This document was too large to scan as a single document. It has been divided into smaller sections.

Section 5

Document Information			
Document #	FOIA-2009-0054	Revision	
Title	FREEDOM OF INFORMATION ACT REQUEST (FOI 2009-0054)		
Date	09/02/2009		
Originator	RIEHLE DC	Originator Co.	DOE-RL
Recipient	JARVIS R	Recipient Co.	HEART OF AMERICA NW
References			
Keywords	OCE, FOIA, SENSITIVE, PRIVATE CITIZEN		
Projects			
Other Information			

1.0 INTRODUCTION

This response action plan (RAP) has been prepared for the Low-Level Burial Grounds, Trenches 31 and 34 of the 218-W-5 Burial Ground, as well as any future trenches that use the same design. Trenches 31 and 34 are Resource Conservation and Recovery Act (RCRA)/Washington Administrative Code (WAC) 173-303 *Dangerous Waste Regulations* (WAC 173-303)-compliant landfills. The 218-W-5 Burial Ground is in the northwestern portion of the 200 West Area on the Hanford Facility (Figure 1).

Trenches 31 and 34 are rectangular landfills (Figure 2) with approximate base dimensions of 76.2 meters by 30.5 meters, with a surface grade footprint of 1.3 hectares. Trenches 31 and 34 are designed for approximately 21,000 cubic meters of mixed waste. The floor of both trenches slopes slightly, giving a variable depth of 9.1 to 12.2 meters. The floor slope is a minimum of 2 percent, draining to a recessed area at the eastern end that houses the sumps for leachate collection. The sideslope ratio is 3 horizontal:1 vertical. Access to the trench floor is provided by a ramp (8 percent slope).

Trenches 31 and 34 were constructed with a double liner and leachate collection and removal system. The bottom and sides of Trenches 31 and 34 are covered with a 0.9-meter operations layer of soil to protect the liner system during fill operations. Additional layers progressing toward the subgrade for Trenches 31 and 34 floor are as follows:

- A geotextile that acts as a filter between the operations layer and the primary drainage gravel
- A 0.3-meter layer of primary drainage gravel
- A geotextile that acts as a cushion between the drainage gravel and the primary and secondary geomembranes
- A geonet with high transmissivity, which functions as a redundant drainage system in conjunction with the drainage gravel on the floor
- The primary leachate barrier, a 60 mil high-density polyethylene (HDPE) liner
- 0.46-meter of compacted clay/soil admix
- A geotextile cushion
- 0.3-meter of drainage gravel
- A geotextile cushion, geonet, and a secondary 60 mil HDPE liner
- 0.94 meter of admix material (clay/soil) meeting permeability requirements.

On the trench sideslopes, the primary and secondary liner systems use geocomposite (two geotextiles thermally bonded to a geonet) drainage layers instead of the drainage gravel and geotextiles used on the floor. The liner system components are illustrated on Figure 3.

The primary leachate collection system is composed of 10.2-centimeter diameter perforated drainage pipes that lie along the centerline of the floor, at the base of the sideslopes, and down the 'upslope' side of the access ramp. The slope of the floor directs leachate to the center of the floor, which also slopes down toward the sump areas located at the east ends of Trenches 31 and 34. The secondary leachate collection system is installed above the secondary liner system. Pumps are provided in both the primary and secondary sump areas. Collected leachate is pumped to RCRA/WAC 173-303-compliant 37,854-liter storage tanks. Trenches 31 and 34 were designed with consideration for the 24-hour peak precipitation event (3.96 centimeters) in a 25-year period.

The planned operational life of Trenches 31 and 34 is 20 years. At the time of closure, a final cover will be constructed to minimize infiltration into these trenches.

The RAP is a site-specific plan that establishes actions to be taken if leakage through the upper (primary) liner of the landfill exceeds a certain rate. The intent of the RAP is to ensure that any leachate that does leak through the primary liner does not migrate out of the landfill into the environment. A key element of the RAP is the action leakage rate (ALR), a threshold value that triggers the responses described (Section 3.0), but below which no special actions are required. Because landfill liner systems have not been perfected, a small amount of leakage through the primary liner generally occurs despite the use of best available materials, construction techniques, and quality assurance procedures. (This leakage is collected by the secondary liner system and removed from the landfill.) Hence, the ALR is set at some level higher than normally expected leakage rates to serve as an indicator that the primary liner is not functioning as expected. Exceeding the ALR might reflect serious failure of the primary liner, and indicates the need for investigation and possibly corrective action while the problem is still manageable.

This RAP has been prepared in accordance with regulatory requirements (40 CFR 264.302) and is part of the supporting material for the *Hanford Facility Dangerous Waste Permit Application, Low-Level Burial Grounds*, as amended (DOE-RL 1989). The current regulations for determining the ALR and preparing a RAP are contained in 40 CFR 264.302.

2.0 ACTION LEAKAGE RATE

The ALR is defined (40 CFR 264.302) as:

"the maximum design flow rate that the leak detection system can remove without the fluid head on the bottom liner exceeding 1 foot." Also noted in 40 CFR 264.302 are the following.

- This leakage rate must account for an adequate margin of safety for uncertainties in design, construction, and operation of the leak detection system.
- The action leakage rate must not be greater than the flow capacity of the drainage layer.
- The action leakage rate should always be less than or equal to the pumping capacity of the leak detection sump.

Thus, the ALR is based on the flow capacity of the leak detection system rather than on types and sizes of flaws in the primary liner. The EPA provides a formula based on Darcy's Law for calculating this flow capacity, assuming that it originates from a single hole in the primary liner (EPA 1992):

$$Q = k\ h\ \tan(a)\ B \qquad (1)$$

where
- Q = flow rate in leak detection system
- k = hydraulic conductivity of drainage medium in leak detection system
- h = head on secondary liner
- a = slope of leak detection system
- B = width of flow in leak detection system, perpendicular to flow direction

The major uncertainty associated with this formula is determining the value of B, which is a complex function and in part dependent on the other parameters. Additional information and guidance is provided by the EPA (EPA 1992). By assuming that the shape of the wetted area down slope from the hole is parabolic, the EPA rewrites equation (1) to read:

$$Q = k\ D\ (2h - D) \qquad (2)$$

where D = thickness of drainage layer

other parameters are the same as in equation (1)

It can be seen that equation (2) does not depend on the slope of the drainage system. This results in part from simplifying assumptions by the EPA related to the cosine of small angles being nearly equal to 1. As a consequence of this simplification, equation (2) indicates that the flow capacity of the geonet drainage layer on the landfill sideslopes would be

0.5-millimeter polyvinyl chloride). Precipitation water would be pumped or evaporated from the pond and would not infiltrate the waste already in the trench. Waste packages would be placed only during periods of dry weather, and stored temporarily at other times. This type of approach also would be used, if necessary, to reduce leakage during the time immediately after the ALR was exceeded, while other remediation options are evaluated.

- If the trench is nearly full, partial construction of the final closure cover might be an option. This would reduce infiltration into the trench, and possibly reduce the leakage rate if the cover is constructed over the failed area.

- A layer of low-permeability soil could be placed over the existing waste, perhaps in conjunction with a geomembrane, to create a second 'primary' liner higher in the trench. This new liner would intercept precipitation and allow its removal.

- A rigid-frame or air-supported structure could be constructed over the trench to ensure that no infiltration occurs. Although costly, this approach might be less expensive than constructing a new trench.

In general, the selected remediation efforts will be those that are easiest to implement, with more difficult or expensive options to be applied only if earlier approaches are not satisfactory.

4.0 REFERENCES

DOE-RL, 1989, *Low-Level Burial Grounds Dangerous Waste Permit Application*, DOE/RL-88-20, Rev. 0, plus Supplements 1 and 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1992, *Action Leakage Rates for Leak Detection Systems*, EPA 530-R-92-004, Office of Solid Waste, Washington, D.C., January.

WHC, 1995, *Construction Quality Assurance Report*, WHC-SD-W025-RPT-002, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

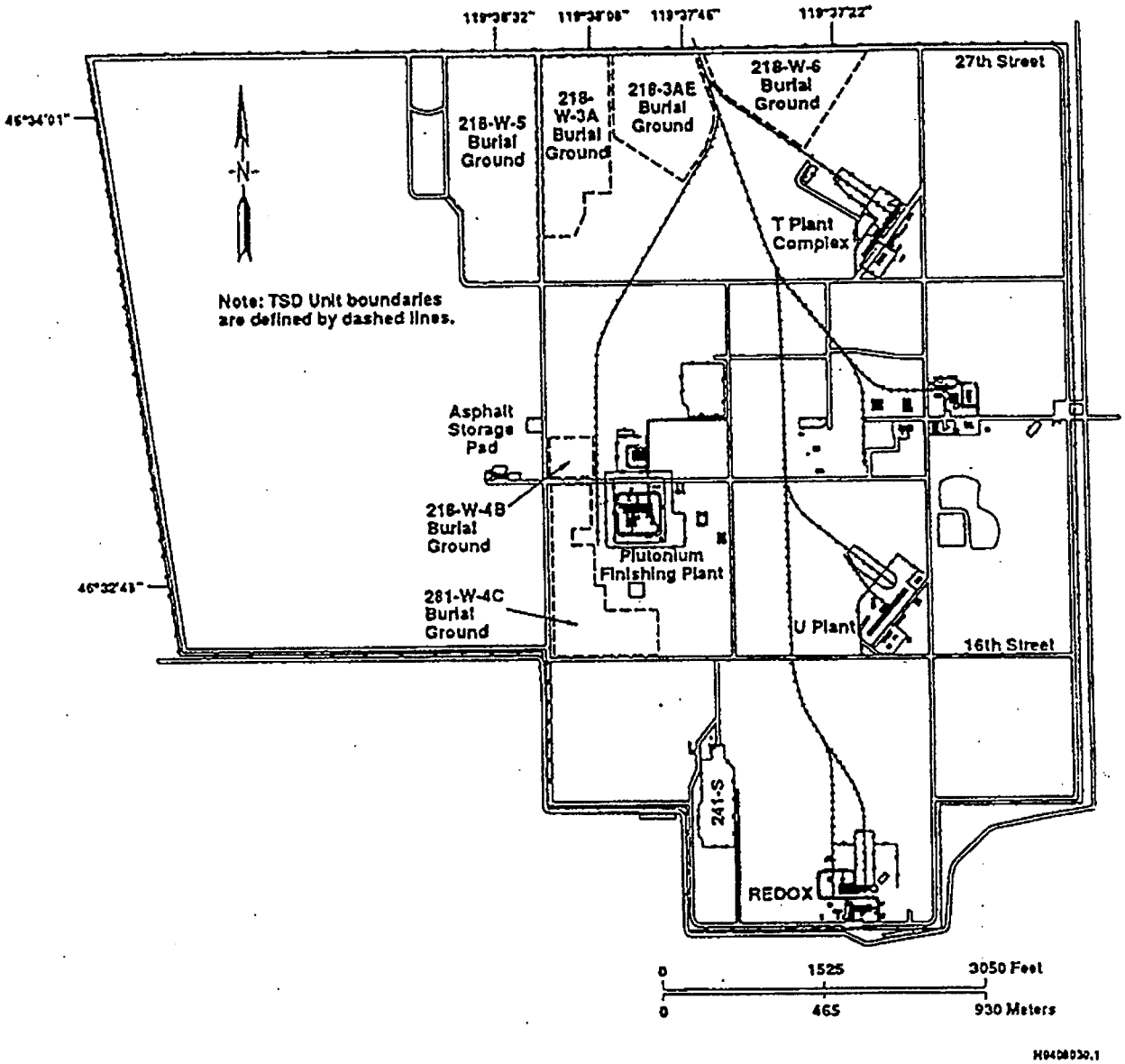
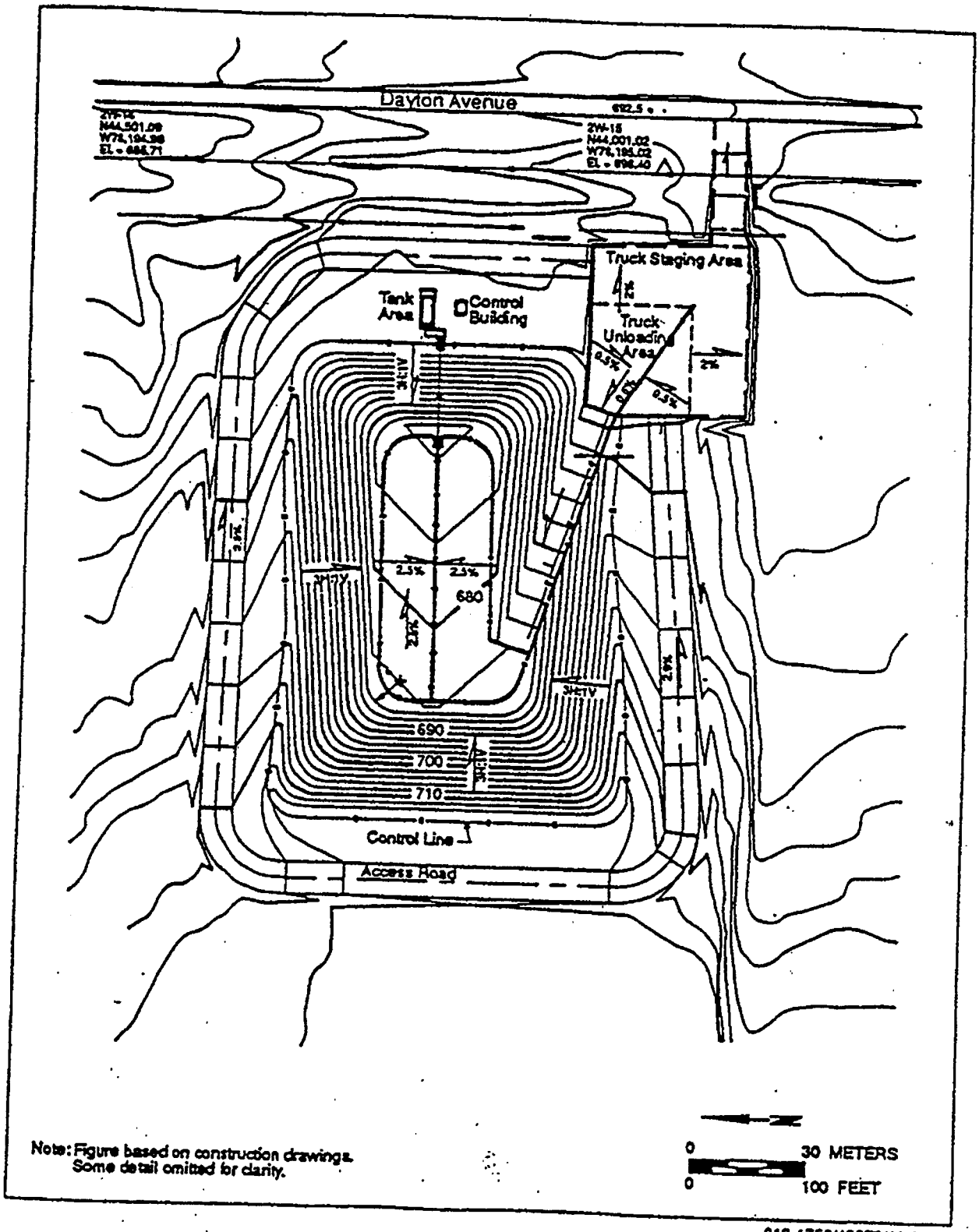


Figure 1. 200 West Area - Low-Level Burial Grounds (Trenches 31 and 34 are located in the 218-W-5 Burial Ground).



913-1756/43672/10-28-92

Figure 2. Typical Trench Floor Plan.

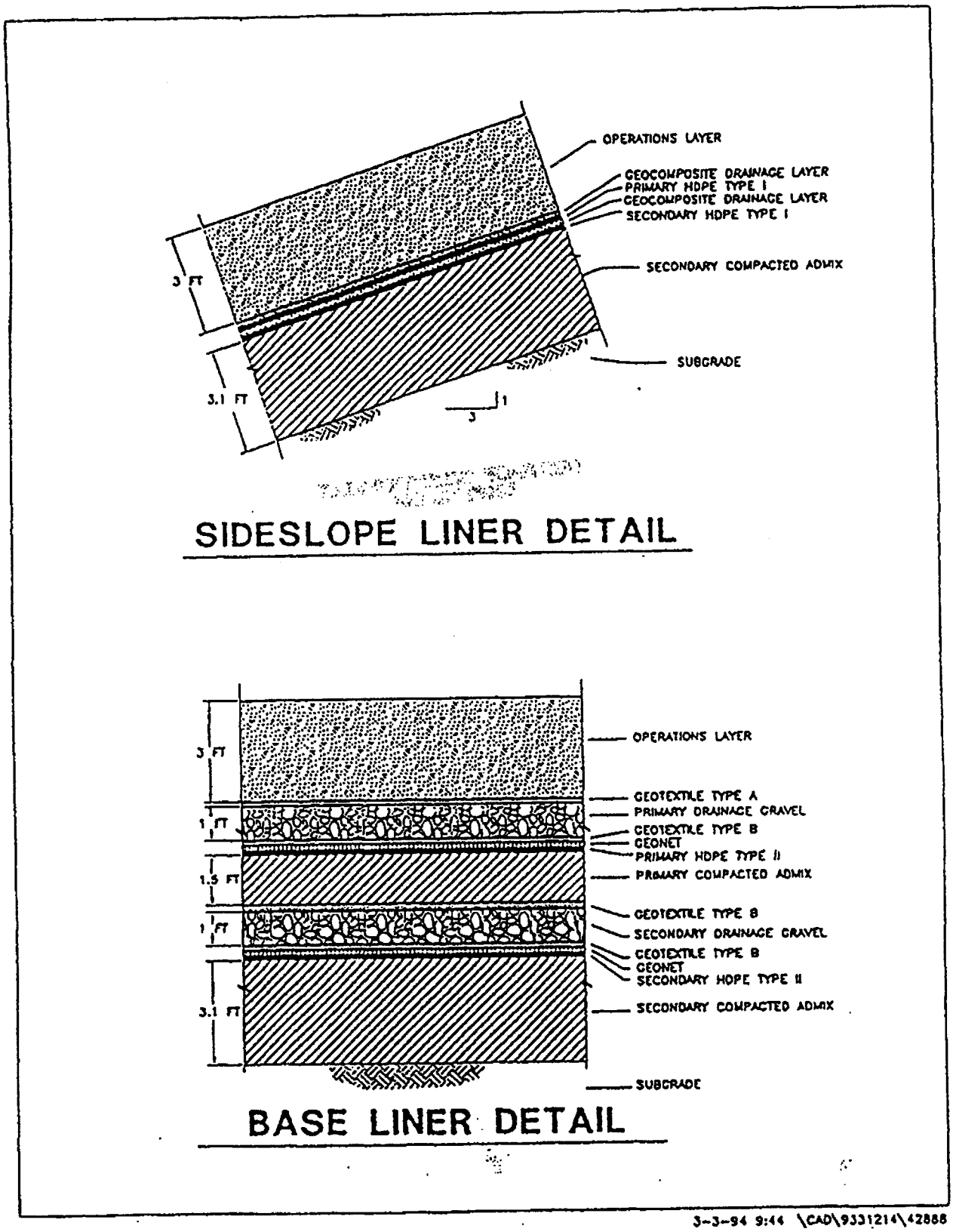


Figure 3. Sideslope Liner Detail and Base Liner Detail.

THIS PAGE INTENTIONALLY
LEFT BLANK

APPENDIX A

ACTION LEAKAGE RATE CALCULATIONS

TRADEMARKS

TEX-NET is a registered trademark of Fluid Systems, Inc.

POLY-NET is a registered trademark of Fluid Systems, Inc.

Trevira is a registered trademark of Hochst Aktiengesellschaft

Golder Associates

SUBJECT Action Leakage Rate - W025 Landfill		
Job No. 913-1756 Ref.	Made by FSS Checked JPP Reviewed	Date 8-13-92 Sheet 1 of 10

Reference: EPA, Action Leakage Rates for Leak Detection Systems, EPA 530-R-92-004, Office of Solid Waste, Washington, D.C., January 1992.

From EPA, page 12, flow capacity of drainage layers where $h \geq D$ is:

$$Q = kD(2h - D)$$

where Q = flow
k = permeability of drainage layer
D = thickness of drainage layer
h = head in drainage layer

Note that $kD = T$, the transmissivity of the drainage layer

For W-025 landfill, assume that geocomposite is TEX-NET 3002 (this material was originally specified)

Also assume that the maximum normal load results from 40 feet of waste @ 100 lbs/ft³
= 4000 psf

From transmissivity chart, transmissivity of TEX-NET 1002 under 4000 psf load ≈ 2×10^{-4} m²/sec

From Polynet transmissivity chart, transmissivity of PN-3000 (used in TEX-NET 3002) is slightly less than that of PN-1000 (used in TEX-NET 1002).

∴ Assume transmissivity of TEX-NET 3002 = 1×10^{-4} m²/sec
= 10.76×10^{-4} ft²/sec

Thickness of geocomposite = 1 layer PN-3000 geonet + 2 layers Trevira 1125

From manufacturers' spec sheets
D = 0.22 + 2 × 0.095 inches/2
= 0.32 inches = 0.027 ft.

Golder Associates

SUBJECT Action Leakage Rate — W025 Landfill		
Job No. 913-1756 Ref.	Made by FSS Checked JFP Reviewed	Date 8-13-92 Sheet 2 of 10

By regulation, h ~ 1 ft

$\therefore Q = 10.76 \times 10^{-4}\ ft^2/sec\ (2 \times 1\ ft - 0.027\ ft)$

$= 21.23 \times 10^{-4}\ ft^3/sec$

$= 1376\ gal/day$

Apply Factor of Safety = 2, per regulations

$Q = \frac{1376}{2} = 688\ gal/day$

Area of W-025 = 3.0 acres (see attached sheet)

$\therefore Q = \frac{688}{3} = 229$ say $\boxed{230\ gal/acre/day}$

minimum technical requirements and other design assumptions to maximize potential head on the bottom liner, and uses a safety factor, EPA believes that the units meeting the minimum technical requirements would not require action leakage rates below 100 gpad for landfills and waste piles and 1,000 gpad for surface impoundments.

Assuming the wetted area in the drainage layer beneath a small hole leak has approximately the shape of a cone from side view and a parabola from top view, the width of the parabola (B) is:

$$B = \frac{2\sqrt{Q/k}}{\sin\alpha}\sqrt{1+\frac{2x\sin\alpha}{\sqrt{Q/k}}}$$

where x = plan distance downslope from hole (i.e., B is a function of the distance x from the hole; most of B is at the hole with only slight increases downslope).

Assuming x = 0 (i.e., looking at B under the hole, $B = \frac{2\sqrt{Q/k}}{\sin\alpha}$) and substituting this value for B into Equation 1 modified for a triangular cross-section of flow (i.e., $Q = 1/2\ k \cdot h \cdot \tan\alpha \cdot B$) and solving for Q yields:

$$Q = k \cdot h^2 \qquad \text{[Equation 2]}$$

where h = head on the bottom liner and h < thickness of drainage layer.

This equation becomes the following if the condition is changed from "h < thickness of the drainage layer (D)" to "h ≥ D" (which is important for geonet calculations):

$$Q = k \cdot D\ (2h - D) \qquad \text{[Equation 3].}$$

Solving Equation 3 using the minimum design specifications in the final rule, Q =

for .1 cm/sec: 2100 gpad
.01 cm/sec: 210 gpad
geonet: 6800 gpad.

These numbers are the same as the results given above for Equation 1.

Results Using a 3-D Model

Tables 1-4 and Figures 1-10 in Appendix B were developed from a 3-D model to show the relative effects of various design parameters and assumptions on flow capacity, and to show the shapes of the flow in the drainage layer for various designs and assumptions, including hole size and head. Appendix C gives background information on the 3-D model. The tables show that slope, length of run, and hole size have some effect on flow rate (e.g., 4% increase in flow rate when slope is increased from 1% to 2% [Tables 1, 3-5]; 1% increase in flow rate at 1% slope when

TEX-NET

Installation

No underground drainage system is easier to install than TEX-NET composite. It is a simple one-step operation. Because it is lightweight, flexible and strong, it can be rolled out in place on flat or steep slopes, around building foundations or along footings. The composite is supplied with a geotextile overlap of 2" on both edges or 5" on one edge so that continuity of drainage action can be assured from one strip of the composite to the next. TEX-NET sheets can be cut to size in the field to fit nearly any required area. It is also easily hung vertically on basement or retaining walls prior to backfilling.

By specifying TEX-NET on your next drainage project you will save considerable time and labor costs. And when compared to a sand and gravel system, extra savings can be expected through lower transportation and installation costs.

Hydraulic Properties

Transmissivity/flow charts for TEX-NET are available on supplemental data sheets. They are prepared for use by design engineers to help determine TEX-NET performance under varying conditions of pressure, hydraulic gradient and field profile. All transmissivity tests were performed in accordance with ASTM D4716 where a drainage layer is characterized by its transmissivity or $\Theta = (Q/B)/i$

TEX-NET can also be specified with non-woven polypropelene fabrics and woven monofilaments heat laminated to any style of POLY-NET. Call FSI for further details.

To determine Q (flow per unit width of TEX-NET) in actual conditions, simply multiply Θ (transmissivity m^2/sec) by i (hydraulic gradient).

