTS		undetermined quantity

Figure 7: Summary of the contaminants recorded in historical logbook 43, page 49

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Interpreted Contaminants (based on knowledge of current wastes)

Long Lived Nuclide		
AG-108M	1.74E+04 Bq	
AM-241	6.41E+07 Bq	
AM-242M	3.52E+04 Bq	
AM-243	3.36E+06 Bq	
AR-39	3.44E+01 Bq	suspect
C-14	1.77E+09 Bq	
CA-41	7.10E+02 Bq	
CD-109	2.08E+04 Bq	
CD-113M	4.45E+06 Bq	
CL-36	2.34E+04 Bq	suspect
CM-243	2.73E+04 Bq	
CM-244	4.39E+07 Bq	
CM-245	5.13E+01 Bq	
CM-246	8.94E+00 Bq	
CO-60	1.02E+12 Bq	
CS-134	2.70E+10 Bq	
CS-135	9.84E+04 Bq	
CS-137	6.66E+10 Bq	
EU-152	4.78E+04 Bq	
EU-154	2.07E+09 Bq	
EU-155	2.00E+09 Bq	
FE-55	8.02E+08 Bq	
H-3	7.06E+09 Bq	
HO-166M	1.40E+02 Bq	
I-129	9.76E+07 Bq	suspect
KR-85	1.52E+11 Bq	suspect
MO-93	6.07E+03 Bq	
NB-93M	5.87E+04 Bq	
NB-94	1.25E+10 Bq	
NI-59	5.06E+06 Bq	
NI-63	1.06E+09 Bq	
NP-237	1.05E+08 Bq	
PD-107	2.77E+04 Bq	
PM-147	4.98E+10 Bq	
PU-236	2.59E+03 Bq	
PU-238	5.11E+07 Bq	
PU-239	1.18E+08 Bq	
PU-240	1.38E+08 Bq	
PU-241	2.64E+10 Bq	
PU-242	3.74E+05 Bq	
RU-106	4.47E+12 Bq	
SB-125	1.49E+10 Bq	
SE-79	2.09E+05 Bq	
SM-151	4.34E+08 Bq	
SN-121M	5.96E+04 Bq	
SN-126	2.64E+05 Bq	
SR-90	5.03E+10 Bq	
TB-157	5.92E+01 Bq	
TC-99	4.86E+07 Bq	
TH-228	1.06E+01 Bq	
TH-230	6.37E+00 Bq	
U-232	4.49E+01 Bq	
U-234	1.49E+07 Bq	
U-235	2.92E+05 Bq	
U-236	5.69E+04 Bq	
U-238	1.15E+05 Bq	
ZR-93	8.13E+07 Bq	

Short Lived Nuclide		
AG-110M	2.48E+07 Bq	
CE-141	9.79E+12 Bq	
CE-144	1.31E+12 Bq	
CM-242	4.32E+07 Bq	
I-131	6.29E+13 Bq	
MO-99	5.83E+14 Bq	
NB-95	8.35E+13 Bq	
RU-103	2.84E+14 Bq	
TE-129	8.99E+11 Bq	
XE-133	1.12E+14 Bq	
XE-135	3.11E+13 Bq	
ZR-95	6.90E+14 Bq	
Toxic Substance		
ALUMINUM	6.05E+03 grams	
CHROMIUM	3.88E+01 grams	
COBALT	1.14E-01 grams	
MERCURY	5.38E+00 grams	
NICKEL	1.60E+01 grams	
NITRIC ACID	1.47E+03 grams	
solid		
4A MOLECULAR SIEVE		suspect
5A MOLECULAR SIEVE		suspect
ALUMINUM SHEATHING		suspect
ASCARITE		suspect
CHARCOAL		suspect
IRRADIATED FUEL - FINE DEB		suspect
PROCESS EQUIPMENT		suspect
anion		
NITRATE	1.78E+02 grams	
Unidentified		
ACTIVATION AND FISSION PR		suspect

Figure 8: Additional contaminants interpreted to be in the historic inventory when some historical records were matched to current waste blocks