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Independent Technical Review Report: Idaho Operations

Review of the Idaho CERCLA Disposal Facility (ICDF) at Idaho National Laboratory

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1. INTRODUCTION

The Idaho CERCLA Disposal Facility (ICDF) is a land disposal facility authorized by the US Environmental Protection Agency and the Idaho Department of Environmental Quality that is used to dispose of LLW and MLW generated from remedial activities at the Idaho National Laboratory (INL). Components of the ICDF include a landfill that is used for disposal of solid waste, an evaporation pond that is used to manage leachate from the landfill and other aqueous wastes (8.3 million L capacity), and a staging and treatment facility. The ICDF is located near the southwest corner of the Idaho Nuclear Technology and Engineering Center, and covers approximately 16 ha (including buffer areas). The landfill has a disposal capacity of approximately 390,000 m^3 and currently contains approximately 170,000 m^3 of waste. S.M. Stoller Corporation operates the ICDF under contract to CH2M-WG Idaho (CWI), the prime contractor for remedial activities at INL.

A schematic of the ICDF landfill is shown in plan view in Fig. 1. The landfill is 213 m x 244 m at ground surface and is approximately 12 m deep. Construction of the first landfill cell and the evaporation pond began in 2001. Construction of the second landfill cell began in 2004. Placement of waste in the first cell began in September 2003, and the second cell began receiving waste in February 2006. Both cells include a double composite liner system, a leachate collection system, and a leak detection system (Fig. 2). After the ICDF landfill is filled, an engineered final cover will be installed that consists of a store-and-release layer overlying a composite barrier system (Fig. 3). The purpose of the final cover is to minimize the amount of precipitation that percolates into the waste.

2. OBJECTIVE AND SCOPE

The US Department of Energy (DOE) charged an Independent Technical Review (ITR) team with reviewing and critiquing operations at the ICDF landfill. The ITR team, which was comprised of Craig H. Benson, PhD, PE (University of Wisconsin; Madison, WI), William H. Albright, PhD (Desert Research Institute; Reno, NV), David P. Ray, PE (US Army Corps of Engineers; Omaha, NE), and John Smegal (Legin Group; Washington, DC), has expertise in waste containment, civil engineering, geotechnical engineering, and project management. The ITR team was requested to address three lines of inquiry (LOI):

> **LOI No. 1:** *Do any issues exist with the landfill design, operations, and management that could impact its ability to meet performance objectives? Are there potential issues in the landfill program that could lead to problems similar to those identified at Hanford's Environmental Restoration Disposal Facility (ERDF)? If yes, have preventive and mitigative measures been taken to remedy the situation?*
>
> **LOI No. 2:** *Are there cost-effective lessons learned from the ERDF review that may be recommended to improve reliability and effectiveness of the ICDF landfill operations and management?*
>
> **LOI No. 3:** *Are there good practices at the ICDF that may benefit other EM sites?*

These LOI were addressed by conducting a site visit on 25 October 2007 and reviewing design and operation documents provided by personnel from INL. Findings of the ITR team for each LOI are described in the following sections.

3. LINE OF INQUIRY NO. 1

> *Do any issues exist with the landfill design, operations, and management that could impact its ability to meet performance objectives? Are there potential issues in the landfill program that could lead to problems similar to those identified at Hanford's ERDF? If yes, have preventive and mitigative measures been taken to remedy the situation?*

The ITR team found no issues of immediate concern affecting the performance of the ICDF. A similar finding was reported in the Five-Year Review of CERCLA Response Actions in February 2007[1]. However, the ITR team believes there are several issues that should be addressed to ensure that the ICDF landfill will meet the performance objectives over the long term. Each of these issues is described in the following sections.

3.1 Containerized Waste

A large fraction of the waste is being placed in the ICDF landfill in metallic shipping containers. Grout is added to the interior of these containers after placement to minimize the presence of internal voids. The ICDF Landfill Compaction/Subsidence Study indicates that the void space in these containers (and other bulk objects) must be no more than 5%. However, there is no procedure in place to ensure that the grouting procedure reduces the void volume within the containers to less than 5%. Information regarding in-cell grouting is in Appendix A of the ICDF Operations and Maintenance Plan. Procedures for grouting the exterior of containers are described in Appendix A along with interior grouting of plywood box assemblies. However, interior grouting of metallic containers is not included in this plan.

