IDENTIFICATION OF ISSUES TO BE CONSIDERED FOR PLUTONIUM FINISHING PLANT ACCELERATED CLOSURE

A. Hopkins, J. Lilly
Fluor Hanford Inc.
P.O. Box 1000 Richland WA 99352

J. Teal, L. Rogers
SAIC
3250 Port of Benton Blvd. Richland WA 99354

ABSTRACT

This paper describes some of the basic issues identified to date related to the proposed closure of the PFP site. It is to be used as a preliminary planning supplement to enable application of the many guidance documents that are now available to describe the statutory and DOE requirements for closure of a Hanford site contaminated with low levels of plutonium. The major issues identified herein include:

- Closure barrier performance, life expectancy and design criteria
- Public and interest group acceptability of closure approach
- Quantity of plutonium that will remain
- Void backfilling prior to barrier placement
- Identification of closure zone boundary
- Impact of 241Z and 241Z-361 waste unit closure plans on the PFP surface barrier design

INTRODUCTION

PFP consists of a number of process and support buildings for handling plutonium. Building construction began in the late 1940's to meet national priorities and became operational in 1950 producing refined plutonium salts and metal for the US nuclear weapons program and other uses. Additional buildings and facilities have been added over the years in support of PFP's work. PFP has now completed its mission and at this date contains residual plutonium in the main building and in several support facilities and packaged plutonium in the vaults. The buildings are to be reduced to ground level and the site remediated to satisfy national, DOE and Washington state requirements.

During the PFP operational period there were several discharges of plutonium that escaped the facilities containment zones. The closure plan for the facility, a part of the overall Central Plateau closure program, will need to address the residual plutonium contamination and provide directions to ameliorate potential environmental and cultural issues associated with the residual contamination. The closure program will prescribe the surface barrier design necessary for long term resolution of the threat posed by the residual plutonium contamination. Also being researched is how much plutonium is acceptable to remain at waste sites and what is the appropriate manner in which to quantify plutonium in sites underground. This discussion is being held with interested parties at this time.

Site Characteristics

PFP is located in the 200 West area of the Hanford site and is currently surrounded with an inner security fencing which encloses approximately 13.5 acres of graveled and paved land. The above-ground structures within this area are in the process of decontamination and demolition to reduce all facilities to grade level. The major underground structures, primarily 241-Z, 291-Z and 241-Z-361 Catch Tank are to be remediated and stabilized. Low levels of residual plutonium are expected to remain in these locations. There are a number of underground pipes and pipe enclosures contaminated with plutonium that will possibly remain after all above-ground structures are removed. There are two large underground ventilation ducts that may also remain.