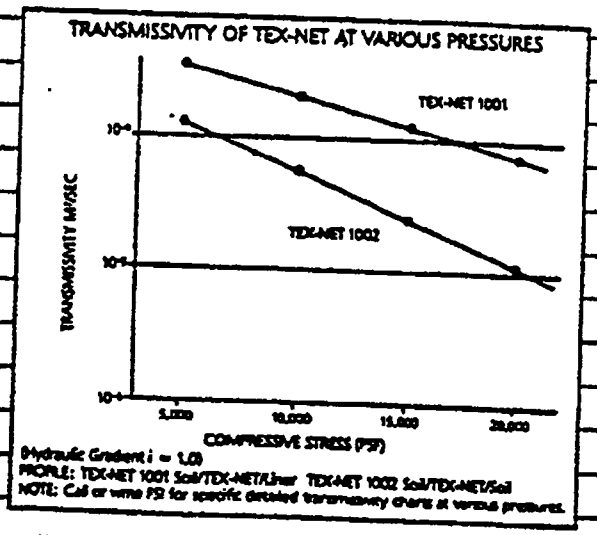
Example: TEX-NET 1001 under 4000 p.s.f and gradient of 0.75 has a transmissivity of $1.0 \times 10^{-3} m^2$/sec.

$Q = 1.0 \times 10^{-3} m^2/sec\ (0.75)$
$= 7.5 \times 10^{-4} m^2/sec$
$= 3.6$ GPM/FT of WIDTH

The information contained herein is, to the best of our knowledge, true and accurate; however, all recommendations or suggestions are made without guarantee, since the conditions of use are beyond our control. There is no expressed warranty and no implied warranty of fitness for purpose of the product or products described herein. In submitting this information, no liability is assumed or license or other rights implied or given with respect to any existing or pending patent, patent applications or trademarks. The observance of all legal regulations and patents is the responsibility of the user.

Specifications

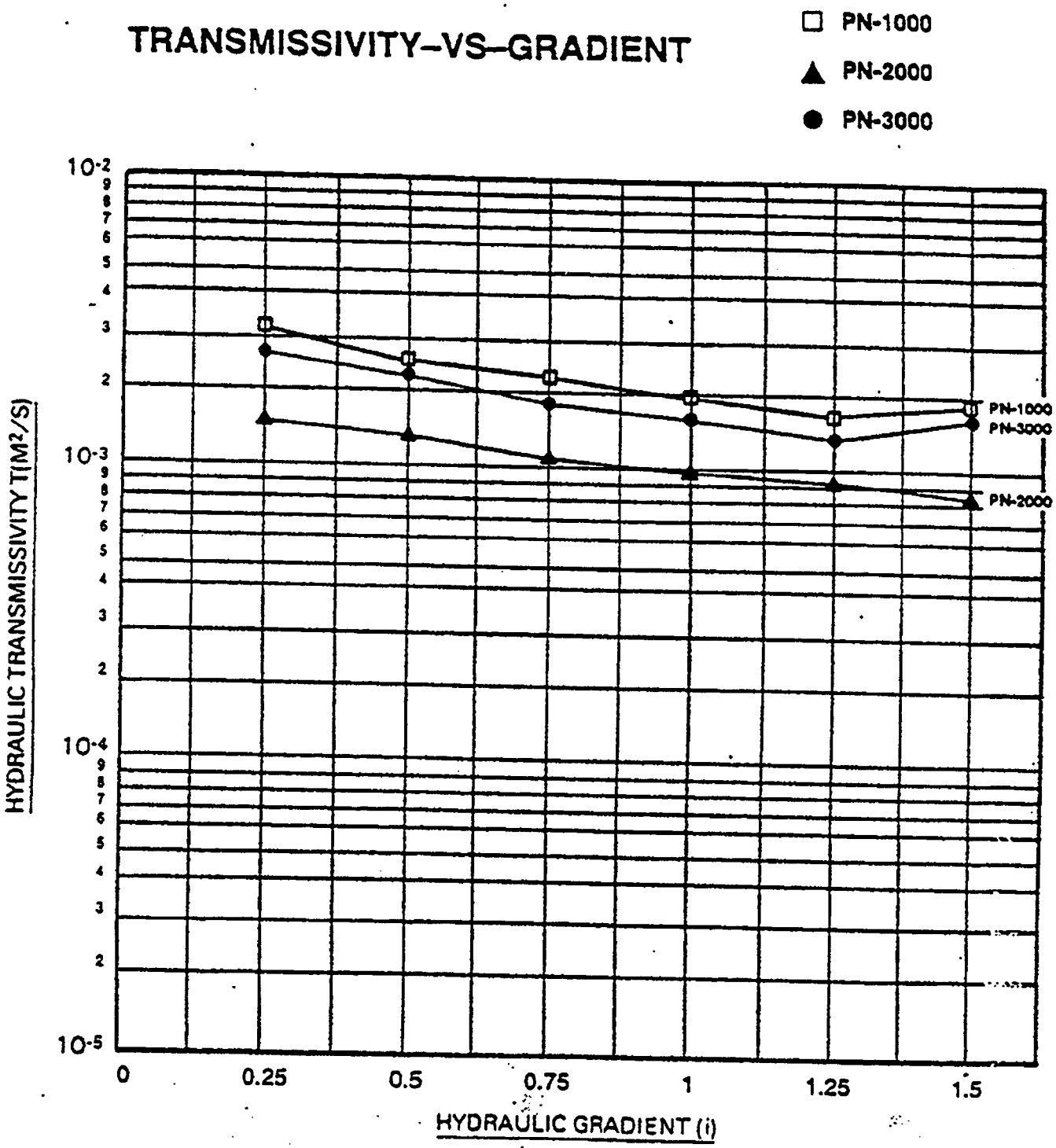
Refer to supplemental data sheets and performance curves.



FSI
FLUID SYSTEMS, INC.
32 Triangle Park Drive
Suite 3201
Cincinnati, OH 45246
(513) 771-5656-(800) 346-9107
FAX: (513) 771-4844
Offices in Denver and Atlanta

POLY-NET® TRANSMISSIVITY	INSTALLATION METHOD LEAK DETECTION HDPE LINER/POLY-NET/HDPE LINER	HYDRAULIC PRESSURE 4000 P.S.F.

TRANSMISSIVITY–VS–GRADIENT



FSI FLUID SYSTEMS, INC.
32 TRIANGLE PARK DRIVE
SUITE 3201
CINCINNATI, OH 45246
513/771-5656
800/348-9107
FAX - 513/771-4844

Installation

Poly-Net is easily installed by hand. On steep slopes, nets should be anchored at the top, then unrolled. On vertical walls, anchoring the net with masonry nails may be necessary.

Adjacent rolls can be easily joined by plastic ties supplied with the Poly-Net. When joining adjacent rolls in the direction of the flow, butt the rolls together, or overlap 2-4". When joints are not in the direction of flow, overlap adjacent rolls in shingle fashion. On the bottom of landfills or ponds, a 2-4" overlap is recommended to maintain flow.

Geotextiles should always be used to prevent migration of soil particles into the net, except when Poly-Net is between two geomembranes, in which case a geotextile is not necessary. Poly-Net is U.V. stabilized and can be stored outside for short periods, but care should be taken to keep them clean of mud and debris. If Poly-Net becomes dirty, simply wash out debris with a high pressure hose.

FSI
FLUID SYSTEMS, INC.
32 Triangle Park Drive • Suite 3201
Cincinnati, Ohio 45246 • FAX: 513/771-4844
513/771-5656 • 800/346-9107
Offices in Denver and Atlanta

Hydraulic Properties

Transmissivity charts for Poly-Net under various profiles, gradients, and pressures are available in the FSI transmissivity brochure.

Specifications

Refer to specifications below and FSI "suggested specification guide" brochure.

The information contained herein is, to the best of our knowledge, true and accurate; however, all recommendations or suggestions are made without guarantee, since the conditions of use are beyond our control. There is no expressed warranty and no implied warranty of fitness for purpose of the product or products described herein. In submitting this information, no liability is assumed or license or other rights implied or given with respect to any existing or pending patent, patent applications or trademarks. The observance of all legal regulations and patents is the responsibility of the user.

SPECIFICATION

Details

	PN-1000*	PN-2000	PN-3000	PN-3000-CN*	PN-4000*
Raw material	polyethylene	polyethylene	polyethylene	polyethylene	polyethylene
Weight (lbs/ft²) D-3776	.165±0.016	.130±0.013	.180±0.018	.115±0.011	.245±0.024
Thickness (inches) D-1777	.250±0.025	.160±0.016	.220±0.022	.220±0.022	.300±0.030
Density of polymer (g/cm³) D-1505	.937±0.002	.937±0.002	.937±0.002	.937±0.002	.937±0.002
Tensile strength (lb/in) D-1682	40±10	38±10	50±10	28±10	54±10
Porosity	.81-.84	.81-.84	.81-.84	.81-.84	.81-.84
Roll width (feet)	7.54	7.54	7.54	7.54	7.00
Standard roll length (feet)	250	300	300	300	220
Square feet per roll	1885	2262	2262	2262	1540
Carbon black ASTM D-1603	2-3%	2-3%	2-3%	2-3%	2-3%
Nominal Transmissivity (m²/s) D-4716	See Transmissivity Charts				

*Foamed.

FSI-PN89 7.5M

Trevira® Spunbond nonwoven engineering products are highly needled fabrics with excellent tensile properties, high filtration potential and outstanding permeability.

Trevira® Spunbond Type 11 products are 100% continuous filament polyester nonwoven needlepunched engineering fabrics. They deliver a combination of advantages unmatched by any other spunbonded geotextiles. They're resistant to freeze-thaw, soil chemicals and ultraviolet light exposure.

Trevira® Spunbond nonwoven engineering fabrics offer excellent performance where the requirement is tensile reinforcement, planar flow, filtration, or separation. They are ideal for roadways, railbeds, drainage systems, pondliners, retaining walls. And much more.

The information contained herein is offered free of charge, and is, to our best knowledge, true and accurate; however, all recommendations or suggestions are made without guarantee, since the conditions of use are beyond our control. There is no expressed warranty and no implied warranty of merchantability or of fitness for purpose of the product or products described herein. In submitting this information, no liability is assumed or license or other rights implied given with respect to any existing or pending patent, patent applications or trademarks. The observance of all legal regulations and patents is the responsibility of the user.

TYPICAL PHYSICAL PROPERTIES OF TREVIRA® TYPE 11 PRODUCTS

Fabric Property	Unit	Test Method	1112	1114	1120	1125	1136	1146	1186
Fabric Weight	oz/yd²	ASTM D-3776	3.5	4.2	6.0	7.5	10.5	13.5	16.5
Thickness, t	mils	ASTM D-1777	60	70	90	110	140	170	210
Grab Strength (MD/CD)[1]	lbs	ASTM D-4632	120/95	150/115	230/180	300/235	420/350	540/450	650/570
Grab Elongation (MD/CD)[1]	%	ASTM D-4632	65/75	75/85	75/85	75/85	75/80	80/80	85/85
Trapezoid Tear Strength (MD/CD)[1]	lbs	ASTM D-4533	50/40	55/50	80/75	105/95	140/125	180/165	225/200
Puncture Resistance	lbs	ASTM D-4833	55	65	95	115	155	185	225
Mullen Burst Strength	psi	ASTM D-3786	195	225	320	400	560	700	855
Water Flow Rate	gpm/ft²	ASTM D-4491	195	190	170	150	120	100	80
Permittivity, Ψ	sec⁻¹	ASTM D-4491	2.61	2.54	2.27	2.01	1.60	1.34	1.07
Permeability, k = Ψt	cm/sec	ASTM D-4491	.40	.45	.52	.56	.57	.58	.57
AOS	Sieve Size mm	ASTM D-4751	70-100 .210-.149	70-100 .210-.149	70-100 .210-.149	70-100 .210-.149	100-120 .149-.125	120-140 .125-.106	140-170 .106-.088
Standard Roll Widths[2]	ft		12.5 and 16.0						
Standard Roll Length[2]	ft		400	400	300	300	300	300	300

[1]MD = Machine Direction, CD = Cross Machine Direction.

[2]Other width and length rolls are available upon request.

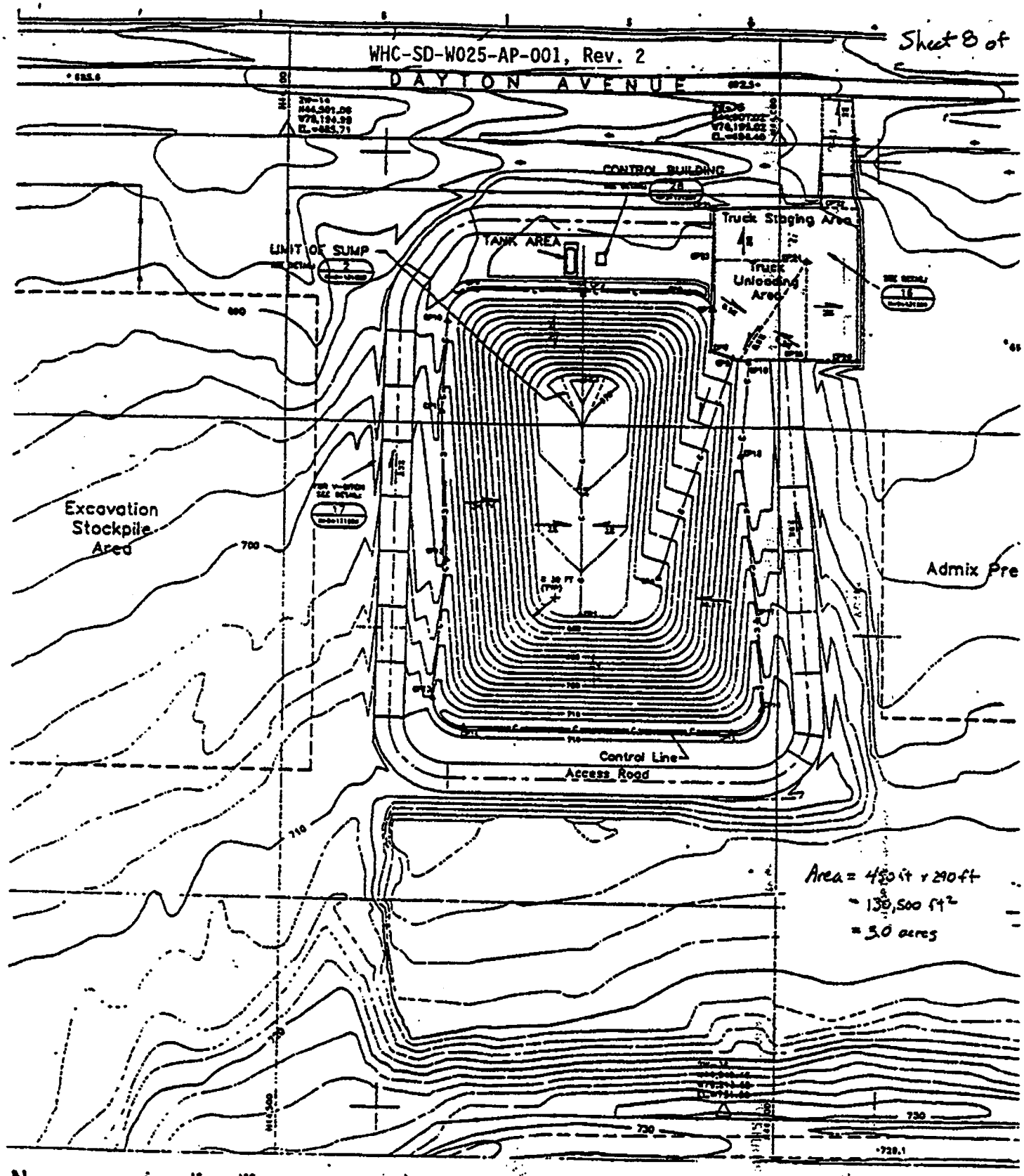
MINIMUM[1] PHYSICAL PROPERTIES OF TREVIRA® TYPE 11 PRODUCTS

Fabric Property	Unit	Test Method	1112	1114	1120	1125	1136	1146	1186
Fabric Weight	oz/yd²	ASTM D-3776	3.3	4.0	5.7	7.1	10.0	13.0	16.0
Thickness, t	mils	ASTM D-1777	50	55	75	95	125	150	185
Grab Strength	lbs	ASTM D-4632	80	100	160	210	305	390	500
Grab Elongation	%	ASTM D-4632	60	60	60	60	60	65	70
Trapezoid Tear Strength	lbs	ASTM D-4533	30	40	60	75	100	130	150
Puncture Resistance	lbs	ASTM D-4833	40	50	80	95	130	155	195
Mullen Burst Strength	psi	ASTM D-3786	170	190	275	360	510	640	780
Water Flow Rate	gpm/ft²	ASTM D-4491	155	150	130	110	80	60	40
Permittivity, Ψ	sec⁻¹	ASTM D-4491	2.07	2.01	1.74	1.47	1.07	0.80	0.53
Permeability, k = Ψt	cm/sec	ASTM D-4491	.28	.28	.33	.35	.34	.31	.25
AOS	Sieve Size mm	ASTM D-4751	50 .300	50 .300	70 .210	70 .210	70 .210	100 .149	100 .149

[1]These minimum values represent minimum test values determined from Q.C. testing on all lots produced in 1989. Certified "Minimum Average Roll Values" representing the industry standard of a 95 percent confidence level (i.e. mean less two standard deviations) may be higher than these values and are determined for each production lot. Please contact your Trevira® Distributor or Hoechst Celanese Corporation for additional information.

Sheet 7 of 10

Sheet 8 of


DAYTON AVENUE
CONTROL BUILDING
Truck Staging Area
TANK AREA
LIMIT OF SUMP
Truck Unloading Area
Excavation Stockpile Area
Admix Pre
Control Line
Access Road
Area = 450 ft x 290 ft
= 130,500 ft²
= 3.0 acres
N
FEET

Golder Associates

SUBJECT Action Leakage Rate - W025 Landfill

Job No. 913-1756	Made by FSS	Date 8-13-92
Ref.	Checked JPP	Sheet 9 of 10
	Reviewed	

Pump Capacity: from Specifications, pump is Gardner 7503-B

from attached curve, capacity is at least 10 gpm (head ≈ 40 ft)

10 gal/min × 60 min/hr × 24 hr/day = 14,400 gal/day

required: ALR = 230 gal/acre-day × 3.0 acres = 690 gal/day

∴ Pump has more than enough capacity to remove ALR volume.

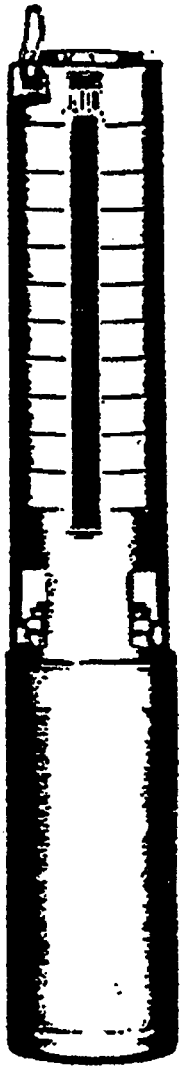
MODEL 7S

7 GPM

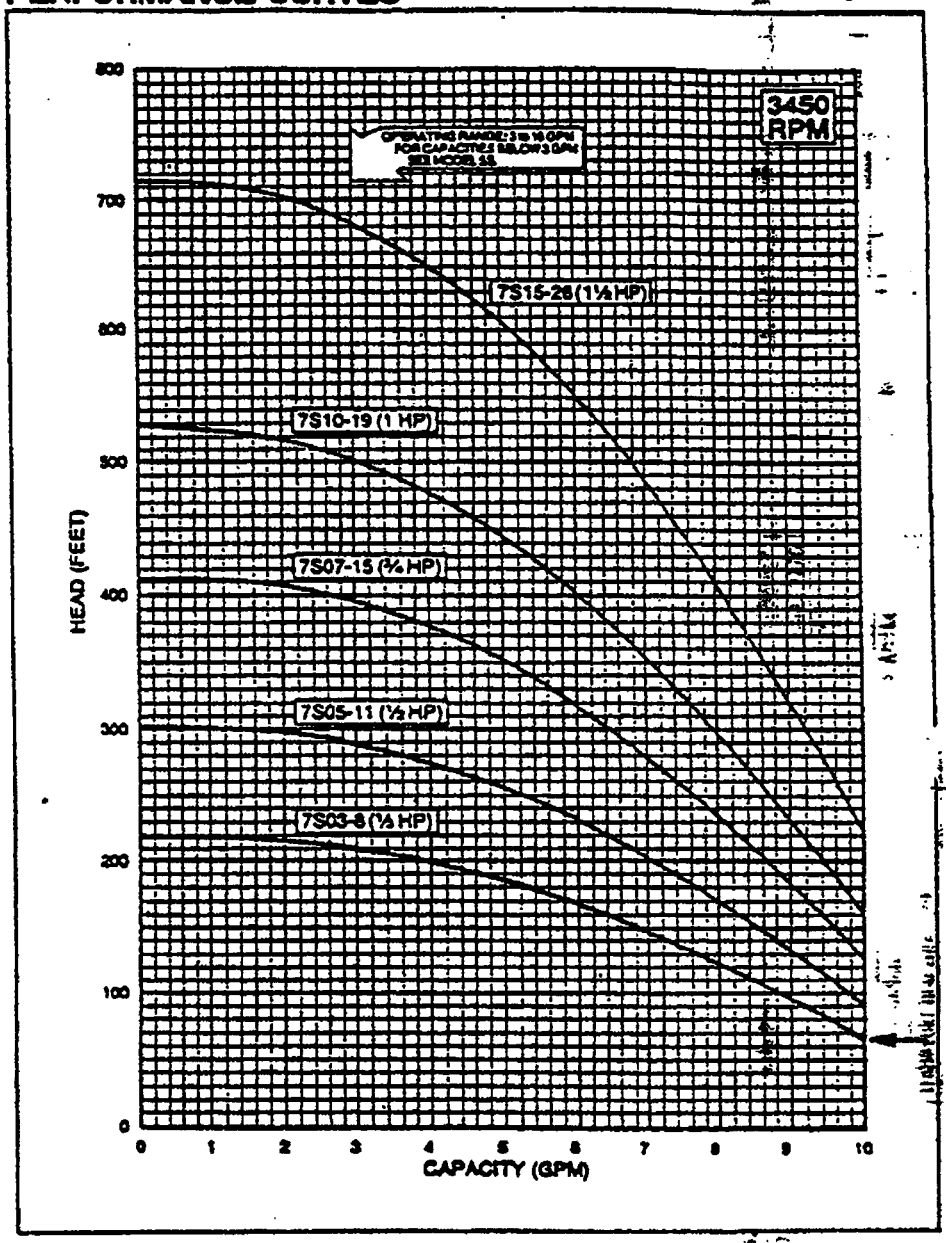
GRUNDFOS

FLOW RANGE
3 to 10 GPM

PUMP OUTLET
1" NPT



PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
7S03-8	⅓	23½	3 15/16	27
7S05-11	½	26⅞	3 15/16	30
7S07-15	¾	30¾	3 15/16	33
7S10-19	1	34⅝	3 15/16	36
7S15-26	1½	42	3 15/16	45

Specifications are subject to change without notice.

9513383.2209

0042155

START

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

May 24, 1995
10:30 a.m. - 11:00 a.m.

The undersigned indicate by their signatures that these meeting minutes reflect the actual occurrences of the above dated Unit Managers' Meeting.

Clifford E. Clark, Unit Manager, RL — Date: 10/6/95

Daniel L. Duncan, RCRA Program Manager, EPA Region 10 — Date: 9/12/95

Norman T. Hepner, Unit Manager, Washington State Department of Ecology — Date: 7/20/95

Low-Level Burial Grounds, WHC Concurrence

Richard D. Pierce, Contractor Representative, WHC (Represented by Brett M. Barnes, WHC) — Date: 8/29/95

Purpose: Discuss Permitting Process

Meeting Minutes are attached. The minutes are comprised of the following:
Attachment 1 - Agenda
Attachment 2 - Summary of Discussion and Commitments/Agreements
Attachment 3 - Attendance List
Attachment 4 - Action Items
Attachment 5 - Status of Pump and Treat

OCT 1995
RECEIVED
EDMC

9513383.2210

Attachment 1

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting (Videoconference)
Federal Building, Room 784B
2704HV Building, Room 213
Richland, Washington
Lacey, Washington

May 24, 1995
10:30 a.m. - 11:00 a.m.

AGENDA

1. **PREVIOUS MEETING MINUTES**
   - April 27, 1995 Meeting Minutes
2. **PROGRAM STATUS**
   - Status of Mixed Waste Trench Readiness
     - Performance Assessments
3. **PERMIT APPLICATION STATUS**
4. **RCRA TOPICS**
   - Discussion of 4-9-93 NOD Response Table
5. **GENERAL TOPICS**
   - Status of Pump and Treat (R. Mercer)
   - Past Action Items
     - 10-27-93:1 Pump and Treat Status
   - New Action Items
6. **SCHEDULE NEXT MEETING**
   - Tentative Date
   - Proposed Topics

Attachment 2

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

May 24, 1995
10:30 a.m. - 11:00 a.m.

Summary of Discussion and Commitments/Agreements

1. PREVIOUS MEETING MINUTES

The April 27, 1995 Unit Manager Meeting minutes are currently being reviewed by Ecology and EPA.

2. PROGRAM STATUS

- **Status of Mixed Waste Trench Readiness**

Ms. A. Crowell (RL) stated that RL/WHC are working on the safety evaluation report (SER), which documents DOE's approval of the interim safety basis (ISB) for Trench 31. The safety evaluation report is the major item remaining to be completed before start-up of Trench 31.