During the site visit, voids were observed between containers and beneath each container. The ICDF Landfill Compaction/Subsidence Study indicates that these voids are to be grouted if the void space exceeds more than 5% of the total volume. Alternatively, the containers are to be spaced far enough apart to permit compaction of soil placed between the containers with a bulldozer. Observations made during the site visit indicated that the space between the containers was too narrow to permit placement and compaction of soil. Although grouting of these spaces was not occurring during the site visit, ICDF personnel indicate that the spaces are grouted before cover soil is placed over the containers. An example of grout placed between the containers is shown in Fig. 4.

Collapse of voids within, between, and underneath the containers may result in differential settlement of the waste mass. Such settlements may affect the long-term performance of the

[1]Five-Year Review of CERCLA Response Actions at the Idaho National Laboratory, Prepared for the U.S. Department of Energy DOE-NE Idaho Operations Office, DOE/NE-ID-11201 Revision 3, Project No. 23037, February 2007.

final cover, the rate of leachate generation within the ICDF landfill, and long-term discharges to groundwater. Accordingly, the ITR team recommends that methods used to place grout within the containers be re-evaluated to ensure that the maximum void space criterion is met using procedures applied in the field. The ITR team also recommends that a method be identified or developed to confirm that the grout is adequately distributed within the containers and that the 5% void space criterion is met. The Operations and Maintenance Plan should also be updated to reflect current grouting methods (or future changes to the grouting method).

The ITR team also recommends that spaces between and underneath containers continue to be filled with grout, or the container spacing be increased to permit filling of these spaces with compacted soil. Filling the spaces between containers with soil may be beneficial by providing conduits for moisture flow, thereby reducing the amount of moisture contacting the waste. The quality and uniformity of the grout should also be verified annually by an independent entity, and the ability of the grout to both stabilize waste *and* retard contaminant movement should be explored.

3.2 Compacted Mixtures of Soil and Debris

Contaminated soils and soil-debris mixtures are being placed and compacted in the ICDF landfill. In contrast to Hanford's ERDF, the materials being placed in the ICDF landfill are primarily soil. Thus, many of the issues raised regarding compaction of the waste at the ERDF are less important for the ICDF. Nevertheless, the ITR team was concerned with the use of a nuclear densometer to verify that the materials are being compacted properly. Even though the compacted materials are largely soil, they do contain a substantial fraction of cobbly materials. Large particles such as cobbles can have a strong influence on the density measured with a nuclear densometer. Consequently, the densities being measured in the ICDF landfill with a nuclear densometer may not reflect the actual density of the compacted material.

The ITR team recommends that nuclear density testing be discontinued and that other methods to evaluate the density of the compacted material be explored. Intelligent compaction equipment is one option, but this technology may not be cost-effective for the small-scale operation at the ICDF. Another approach is to verify that the soil materials have been compacted adequately with past procedures using a sand or liquid replacement method in a test pit (e.g., as in ASTM D 4914). If these methods confirm that the soil has been compacted adequately using existing procedures, future compaction control could be conducted based solely on performance measures (e.g., by ensuring a minimum number of equipment passes and a maximum lift thickness) and nuclear density testing could be eliminated. However, this issue would need to be discussed with regulatory authorities before action was taken.

3.3 Final Cover Settlement

The final cover proposed for the ICDF landfill is more flexible than the Hanford Barrier proposed for Hanford's ERDF. Thus, differential settlement is a less significant concern for the ICDF landfill than at Hanford's ERDF. Nevertheless, the composite barrier at the base of the ICDF cover can be affected by differential settlement. Consequently, the impacts of differential settlement should be evaluated and the methods of waste placement should be reviewed to ensure

that adequate support for the final cover will exist over the long term. Evaluating placement methods in the near term is important. If needed, changes in placement methods made in the near term probably would be far less costly than remedial measures required to stabilize the waste at closure.