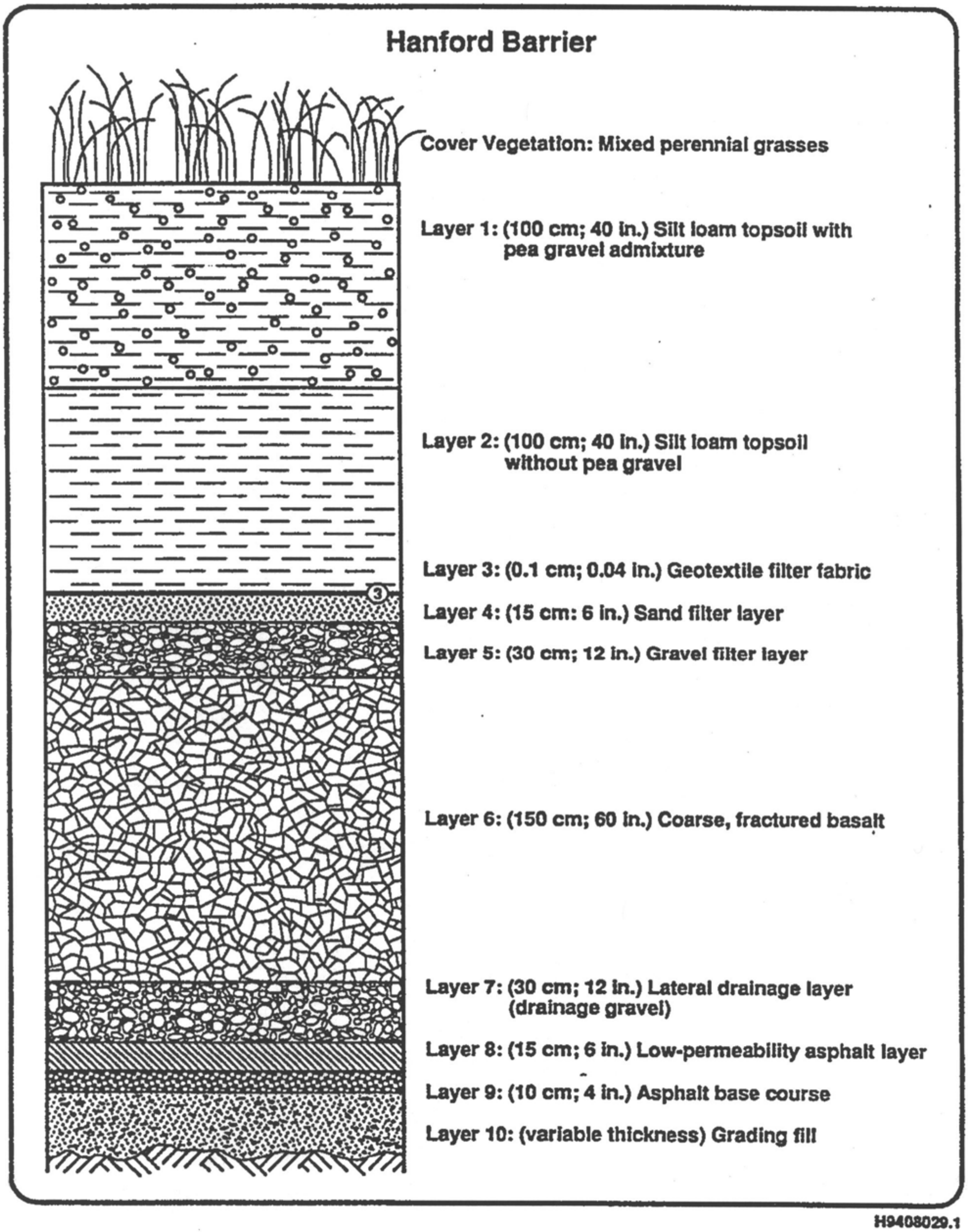

Fig. 1. Hanford Barrier Profile

Plutonium contamination areas

Over the life of the PFP complex there have been instances of plutonium escape to the ground. The following is a list of underground features that may currently contain small amounts of plutonium and/or have leaked plutonium to the subsurface. Included are subsurface facilities that are being or planned to be remediated.

Site	Estimated grams
291-Z Sump (to be remediated [TBR])	40
241Z-361 Settling Tank (TBR)	TBD
241-Z Waste Treatment Facility (TBR)	TBD
Settling Basins and discharge piping	5
Encased lines and encasement (and surrounding soil) to 241-Z	100
Waste-water clay and metal piping and manholes to Z-19 ditch	100
Subsurface Ventilation ductwork from 232-Z and 236-Z	5
Stainless steel waste lines from Recuplex to Z-9 (east side of PFP)	0 to 100
234-5Z First Floor floor drains below slab	TBD
Subsurface southern yard area	2

These estimates, where shown, are based upon known discharges of plutonium. Lines known to have contained plutonium but having no established plutonium value are marked "TBD". It is likely that the quantity of plutonium remaining within the PFP complex after completion of remediation and closure of the 241Z and 241Z-361 waste units will be less than one kilogram. At this time, a barrier is proposed as the closure method for these sites. The exact placement of the barrier is still under discussion as is the question of how much contamination will be removed for disposal. The question of how much contamination will be removed from certain waste sites is necessary in order to plan exact barrier placement.