Mr. N. Hepner (Ecology) inquired about a projected start-up date for Trench 31. Ms. Crowell responded that Trench 31 will be ready to receive waste next fiscal year (October 1995), and it is dependent upon when Bechtel Hanford, Inc., prepares a schedule for sending waste.

Performance Assessments

Ms. Crowell reported that the 200 West Area Performance Assessment (PA) is still in DOE-Headquarters' review.

3. PERMIT APPLICATION STATUS

Mr. C. Clark (RL) stated that RL/WHC are seeking further clarification from Ecology regarding the Engineer Performance Plan (EPP). Mr. Hepner stated that Ecology is prepared to discuss the issue and make a decision based on the information presented by the Navy. Mr. M. French (RL) agreed to provide Mr. Hepner a briefing on the EPP outside of the Unit Manager Meeting.

Mr. Hepner inquired about the accuracy of the trench capacity included in the Notice of Intent (NOI). Ms. G. Cummins (WHC) responded by asking Mr. Hepner if he had read the justification of need, which provides a description of how the total capacity was calculated. Mr. Hepner indicated that he had reviewed it. Mr. Clark explained that it is the total volume within the

boundaries of the Burial Grounds down to 70 feet, whether or not it would be used for waste disposal.

Mr. Hepner noted his concern regarding the information provided to the public, which indicated that the Environmental Restoration Disposal Facility (ERDF) was needed because the capacity was not available at the Burial Grounds, and now the Burial Grounds will be permitted for 1 1/2 times the capacity of ERDF. Ms. Crowell agreed with Mr. Hepner's concern, and stated that the intent is to revise the capacity in the NOI. Mr. Hepner suggested that the number be based on a forecast. Ms. Crowell responded that the treatment plans for each of the federal facilities are for only five years. Mr. Clark noted the continual changes occurring in all the programs on site and at other DOE facilities, and that were beyond expressed little confidence with a forecast ~~of~~ for five years. Ms. Cummins stated that the original intent of the capacity in the NOI was to maintain flexibility, and Ms. Crowell added that RL/WHC wanted to avoid the cost of revising the Part A permit application every year if the capacity volume needed to be revised.

4. RCRA TOPICS

- **Discussion of 4-9-93 NOD Response Table**

Ms. Cummins stated that RL/WHC are reviewing the draft issue paper that Ecology provided at the last Unit Managers Meeting. Mr. B. Cordts (Ecology) stated that he would formally transmit the issue paper to RL/WHC.

5. GENERAL TOPICS

- **Status of Pump and Treat**

Mr. R. Mercer (WHC) provided an update on the pump and treat operation (Attachment 5). Mr. Mercer stated that Bechtel's pilot pump and treat program at the 218-W-4C Burial Ground is ongoing. A pump test was performed on the injection well located west of the burial ground last week, and the results are not available. The carbon steel casing on extraction Well No. 2 separated during drilling, and Bechtel decided to redrill it. Mr. Mercer stated that start-up of the pump and treat operation is scheduled for October 1995.

Ms. Crowell inquired about RL/WHC performing RCRA monitoring during the pump and treat activity. Mr. Mercer responded that Bechtel is preparing a paper on the impacts of the pump and treat, and WHC has a proposed outline for RCRA monitoring during the pump and treat. However, Mr. Mercer indicated that in an effort to avoid duplication, he is waiting for the results of Bechtel's study before completing his proposal for RCRA monitoring.

- **Past Action Items**

  Action item 10-27-93:1, schedule a technical issues meeting for RCRA/CERCLA integration and discussion of pump and treat evaluations.

  WHC is continuing to provide pump and treat information to Ecology. This action item was left open.

- **New Action Items**

  There were no new action items generated during the meeting.

6. **SCHEDULE NEXT MEETING**

- **Tentative Date**

  The next Unit Managers Meeting was scheduled for videoconference on July 12, 1995.

- **Proposed Topics**

  There were no new proposed topics for discussion.

9513383.2214

Attachment 3

LOW LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

May 24, 1995
10:00 a.m. - 11:00 a.m.

Attendance List

A stenographer is present to take detailed notes on the proceedings of this meeting. These notes will be used for the sole purpose of preparing unit manager meeting minutes. After these unit manager meeting minutes are finalized, the detailed notes will be discarded. If any attendee has objections with this approach, they should voice these objections at this time.

Name	Organization	Phone #
Kathy Knox	WHC	372-3596
Brett M. Barnes	WHC	376-3640
Clifford E. Clark	DOE-RL EAP	376-9333
Mark French	DOE-RL WPD	373-9863
R B Mercer	WHC	376-8945
RC Bowman	WHC	376-4876
Michael Cimineira	Barnes & Moore / GSSC	946-3681
Gloria D. Cummins	WHC	372-2484
Sarah F Campbell	WHC	372-0667
Norm Haggner	Ecology	736-3048
Dean Powell	WHC	373-9240
Dan Duncan	EPA	(206) 553-6693
Bob Cordts	Ecology	(360) 407-7142

9513383.2215

Attachment 4

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

May 24, 1995
10:30 a.m. - 11:00 a.m.

Action Items

Action Item	Description
10-27-93:1	Schedule a technical issues meeting for RCRA/CERCLA integration and discussion of pump and treat evaluations. **OPEN**
09-01-94:1	RL/WHC will provide the Yakama Indian Nation a copy of all the notice of deficiencies (NODs), including a description of the NODs that have been resolved and the NODs that remain open. ACTION: A. Crowell (RL) **CLOSED**
10-18-94:1	RL will provide Ecology (Mr. R. Cordts) a preview of the engineering change notices (ECNs) on Trench 31 and 34. ACTION: A. Crowell (RL) **CLOSED**

9513383.2216

Attachment 5

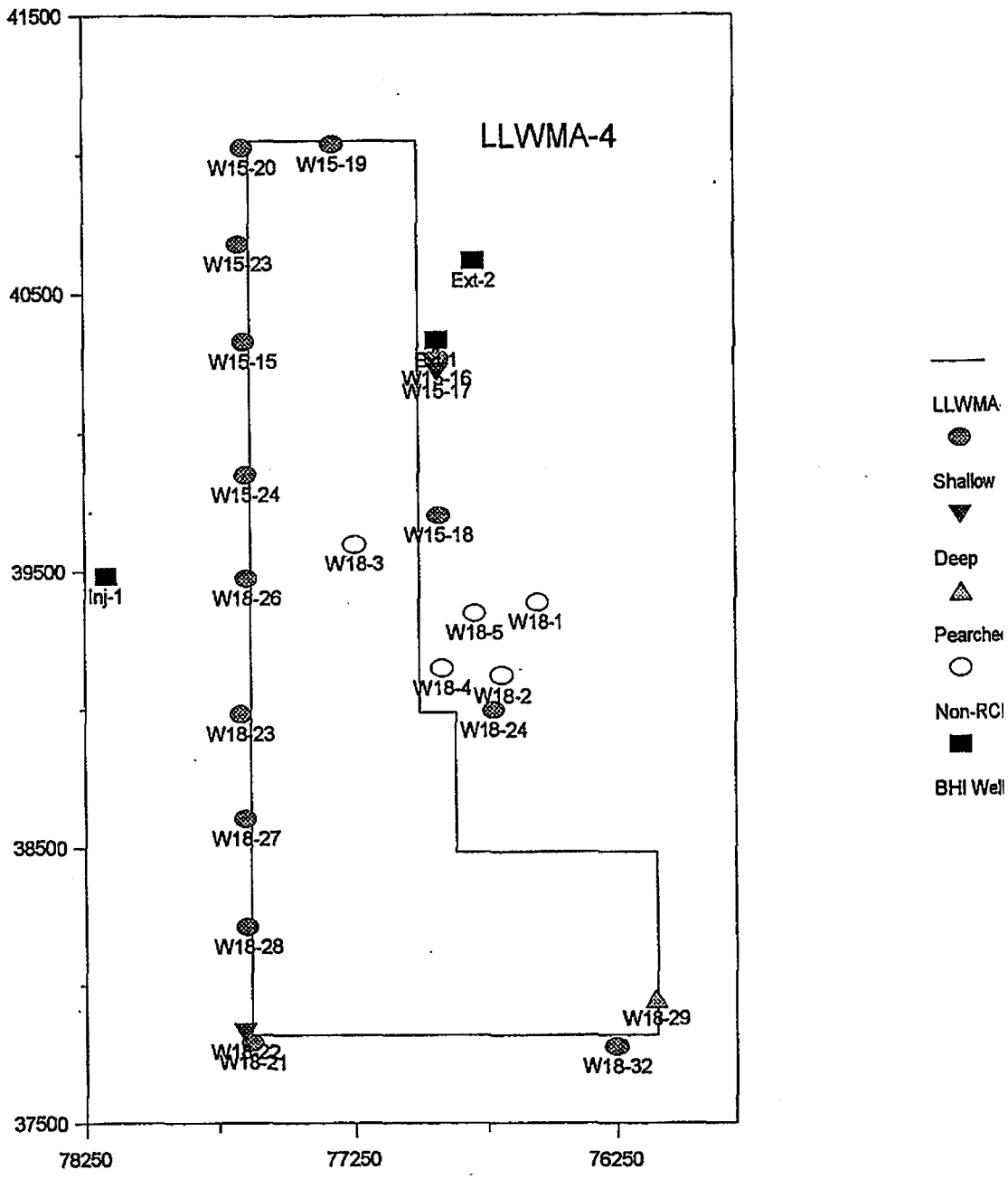
LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

May 24, 1995
10:30 a.m. - 11:00 a.m.

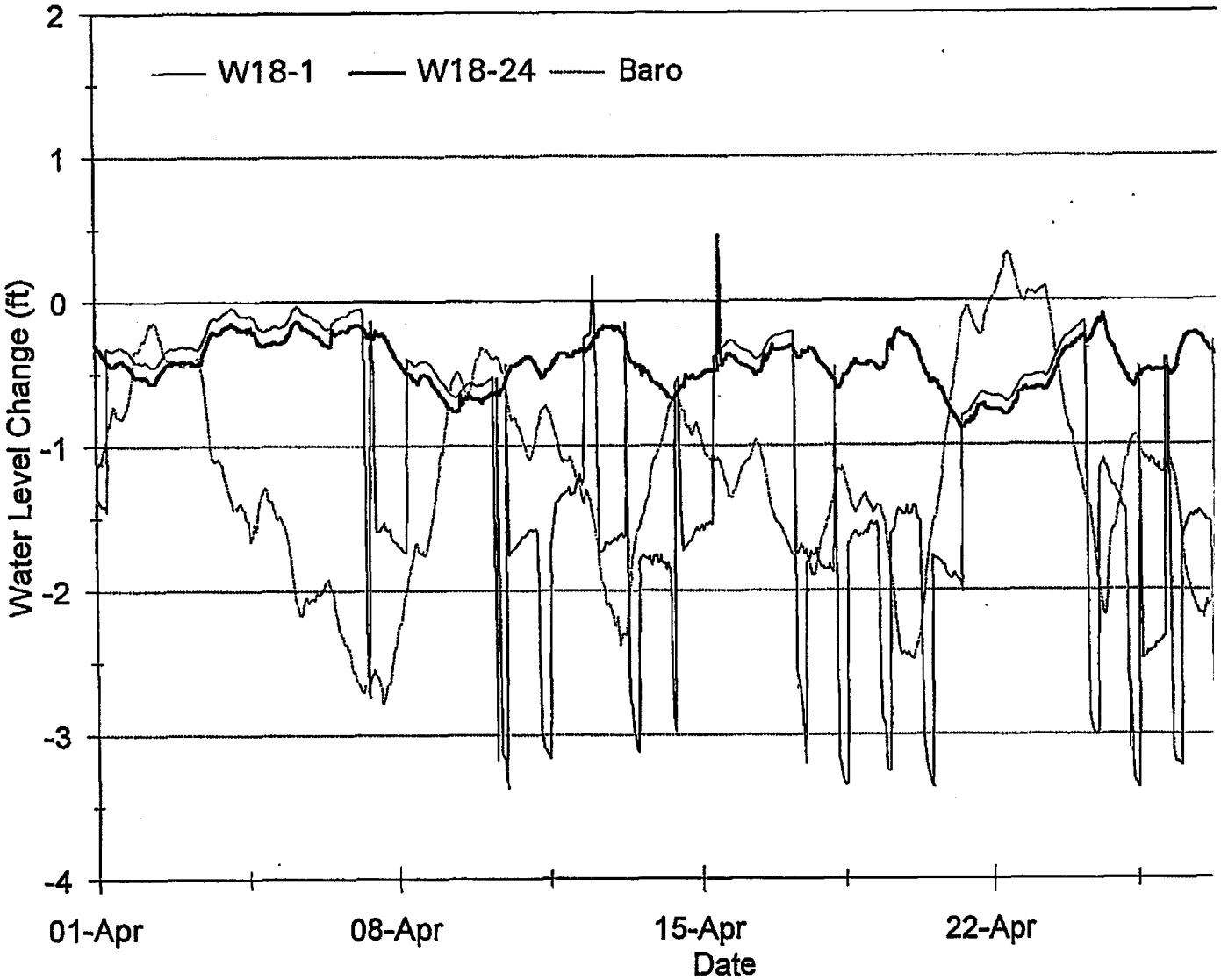
STATUS OF PUMP AND TREAT

LLBG
5-24-95

9513383.2217

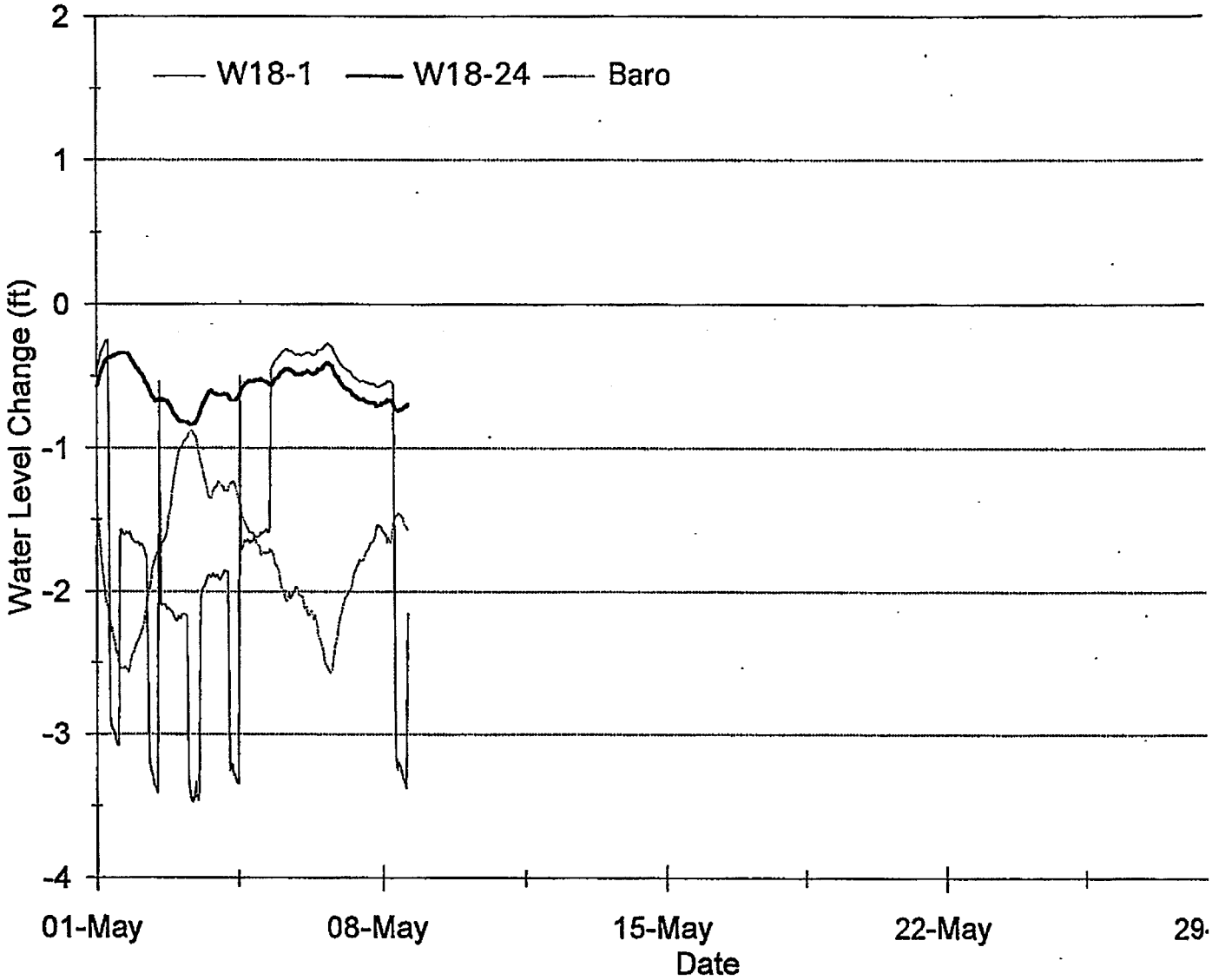


200-ZP-1 Water Level Monitoring
April 1995



9513383.2218

200-ZP-1 Water Level Monitoring
May 1995



9513383.2219

9513383.2220

Distribution:

L. D. Arnold	WHC	B2-35
B. M. Barnes	WHC	T3-04
R. C. Bowman	WHC	H6-24
B. J. Broomfield	WHC	T3-04
S. E. Campbell	WHC	T4-05
R. M. Carosino	RL	A4-52
C. E. Clark	RL	A5-15
R. E. Cordts	Ecology	Lacey
A. K. Crowell	RL	S7-55
G. D. Cummins	WHC	H6-24
D. L. Duncan	EPA	HW-106
D. Dunning	ODOE	
N. P. Emerson	WHC	T4-03
M. S. French	RL	S7-55
R. J. Giroir	WHC	T4-05
R. F. Guercia	RL	S7-55
P. L. Hapke	WHC	T4-05
G. D. Hendricks	GSSC	B1-42
N. T. Hepner	Ecology	B5-18
M. N. Jaraysi	Ecology	B5-18
G. H. Landeen	WHC	H6-23
S. Leja	Ecology	B5-18
D. R. Lucas	WHC	G3-15
P. J. Mackey	WHC	B3-15
R. D. Pierce	WHC	T3-04
D. B. Powell	WHC	T4-03
D. A. Pratt	WHC	T4-03
S. M. Price	WHC	H6-23
L. T. St. Georges	WHC	H6-20
H. T. Tilden	PNL	P7-79

ADMINISTRATIVE RECORD: Low-Level Burial Grounds, D-2-9
[Care of EDMC, WHC (H6-08)]

Washington State Department of Ecology Nuclear and Mixed Waste Library, P.O. Box 47600, Olympia, Washington 98504-7600

Environmental Protection Agency Region 10, Seattle, Washington 98101, Mail Stop HW-074

Please send comments on distribution list to K. E. Knox, WHC (H6-23), (509) 372-3596

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

0041699

95-SWT-427

JUL 19 1995

Mr. Doug R. Sherwood
Hanford Project Manager
U.S. Environmental Protection Agency
Region 10
712 Swift Boulevard, Suite 5
Richland, Washington 99352

Mr. Michael A. Wilson, Program Manager
Nuclear and Mixed Waste Program
State of Washington
Department of Ecology
Post Office Box 47600
Olympia, Washington 98504-7600

Dear Messrs. Sherwood and Wilson:

REVISION TO THE RESPONSE ACTION PLAN FOR THE LOW-LEVEL BURIAL GROUNDS MIXED WASTE DISPOSAL TRENCHES

Attached for your review in accordance with the requirements of 40 Code of Federal Regulations 265.302, is the "Response Action Plan for the Low-Level Burial Grounds Mixed Waste Disposal Trench 31 and 34 (Project W-025 and Project W-025A)," Revision 2 (WHC-SD-W025-AP-001). This response action plan, has been revised to add Trench 34 and any future trenches that use the same design as Trench 31. No additional trenches are planned at this time. In addition, this response action plan has been revised to reflect the fact that both these landfills have been constructed. The response action plan is a site-specific document that establishes actions to be taken if leakage through the upper (primary) liner exceeds a certain rate, referred to as the action leakage rate.

Trench 31 and 34 are located in the northwestern portion of the 200 West Area in Burial Ground 218-W-5 of the Hanford Site. Trench 31 and 34 are a Resource Conservation and Recovery Act/Washington Administrative Code 173-303 Dangerous Waste Regulations compliant landfills. Trench 31 and 34 are nearly identical in design.

Revision 1 of the Response Action Plan was submitted to the U. S. Environmental Protection Agency and the State of Washington, Department of Ecology, on April 7, 1993, as required by Notice of Deficiency Number 160 for the "Low-Level Burial Grounds Dangerous Waste Permit Application," (DOE/RL-88-20, Revision 0).

JUL 1995
RECEIVED
EDMC

THIS PAGE INTENTIONALLY
LEFT BLANK

Should you have any questions regarding the revised response action plan, please contact A. K. Crowell, on (509) 372-2346 or Mr. R. D. Pierce of the Westinghouse Hanford Company, on (509) 372-0732.

Sincerely,

Thomas K. Teynor, Director
Waste Programs Division

Attachment

cc: R. Bowman, WHC w/attach
R. Cordts, Ecology w/attach
D. Duncan, EPA w/attach
W. Hamilton, Jr., WHC w/attach
N. Hepner, Ecology w/attach
M. Jaraysi, Ecology w/attach
D. Lundstrom, Ecology w/attach
R. Pierce, WHC w/attach
S. Price, WHC w/o attach
Administrative Records, H6-08 w/attach

THIS PAGE INTENTIONALLY
LEFT BLANK

RESPONSE ACTION PLAN
FOR THE HANFORD FACILITY
LOW-LEVEL BURIAL GROUNDS,
TRENCHES 31 AND 34 OF THE 218-W-5 BURIAL GROUND

APRIL 1995

THIS PAGE INTENTIONALLY
LEFT BLANK

SUMMARY

This response action plan is for Trench 31 and Trench 34 of the 218-W-5 Burial Ground, which are located in the 200 West Area of the Hanford Facility. Trenches 31 and 34 are Resource Conservation and Recovery Act/Washington Administrative Code 173-303 Dangerous Waste Regulations-compliant landfills. Trenches 31 and 34 are nearly identical in design.

A response action plan is required by the U.S. Environmental Protection Agency and, by extension, to the Washington State Department of Ecology for all hazardous/dangerous waste landfills. The response action plan is a site-specific document that establishes actions to be taken if leakage through the upper (primary) liner exceeds a certain rate, referred to as the action leakage rate.

The action leakage rate for Trenches 31 and 34 is 2,150 liters per hectare per day.

Revision 1 of the Response Action Plan was submitted to the U.S. Environmental Protection Agency and the Washington State Department of Ecology on April 7, 1993, as required by Notice of Deficiency Number 160 for the "Low-Level Burial Grounds Dangerous Waste Permit Application" (DOE/RL-88-20, Revision 0).

This revised response action plan, Revision 2, adds Trench 34 and any future trenches that use the same design as Trench 31. In addition, this response action plan has been revised to reflect that both these landfills (Trench 31 and Trench 34) have been constructed. If a new landfill design is used, a new response action plan will be developed to satisfy the requirements of 40 Code of Federal Regulations 264.302.

CONTENTS

SUMMARY iii

METRIC CONVERSION CHART v

1.0 INTRODUCTION 1

2.0 ACTION LEAKAGE RATE 2

3.0 RESPONSE ACTIONS 4

4.0 REFERENCES 6

APPENDIX

A ACTION LEAKAGE RATE CALCULATIONS . . . . . APP A-1

FIGURES

1. 200 West Area - Low-Level Burial Grounds (Trenches 31 and 34 are located in the 218-W-5 Burial Ground) F-1
2. Typical Trench Floor Plan F-2
3. Sideslope Liner Detail and Base Liner Detail F-3

METRIC CONVERSION CHART

The following conversion chart is provided to the reader as a tool to aid in conversion.

Into metric units			Out of metric units		
If you know	Multiply by	To get	If you know	Multiply by	To get
Length			**Length**		
inches	25.40	millimeters	millimeters	0.0393	inches
inches	2.54	centimeters	centimeters	0.393	inches
feet	0.3048	meters	meters	3.2808	feet
yards	0.914	meters	meters	1.09	yards
miles	1.609	kilometers	kilometers	0.62	miles
Area			**Area**		
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.092	square meters	square meters	10.7639	square feet
square yards	0.836	square meters	square meters	1.20	square yards
square miles	2.59	square kilometers	square kilometers	0.39	square miles
square miles	259	hectares	hectares	0.00391	square miles
acres	0.404	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	grams	grams	0.0352	ounces
pounds	0.453	kilograms	kilograms	2.2046	pounds
short ton	0.907	metric ton	metric ton	1.10	short ton
Volume			**Volume**		
fluid ounces	29.57	milliliters	milliliters	0.03	fluid ounces
quarts	0.95	liters	liters	1.057	quarts
gallons	3.79	liters	liters	0.26	gallons
cubic feet	0.03	cubic meters	cubic meters	35.3147	cubic feet
cubic yards	0.76	cubic meters	cubic meters	1.308	cubic yards
Temperature			**Temperature**		
Fahrenheit	subtract 32 then multiply by 5/9ths	Celsius	Celsius	multiply by 9/5ths, then add 32	Fahrenheit

Source: *Engineering Unit Conversions*, M. R. Lindeburg, PE., Second Ed., 1990, Professional Publications, Inc., Belmont, California.