A particular concern is that the existing Landfill Compaction/Subsidence Study only accounts for compression of the containment facility and its foundation, and only considers differential settlement over broad distances. Localized differential settlements were not considered and settlement of the waste after placement was assumed to be nil. The ITR team believes that these assumptions are unrealistic given that the stiffness of the waste is likely to vary over a broad range (lowest in areas containing primarily compacted soil, highest in areas that are fully grouted) and that voids existing within and between containers may result in localized settlements due to collapse. Moreover, given the long design life (1000 yr) for the ICDF landfill, long-term creep compression of the waste may be important.

The ITR team recommends that the Landfill Compaction/Subsidence Study be re-evaluated. This re-evaluation should consider the impacts of differential settlement caused by variations in stiffness, collapse of voids, and long-term creep settlement of the various types of waste forms being disposed in the ICDF landfill. This re-evaluation should also include a quantitative linkage between the void space criterion used for grouting and acceptable differential settlements. If this re-evaluation indicates that differential settlement may be problematic, reinforcement of upper and intermediate layers of the waste may be considered (e.g., with grout, geosynthetic reinforcement, or select wastes such as broken concrete, steel beams, or other solid debris). A preloading test may also be considered to quantify the settlement under expected loads applied by the final cover.

3.4 Leachate Collection System and Leak Detection Zone Monitoring

Automated methods are being used to monitor liquid levels in the leachate collection system and the leak detection zone in the ICDF landfill (Fig. 5). The ITR team believes this approach is suitable to ensure that liquid levels are maintained below specified maxima. However, the ITR team recommends that the data be reviewed periodically from a historical context. This will permit an assessment of trends in the data indicative of long-term changes in the performance of the collection and detection systems.

The ITR team also recommends that the testing strategy for the alarm system be re-evaluated to ensure that the frequency of testing is sufficient. Testing should be conducted with sufficient frequency to ensure that excessive leachate volumes will not accumulate between testing events if complete failure of the alarm and monitoring system occurred.

4. LINE OF INQUIRY NO. 2

> *Are there cost-effective lessons learned from the ERDF review that may be recommended to improve reliability and effectiveness of the landfill operations and management?*

Idaho's ICDF and Hanford's ERDF differ appreciably in size and scale of operation. The smaller operation at the ICDF makes many of the lessons learned from the ERDF less applicable to the ICDF. However, conceptual issues regarding compaction control, settlement evaluation, and leachate monitoring indentified when evaluating the ERDF are relevant to the ICDF. In particular, the recommendations in Section 3 include revising the compaction test procedure to ensure its relevancy to material with large particles, reviewing the settlement analysis that was conducted for the conceptual final cover with particular attention to the impacts of differential settlement, and evaluation of the leachate monitoring system to ensure that the system is being tested with sufficient frequency and with historical context. Addressing each of these issues now can prevent problems in the future. A proactive approach towards addressing these issues may also prevent a negative response from regulatory authorities should they become concerned with these issues in the future.

The ERDF review also illustrated the importance of periodically reviewing assumptions, practices, and procedures. This lesson should apply to all EM sites, and will result in cost savings along with superior operations. For example, the recommendations in this review may result in reduced compaction monitoring over the long-term and a re-assessment of the assumptions used to evaluate the impacts of settlement on the final cover for the ICDF.

5. LINE OF INQUIRY NO. 3

Are there good practices at the ICDF that may benefit other EM sites?

Three practices at the ICDF should be considered for use at other EM sites operating landfills:

- The automated monitoring system used for the leachate collection system and leak detection zone at the ICDF landfill provides a continuous record of compliance with acceptable liquid levels. Similar systems should be employed for all landfills operated by EM.

- Trucks used to transport roll-off boxes at the ICDF are equipped with a mechanical arm to load and unload the box (Fig. 6). This mechanism is much safer than the cable winch system commonly used for roll-off boxes. Trucks with mechanical arms are more costly than trucks with cable winches. However, this additional cost will be offset at least partially by cost savings associated with reductions in lost time and disability due to accidents with cable winches.