Adjacent Sites

There are a number of waste sites, cribs and sites where the soil has been contaminated with plutonium and carbon tetrachloride located east of the PFP and west of Camden Ave. These sites and their contents are listed in "Estimates of Hanford Materials and Waste Containing Plutonium", July 21, 2004, DRAFT. The natural slope of the PFP terrain is eastward and the water runoff pathway from the PFP closure barrier may have a deleterious effect on these sites. The PFP site closure plan and barrier design should address these concerns. These sites locations can be found in the Hanford Site Atlas, BHI-01119.

Below Grade Cavities

It appears prudent to back fill large underground cavities to preclude slumping of the barrier cap. Some analysis under maximum environmental conditions may be necessary to determine the acceptable minimal cavity size left unfilled. The analysis should also recognize the cavities below 234-5Z ground floor. A list of types of large cavities follows:

- 3 Septic tanks
- 241-Z-361 catch tank void
- 2 Retention basins and 241-Z cell voids
- Pipe encasements from 234-5Z and 236-Z to 241-Z and from 241-Z to fence line
- Ventilation ductwork from 232-Z and 236-Z to 291-Z
- Waste water discharge lines and manholes to fence line
- Low Level Waste Treatment retention tank void

There are also a number of large sanitary and fire water mains that encompass the facilities that should be addressed by the minimum acceptable void size study. These lines also pose a potential transport path for water and other contaminates.

PFP Closure Considerations

- Surface Barrier Life- The expected design life of the surface closure barrier is estimated to be 1000 years. T
- Some barrier design concepts, including the Hanford Barrier, incorporate an impervious water barrier layer. Effect of this feature on nearby underground Pu facilities and contamination is under discussion.
- Surface Barrier Maintenance is under discussion.
- Gas Generation- The possible effects of gases generated by the plutonium-contaminated soils and sanitary drain fields on barrier design is under development.
- Sub Surface Voids- Subsurface voids created by the large ductwork, waste-water clay and metal piping, sanitary water and electrical conduit and the waste transfer lines interspersed at PFP may affect long term surface barrier performance. Back
- Both 241Z and 241Z-361 are designated as waste units separate from PFP and must be remediated and closed. The closure actions need to be coordinated with the general PFP closure actions.

Proposed Barriers

The planned surface barriers for the PFP site have not yet been prescribed by the DOE. Evaluation of barrier designs is ongoing. The development of the barrier design is under way. One of the considerations is that the approved engineered barrier for PFP should safely isolate the residual plutonium from the surrounding environs for at least 1000 years. The extent of the barrier could be as great as the acreage within the inner security fence line of PFP. One barrier design, the Hanford Barrier, is described in the DOE/RL-93-33 [1] barrier feasibility study. This design appears robust and may be satisfactory for PFP. As this design evolved in 1993 there may be newer designs available more suited to the PFP requirements.

Barrier Criteria

Barrier design will be influenced by National and Washington state barrier standards and performance objectives and Native American and DOE prescribed performance objectives. Interactions with other states that border the Columbia River, citizen interest groups and marine agencies may also influence the barrier design. The design should consider any anticipated enhancement of existing standards and performance objectives that are projected to be promulgated before placement of the barrier.

A number of surface barrier design efforts have been proposed/used at Hanford[1] and other facilities, one is described below and shown in Figure 1. An initial set of criteria for the PFP site barrier cap should include the following:

- No radionuclide escape
- 1000 year durability
- No required maintenance
- Prevent plant and animal intrusion into the contaminated zone
- Discourage human intrusion
- Minimal hydrological impact
- Surface and subsurface water diversion
- Technically supportable design
- Minimal surface degradation
- Culturally and esthetically acceptable
- Consider ecological changes
- Consider erosion

Hanford has capped the BC crib, a major radioactive site. Lessons learned to date from this site may provide useful information as to successful design features.

Barrier Types

The type of covers proposed for the PFP complex and the PFP proposed zone are alternative cover systems, such as evapotranspiration (ET) cover systems. These types of systems are increasingly being considered and used at sites where waste will be left in place and contained. Conventional cover systems use low-permeability barrier layers, such as compacted clay, geomembranes, or geosynthetic clay liners, to minimize percolation. Regulation under the Resource Conservation and Recovery Act (RCRA) for the design and construction of cover systems are based on using a barrier layer.