This page intentionally left blank.

1.0 INTRODUCTION

This response action plan (RAP) has been prepared for the Low-Level Burial Grounds, Trenches 31 and 34 of the 218-W-5 Burial Ground, as well as any future trenches that use the same design. Trenches 31 and 34 are Resource Conservation and Recovery Act (RCRA)/Washington Administrative Code (WAC) 173-303 *Dangerous Waste Regulations* (WAC 173-303)-compliant landfills. The 218-W-5 Burial Ground is in the northwestern portion of the 200 West Area on the Hanford Facility (Figure 1).

Trenches 31 and 34 are rectangular landfills (Figure 2) with approximate base dimensions of 76.2 meters by 30.5 meters, with a surface grade footprint of 1.3 hectares. Trenches 31 and 34 are designed for approximately 21,000 cubic meters of mixed waste. The floor of both trenches slopes slightly, giving a variable depth of 9.1 to 12.2 meters. The floor slope is a minimum of 2 percent, draining to a recessed area at the eastern end that houses the sumps for leachate collection. The sideslope ratio is 3 horizontal:1 vertical. Access to the trench floor is provided by a ramp (8 percent slope).

Trenches 31 and 34 were constructed with a double liner and leachate collection and removal system. The bottom and sides of Trenches 31 and 34 are covered with a 0.9-meter operations layer of soil to protect the liner system during fill operations. Additional layers progressing toward the subgrade for Trenches 31 and 34 floor are as follows:

- A geotextile that acts as a filter between the operations layer and the primary drainage gravel
- A 0.3-meter layer of primary drainage gravel
- A geotextile that acts as a cushion between the drainage gravel and the primary and secondary geomembranes
- A geonet with high transmissivity, which functions as a redundant drainage system in conjunction with the drainage gravel on the floor
- The primary leachate barrier, a 60 mil high-density polyethylene (HDPE) liner
- 0.46-meter of compacted clay/soil admix
- A geotextile cushion
- 0.3-meter of drainage gravel
- A geotextile cushion, geonet, and a secondary 60 mil HDPE liner
- 0.94 meter of admix material (clay/soil) meeting permeability requirements.

On the trench sideslopes, the primary and secondary liner systems use geocomposite (two geotextiles thermally bonded to a geonet) drainage layers instead of the drainage gravel and geotextiles used on the floor. The liner system components are illustrated on Figure 3.

The primary leachate collection system is composed of 10.2-centimeter diameter perforated drainage pipes that lie along the centerline of the floor, at the base of the sideslopes, and down the 'upslope' side of the access ramp. The slope of the floor directs leachate to the center of the floor, which also slopes down toward the sump areas located at the east ends of Trenches 31 and 34. The secondary leachate collection system is installed above the secondary liner system. Pumps are provided in both the primary and secondary sump areas. Collected leachate is pumped to RCRA/WAC 173-303-compliant 37,854-liter storage tanks. Trenches 31 and 34 were designed with consideration for the 24-hour peak precipitation event (3.96 centimeters) in a 25-year period.

The planned operational life of Trenches 31 and 34 is 20 years. At the time of closure, a final cover will be constructed to minimize infiltration into these trenches.

The RAP is a site-specific plan that establishes actions to be taken if leakage through the upper (primary) liner of the landfill exceeds a certain rate. The intent of the RAP is to ensure that any leachate that does leak through the primary liner does not migrate out of the landfill into the environment. A key element of the RAP is the action leakage rate (ALR), a threshold value that triggers the responses described (Section 3.0), but below which no special actions are required. Because landfill liner systems have not been perfected, a small amount of leakage through the primary liner generally occurs despite the use of best available materials, construction techniques, and quality assurance procedures. (This leakage is collected by the secondary liner system and removed from the landfill.) Hence, the ALR is set at some level higher than normally expected leakage rates to serve as an indicator that the primary liner is not functioning as expected. Exceeding the ALR might reflect serious failure of the primary liner, and indicates the need for investigation and possibly corrective action while the problem is still manageable.

This RAP has been prepared in accordance with regulatory requirements (40 CFR 264.302) and is part of the supporting material for the *Hanford Facility Dangerous Waste Permit Application, Low-Level Burial Grounds*, as amended (DOE-RL 1989). The current regulations for determining the ALR and preparing a RAP are contained in 40 CFR 264.302.

2.0 ACTION LEAKAGE RATE

The ALR is defined (40 CFR 264.302) as:

"the maximum design flow rate that the leak detection system can remove without the fluid head on the bottom liner exceeding 1 foot." Also noted in 40 CFR 264.302 are the following.

- This leakage rate must account for an adequate margin of safety for uncertainties in design, construction, and operation of the leak detection system.

- The action leakage rate must not be greater than the flow capacity of the drainage layer.

- The action leakage rate should always be less than or equal to the pumping capacity of the leak detection sump.

Thus, the ALR is based on the flow capacity of the leak detection system rather than on types and sizes of flaws in the primary liner. The EPA provides a formula based on Darcy's Law for calculating this flow capacity, assuming that it originates from a single hole in the primary liner (EPA 1992):

$$Q = k\ h\ \tan(a)\ B \qquad (1)$$

where
- Q = flow rate in leak detection system
- k = hydraulic conductivity of drainage medium in leak detection system
- h = head on secondary liner
- a = slope of leak detection system
- B = width of flow in leak detection system, perpendicular to flow direction

The major uncertainty associated with this formula is determining the value of B, which is a complex function and in part dependent on the other parameters. Additional information and guidance is provided by the EPA (EPA 1992). By assuming that the shape of the wetted area down slope from the hole is parabolic, the EPA rewrites equation (1) to read:

$$Q = k\ D\ (2h - D) \qquad (2)$$

where D = thickness of drainage layer

other parameters are the same as in equation (1)

It can be seen that equation (2) does not depend on the slope of the drainage system. This results in part from simplifying assumptions by the EPA related to the cosine of small angles being nearly equal to 1. As a consequence of this simplification, equation (2) indicates that the flow capacity of the geonet drainage layer on the landfill sideslopes would be

equal to that of the geonet on the landfill floor, all other factors being equal. While intuitively unsatisfying, this approach appears to be conservative. In addition, the added capacity of the gravel drainage layer on the landfill floor can be ignored when finding the lowest flow capacity in the system (i.e., the sideslopes). Again, the EPA approach appears to be conservative.

With respect to selecting appropriate input parameter values for use in solving equation (2), the hydraulic conductivity of the geocomposite drainage layer is based on manufacturer's test results and includes the effects of compression from the load applied by the waste. The thickness of the geocomposite layer is the combined thickness of a geonet plus two layers of geotextile, all of which conform to specifications (WHC 1995). To account for compression, the thickness of the geotextile layers was reduced by 50 percent. The head on the secondary liner system is defined as 1 foot by the regulations.

Using equation (2) and the assumed input parameters, the ALR is 2,150 liters per hectare per day per trench (40 CFR 264.302). This value includes a factor of safety of 2 in accordance with EPA guidelines (EPA 1992). It is also much lower than the pump capacity of (45,000 liters per hectare per day per trench). Thus, this ALR value satisfies all the regulatory requirements noted previously. Details of the calculation (in English units) are presented in Appendix A.

In accordance with 40 CFR 264.302, the flow rate used to determine if the ALR has been exceeded is calculated as the average daily flow rate into the sump, expressed as liters per hectare. This calculation is performed weekly during the active (operational) life of the landfill, and monthly after the landfill has been closed. Postclosure frequency might be reduced if only minimal amounts of leachate accumulate in the leak detection system sump.

3.0 RESPONSE ACTIONS

The following actions are required if the ALR is exceeded (40 CFR 264.304):

- Notify the EPA Regional Administrator and Ecology in writing of the exceedence within 7 days of the determination

- Submit a preliminary written assessment to the EPA Regional Administrator and Ecology within 14 days of the determination, as to the amount of liquids, likely sources of liquids, possible location, size, and cause of any leaks, and short-term actions taken and planned

- Determine to the extent practicable the location, size, and cause of any leak

- Determine whether waste receipt should cease or be curtailed, whether any waste should be removed from the trench for inspection, repairs, or controls, and whether or not the trench should be closed

- Determine any other short-term and long-term actions to be taken to mitigate or stop any leaks

- Within 30 days after the notification that the ALR has been exceeded, submit to the EPA Regional Administrator and Ecology the results of the analyses, the results of actions taken, and actions planned. Monthly thereafter, as long as the flow rate in the leak detection system exceeds the ALR, the owner or operator must submit to the EPA Regional Administrator and Ecology a report summarizing the results of any remedial actions taken and actions planned.

If the ALR is exceeded, the U.S. Department of Energy, Richland Operations, will submit the required notifications to the EPA and Ecology as stated previously.

The leachate will be analyzed for chemical compounds and radionuclides. If the analytical results indicate that regulated constituents are present, and if the constituents can be traced to a particular type of waste placed in a known area of the trench, it might be possible to estimate the location of the leak. However, because the waste meets land disposal restrictions (e.g., stabilized, solidified, neutralized, etc.,) and contains no free liquids, it is possible that the leachate might be clean or the composition too general to indicate a specific source location.

If the source location cannot be identified, large-scale removal of the waste and operations layer to find and repair the leaking area of the liner would be one option for remediation. However, this procedure could risk damage to the liner. In addition, waste would have to be handled, stored, and replaced in the trench. Backfill would need to be removed from the waste to accomplish this. This could cause an increase in risk of accidental exposure to operations personnel or a release to the environment. For these reasons, large-scale removal of waste and liner system materials is not considered a desirable option and will not be implemented except as a last resort.

The preferred options for remediation include covers and changes in trench operating procedures. The preferred alternative depends on factors such as the amount of waste already in the trench, the rate of waste receipt, the chemistry of the leachate (i.e., is it clean?), the availability of other RCRA/WAC 173-303-compliant disposal units, and similar considerations. Hence, at this time no single approach can be selected. If the ALR is exceeded, potential options will be evaluated before selecting a remediation process. If necessary, an interim solution will be implemented while the evaluation and permanent remediation is performed. Examples of potential approaches include the following.

- The surface of the intermediate soil cover over the waste could be graded to direct run-off into a shallow pond. The surface would be covered with a discardable, temporary geomembrane (e.g.,

0.5-millimeter polyvinyl chloride). Precipitation water would be pumped or evaporated from the pond and would not infiltrate the waste already in the trench. Waste packages would be placed only during periods of dry weather, and stored temporarily at other times. This type of approach also would be used, if necessary, to reduce leakage during the time immediately after the ALR was exceeded, while other remediation options are evaluated.

- If the trench is nearly full, partial construction of the final closure cover might be an option. This would reduce infiltration into the trench, and possibly reduce the leakage rate if the cover is constructed over the failed area.

- A layer of low-permeability soil could be placed over the existing waste, perhaps in conjunction with a geomembrane, to create a second 'primary' liner higher in the trench. This new liner would intercept precipitation and allow its removal.

- A rigid-frame or air-supported structure could be constructed over the trench to ensure that no infiltration occurs. Although costly, this approach might be less expensive than constructing a new trench.

In general, the selected remediation efforts will be those that are easiest to implement, with more difficult or expensive options to be applied only if earlier approaches are not satisfactory.

4.0 REFERENCES

DOE-RL, 1989, *Low-Level Burial Grounds Dangerous Waste Permit Application*, DOE/RL-88-20, Rev. 0, plus Supplements 1 and 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1992, *Action Leakage Rates for Leak Detection Systems*, EPA 530-R-92-004, Office of Solid Waste, Washington, D.C., January.

WHC, 1995, *Construction Quality Assurance Report*, WHC-SD-W025-RPT-002, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

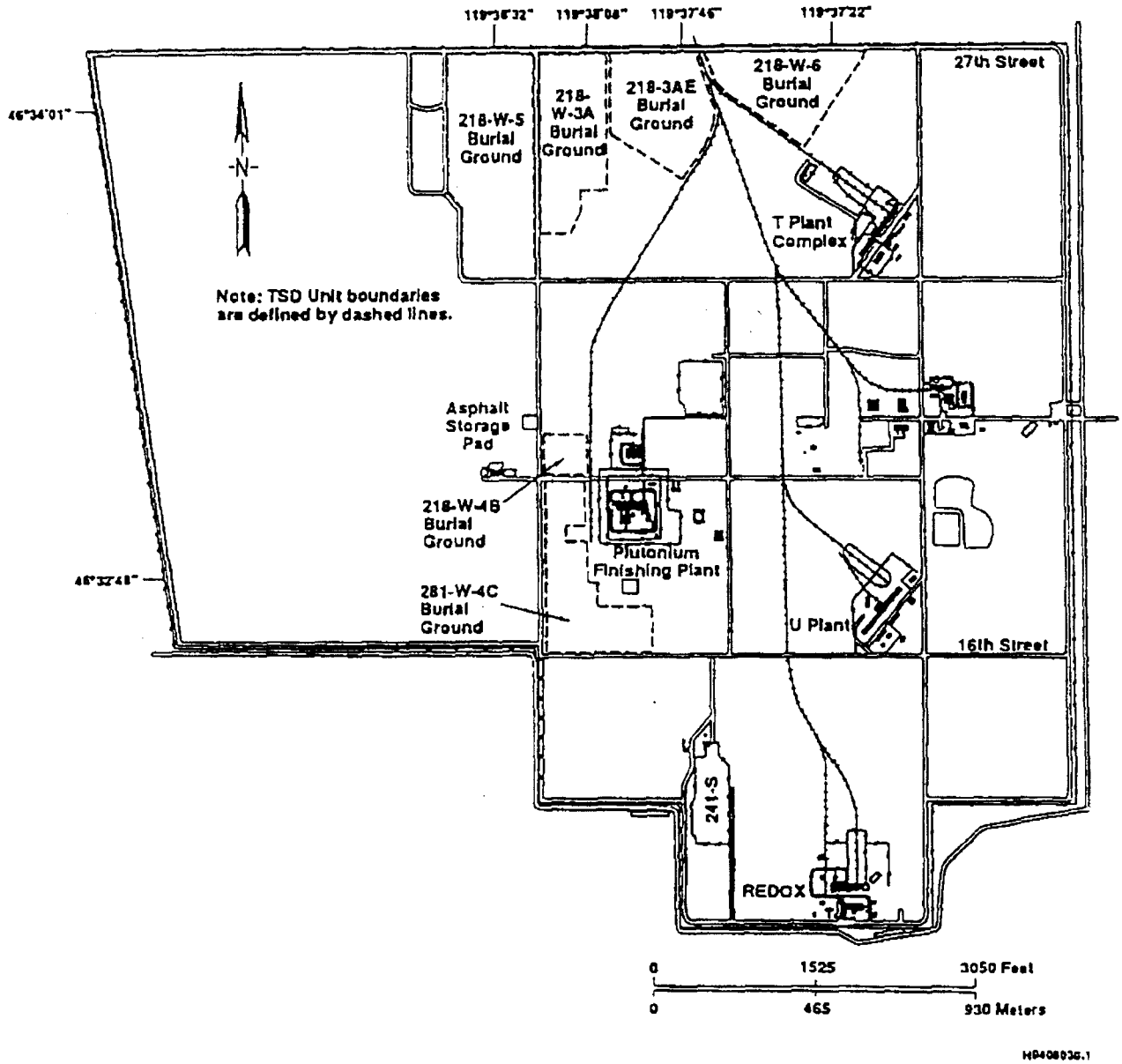
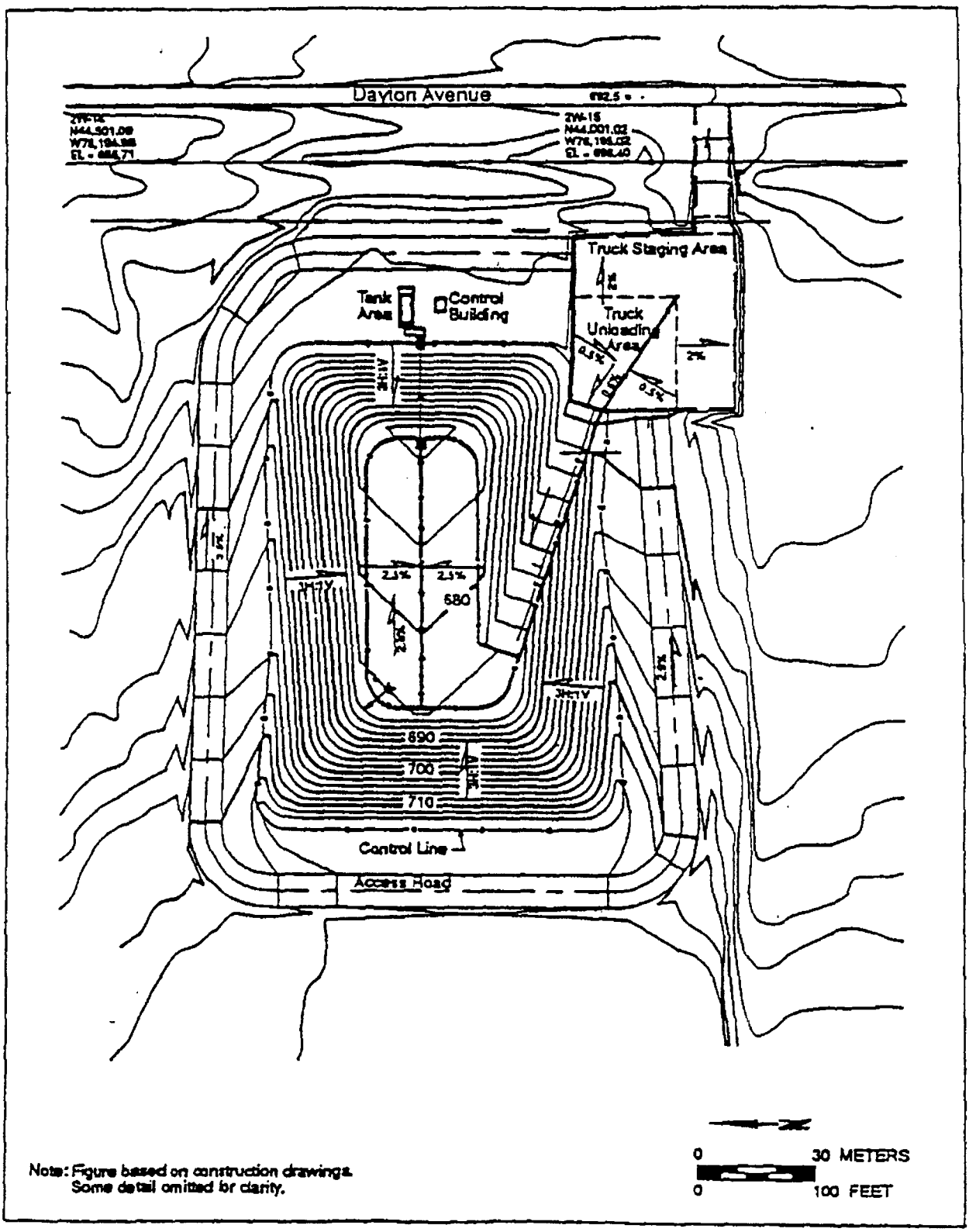


Figure 1. 200 West Area - Low-Level Burial Grounds (Trenches 31 and 34 are located in the 218-W-5 Burial Ground).

THIS PAGE INTENTIONALLY
LEFT BLANK



913-1756/43672/10-28-92

Figure 2. Typical Trench Floor Plan.

THIS PAGE INTENTIONALLY
LEFT BLANK

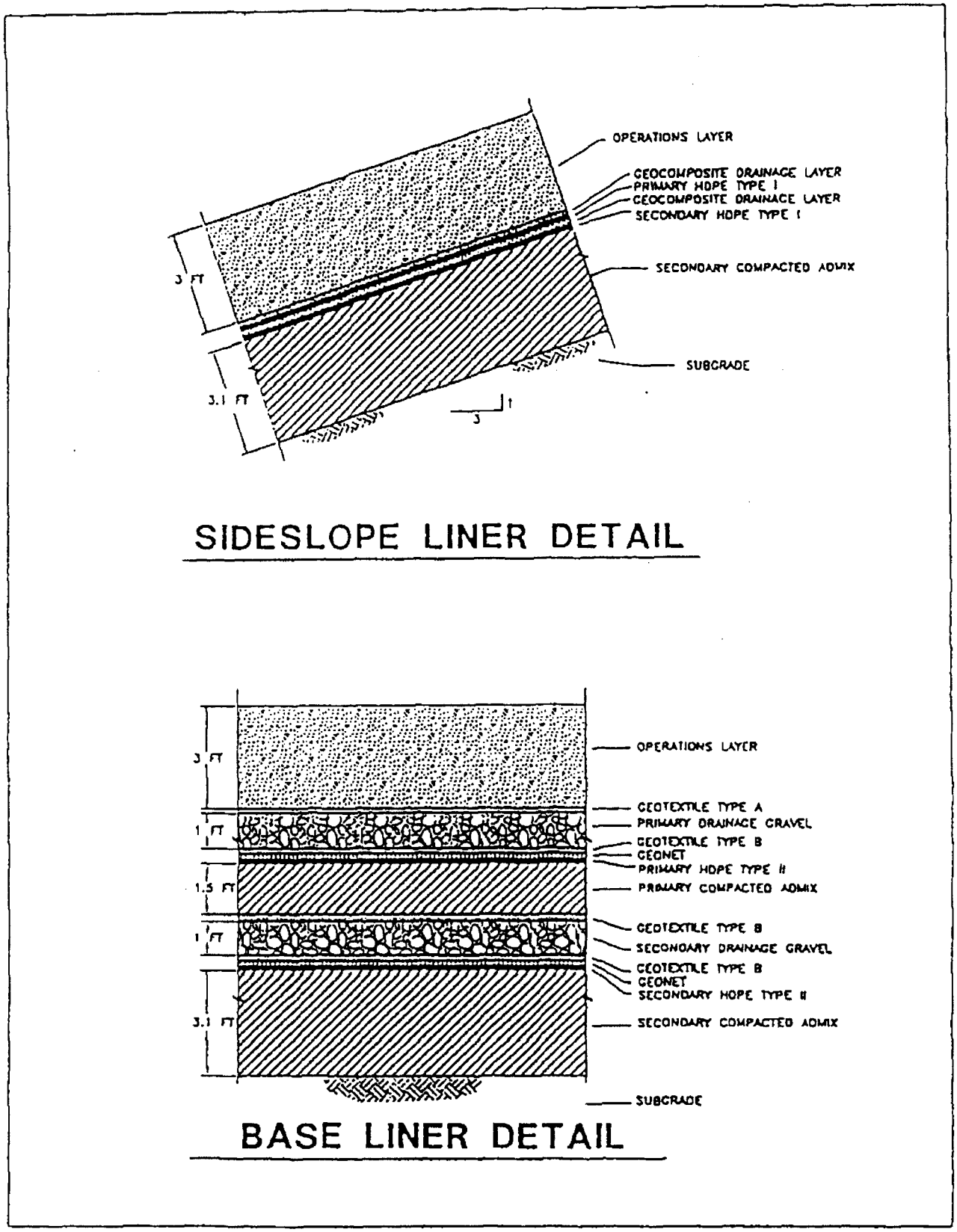


Figure 3. Sideslope Liner Detail and Base Liner Detail.

THIS PAGE INTENTIONALLY
LEFT BLANK

APPENDIX A

ACTION LEAKAGE RATE CALCULATIONS

TRADEMARKS

TEX-NET is a registered trademark of Fluid Systems, Inc.

POLY-NET is a registered trademark of Fluid Systems, Inc.

Trevira is a registered trademark of Hochst Aktiengesellschaft

Golder Associates

SUBJECT Action Leakage Rate - W025 Landfill		
Job No. 913-1756	Made by FSS	Date 8-13-92
Ref.	Checked JPP	Sheet 1 of 10
	Reviewed	

Reference: EPA, Action Leakage Rates for Leak Detection Systems, EPA 530-R-92-004, Office of Solid Waste, Washington, D.C., January 1992.

From EPA, page 12, flow capacity of drainage layers where $h > D$ is:

$$Q = kD(2h - D)$$

where Q = flow
k = permeability of drainage layer
D = thickness of drainage layer
h = head in drainage layer

note that $kD = T$, the transmissivity of the drainage layer

For W-025 landfill, assume that geocomposite is TEX-NET 3002 (this material was originally specified)

Also assume that the maximum normal load results from 40 feet of waste @ 100 lbs/ft^3

$= 4000$ psf

From transmissivity chart, Transmissivity of TEX-NET 1002 under 4000 psf load $\approx 2 \times 10^{-4}$ m^2/sec

From Polyfelt transmissivity chart, transmissivity of PN-3000 (used in TEX-NET 3002) is slightly less than that of PN-1000 (used in TEX-NET 1002).

$\therefore$ Assume transmissivity of TEX-NET 3002 $= 1 \times 10^{-4}$ m^2/sec
$= 10.76 \times 10^{-4}$ ft^2/sec

Thickness of geocomposite = 1 layer PN-3000 geonet + 2 layers Trevira 1125

From manufacturers' spec sheets
$D = 0.22 + 2 \times 0.095$ inches/2
$= 0.32$ inches $= 0.027$ ft

Golder Associates

SUBJECT Action Leakage Rate — W025 Landfill		
Job No. 913-1756 Ref.	Made by FSS Checked JFP Reviewed	Date 8-13-92 Sheet 2 of 10

By regulation, $h \sim 1$ ft

$\therefore Q = 10.76 \times 10^{-4}\ ft^2/sec\ (2 \times 1\ ft - 0.027\ ft)$

$= 21.23 \times 10^{-4}\ ft^3/sec$

$= 1376$ gal/day

Apply Factor of Safety = 2, per regulations

$Q = \frac{1376}{2} = 688$ gal/day

Area of W-025 = 3.0 acres (see attached sheet)

$\therefore Q = \frac{688}{3} = 229$ say $\boxed{230 \text{ gal/acre/day}}$

minimum technical requirements and other design assumptions to maximize potential head on the bottom liner, and uses a safety factor, EPA believes that the units meeting the minimum technical requirements would not require action leakage rates below 100 gpad for landfills and waste piles and 1,000 gpad for surface impoundments.