- The ICDF ensures rigorous control of waste entering the ICDF landfill by careful monitoring at the scale and at an entry point of the landfill. Similar control procedures should be applied at all landfills operated by EM to ensure that inappropriate wastes are not landfilled. Technologies such as RFID tags should be considered at all EM sites to provide even tighter control on the waste stream being landfilled.

6. SUMMARY OF RECOMMENDATIONS

The following recommendations are made by the ITR team for the ICDF and other EM sites:

- Methods used to place grout within the containers should be evaluated to ensure that the maximum void space criterion is met. A method should also be identified or developed to confirm that the grout is adequately distributed within the containers and that the 5% void space criterion is met. The Operations and Maintenance Plan should also be revised to reflect current grouting methods, and any changes to the grouting methods made in the future.

- Spaces between and underneath containers should continue to be grouted, or the container spacing should be increased to permit filling of these spaces with compacted soil.

- Nuclear density testing should be discontinued and a performance-based method for compaction should be used at the ICDF landfill henceforth. Action on this issue will require discussion with regulatory authorities.

- The Landfill Compaction/Subsidence Study should be re-evaluated to consider the impacts of differential settlement caused by variations in stiffness, collapse of voids, and long-term creep settlement of the wastes being disposed in the ICDF landfill. Linkages should be made between the waste placement and grouting methods and the acceptable differential settlements for the cover.

- The testing strategy for the leachate alarm system should be re-evaluated to ensure that the frequency of testing is sufficient.

- Automated monitoring of leachate collection systems and leak detection zones should be employed at all landfills operated by EM.

- Trucks equipped with mechanical arms should be considered for transporting roll-off boxes at EM sites to reduce lost time and disability due to accidents associated with cable winches.

- Technologies such as RFID tags should be considered at all EM sites to provide tight control on the waste stream being landfilled.

7. ACKNOWLEDGEMENTS

This technical review was supported by Mark Gilbertson (DOE-HQ), Vincent Adams (DOE-HQ), Dinesh Gupta (DOE-HQ), and John Gilmore (DOE-ID). Owen Robertson (DOE-RL) participated in the site visit and the review. Discussions held with representatives of CH2M-WG Idaho (CWI) and Stoller Corporation were critical to the mission of the ITR team. The ITR thanks those individuals with DOE, CWI, and Stoller who provided information and input during the review.