Under RCRA, and alternative design, such as an ET cover, can be proposed in lieu of a RCRA barrier if it can be shown to provide equivalent performance. The Environmental Protection Agency (EPA) has issued guidance for the minimum design of these alternative cover systems. [2] ET cover systems use one or more vegetative soil layers to retain water near the surface until it is either evaporated from the soil surface or transpired through vegetation. These cover systems rely on the water storage capacity of the soil layer rather than on the low permeability of the materials to minimize percolation. ET cover systems are designed to use the natural hydrological processes at the site, which include water storage capacity of the soil, precipitation, surface runoff, infiltration, and evapotranspiration.

Work in recent years has shown that the ET type of barrier has very desirable characteristics for an arid region like Hanford. Some advantages of ET barriers are: they are simpler and cheaper to construct; they are not susceptible to desiccation cracking of the clays contained in the standard RCRA designs; they don’t rely on manmade materials that will eventual degrade over time; they are self-healing and not as susceptible to creating preferential flow pathways as multilayer designs when subjected to subsidence and/or tectonic movement; they are designed to act as a ‘sponge’ for wet years or events, then evaporate and transpire water back into the atmosphere; and they can be designed to prevent plant root and animal and human intrusion with the installation of a biointrusion layer under the ET barrier.

Extensive work has been conducted to demonstrate the effectiveness of ET barriers. The work to date has demonstrated good long-term performance. As a result of this work, EPA is changing guidance to support ET barriers for waste sites in arid western states.

The Hanford Barrier type is also being considered for the PFP. A description of the Hanford Barrier follows.

Hanford Barrier Description

The Hanford Barrier Design evolved from the requirements to meet the 1987 Final EIS for Hanford’s High Level, TRU, and Tank Waste Disposal. A number of designs were evaluated and in 1992 the Hanford Barrier emerged as the baseline design.

The Hanford Barrier is comprised of 9 engineered layers each providing a specific long-term function (Figure 1). [1]
Layer 1, the top layer is comprised of a local topsoil that contains pea gravel to minimize soil loss in the high winds of Hanford. It provides moisture retention necessary for plant growth and yet allows for transpiration to remove essentially all of the natural rainfall. Necessary runoff is achieved by a shallow 2-degree slope that does not jeopardize the erosion characteristics of the top soil/pea gravel mixture.
Layer 2, like layer 1, is local topsoil without pea gravel. It serves the same function as Layer 1 but does not require the wind erosion protection of Layer 1. It allows for both moisture retention and transpiration and adequate root penetration for the cover grass crop.

Layer 3 is a graded sand filter to prevent the fine silty topsoil layers from migrating downward.
Layer 4 is the graded gravel support layer for the sand filter.
Layer 5 is coarse fractured basalt. It controls bio-intrusion by plant roots and burrowing animals. It also presents an obstacle to human intrusion. The size of the basalt is chosen to preclude moisture retention. This layer does not prevent human intrusion.
Layer 6 is a selectively graded clean gravel lateral drainage layer that removes any penetrating moisture that may be created by extreme weather conditions. This layer has a 2 percent slope to allow any penetrating moisture to move to the edges of the barrier.
Layer 7 is a 6-inch thick-coated rich asphaltic concrete layer with a 2 percent slope. It functions as a low permeable layer and a redundant intrusion layer. Protected by the prior layers from

ultraviolet light and freeze-thaw heaving, the asphalt layer is estimated to remain functional for thousands of years in the Hanford environment.
Layer 8 is the compacted crushed gravel base for the asphalt layer.
Layer 9 is the grading fill to establish a smooth planer surface for the overlying layers. This layer is graded to a 2 percent slope.

A modified Hanford barrier design may provide more redundancy to account for potential, although unlikely, bio-degradation of the asphaltic layer. One possibility might be to add a low permeability structural layer of concrete between the asphalt and the gravel base course.

The 15-foot thickness of the Hanford Barrier design should not be esthetically offensive on the Hanford Plateau as the plateau is comprised of gentle contours and more abrupt dips.

REFERENCES

1. DOE-RL, 1993, Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas, DOE/RL-93-33, Rev1

2. EPA 542-F-03-1-015, September, 2003