Assuming the wetted area in the drainage layer beneath a small hole leak has approximately the shape of a cone from side view and a parabola from top view, the width of the parabola (B) is:

$$B = \frac{2\sqrt{Q/k}}{\sin\alpha}\sqrt{1+\frac{2x\sin\alpha}{\sqrt{Q/k}}}$$

where x = plan distance downslope from hole (i.e., B is a function of the distance x from the hole; most of B is at the hole with only slight increases downslope).

Assuming x = 0 (i.e., looking at B under the hole, $B = \frac{2\sqrt{Q/k}}{\sin\alpha}$) and substituting this value for B into Equation 1 modified for a triangular cross-section of flow (i.e., $Q = 1/2\ k \cdot h \cdot \tan\alpha \cdot B$) and solving for Q yields:

$$Q = k \cdot h^2 \qquad \text{[Equation 2]}$$

where h = head on the bottom liner and h < thickness of drainage layer.

This equation becomes the following if the condition is changed from "h < thickness of the drainage layer (D)" to "h ≥ D" (which is important for geonet calculations):

$$Q = k \cdot D\ (2h - D) \qquad \text{[Equation 3].}$$

Solving Equation 3 using the minimum design specifications in the final rule, Q =

for .1 cm/sec: 2100 gpad
.01 cm/sec: 210 gpad
geonet: 6800 gpad.

These numbers are the same as the results given above for Equation 1.

Results Using a 3-D Model

Tables 1-4 and Figures 1-10 in Appendix B were developed from a 3-D model to show the relative effects of various design parameters and assumptions on flow capacity, and to show the shapes of the flow in the drainage layer for various designs and assumptions, including hole size and head. Appendix C gives background information on the 3-D model. The tables show that slope, length of run, and hole size have some effect on flow rate (e.g., 4% increase in flow rate when slope is increased from 1% to 2% [Tables 1, 3-5]; 1% increase in flow rate at 1% slope when

TEX-NET

Installation

No underground drainage system is easier to install than TEX-NET composite. It is a simple one-step operation. Because it is lightweight, flexible and strong, it can be rolled out in place on flat or steep slopes, around building foundations or along footings. The composite is supplied with a geotextile overlap of 2" on both edges or 5" on one edge so that continuity of drainage action can be assured from one strip of the composite to the next. TEX-NET sheets can be cut to size in the field to fit nearly any required area. It is also easily hung vertically on basement or retaining walls prior to backfilling.

By specifying TEX-NET on your next drainage project you will save considerable time and labor costs. And when compared to a sand and gravel system, extra savings can be expected through lower transportation and installation costs.

Hydraulic Properties

Transmissivity/flow charts for TEX-NET are available on supplemental data sheets. They are prepared for use by design engineers to help determine TEX-NET performance under varying conditions of pressure, hydraulic gradient and field profile. All transmissivity tests were performed in accordance with ASTM D4716 where a drainage layer is characterized by its transmissivity or $\Theta = (Q/B)/i$

TEX-NET can also be specified with non-woven polypropelene fabrics and woven monofilaments heat laminated to any style of POLY-NET. Call FSI for further details.

To determine Q (flow per unit width of TEX-NET) in actual conditions, simply multiply Θ (transmissivity m^2/sec) by i (hydraulic gradient).

Example: TEX-NET 1001 under 4000 p.s.f. and gradient of 0.75 has a transmissivity of $1.0 \times 10^{-3} m^2$/sec.

$Q = 1.0 \times 10^{-3} m^2/sec\ (0.75)$

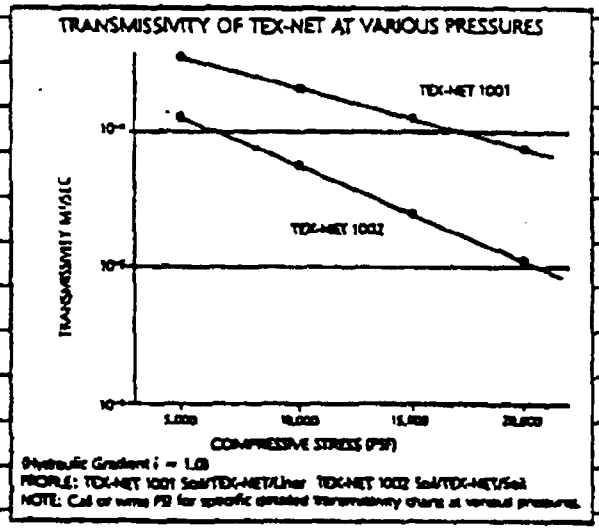
$= 7.5 \times 10^{-4} m^2/sec$

$= 3.6$ GPM/FT of WIDTH

The information contained herein is, to the best of our knowledge, true and accurate; however, all recommendations or suggestions are made without guarantee, since the conditions of use are beyond our control. There is no expressed warranty and no implied warranty of fitness for purpose of the product or products described herein. In submitting this information, no liability is assumed or license or other rights implied or given with respect to any existing or pending patent, patent applications or trademarks. The observance of all legal regulations and patents is the responsibility of the user.

Specifications

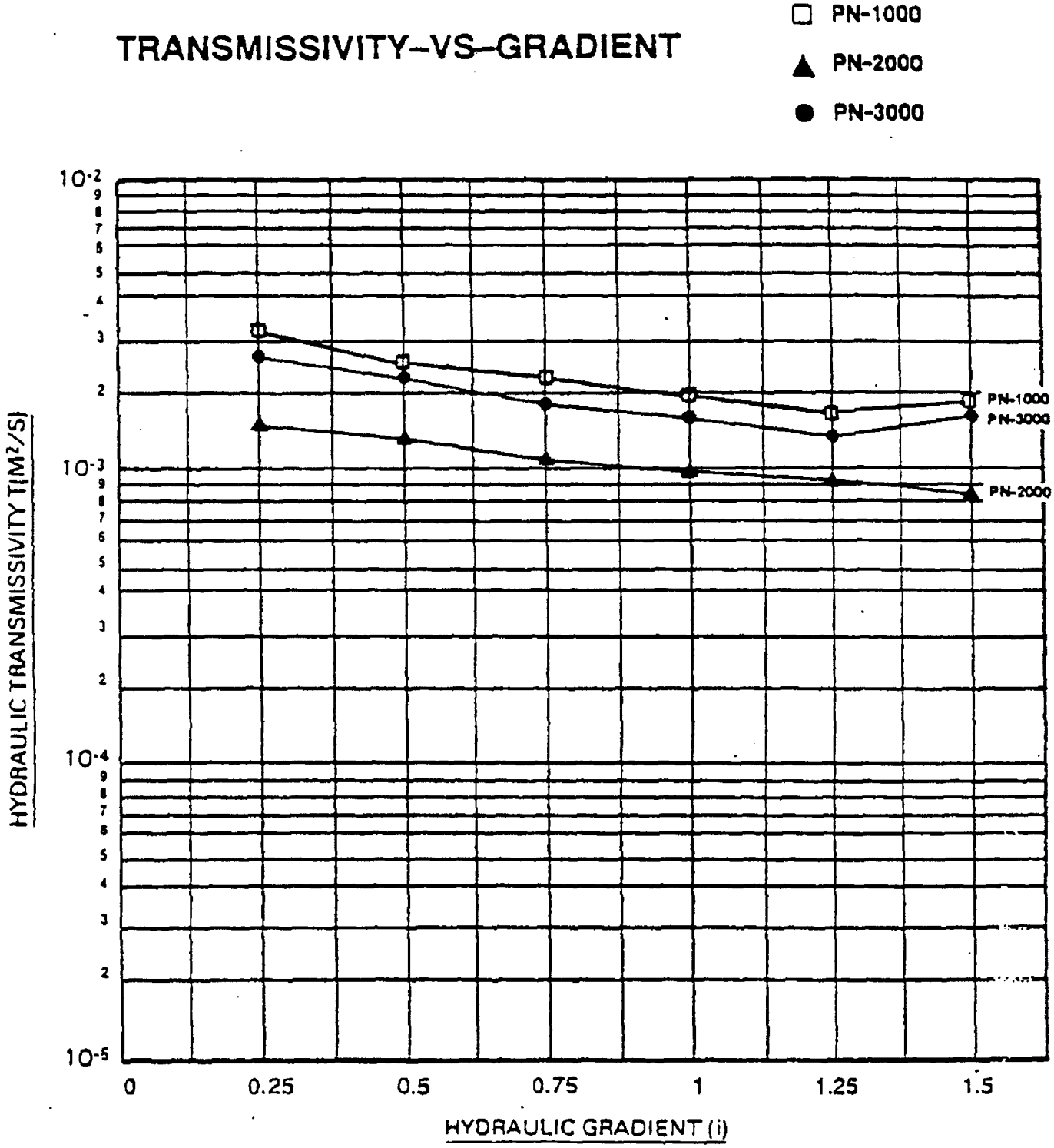
Refer to supplemental data sheets and performance curves.



FSI
FLUID SYSTEMS, INC.
32 Triangle Park Drive
Suite 3201
Cincinnati, OH 45246
(513) 771-5656-(800) 346-9107
FAX: (513) 771-4844
Offices in Denver and Atlanta

POLY-NET® TRANSMISSIVITY	INSTALLATION METHOD LEAK DETECTION HDPE LINER/POLY-NET/HDPE LINER	HYDRAULIC PRESSURE 4000 P.S.F.

TRANSMISSIVITY–VS–GRADIENT



FSI FLUID SYSTEMS, INC.
32 TRIANGLE PARK DRIVE
SUITE 3201
CINCINNATI, OH 45246
513/771-5656
800/346-6107
FAX - 513/771-4844

Installation

Poly-Net is easily installed by hand. On steep slopes, nets should be anchored at the top, then unrolled. On vertical walls, anchoring the net with masonry nails may be necessary.

Adjacent rolls can be easily joined by plastic ties supplied with the Poly-Net. When joining adjacent rolls in the direction of the flow, butt the rolls together, or overlap 2-4". When joints are not in the direction of flow, overlap adjacent rolls in shingle fashion. On the bottom of landfills or ponds, a 2-4" overlap is recommended to maintain flow.

Geotextiles should always be used to prevent migration of soil particles into the net, except when Poly-Net is between two geomembranes, in which case a geotextile is not necessary. Poly-Net is U.V. stabilized and can be stored outside for short periods, but care should be taken to keep them clean of mud and debris. If Poly-Net becomes dirty, simply wash out debris with a high pressure hose.

FSI
FLUID SYSTEMS, INC.
32 Triangle Park Drive • Suite 3201
Cincinnati, Ohio 45246 • FAX: 513/771-4844
513/771-5656 • 800/346-9107
Offices in Denver and Atlanta

Hydraulic Properties

Transmissivity charts for Poly-Net under various profiles, gradients, and pressures are available in the FSI transmissivity brochure.

Specifications

Refer to specifications below and FSI "suggested specification guide" brochure.

The information contained herein is, to the best of our knowledge, true and accurate; however, all recommendations or suggestions are made without guarantee, since the conditions of use are beyond our control. There is no expressed warranty and no implied warranty of fitness for purpose of the product or products described herein. In submitting this information, no liability is assumed or license or other rights implied or given with respect to any existing or pending patent, patent applications or trademarks. The observance of all legal regulations and patents is the responsibility of the user.

SPECIFICATION

Details

	PN-1000*	PN-2000	PN-3000	PN-3000-CN*	PN-4000*
Raw material	polyethylene	polyethylene	polyethylene	polyethylene	polyethylene
Weight (lbs/ft²) D-3776	.165 ± 0.016	.130 ± 0.013	.180 ± 0.018	.115 ± 0.011	.245 ± 0.024
Thickness (inches) D-1777	.250 ± 0.025	.160 ± 0.016	.220 ± 0.022	.220 ± 0.022	.300 ± 0.030
Density of polymer (g/cm³) D-1505	.937 ± 0.002	.937 ± 0.002	.937 ± 0.002	.937 ± 0.002	.937 ± 0.002
Tensile strength (lb/in) D-1682	40 ± 10	38 ± 10	50 ± 10	28 ± 10	54 ± 10
Porosity	.81-.84	.81-.84	.81-.84	.81-.84	.81-.84
Roll width (feet)	7.54	7.54	7.54	7.54	7.00
Standard roll length (feet)	250	300	300	300	220
Square feet per roll	1885	2262	2262	2262	1540
Carbon black ASTM D-1603	2-3%	2-3%	2-3%	2-3%	2-3%
Nominal Transmissivity (m²/s) D-4716	See Transmissivity Charts				

*Foamed

FSI-PN89 7.5M

Trevira® Spunbond nonwoven engineering p are highly needled fabrics with excellent tensile high filtration potential and outstanding perm

Trevira® Spunbond Type 11 products are 100% continuous filament polyester nonwoven needlepunched engineering fabrics. They deliver a combination of advantages unmatched by any other spunbonded geotextiles. They're resistant to freeze-thaw, soil chemicals and ultraviolet light exposure.

Trevira® Spunbond nonwoven engineering fabrics offer excellent performance where the requirement is tensile reinforcement, planar flow, filtration, or separation. They are ideal for roadways, railbeds, drainage systems, pondliners, retaining walls. And much more.

The information contained herein is offered free of charge, and is, to our best knowledge, true and accurate; however, all recommendations or suggestions are made without guarantee, since the conditions of use are beyond our control. There is no expressed warranty and no implied warranty of merchantability or of fitness for purpose of the product or products described herein. In submitting this information, no liability is assumed or license or other rights implied given with respect to any existing or pending patent, patent applications or trademarks. The observance of all legal regulations and patents is the responsibility of the user.

TYPICAL PHYSICAL PROPERTIES OF TREVIRA® TYP

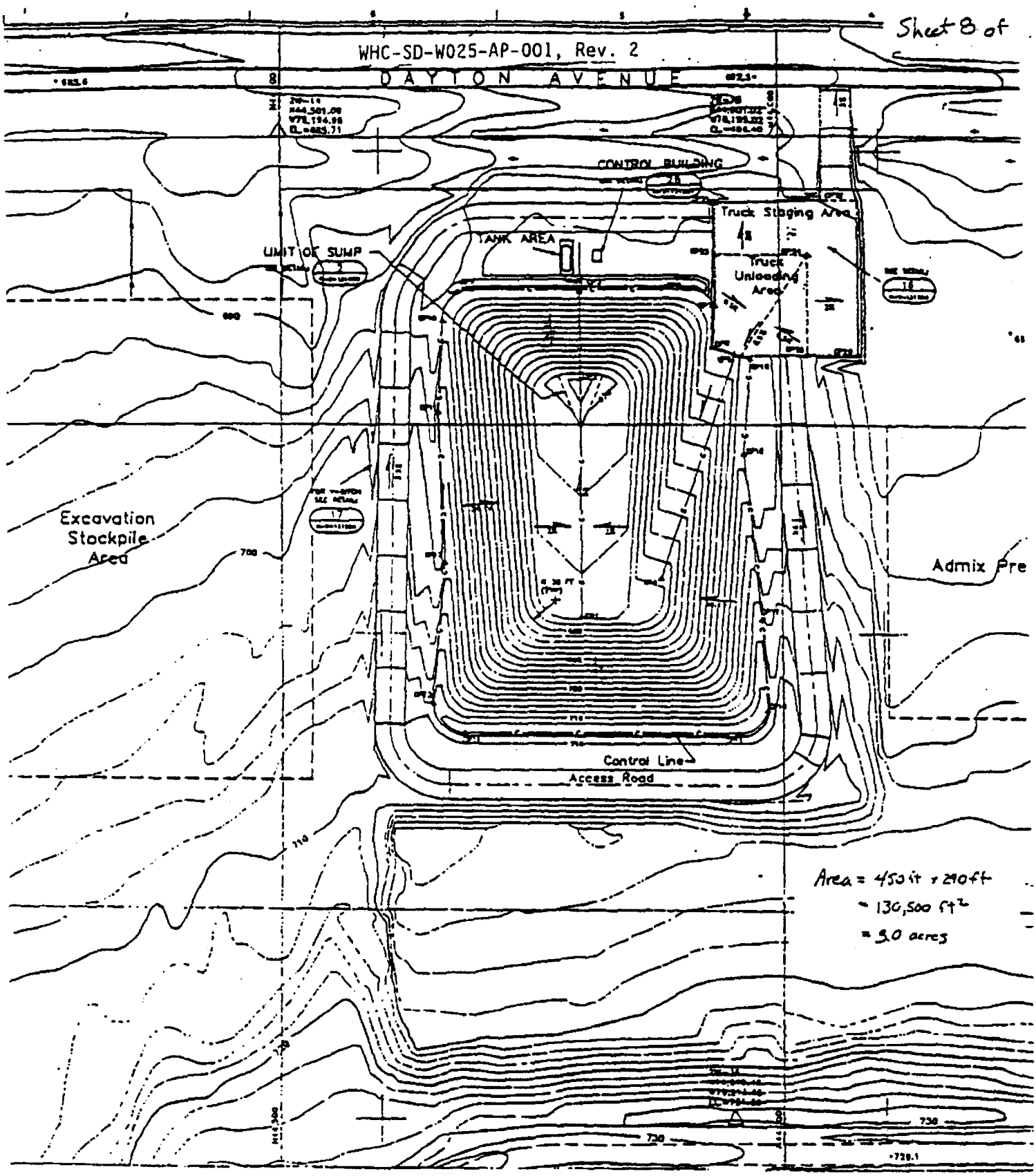
Fabric Property	Unit	Test Method	1112	1114	1120
Fabric Weight	oz/yd²	ASTM D-3776	3.5	4.2	6.0
Thickness, t	mils	ASTM D-1777	60	70	90
Grab Strength (MD/CD)[1]	lbs	ASTM D-4632	120/95	150/115	230/180
Grab Elongation (MD/CD)[1]	%	ASTM D-4632	65/75	75/85	75/85
Trapezoid Tear Strength (MD/CD)[1]	lbs	ASTM D-4533	50/40	55/50	80/75
Puncture Resistance	lbs	ASTM D-4833	55	65	95
Mullen Burst Strength	psi	ASTM D-3786	195	225	320
Water Flow Rate	gpm/ft²	ASTM D-4491	195	190	170
Permittivity, Ψ	sec⁻¹	ASTM D-4491	2.61	2.54	2.27
Permeability, k = Ψt	cm/sec	ASTM D-4491	.40	.45	.52
AOS	Sieve Size mm	ASTM D-4751	70-100 .210-.149	70-100 .210-.149	70-100 .210-.14
Standard Roll Widths[2]	ft				
Standard Roll Length[2]	ft		400	400	300

[1]MD = Machine Direction, CD = Cross Machine Direction. [2]Other width and length rolls a

MINIMUM[1] PHYSICAL PROPERTIES OF TREVIRA® TYP

Fabric Property	Unit	Test Method	1112	1114	1120
Fabric Weight	oz/yd²	ASTM D-3776	3.3	4.0	5.7
Thickness, t	mils	ASTM D-1777	50	55	75
Grab Strength	lbs	ASTM D-4632	80	100	160
Grab Elongation	%	ASTM D-4632	60	60	60
Trapezoid Tear Strength	lbs	ASTM D-4533	30	40	60
Puncture Resistance	lbs	ASTM D-4833	40	50	80
Mullen Burst Strength	psi	ASTM D-3786	170	190	275
Water Flow Rate	gpm/ft²	ASTM D-4491	155	150	130
Permittivity, Ψ	sec⁻¹	ASTM D-4491	2.07	2.01	1.74
Permeability, k = Ψt	cm/sec	ASTM D-4491	.26	.28	.33
AOS	Sieve Size mm	ASTM D-4751	50 .300	50 .300	70 .210

[1]These minimum values represent minimum test values determined from Q.C. testing on all lots produced in 19 ing the industry standard of a 95 percent confidence level (i.e. mean less two standard deviations) may be high production lot. Please contact your Trevira® Distributor or Hoechst Celanese Corporation for additional informati


DAYTON AVENUE
CONTROL BUILDING
TANK AREA
LIMIT OF SUMP
Truck Staging Area
Truck Unloading Area
Excavation Stockpile Area
Admix Pre
Control Line
Access Road
Area = 450 ft x 290 ft
= 130,500 ft²
= 3.0 acres
N
FEET

Golder Associates

SUBJECT Action Leakage Rate - W025 Landfill		
Job No. 913-1756 Ref.	Made by FSS Checked JPP Reviewed	Date 8-13-92 Sheet 9 of 10

Pump Capacity: from Specifications, pump is Gandfos 7503-B

from attached curve, capacity is at least 10 gpm (head ≈ 40 ft)

10 gal/min × 60 min/hr × 24 hr/day = 14,400 gal/day

required: ALR = 230 gal/acre-day × 3.0 acres = 690 gal/day

∴ Pump has more than enough capacity to remove ALR volume.

MODEL
7S

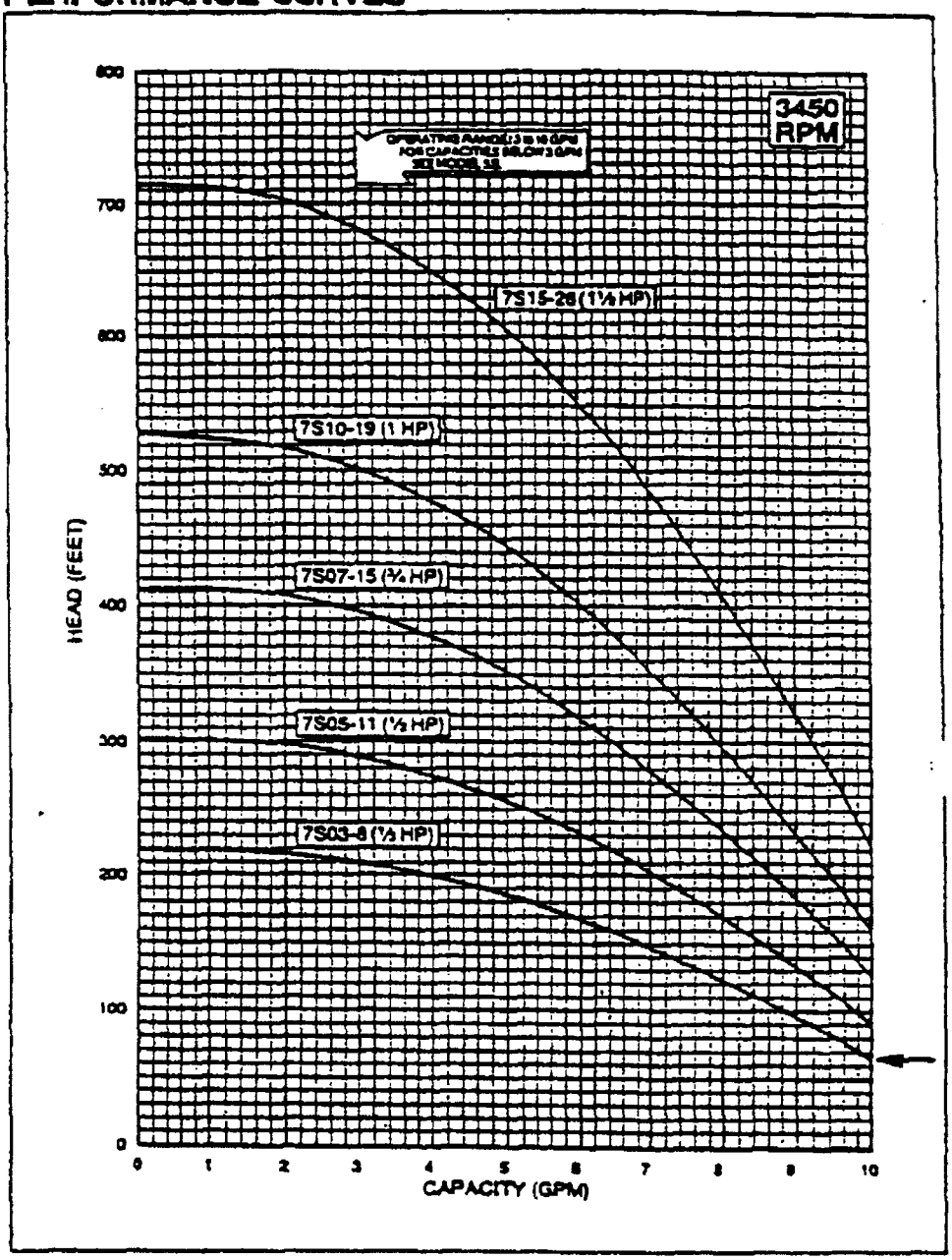
7 GPM

GRUNDFOS

FLOW RANGE
3 to 10 GPM

PUMP OUTLET
1" NPT

PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
7S03-8	⅓	23½	3 15/16	27
7S05-11	½	26⅞	3 15/16	30
7S07-15	¾	30¾	3 15/16	33
7S10-19	1	34⅝	3 15/16	36
7S15-26	1½	42	3 15/16	46

Specifications are subject to change without notice.