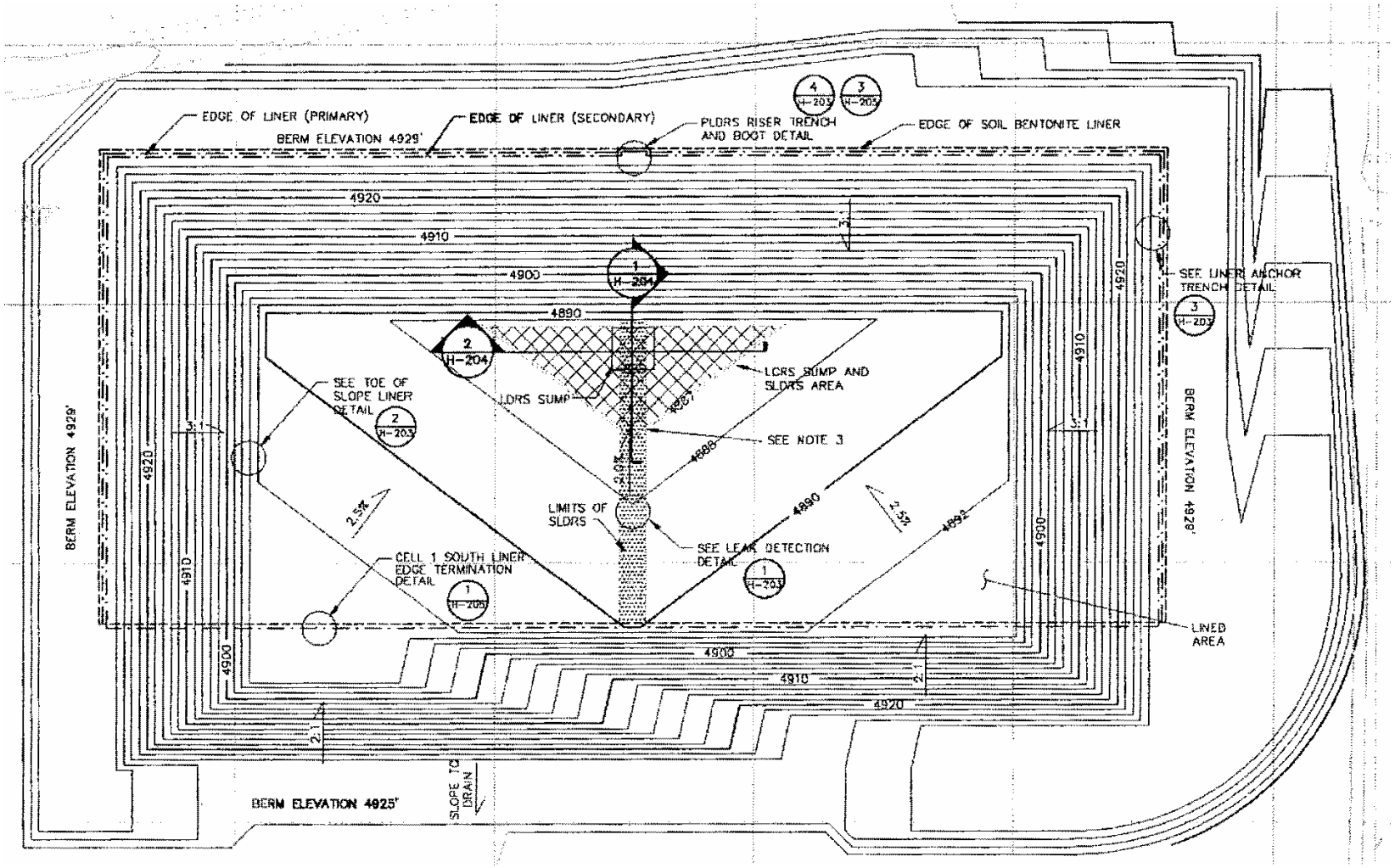

Fig. 1. Plan view of ICDF landfill

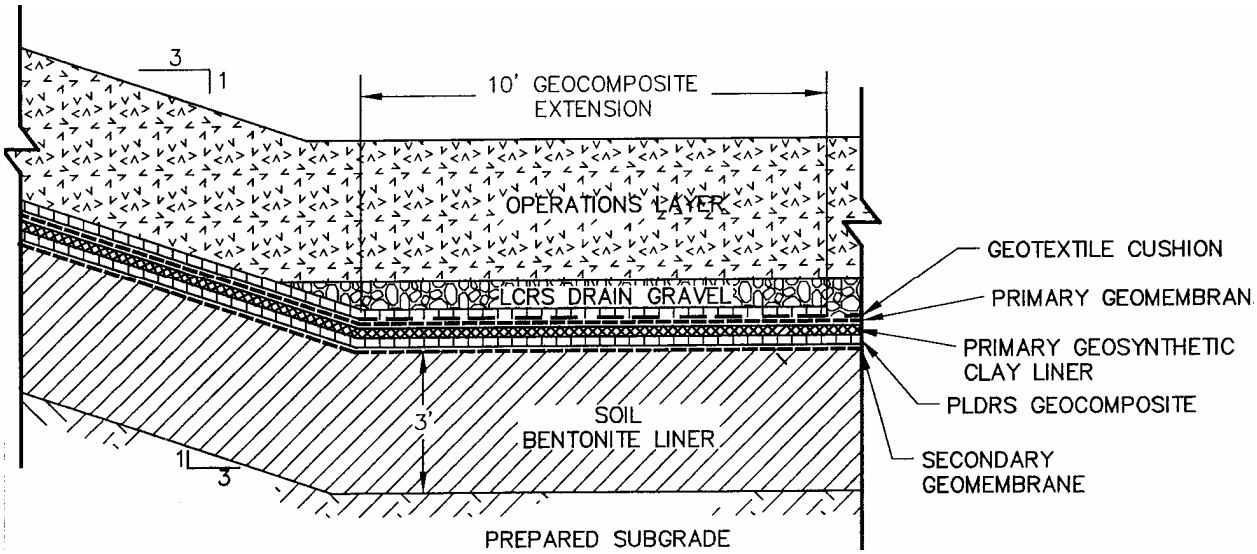

Fig. 2. Schematic of double composite liner system used for the ICDF landfill.

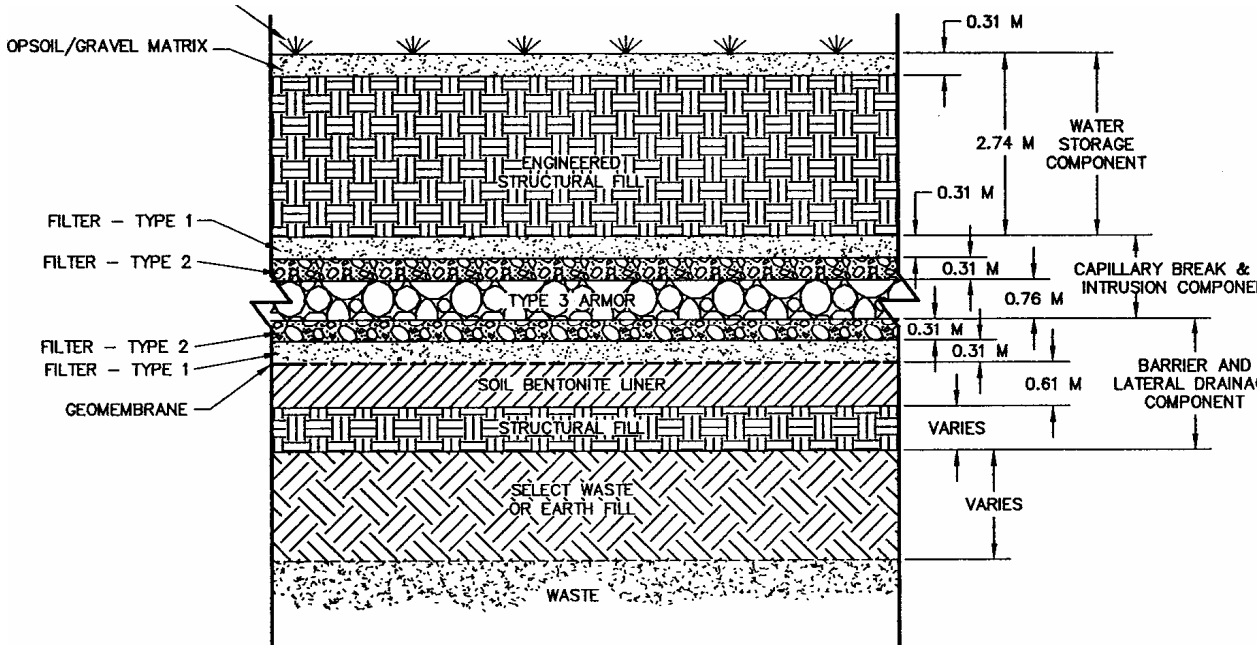

Fig. 3. Schematic of cover profile planned for the ICDF landfill.

Fig. 4. Photograph of grout placed between metallic containers in the ICDF landfill (photograph courtesy of J. Gilmore, DOE-IL).

Fig. 5. Monitoring system for leachate collection system and leak detection system (photograph courtesy of O. Robertson, DOE-RL).

Fig. 6. Unloading and loading of roll-off boxes: (a) trucks with a mechanical arm used at the ICDF and (b) trucks with a cable winch used at ERDF (photographs courtesy of O. Robertson, DOE-RL)