7/20/95

Distribution:

L. D. Arnold	WHC	B2-35
B. M. Barnes	WHC	T3-04
R. C. Bowman	WHC	H6-24
B. J. Broomfield	WHC	T3-04
S. E. Campbell	WHC	T4-05
R. M. Carosino	RL	A4-52
C. E. Clark	RL	A5-15
R. E. Cordts	Ecology	Lacey
A. K. Crowell	RL	S7-55
G. D. Cummins	WHC	H6-24
D. L. Duncan	EPA	HW-106
D. Dunning	ODOE	
N. P. Emerson	WHC	T4-03
M. S. French	RL	S7-55
R. J. Giroir	WHC	T4-05
R. F. Guercia	RL	S7-55
P. L. Hapke	WHC	T4-05
G. D. Hendricks	GSSC	B1-42
N. T. Hepner	Ecology	B5-18
M. N. Jaraysi	Ecology	B5-18
S. Leja	Ecology	B5-18
D. R. Lucas	WHC	G3-15
P. J. Mackey	WHC	B3-15
R. D. Pierce	WHC	T3-04
D. B. Powell	WHC	T4-03
D. A. Pratt	WHC	T4-03
S. M. Price	WHC	H6-23
L. T. St. Georges	WHC	H6-20
H. T. Tilden	PNL	P7-79
RCRA Files	WHC	H6-23

ADMINISTRATIVE RECORD: Low-Level Burial Grounds, D-2-9
[Care of EDMC, WHC (H6-08)]

Washington State Department of Ecology Nuclear and Mixed Waste Library, P.O. Box 47600, Olympia, Washington 98504-7600

Environmental Protection Agency Region 10, Seattle, Washington 98101, Mail Stop HW-074

Please send comments on distribution list to G. D. Cummins, WHC (H6-24), (509) 372-2484

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

July 20, 1995
11:00 a.m. - 12:00 p.m.

The undersigned indicate by their signatures that these meeting minutes reflect the actual occurrences of the above dated Unit Managers' Meeting.

Date: 10/6/95
Clifford E. Clark, Unit Manager, RL

Date: 10/16/95
Daniel L. Duncan, RCRA Program Manager, EPA Region 10

Date: 10/4/95
Norman T. Hepner, Unit Manager, Washington State Department of Ecology

---

Low-Level Burial Grounds, WHC Concurrence

Brett M. Barnes Date: Oct 4, 1995
Richard D. Pierce, Contractor Representative, WHC
(Represented by Brett M. Barnes, WHC)

Purpose: Discuss Permitting Process

Meeting Minutes are attached. The minutes are comprised of the following:
Attachment 1 - Agenda
Attachment 2 - Summary of Discussion and Commitments/Agreements
Attachment 3 - Attendance List
Attachment 4 - Action Items
Attachment 5 - Hanford Facility Permit Low-Level Burial Grounds (LLBG) Proposed Unit Inclusion Schedule for Mod C
Attachment 6 - Presentation on the Disposal of Bulk Waste in the Low-Level Burial Grounds for the Washington State Department of Health
Attachment 7 - Status of Pump and Treat

Attachment 1

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting (Videoconference)
Federal Building, Room 784B/2704HV Room E213
Richland, Washington
Lacey, Washington

Thursday, July 20, 1995
11:00 a.m. - 12:00 p.m.

AGENDA

1. **PREVIOUS MEETING MINUTES**
   - April 27, 1995 and May 24, 1995 Meeting Minutes
2. **PROGRAM STATUS**
   - Status of Mixed Waste Trench Readiness
3. **PERMIT APPLICATION STATUS**
4. **RCRA TOPICS**
   - Discussion of 4-9-93 NOD Response Table
5. **GENERAL TOPICS**
   - Status of Pump and Treat (R. Mercer)
   - Past Action Items
     - 10-27-93:1 Pump and Treat Status
   - New Action Items
6. **SCHEDULE NEXT MEETING**
   - Tentative Date
   - Proposed Topics

Attachment 2

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

July 20, 1995
11:00 a.m. - 12:00 p.m.

Summary of Discussion and Commitments/Agreements

1. PREVIOUS MEETING MINUTES

Mr. D. Duncan (EPA) conferred signature approval to Mr. R. Bowman (WHC) via the videoconference for the May 24, 1995 Unit Manager Meeting minutes. Mr. Duncan was not present during the April 27, 1995 Unit Manager Meeting. Mr. R. Cordts (Ecology) was not present at today's meeting, and his approval of the April 27, 1995 Unit Manager Meeting minutes will be obtained at a later time. Mr. N. Hepner (Ecology) approved the May 24, 1995 Unit Manager Meeting minutes.

2. PROGRAM STATUS

- **Status of Mixed Waste Trench Readiness**

Ms. A. Crowell (RL) stated that the Response Action Plan for Trench 31 and 34 was transmitted to the regulators on July 19, 1995.

The safety evaluation report (SER) has not been finalized, and it is the remaining item to be completed before start-up of Trench 31. The concrete load-out pad for Trench 34 has been poured, and the epoxy coating will be poured within two weeks.

Mr. Hepner stated his understanding was that budgeting was not available to operate the trenches in 1996. Ms. Crowell responded that the trenches are budgeted for fiscal year 1996. Ms. Crowell explained that there is a question whether money will be available in 1997 for the leachate, and therefore operating in 1996 would not be practical.

Ms. Crowell inquired about the schedule for the Notice of Deficiency (NOD) workshops. Ms. G. Cummins (WHC) provided Mr. Hepner a proposed unit inclusion schedule for Mod C (Attachment 5), which was prepared approximately three months ago. The proposed schedule includes a NOD workshop period from 10-15-95 to 8-8-96. Mr. Hepner accepted the schedule, and suggested that the parties initiate the NOD workshops as soon as possible.

3. PERMIT APPLICATION STATUS

Ms. Cummins stated that the Notice of Intent (NOI) is in the 150-day public review. RL/WHC have received comments from Ecology, and WHC is incorporating the comments into the Part A permit application. The revised Part A will be submitted to Ecology for review following the 150-day public review.

Mr. Hepner inquired about the revised number for trench capacity. Mr. C. Clark (RL) responded that the new number is 1,414 hectare meters. Ms. Cummins stated that the revised Part A will reflect the new numbers, following agreement among RL/WHC and Ecology. Ms. Cummins noted that the capacity available for mixed waste in the burial grounds is provided in the process design capacity and is not based on forecast. Mr. Hepner stated his preference for the forecast approach to determine trench process design capacity. Ms. Cummins reiterated RL/WHC's preference to avoid the cost of revising the Part A yearly because of the changes in waste receipt. A meeting was scheduled with RL/WHC and Ecology on July 25, 1995, to discuss the process design capacity for the Low-Level Burial Grounds and how the new numbers were calculated.

Mr. Hepner asked if RL is preparing a State of Washington Environmental Policy Act (SEPA) checklist. Mr. Clark pointed out that the revised trench process design capacity number is not an expansion of lateral boundaries in the Low-Level Burial Grounds. Mr. Hepner stated that his SEPA point of contact had indicated the revised trench process design capacity was significant enough to possibly require a new SEPA checklist.

Ms. Cummins distributed a handout (Attachment 6) pertaining to the disposal of bulk waste disposal at the mixed waste trenches. This handout is a copy of the presentation given to Mr. A. Conklin (Department of Health) in May 1995.

4. RCRA TOPICS

- **Discussion of 4-9-93 NOD Response Table**

Ms. Cummins stated that RL/WHC received a letter from Ecology addressing the remaining NODs. RL/WHC will provide a response to Ecology in the near future.

5. GENERAL TOPICS

- **Status of Pump and Treat**

Mr. R. Mercer (WHC) provided an update on the pump and treat operation (Attachment 7). Bechtel Hanford, Inc. (BHI) is continuing with the pump and treat pilot project, and WHC has not observed any effects in the burial ground wells. Mr. Mercer reported that BHI is not getting the anticipated production from the two extraction wells. BHI plans to redevelop the extraction wells in an effort to raise production; and if redevelopment of

the wells does not raise production, BHI may drill more wells. Construction of a pipeline is scheduled to begin in October 1995, and the official start-up is scheduled for March 1996. BHI plans to drill four extraction wells, two injection wells, and two monitoring wells in 1996. If the 1996 well drilling is successful, BHI plans to drill the same amount of new wells in 1997.

- **Past Action Items**

  Action item 10-27-93:1, schedule a technical issues meeting for RCRA/CERCLA integration and discussion of pump and treat evaluations.

  WHC is continuing to provide pump and treat information to Ecology. This action item was left open.

- **New Action Items**

  There were no new action items generated during the meeting.

6. **SCHEDULE NEXT MEETING**

- **Tentative Date**

  The next Unit Managers Meeting was scheduled for videoconference on September 6, 1995.

- **Proposed Topics**

  There were no new proposed topics for discussion.

Attachment 3

Unit Managers Meeting
for
Low-Level Burial Grounds

Date: July 20, 1995

Attendance List

Name	Organization	Phone #
Kathy Knox	WHC	372-3596
Dan Duncan	EPA	(206) 553-6693
Rich Mercer	WHC	376-8945
Norm Hepner	Ecology	736-3048
Tony McKarns	DOE	376-8981
Gloria Cummins	WHC	372-2484
Gerry Hendricks	GSSC	946-3687
Roger Bowman	WHC	376-4876
Sarah Campbell	WHC	372-0667
Alison Crowell	RL	372-2346
Brett Barnes	WHC	376-3640
Cliff Clark	RL	376-9333

Attachment 4

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

July 20, 1995
11:00 a.m. - 12:00 p.m.

Action Items

Action Item	Description
10-27-93:1	Schedule a technical issues meeting for RCRA/CERCLA integration and discussion of pump and treat evaluations. **OPEN**
10-18-94:1	RL will provide Ecology (Mr. R. Cordts) a preview of the engineering change notices (ECNs) on Trench 31 and 34. ACTION: A. Crowell (RL) **CLOSED**

Attachment 5

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

July 20, 1995
11:00 a.m. - 12:00 p.m.

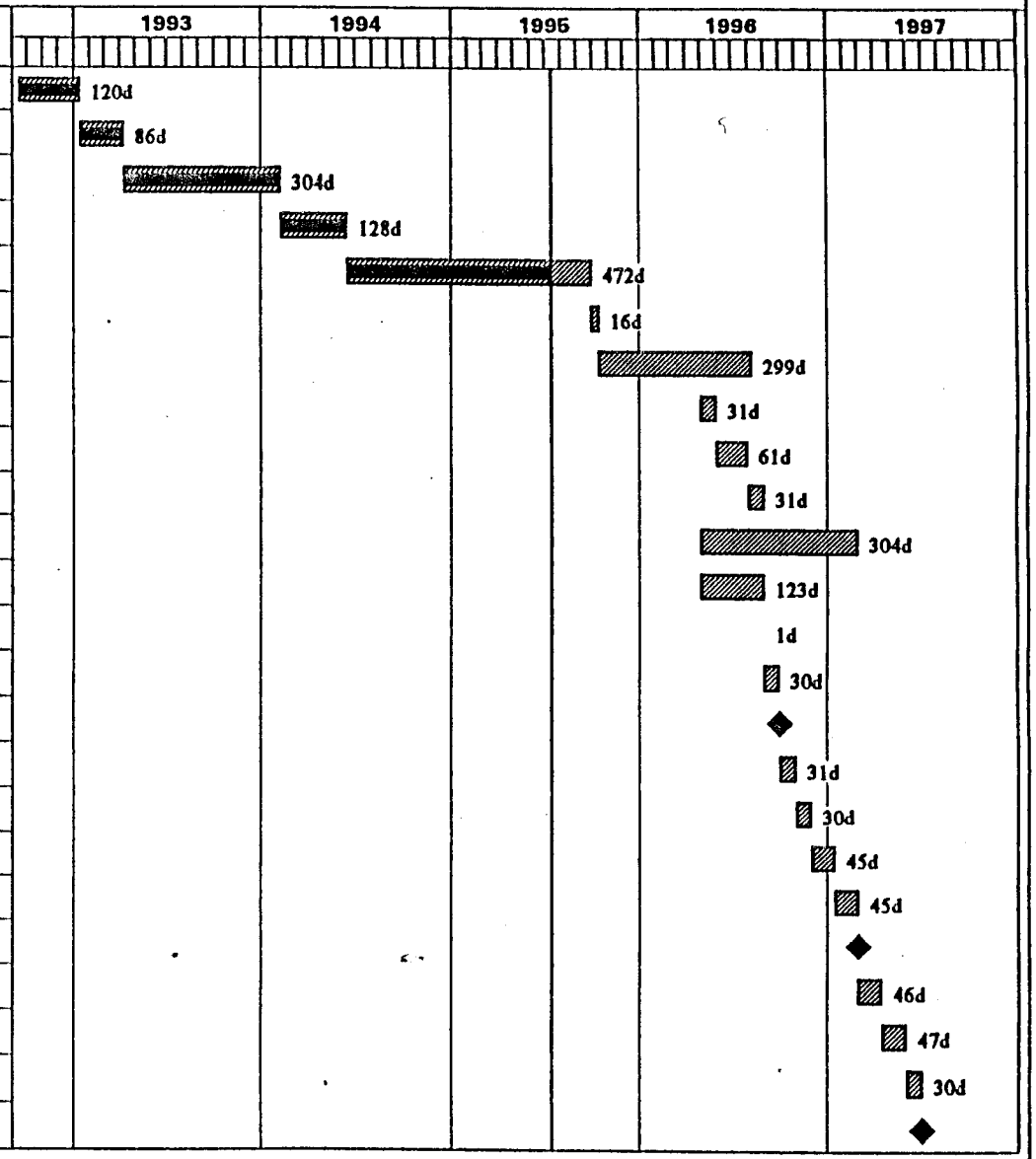
HANFORD FACILITY PERMIT
LOW-LEVEL BURIAL GROUNDS (LLBG)
PROPOSED UNIT INCLUSION SCHEDULE FOR MOD C

Hanford Facility Permit

Low-Level Burial Grounds (LLBG)

Proposed Unit Inclusion Schedule for Mod C

Name	Start	Finish	Duration
Ecology Review of NOD	9/16/92	1/13/93	120d
DOE-RL Response (4th NOD Response Table)	1/14/93	4/9/93	86d
Ecology Review (Review 4th NOD Response Table)	4/10/93	2/7/94	304d
UMM to resolve issues (Incorporate NOD Comments)	2/8/94	6/15/94	128d
WHC/DOE-RL Revise Document (Rev. 1 Working Draft)	6/16/94	9/30/95	472d
DOE-RL Approval (Submit Working Draft)	9/30/95	10/15/95	16d
Ecology Review (Review Rev. 1 Working Draft) & Workshop Meeting	10/15/95	8/8/96	299d
Revise Working Draft	5/1/96	5/31/96	31d
Stakeholder Review	6/1/96	7/31/96	61d
Incorporate Stakeholder Comments/Prepare for Approval	8/1/96	8/31/96	31d
Draft Permit Modification Preparation	5/1/96	2/28/97	304d
Prepare Modification package (revise/assemble per workshop)	5/1/96	8/31/96	123d
Submit to RL for Approval	9/1/96	9/1/96	1d
Pre-certification WHC/RL Concurrent Review of Mod Pkg.	9/1/96	9/30/96	30d
Submit Advance Copy to Ecology	10/1/96	10/1/96	◆
Advance Ecology Review of Mod Pkg. - issue completeness letter	10/2/96	11/1/96	31d
Compile Comments	11/2/96	12/1/96	30d
Prepare Mod. pkg. for Public Review (duplication, notices, etc.)	12/2/96	1/15/97	45d
Certification Process (WHC - 2 wks, RL - 4 wks)	1/16/97	3/1/97	45d
Submit Modification Package to Ecology	3/1/97	3/1/97	◆
Public Review/Comment	3/1/97	4/15/97	46d
Comment Incorporation & Page Changes	4/16/97	6/1/97	47d
30-Day Waiting Period/Appeal Submittal	6/2/97	7/1/97	30d
Mod C Effective Date	7/1/97	7/1/97	◆



File: LLBG-B1.MPW
Date: 7/12/95
Permitting Lead: G. D. Cummins

Scheduled Completed Milestone ◆

Attachment 6

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

July 20, 1995
11:00 a.m. - 12:00 p.m.

PRESENTATION ON THE DISPOSAL OF BULK WASTE IN THE LOW-LEVEL BURIAL GROUNDS
FOR THE WASHINGTON STATE DEPARTMENT OF HEALTH

LLBG
7-20-95

PRESENTATION ON THE DISPOSAL OF BULK WASTE IN THE LOW-LEVEL BURIAL GROUNDS FOR THE WASHINGTON STATE DEPARTMENT OF HEALTH

MAY 1995

BY
BARBARA J. BROOMFIELD

THE FOLLOWING DESCRIBED HOW PARTICULATES WILL BE REDUCED AND/OR ELIMINATED DURING DISPOSAL OF BULK WASTE AT THE LOW-LEVEL BURIAL GROUNDS TRENCH 31 AND 34.

THE FOLLOWING WILL BE PERFORM ON INCOMING BULK WASTE SHIPMENTS

- The transport vehicle loaded with bulk waste will be positioned into the trench and unloaded. The transport vehicle will be responsible for proper containment of bulk waste while in transport (e.g., closed and clamped cover, etc.,).

- A radiological control technician (RCT) upon receipt will survey the truck prior to entry into the trench area.

- The bulk waste will be moved by the dedicated front-loader and can either be used for backfill if applicable or be placed for disposal.

- Radiological and hazardous constituent air monitoring will be available to provide definition of personnel exposure due to possible airborne contamination.

- Dust suppression spray equipment will be placed to spray fixative agents on loose bulk waste to contain dust emissions during unloading.

- An RCT and a industrial hygiene (IH) will determine if air monitoring is necessary. If necessary, the RCT and HI will be responsible for setting up the appropriate air monitoring equipment.

- While unloading the bulk waste, spray equipment will be used to contain dust. Turn off spray dust control equipment as soon as the bulk waste is unloaded and dust has settled.

- Bulk waste will not be unloaded or moved when wind speeds are in excess of 24 km/hr (15 mph), the RCT or IH determine through monitoring, or other discrepancies are observed (e.g., broken tamper seals, etc.,). Bulk waste will not be accepted if it does not meet the waste acceptance criteria.

- Bulk waste disposal operations will cease and fixatives will be applied as needed to stop the spread of waste material if wind speed exceeds 24 km/hr (15 mph) or bulk waste will be covered with 0.61 meters (2 feet) of clean backfill.

- Bulk waste will be covered with 0.61 meters (2 feet) of clean soil prior to end of shift, or before ceasing operations for the day if not sprayed with fixatives.

- Bulk waste will be compacted in its final location(s) after a 0.61 meters (2 feet) clean soil cover as been added. Compaction will be accomplished by running a loader over the clean soil cover.

- No more than one bulk waste shipment will be off-loaded at anyone time.

- Loose placement of bulk waste in the burial ground will be allowed for earth (minimum moisture content for soils is 3 percent), vegetation, building rubble and other homogeneous waste. Equipment, piping and other forms of non-homogeneous waste should be containerized

- The maximum surface-radiation dose rate for bulk waste shall not exceed 200 mrem/hr at any point on the surface of the transport vehicle.

- Bulk waste that exceeds the following limits (perform sum of the fractions calculations for mixtures) will be packaged in single use containers and is not acceptable for bulk unloading:

Radionuclide	Limit (curies per gram)	
	21 m^3 Case	128 m^3 Case
^{14}C	6.16 E-05	8.56 E-06
^{22}Na	1.85 E-05	2.57 E-06
^{40}K	1.23 E-05	1.71 E-06
^{60}Co	6.16 E-07	8.56 E-08
^{90}Sr	1.23 E-07	1.71 E-08
^{99}Tc	1.85 E-05	2.57 E-06
^{137}Cs	4.31 E-06	5.99 E-07

Radionuclide	Limit (curies per gram)	
	21 m^3 Case	128 m^3 Case
^{152}Eu	6.16 E-07	8.56 E-08
^{154}Eu	4.92 E-07	6.85 E-08
^{155}Eu	2.46 E-06	3.42 E-07
^{226}Ra	1.85 E-08	2.57 E-09
^{228}Th	2.46 E-10	3.42 E-11
^{232}Th	3.08 E-11	4.28 E-12
$^{233}U/^{234}U$	1.23 E-09	1.71 E-10
^{235}U	1.23 E-09	1.71 E-10
^{238}U	1.23 E-09	1.71 E-10
^{238}Pu	1.85 E-10	2.57 E-11
$^{239}Pu/^{240}Pu$	1.23 E-10	1.71 E-11
^{241}Am	1.23 E-10	1.71 E-11

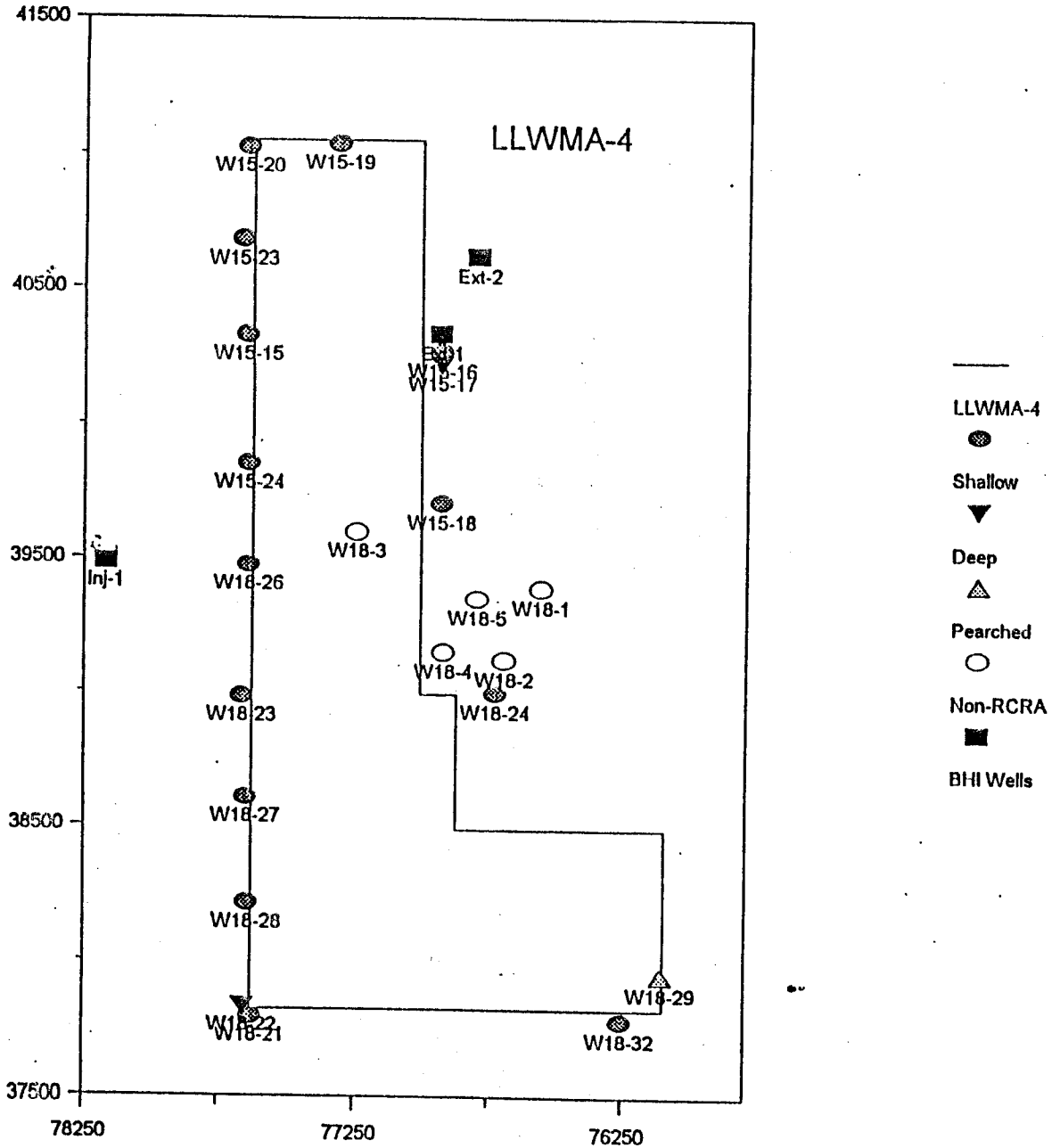
Attachment 7

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

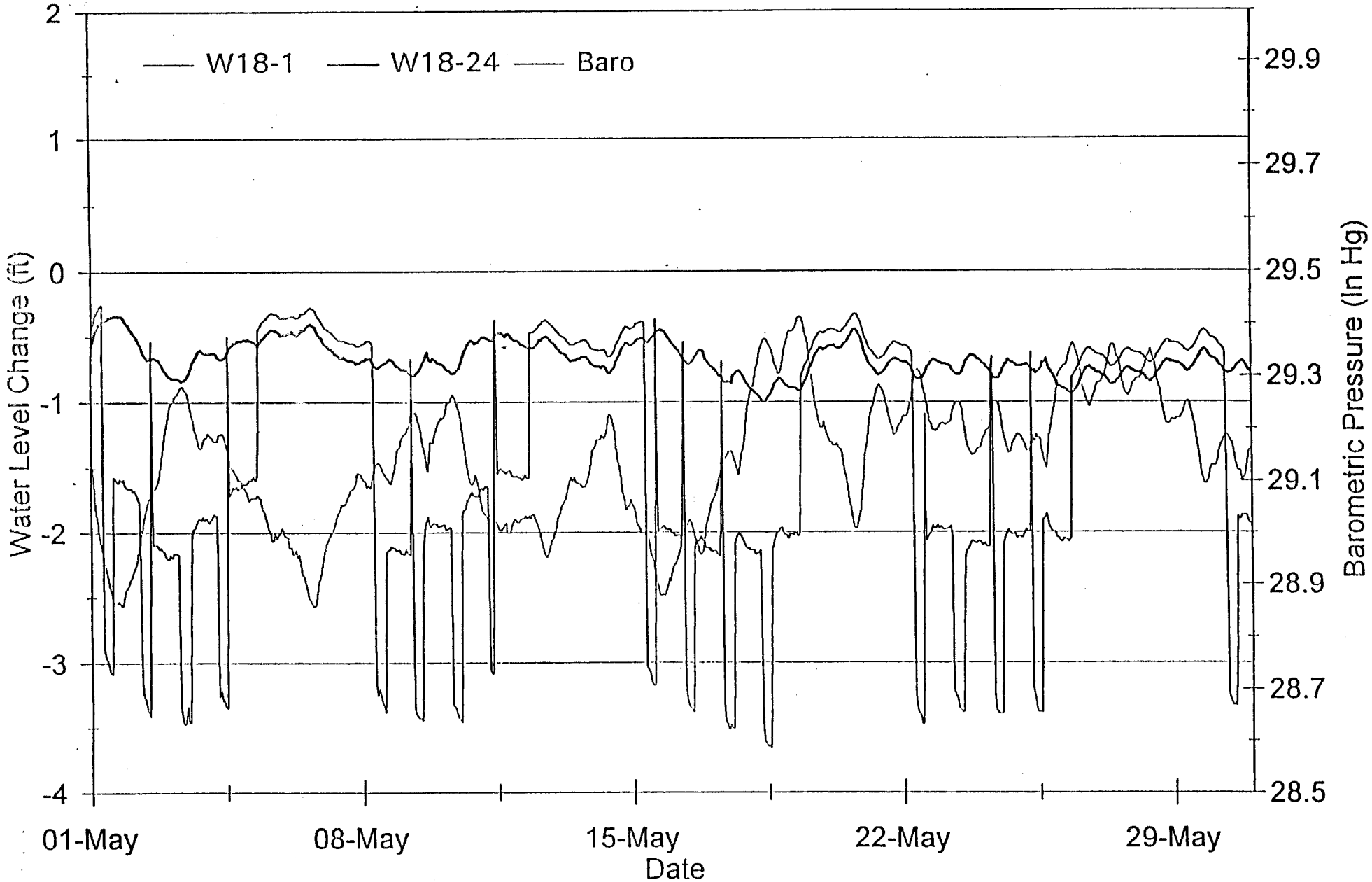
July 20, 1995
11:00 a.m. - 12:00 p.m.

STATUS OF PUMP AND TREAT

LLBG
7-20-95


LLWMA-4
41500
40500
39500
38500
37500
78250
77250
76250
W15-20
W15-19
W15-23
W15-15
W15-24
W18-26
W18-23
W18-27
W18-28
W18-22
W18-21
W15-16
W15-17
W15-18
W18-3
W18-5
W18-1
W18-4
W18-2
W18-24
W18-29
W18-32
Ext-2
Inj-1
LLWMA-4
Shallow
Deep
Pearched
Non-RCRA
BHI Wells

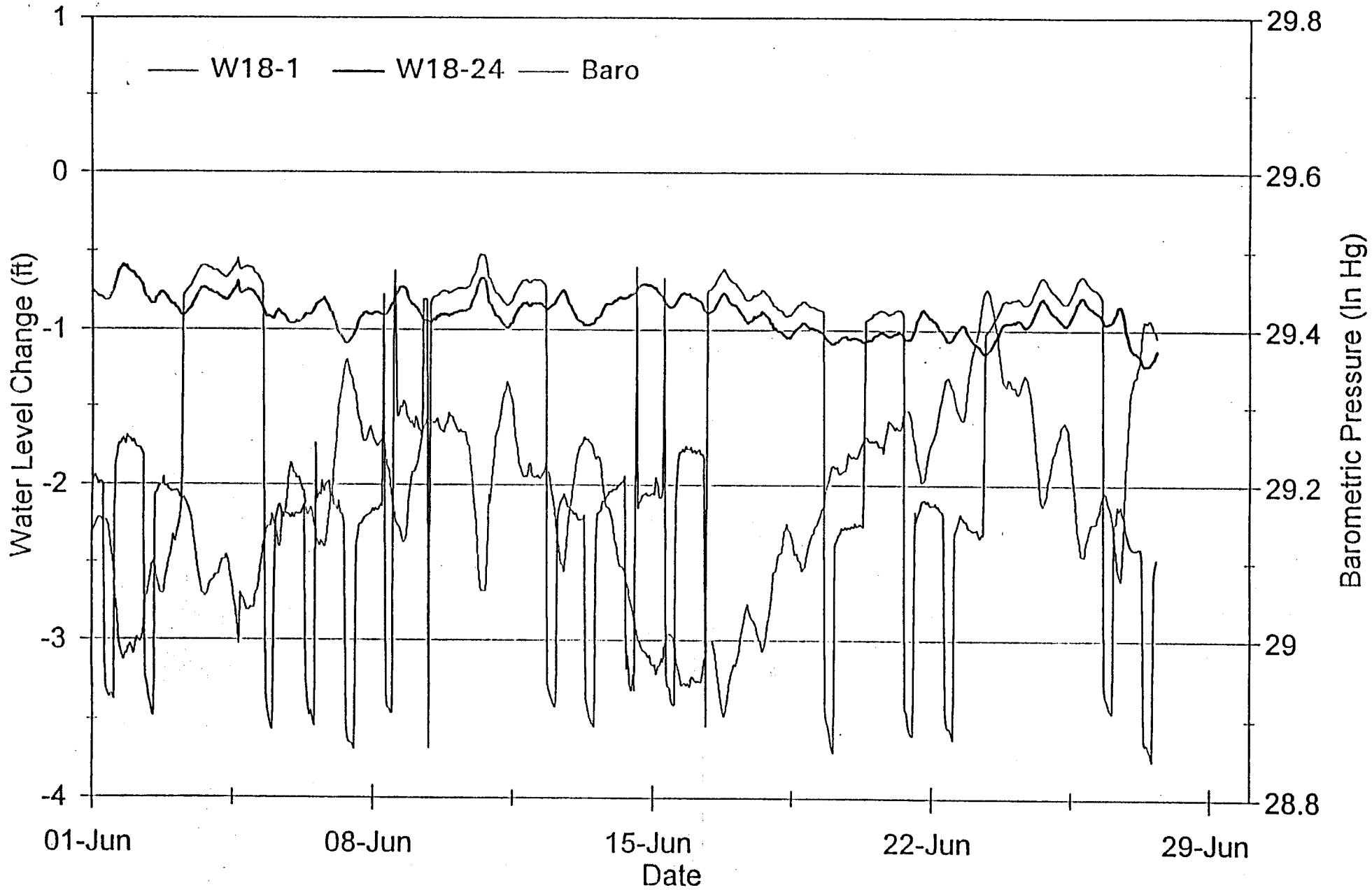
200-ZP-1 Water Level Monitoring
May 1995



Rev 11-Jul-95

Graphed by R S Edington

200-ZP-1 Water Level Monitoring
June 1995



Rev 11-Jul-95

Graphed by R.S. Edington

9513383.1074

0042032

START

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

SEP 1 9 1995

95-SWT-568

Mr. Moses N. Jaraysi
200 Area Unit Supervisor
Nuclear Waste Program
State of Washington
Department of Ecology
1315 West Fourth Avenue
Kennewick, Washington 99336

Mr. Doug R. Sherwood
Hanford Project Manager
U.S. Environmental Protection Agency
Region 10
712 Swift Boulevard, Suite 5
Richland, Washington 99352

Dear Messrs. Jaraysi and Sherwood:

TRANSMITTAL OF THE HANFORD FACILITY LOW-LEVEL BURIAL GROUNDS CONSTRUCTION QUALITY ASSURANCE REPORT FOR TRENCH 31

This letter transmits a copy of the "Hanford Facility Low-Level Burial Grounds Construction Quality Assurance Report," (WHC-SD-W025-001, Rev. 0), to the State of Washington, Department of Ecology and the U. S. Environmental Protection Agency. 40743

Should you have any questions regarding this transmittal, please contact A. K. Crowell, of my staff, on 372-2346, or R. W. Whitlock, of the Westinghouse Hanford Company, on 373-1737.

Sincerely,

Thomas K. Teynor

Thomas K. Teynor, Director
Waste Programs Division

SEP 1995
RECEIVED
EDMC

WPD:AKC

Attachment

SEP 1 9 1995

cc: Administrative Records, H6-08
R. Bowman, WHC
D. Duncan, EPA (w/attach)
W. Hamilton, Jr., WHC
N. Hepner, Ecology (w/attach)
R. Pierce, WHC
S. Price, WHC
M. Wilson, Ecology

Attachment 1

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting (Videoconference)
Federal Building, Room 784B/2704HV Room 213
Richland, Washington
Seattle, Washington

October 4, 1995
2:00 p.m. - 3:00 p.m.

AGENDA

1. **PREVIOUS MEETING MINUTES**
   - July 20, 1995 Meeting Minutes
2. **PROGRAM STATUS**
   - Status of Mixed Waste Trench Readiness
3. **PERMIT APPLICATION STATUS**
4. **RCRA TOPICS**
   - Discussion of 4-9-93 NOD Response Table
5. **GENERAL TOPICS**
   - Status of Pump and Treat (R. Mercer)
   - Past Action Items
     - 10-27-93:1 Pump and Treat Status
   - New Action Items
6. **SCHEDULE NEXT MEETING**
   - Tentative Date
   - Proposed Topics

A-T026-0042387

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

October 4, 1995
2:00 p.m. - 3:00 p.m.

The undersigned indicate by their signatures that these meeting minutes reflect the actual occurrences of the above dated Unit Managers' Meeting.

Tony McGuire (for) Date: 11/2/95
Clifford E. Clark, Unit Manager, RL

Not Present Date:
Daniel L. Duncan, RCRA Program Manager, EPA Region 10

Date: 11/1/95
Norman T. Hepner, Unit Manager, Washington State Department of Ecology

---

Low-Level Burial Grounds, WHC Concurrence

Brett M. Barnes Date: 11/1/95
Richard D. Pierce, Contractor Representative, WHC
(Represented by Brett M. Barnes, WHC)

Purpose: Discuss Permitting Process

Meeting Minutes are attached. The minutes are comprised of the following:
Attachment 1 - Agenda
Attachment 2 - Summary of Discussion and Commitments/Agreements
Attachment 3 - Attendance List
Attachment 4 - Action Items
Attachment 5 - Status of Pump and Treat

NOV 1995
RECEIVED
EDMC

Attachment 2

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

October 4, 1995
2:00 p.m. - 3:00 p.m.

Summary of Discussion and Commitments/Agreements

1. PREVIOUS MEETING MINUTES

The July 20, 1995 Unit Manager Meeting minutes were approved by Ecology. The minutes will be sent to Mr. D. Duncan (EPA) for signature.

2. PROGRAM STATUS

- **Status of Mixed Waste Trench Readiness**

Mr. D. Pratt (WHC) provided an update on the mixed waste trenches. All of the post start items for Trench 31 have been closed. The readiness review for Trench 34 was completed, and a letter notifying DOE-RL that Trench 34 is ready to operate was sent three weeks ago. The budget currently allows for maintenance only, so the rainwater is being pumped out of the sumps.

Mr. N. Hepner (Ecology) inquired about the status of bulk material acceptance at the trenches. Mr. B. Barnes (WHC) stated that the trenches are capable of accepting bulk material.

3. PERMIT APPLICATION STATUS

Ms. G. Cummins (WHC) reported that a working draft of the Part B permit application, Revision 1, is in DOE-RL review. The current draft was revised according to the new Ecology checklist. This working draft reflects the date that Ecology was authorized to regulate the dangerous waste portion of mixed waste as identified in the "Final Authorization of State Hazardous Waste Management Program; Washington" (52 Federal Register 35556). This authorization became effective on November 23, 1987. Ms. Cummins noted that the General Information Volume, which supports the Part B permit applications, is targeted for transmittal to the regulators in mid-October 1995.

Mr. Hepner requested that at least one chapter of the Part B permit application be transmitted to Ecology for review by the first week of November 1995. Ms. Cummins also reported that a revised Part A permit application (Revision 8) will be included with the Part B permit application transmittal. The Part A has been revised to add tank storage for collected leachate, and the

mixed waste trench design capacity has been revised to 400 hectare meters.

Mr. Hepner referred to RL/WHC's request for greater than 90-day storage for the leachate storage tanks, and he asked if the tanks could hold greater than 90 days of rainfall. Mr. Pratt stated that each tank holds 10,000 gallons, and the leachate tank could fill up in a week if there was enough rainfall. Mr. Barnes pointed out that there is a dedicated tanker truck which is available to pump out collected leachate and transport it to the 204-AR Waste Unloading Station. Mr. T. McKarns (DOE-RL) noted that DOE-RL will be transmitting a letter to the regulators stating that daily inspections on the leachate storage tanks will be performed during the week; and if there is leachate in the tanks, then inspections will also be performed on the weekends and holidays.

4. RCRA TOPICS

- Discussion of 4-9-93 NOD Response Table

Mr. Barnes stated that a letter responding to Ecology's Notice of Deficiency (NOD) comments has been transmitted to DOE-RL for their review and eventual transmittal to Ecology.

5. GENERAL TOPICS

- Status of Pump and Treat

Mr. R. Mercer (WHC) provided an update on the pump and treat operation. Mr. Mercer stated that the treatability study is ongoing. Bechtel plans to begin drilling another extraction well in mid-October 1995. Following completion of the extraction well, Bechtel plans to perform a pump test to evaluate locations for the 11 to 12 extraction wells planned for FY '96.

- Past Action Items

Action item 10-27-93:1, schedule a technical issues meeting for RCRA/CERCLA integration and discussion of pump and treat evaluations.

WHC is continuing to provide pump and treat information to Ecology. This action item was left open.

- New Action Items

Mr. Hepner requested an action for RL/WHC to provide Ecology a portion or all of the Part B permit application for review by the first week of November 1995.

6. SCHEDULE NEXT MEETING

- **Tentative Date**

  The next Unit Managers Meeting was scheduled for November 1, 1995. It was agreed to hold the first NOD workshop following the Unit Manager Meeting.

- **Proposed Topics**

  Ms. Cummins reported that a RCRA/CERCLA integration meeting was held yesterday (10-3-95). Resolution of RCRA/CERCLA overlap at the LLBG for the RCRA groundwater monitoring concerns relative to the pump and treat was discussed. A status will be provided at future Unit Manager Meetings.

Attachment 3

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

October 4, 1995
2:00 p.m. - 3:00 p.m.

Attendance List

A stenographer is present to take detailed notes on the proceedings of this meeting. These notes will be used for the sole purpose of preparing Unit Manager Meeting minutes. After these Unit Manager Meeting minutes are finalized, the detailed notes will be discarded. If any attendee has objections with this approach, they should voice these objections at this time.

Name	Organization	Phone #
Kathy Knox	WHC	372-3596
Brett M. Barnes	WHC	376-3640
Rich Merler	WHC	376-8945
Mark French	DOE/WPD	373-9863
Gerry Henderickx	GSSC	946-3687
Roger Bowman	WHC	376-4876
Tony McKalns	DOE	376-8981
Sarah Campbell	WHC	378-4323
Allison Crowell	RL/WPD	372-2346
Norm Hepner	Ecology	736-3048
Dean Pratt	WHC	

Attachment 4

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

October 4, 1995
2:00 p.m. - 3:00 p.m.

Action Items

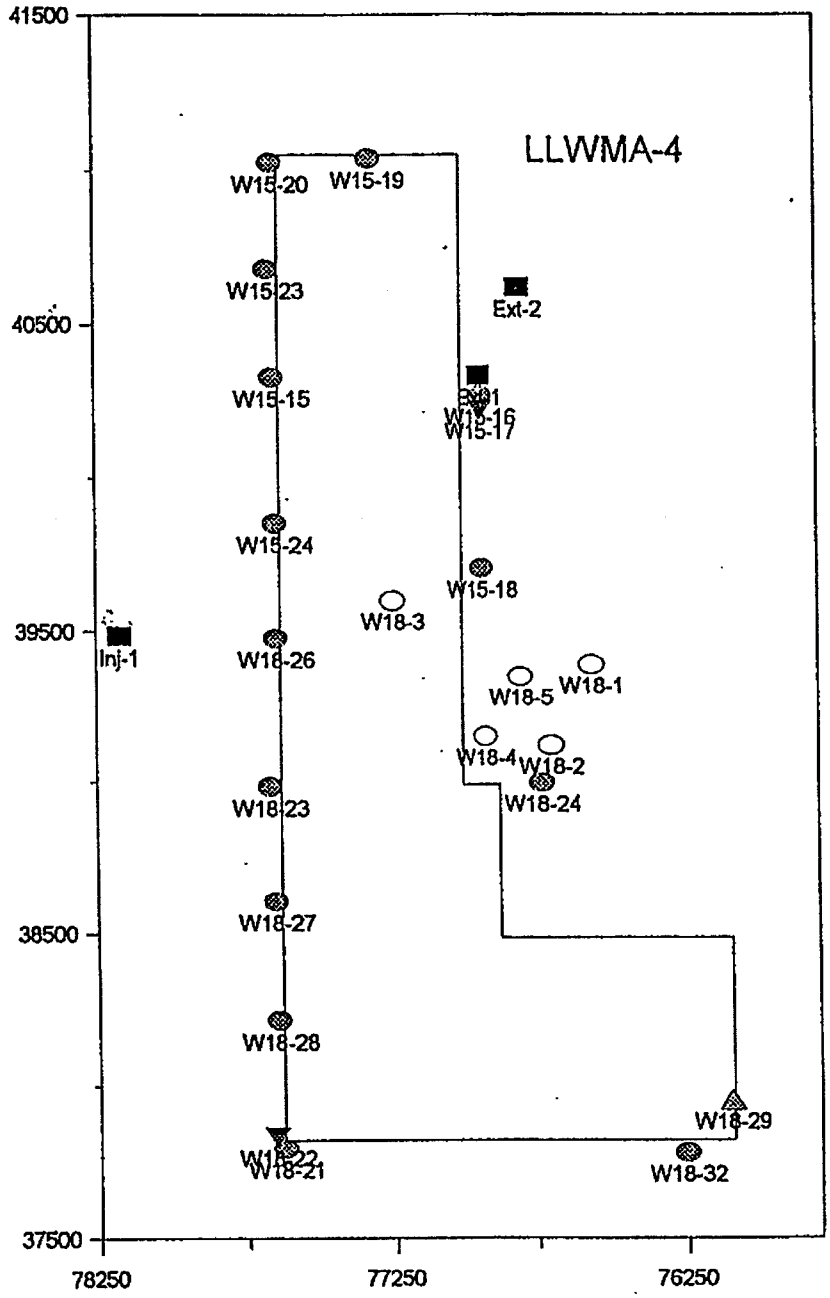
Action Item	Description
10-27-93:1	Schedule a technical issues meeting for RCRA/CERCLA integration and discussion of pump and treat evaluations. **OPEN**
09-01-94:1	RL/WHC will provide the Yakama Indian Nation a copy of all the notice of deficiencies (NODs), including a description of the NODs that have been resolved and the NODs that remain open. ACTION: A. Crowell (RL) **CLOSED**
10-18-94:1	RL will provide Ecology (Mr. R. Cordts) a preview of the engineering change notices (ECNs) on Trench 31 and 34. ACTION: A. Crowell (RL) **CLOSED**
10-04-95:1	RL/WHC will provide Ecology a portion or all of the Part B permit application for review by the first week of November 1995. **OPEN**

Attachment 5

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
Federal Building, Room 784B
Richland, Washington

October 4, 1995
2:00 p.m. - 3:00 p.m.

STATUS OF PUMP AND TREAT



LLWMA
Shallow
Deep
Pearch
Non-R
BHI W

Distribution:

L. D. Arnold	WHC	B2-35
B. M. Barnes	WHC	T3-04
R. C. Bowman	WHC	H6-24
B. J. Broomfield	WHC	T3-04
S. E. Campbell	WHC	T4-05
R. M. Carosino	RL	A4-52
C. E. Clark	RL	A5-15
R. E. Cordts	Ecology	Lacey
A. K. Crowell	RL	S7-55
G. D. Cummins	WHC	H6-24
D. L. Duncan	EPA	HW-106
D. Dunning	ODOE	
N. P. Emerson	WHC	T4-03
M. S. French	RL	S7-55
R. J. Giroir	WHC	T4-05
R. F. Guercia	RL	S7-55
P. L. Hapke	WHC	T4-05
G. D. Hendricks	GSSC	B1-42
N. T. Hepner	Ecology	B5-18
M. N. Jaraysi	Ecology	B5-18
G. H. Landeen	WHC	H6-23
S. Leja	Ecology	B5-18
D. R. Lucas	WHC	G3-15
P. J. Mackey	WHC	B3-15
R. D. Pierce	WHC	T3-04
D. B. Powell	WHC	T4-03
D. A. Pratt	WHC	T4-03
S. M. Price	WHC	H6-23
L. T. St. Georges	WHC	H6-20
H. T. Tilden	PNL	P7-79

ADMINISTRATIVE RECORD: Low-Level Burial Grounds, D-2-9
[Care of EDMC, WHC (H6-08)]

Washington State Department of Ecology Nuclear and Mixed Waste Library, P.O. Box 47600, Olympia, Washington 98504-7600

Environmental Protection Agency Region 10, Seattle, Washington 98101, Mail Stop HW-074

Please send comments on distribution list to G. D., WHC (H6-24), (509) 372-0743

1/1/95

Distribution:

L. D. Arnold	WHC	B2-35
B. M. Barnes	WHC	T3-04
R. C. Bowman	WHC	H6-24
B. J. Broomfield	WHC	T3-04
S. E. Campbell	WHC	T4-05
R. M. Carosino	RL	A4-52
C. E. Clark	RL	A5-15
A. K. Crowell	RL	S7-55
G. D. Cummins	WHC	H6-24
N. P. Emerson	WHC	T4-03
M. S. French	RL	S7-55
R. J. Giroir	WHC	T4-05
R. F. Guercia	RL	S7-55
P. L. Hapke	WHC	T4-05
G. D. Hendricks	GSSC	B1-42
N. T. Hepner	Ecology	B5-18
S. Leja	Ecology	B5-18
D. R. Lucas	WHC	G3-15
P. J. Mackey	WHC	B3-15
R. D. Pierce	WHC	T3-04
D. B. Powell	WHC	T4-03
D. A. Pratt	WHC	T4-03
S. M. Price	WHC	H6-23
L. T. St. Georges	WHC	H6-20
H. T. Tilden	PNL	P7-79
RCRA/File	WHC	H6-24

ADMINISTRATIVE RECORD: Low-Level Burial Grounds, D-2-9
[Care of EDMC, WHC (H6-08)]

Washington State Department of Ecology Nuclear and Mixed Waste Library,
P.O. Box 47600, Olympia, Washington 98504-7600

Environmental Protection Agency Region 10, Seattle, Washington 98101,
Mail Stop HW-074

Please send comments on distribution list to JoAnn McCoy, WHC (H6-24),
(509) 372-3596.

LOW-LEVEL BURIAL GROUNDS
Notice of Deficiency Resolution Meeting
2440 Stevens Ctr., Room 2100
Richland, Washington

November 1, 1995
3:00 p.m. - 4:00 p.m.

The undersigned indicate by their signatures that these meeting minutes reflect the actual occurrences of the above Notice of Deficiency Resolution Meeting.

Date: 12/6/95
Clifford E. Clark, Unit Manager, RL
(Represented by Anthony C. McKarns, DOE-RL)

Date: 12/6/95
Norman T. Hepner, Unit Manager, Washington State Department of Ecology

---

Low-Level Burial Grounds, WHC Concurrence

Date: 12/6/95
Richard D. Pierce, Contractor Representative, WHC
(Represented by Brett M. Barnes, WHC)

Purpose: Discuss Notice of Deficiency issues

Meeting Minutes are attached. The minutes are comprised of the following:
Attachment 1 - Agenda
Attachment 2 - Summary of Discussion and Commitments/Agreements
Attachment 3 - Attendance List
Attachment 4 - Action Items
Attachment 5 - LLBG Part B Permit Applications Review and Response Chronology
Attachment 6 - White Paper, Regulation of Radioactive Mixed Waste Under the RCRA
Attachment 7 - LLBG Part B Working Draft Review Distribution List 11/1/95

Attachment 1

LOW-LEVEL BURIAL GROUNDS
Notice of Deficiency Resolution Meeting
2440 Stevens Ctr., Room 2100
Richland, Washington

November 1, 1995
3:00 p.m. - 4:00 p.m.

AGENDA

1. INTRODUCTIONS (RL/WHC)

2. BACKGROUND ON LLBG PART B APPLICATION DEVELOPMENT

   - Fourth NOD Cycle and Remaining Issues
   - Hanford Facility Permit and General Information Volume
   - Modification Schedule
   - New Ecology Checklist
   - NOD Workshop Schedule

3. NOD WORKSHOP FORMAT DISCUSSION (ECOLOGY/RL/WHC)

   - NOD Workshop Approach (chapter-by-chapter resolution and agreement by WHC/RL/Ecology)

4. IDENTIFICATION OF REMAINING NOD ISSUES (ECOLOGY/RL/WHC)

   - Waste Acceptance Criteria - Chapter 3
   - Use of unlined trenches - Chapter 1 (Part A), Chapter 4
   - Closure plan, schedule, design - Chapter 11
   - Vadose Zone Monitoring - Chapter 5
   - Exemption Request and EPP - Chapter 4
   - Lead Shielding - Chapter 1 (Part A)

5. ACTION ITEMS (ECOLOGY/RL/WHC)

   - New Action Items

6. SCHEDULE NEXT MEETING (ECOLOGY/RL/WHC)

   - Tentative Date

   - Proposed Topics

Attachment 2

LOW-LEVEL BURIAL GROUNDS
Notice of Deficiency Resolution Meeting
2440 Stevens Ctr., Room 2100
Richland, Washington

November 1, 1995
3:00 p.m. - 4:00 p.m.

Summary of Discussion and Commitments/Agreements

1. INTRODUCTIONS (RL/WHC)

Introductions were made previously at the Unit Managers Meeting.

2. BACKGROUND ON LLBG PART B APPLICATION DEVELOPMENT

Ms. G. Cummins (WHC) discussed background on LLBG Part B application development. Ms. Cummins said the DOE/RL-88-20, WD-1, "Hanford Facility Dangerous Waste Permit Application Low-Level Burial Ground," working draft is in an electronic format. This draft also follows the revised Ecology Part B checklist issued in February 1995.

Ms. Cummins handed out the LLBG Part B Permit Applications Review and Response Chronology (Attachment 5), stating it may be helpful background information.

The working draft has been reduced from five volumes to one. This volume reduction was largely due to the ability to cross-reference to the Hanford Facility Dangerous Waste Permit Application, General Information volume. In addition, most of the maps and appendices have already been provided to Ecology. Ms. S. Price (WHC) agreed to provide a talk on the General Information volume (DOE/RL-91-28) at the next Ecology permitting team meeting.

3. NOD WORKSHOP FORMAT DISCUSSION (ECOLOGY/RL/WHC)

Ms. Cummins said Mr. R. Julian (Ecology) has gone through NOD workshops for the PUREX Tunnels Part B and she suggested that the LLBG workshop be conducted in the same way. The process involves sending out a DSI, from DOE to Ecology, with a summary of changes and chapters to be reviewed for the next workshop. The DSI will request that comments be identified as 'issue' comments and 'language' comments. For the PUREX Part B, NOD workshop status notes were provided instead of meeting minutes. Status notes will be covered as part of the LLBG unit manager meeting.

On resolution of issue comments and language comments, signoff of the chapter could be completed. One last wrap-up meeting for signoffs would be held before the Part B goes public.

4. IDENTIFICATION OF REMAINING NOD ISSUES (ECOLOGY/RL/WHC)

The need to resolve the five remaining NOD issues by December 1995 was discussed. A commitment was made by DOE/WHC to forward these resolutions to Mr. N. Hepner (Ecology) as soon as they are reviewed internally. A commitment was made by DOE/WHC to expedite their internal review.

Ms. Cummins handed out a White Paper covering the 1987 date for regulation of mixed waste under RCRA (Attachment 6). The participants agreed that this date needs to be discussed by the DOE and Ecology attorneys to reach an agreement. Mr. A. McKarns (RL) and Mr. Hepner agreed to forward the White Paper to their respective Legal departments by 11/30/95 to reach resolution on the 11/87 date.

Ms. Cummins stated that the details of the closure plan, Chapter 11, will be discussed at a later date.

Ms. Cummins stated that Chapter 5, Groundwater Monitoring, will be addressed in the Hanford Facility Permit for the sitewide approach. A discussion of unit-specific interim status groundwater monitoring will be included as an appendix in the LLBG Part B.

Chapter 4, Process Information, will be covered in December 1995.

Regarding Chapter 1 (Part A), Mr. Hepner stated that Ecology's position is that lead shielding is waste if it is meant for disposal. Mr. B. Barnes (WHC) suggested that the lead shielding issue be discussed at a RIPI Council meeting. Mr. Hepner agreed that is was appropriate to take another look at this issue.

Ms. Cummins handed out a Distribution List for LLBG Part B Working Draft Review (Attachment 7).

5. ACTION ITEMS (ECOLOGY/RL/WHC)

- **New Action Items**

Ms. S. Price (WHC) agreed to provide a talk to Ecology on the Hanford Facility Dangerous Waste Permit Application, General Information volume either November 14, December 6, or December 7, 1995.

DOE/WHC will expedite internal review of the responses to the five remaining NOD comments and forward these responses to Mr. Hepner as soon as possible.

Mr. A. McKarns (DOE) and Mr. N. Hepner (Ecology) will forward the White Paper (Attachment 6) to their respective Legal departments by 11/30/95.

Ms. S. Price (WHC) will contact Ms. N. Darling (WHC) in regard to bringing the lead shielding issue before the RIPI Council.

6. **SCHEDULE NEXT MEETING (ECOLOGY/RL/WHC)**

- **Tentative Date**

  The next meeting was scheduled for November 15.

- **Proposed Topics**

Attachment 3

LOW-LEVEL BURIAL GROUNDS
NOD RESOLUTION MEETING
2440 STEVENS CTR., ROOM 2100
RICHLAND, WASHINGTON

November 1, 1995
3:00 p.m. - 4:30 p.m.

Attendance List

A stenographer is present to take detailed notes on the proceedings of this meeting. These notes will be used for the sole purpose of preparing Unit Manager Meeting minutes. After these Unit Manager Meeting minutes are finalized, the detailed notes will be discarded. If any attendee has objections with this approach, they should voice these objections at this time.

Name	Organization	Phone #
Sarah Campbell	WHC/SWM	373-4222
Tony McKarns	DOE	376-8981
Gerry Hendricks	GSSC	946-3687
Dean Pratt	WHC	373-2464
R B Mercer	WHC	376-8945
Norm Hepner	Ecology	736-3048
RJ Pierce	WHC	2-0737
Brett M. Barnes	WHC	376-3640
John McCoy	WHC	372-3596

Attachment 4

LOW-LEVEL BURIAL GROUNDS
Notice of Deficiency Resolution Meeting
2440 Stevens Ctr., Room 2100
Richland, Washington

November 1, 1995
3:00 p.m. - 4:00 p.m.

Action Items

Action Item	Description
11-01-95:1	Forward the White Paper to respective Legal departments to reach resolution on the 11/87 date. ACTION: Mr. A. McKarns (RL) and Mr. N. Hepner (Ecology). **OPEN**
11-01-95:2	Arrange for discussion on lead shielding at the RIPE council meeting. **OPEN**
11-01-95:3	Talk to Ecology about the Hanford Facility Permit and General Information Volume. ACTION: Ms. S. Price (WHC) **OPEN**

Attachment 5

LOW-LEVEL BURIAL GROUNDS
Notice of Deficiency Resolution Meeting
2440 Stevens Ctr., Room 2100
Richland, Washington

November 1, 1995
3:00 p.m. - 4:00 p.m.

LOW-LEVEL BURIAL GROUNDS
PART B PERMIT APPLICATIONS
REVIEW AND RESPONSE CHRONOLOGY

LOW-LEVEL BURIAL GROUNDS
PART B PERMIT APPLICATIONS
REVIEW AND RESPONSE CHRONOLOGY

NOVEMBER 1, 1995

1. DOE/WHC transmits to Ecology on 12-21-89 Revision 0 of LLBG Part B.

2. Ecology transmits to DOE/WHC on 3-30-90 partial review comments on Revision 0 of LLBG Part B; Ecology states that additional written comments, in NOD format, will be submitted within 45 calendar days. No response date for NODs is cited in the Ecology letter.

3. Ecology transmits to DOE/WHC on 5-25-90 additional review comment on Revision) of LLBG Part B. Ecology requests NOD Response Table be submitted on 6-30-90 for comments dated 3-30-90 and on 8-23-90 for comments dated 5-25-90.

4. DOE/WHC transmits to Ecology on 6-25-90 a request for extension to submit a combined NOD Response Table to Ecology on 9-25-90.

5. Ecology responds to request for extension on 6-28-90. Ecology extends the requested submittal date to 8-25-90 for a combined NOD Response Table addressing NOD comments dated 3-30-90 and 5-25-90.

6. DOE/WHC submits to Ecology on 8-23-90 the combined NOD Response Table.

7. DOE/WHC submits to Ecology on 7-24-90 the 9090 Test Plan for review. This is the Project w-025, Radioactive Mixed Waste Disposal Facility Liner/Leachate Compatibility Test Plan.

8. DOE/WHC submits to Ecology on 7-24-90 Supplement 1. This is the Request for Exemption from Lined Trench Requirements for Submarine Reactor Compartments.

9. DOE/WHC submits to Ecology on 9-20-90 Supplement 2. This is the Design Documentation for Mixed Waste Nondragoff Land Disposal Facility (Project W-025). The 9090 Test Plan was resubmitted as part of the Design Documentation. DOE/WHC requests that ecology Provide comments on the Design Documentation by 12-28-90.

10. DOE/WHC submits to Ecology on 1-10-91 a request for concurrence that the SRC disposal packages with residual liquids comply with disposal regulations.

11. Ecology transmits to DOE/WHC on 4-26-91 the NOD comments on Supplement 2.

12. DOE/WHC submits to Ecology on 6-11-91 the Construction Quality Assurance Plan.

13. DOE/WHC submits to Ecology on 7-26-91 the second NOD Response Table addressing 171 NOD comments received from Ecology.

14. Ecology transmits to DOE/WHC on 2-18-92 the third letter regarding NODs requesting a response table be submitted to Ecology on or before 4-30-92.

15. DOE/WHC submits to Ecology on 4-30-92 the third NOD Response Table addressing the 179 NOD comments received from Ecology. Revisions to table are submitted to Ecology 10-27-92.

16. DOE/WHC submits to Ecology on 1-7-93 the Engineered Performance Plan and requests a temporary exemption regarding Supplement 1 Rev. 1. (Request for Exemption from Lined Trench Requirements and from Land Disposal Restrictions for Residual Liquid at 218-E-12B Burial Ground Trench 94).

17. Ecology transmits to DOE/WHC on 1-8-93 the fourth letter regarding NODs addressing 47 unresolved comments and requesting a response table be submitted to Ecology 4-9-93.

18. DOE/WHC submits to Ecology on 4-7-93 the Response Action Plan for the and the Quality Assurance Program Plan for the Mixed Waste Trench (Project W-025).

19. DOE/WHC submits to Ecology on 4-9-93 the fourth NOD Response Table addressing Ecology's 47 comments that remain unresolved out of the original 389 comments.

20. Ecology transmits to DOE/WHC on 9-2-93 a response to Engineered Performance Plan (EPP) transmittal and temporary exemption request letter from DOE/WHC dated 1-7-93. Ecology determined that the EPP will fulfill their request for a demonstration project to verify the adequacy of the SRC disposal alternative. Also, because Trench 94 is an interim status unit, the alternative landfill design described in Supplement 1 can be used until the design is approved or disapproved in the final permit. Ecology states the exemption will likely be granted when the Low-Level Burial Grounds are incorporated into the Hanford Facility Dangerous Waste Permit. However, this will require Ecology's review of the EPP details and a public comment period.

21. Ecology defers resolution of remaining NOD comments at 10-27-93 Unit Manager's Meeting (UMM) until the Hanford Facility Permit has at least gone through the public comment period due to LLBG related site-wide issues. The UMMs are discontinued until the Hanford Facility Permit issues are resolved. The UMMs resume 9-1-94.

22. The Hanford Facility Permit is finalized 8-1-94 and becomes effective 9-1-94. Negotiations with Ecology regarding when the LLBG permit will be incorporated into the Hanford Facility Permit are completed 1-18-95. It is determined that the LLBG will be incorporated into Modification C which becomes effective 7-1-97. An advanced copy of the revised Part B permit application is due to Ecology on 10-1-96.

23. DOE/WHC submits to Ecology on 1-5-95 the As-built drawings for the Mixed Waste Trenches 31 and 34. A formal transmittal of the As-built drawings and Construction Quality Assurance (CQA) report is submitted to Ecology on 3-28-95.

24. DOE/WHC submits to Ecology on 7-19-95 a revision of the Response Action Plan to include project W-025 trench 34.

Attachment 6

LOW-LEVEL BURIAL GROUNDS
Notice of Deficiency Resolution Meeting
2440 Stevens Ctr., Room 2100
Richland, Washington

November 1, 1995
3:00 p.m. - 4:00 p.m.

WHITE PAPER
REGULATION OF RADIOACTIVE MIXED WASTE UNDER THE RCRA

WHITE PAPER
REGULATION OF RADIOACTIVE MIXED WASTE UNDER THE RCRA

SUMMARY

The EPA has stated that radioactive mixed waste (RMW) disposal that occurred before the effective date of RCRA applicability for the waste is not subject to the provisions for treatment, storage, or disposal under the RCRA. However, the EPA also indicates that such disposed of wastes would qualify as solid waste, and therefore would be subject to all applicable provisions of the RCRA corrective action program. The Hanford Facility Permit and the Tri-Party Agreement address corrective action requirements for Hanford.

The State of Washington received authority to regulate RMW as of November 23, 1987. RMW that is "actively managed" (i.e., treated, stored or disposed) on or after November 23, 1987 must be managed in accordance with the Subtitle C provisions for hazardous wastes. RMW (or suspect RMW) that had been disposed of in Washington prior to November 23, 1987 that is exhumed must be designated pursuant to WAC 173-303 and if dangerous, must be managed pursuant to WAC 173-303. If process knowledge or testing indicates that retrieved wastes exhibit any characteristics/criteria for designation as dangerous waste, then the waste must be designated as dangerous or as radioactive mixed waste and managed in accordance with the generator standards of WAC 173-303-200 or transported to a treatment, storage, and/or disposal unit that can provide for proper management pursuant to WAC 173-303.

BACKGROUND

Historically, there has been considerable confusion regarding the scope of the Resource Conservation and Recovery Act (RCRA), particularly with respect to the regulation of radioactive materials that are also regulated under the Atomic Energy Act. Congress, in originally passing the RCRA, specifically excluded source, special nuclear, and byproduct material as defined by the Atomic Energy Act [RCRA, Section 1004(27)]. However, the DOE did not provide definitive clarification concerning the scope of the byproduct exclusion until May 1, 1987, when the so-called "byproduct rule" was issued.

On July 3, 1986, the U.S. Environmental Protection Agency (EPA) published notice (51 FR 24504) that radioactive mixed wastes are to be part of authorized State programs. In that notice, the EPA required states to demonstrate authority to regulate the hazardous component of mixed waste as a condition for obtaining/maintaining authorization to administer and enforce a hazardous waste program pursuant to Subtitle C of the Resource Conservation and Recovery Act (RCRA). Additionally, the EPA maintained that, as of July 3, 1986, "currently authorized State programs do not apply to radioactive mixed wastes." In making this statement, the EPA indicated that they had now determined that "wastes containing both hazardous waste and radioactive waste are subject to the RCRA regulations." As a result, the July 3, 1986 notice required states with authorized programs to revise their programs and apply for authorization for the hazardous components of radioactive mixed wastes.

The State of Washington had an authorized hazardous waste program at the time of the above notice and did subsequently obtain authorization to regulate the hazardous components of radioactive mixed wastes. On September 23, 1988, the EPA issued a clarification notice (53 FR 37045) that addressed the need for facilities which treat, store, or dispose of radioactive mixed waste to obtain interim status pursuant Subtitle C of the RCRA. In that notice the EPA stated,

"Some facilities in States with base program authorization as of July 3, 1986 may already have interim status under RCRA because they handle other RCRA hazardous wastes. These facilities should submit a revised Part A permit application reflecting their radioactive mixed waste activities within six months of the State's receipt of authorization for radioactive mixed waste."

The Hanford Facility Part A permit application is maintained to address all dangerous waste treatment, storage, and disposal activities, including activities involving the management of radioactive mixed wastes.

The EPA has previously addressed the issue of active management of waste that had been disposed of prior to the effective date of regulations that would otherwise be applicable to the waste. In issuing the First Third rule for the LDRs, the EPA responded to challenges concerning the EPA's interpretation of their own rules. In that rule, the EPA made the following remarks:

"A few commenters disputed the Agency's reading that hazardous waste listings are retroactive; that is, all wastes meeting the listing description are hazardous regardless of when they were disposed. EPA believes this point to be nearly self-evident: a waste either does or does not match a listing description. The time at which a waste was disposed does not affect what that waste is. Spent solvent still bottoms disposed of in 1979 (before Agency action listing these wastes as hazardous) are as much spent solvent still bottoms as those disposed in 1981 (after the listing took effect)...EPA believes therefore that the hazardous waste listing can be retroactive. Thus, wastes derived from treating, storing, or disposing of these wastes likewise are hazardous, as are mixtures of these wastes and other solid wastes. For land disposal restrictions purposes, this means that these residues could become subject to the land disposal restrictions for the listed waste from which they derive if they are managed actively after the effective date of the land disposal prohibition for the underlying waste."

In the above, the EPA takes the position that hazardous waste can be derived from the disposal of waste, irrespective of the date of disposal in relation to the effective date of regulation. The EPA believes that hazardous waste is thus "derived-from waste" if it is actively managed. In the case of hazardous waste disposed of prior to the effective date of regulation, retrieval of the waste would require proper designation and subsequent management pursuant to the land disposal restrictions prior to re-disposal.

In the debris final rule, the EPA again addresses the issue of active management, stating:

"Once debris becomes a solid waste by virtue of being discarded...it is not necessarily subject to the treatment standards. For example, contaminated debris that is not actively managed after the effective date of the prohibitions (i.e., the effective date of the LDRs for the hazardous waste contaminating the debris) would not be subject to the standards...On the other hand, debris which is contaminated with hazardous waste disposed before the hazardous waste listing effective date and which is actively managed is subject to the prohibitions and so would have to be treated to satisfy the treatment standards promulgated today before the debris could be land disposed (assuming disposal will not occur in a no-migration unit)."

Again, the EPA indicates that active management will trigger the RCRA requirements for wastes discarded prior to the applicable effective date.

Some radioactive wastes have been disposed of prior to the date that the State of Washington was granted mixed waste authority. Such wastes, if also hazardous, would not considered to be actively managed under the RCRA unless exhumed.

Attachment 7

LOW-LEVEL BURIAL GROUNDS
Notice of Deficiency Resolution Meeting
2440 Stevens Ctr., Room 2100
Richland, Washington

November 1, 1995
3:00 p.m. - 4:00 p.m.

LLBG PART B WORKING DRAFT REVIEW
DISTRIBUTION LIST 11/1/95

LLBG Part B Working Draft Review
Distribution List 11/1/95

Ecology - Norm Hepner*

EPA - Dave Barths

RL

Allison Crowell - Programs *
Cliff Clark - EAP * (2 copies)
Mike Ciminera/Gerry Hendricks - MACTEC *
Roger Gordon - Programs, PSNS
Mark French - Programs, PSNS *
Rudy Guercia - Programs *
Tony McKarns - EAP*

WHC - Solid Waste Disposal - Bill Hamilton, Mgr. Level 2

Generator Waste Acceptance Services - Rick Pierce, Mgr. Level 3

Brett Barnes *
Acceptance Services - Cindy Girres, Mgr. Level 4

Solid Waste Management - Paul Hapke, Mgr. Level 3; Sarah Campbell, ECO

SWM Operations - Paul Krane, Mgr. Level 4
Don Pyzel *
SWM Facility Engineering - Dean Powell, Mgr. Level 4 *
Dean Pratt *
Roger Whitlock*
SWM - Bob Giroir, Mgr. Level 4
SWM Training and Special Disposal Operations- Norm Emerson, Mgr. Level 4
Ron Mangum *
Stuart Arnold
Ron Robbins (training)*
SWM Ops Support and Work Control - Russ Reddinger, Mgr. Level 4
Sarah Campbell *
Restoration and Upgrade Programs - Dale Mckenney, Mgr. Level 3

Solid Waste Programs - Jeff Riddelle, Mgr. Level 4
Restoration Projects - Tim Erickson, Mgr. Level 4
Solid Waste Systems Engr. - Ken Hladek, Mgr. Level 4

RCRA Permitting - Sue Price - Mgr. Level 3 *

RCRA Unit Permits - Roger Bowman
Joel Williams, Jr.
Gloria Cummins *

*NOD Workshop Participant

12/6/95

Distribution:

L. D. Arnold	WHC	B2-35*
B. M. Barnes	WHC	T3-04
R. C. Bowman	WHC	H6-24*
B. J. Broomfield	WHC	T3-04*
S. E. Campbell	WHC	T4-05*
R. M. Carosino	RL	A4-52*
C. E. Clark	RL	A5-15
A. K. Crowell	RL	S7-55
G. D. Cummins	WHC	H6-24
N. P. Emerson	WHC	T4-03*
M. S. French	RL	S7-55*
R. J. Giroir	WHC	T4-05*
R. F. Guercia	RL	S7-55*
P. L. Hapke	WHC	T4-05*
G. D. Hendricks	GSSC	B1-42*
N. T. Hepner	Ecology	B5-18
S. Leja	Ecology	B5-18*
D. R. Lucas	WHC	G3-15*
P. J. Mackey	WHC	B3-15
A. C. McKarns	RL	A5-15
R. D. Pierce	WHC	T3-04*
D. B. Powell	WHC	T4-03*
D. A. Pratt	WHC	T4-03*
S. M. Price	WHC	H6-23*
L. T. St. Georges	WHC	H6-20*
H. T. Tilden	PNL	P7-79
RCRA File	WHC	H6-24

*cc:Mail

ADMINISTRATIVE RECORD: Low-Level Burial Grounds, D-2-9 [Care of EDMC, WHC (H6-08)]

Washington State Department of Ecology Nuclear and Mixed Waste Library, P.O. Box 47600, Olympia, Washington 98504-7600

Environmental Protection Agency Region 10, Seattle, Washington 98101, Mail Stop HW-070 Records Center

Please send comments on distribution list to Gloria Cummins, WHC (H6-24), (509) 372-2484.

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
2440 Stevens Ctr., Room 2100
Richland, Washington

December 6, 1995
2:00 p.m. - 4:00 p.m.

The undersigned indicate by their signatures that these meeting minutes reflect the actual occurrences of the above dated Unit Managers Meeting.

Anthony C. McKarns Date: 1/23/96
Clifford E. Clark, Unit Manager, RL
(Represented by Anthony C. McKarns, DOE-RL)

Date: 1/16/96
Norman T. Hepner, Unit Manager, Washington State Department of Ecology

---

Low-Level Burial Grounds, WHC Concurrence

Brett M. Barnes Date: 1/16/96
Richard D. Pierce, Contractor Representative, WHC
(Represented by Brett M. Barnes, WHC)

Purpose: Discuss Permitting Process

Meeting Minutes are attached. The minutes are comprised of the following:
Attachment 1 - Agenda
Attachment 2 - Summary of Discussion and Commitments/Agreements
Attachment 3 - Attendance List
Attachment 4 - Action Items
Attachment 5 - Draft Responses to 5 remaining NODs

Attachment 1

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
2440 Stevens Ctr., Room 2100
Richland, Washington

December 6, 1995
2:00 p.m. - 4:00 p.m.

AGENDA

1. **PREVIOUS MEETING MINUTES**

   - November 1, 1995, Meeting Minutes

2. **PROGRAM STATUS**

   - Pump and Treat Status (R. Mercer - WHC)

3. **PERMIT APPLICATION STATUS**

   - Part B NOD Workshop Schedule (G. Cummins - WHC)

4. **RCRA TOPICS - NOD WORKSHOP**

   - NOD Five Remaining Issues Response Letter
   - Chapter 1 - Draft LLBG Part A Rev. 8

5. **GENERAL TOPICS**

   - Past Action Items

     UMM Meeting:

     - 10-27-93:1 Pump and Treat Status (RL/WHC)
     - 11-1-95:1 Schedule a technical meeting to discuss Response Action Plan engineering technology (RL/WHC)
     - 11-1-95:2 Provide a letter approving Response Action Plan (Ecology)

     NOD Resolution Meeting:

     - 11-1-95:1 Forward White Paper on 11/87 date to respective legal departments for resolution (RL/WHC/Ecology)
     - 11-1-95:2 Arrange for discussion on lead shielding at the RIPI Council meeting (RL/WHC)

- 11-1-95:3 Provide Hanford Facility Permit General Information Volume Presentation to Ecology (RL/WHC)

- New Action Items

6. **SCHEDULE NEXT MEETING**

- Tentative Date

- Proposed Topics

Attachment 2

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
2440 Stevens Ctr., Room 2100
Richland, Washington

December 6, 1995
2:00 p.m. - 4:00 p.m.

Summary of Discussion and Commitments/Agreements

1. PREVIOUS MEETING MINUTES

The November 1, 1995, Unit Managers Meeting minutes and the Notice of Deficiency meeting minutes were approved.

2. PROGRAM STATUS

- Pump and Treat Status

Mr. R. Mercer (WHC) gave an update on the status as follows: The new extraction well was completed. Aquifer testing will start in two weeks. A numerical model for the 200 West Area was just completed and an 18-foot mound may develop at the extraction well. The demonstration project is continuing. Bechtel Hanford is drilling a new injection well.

3. PERMIT APPLICATION STATUS

- Part B Notice of Deficiency (NOD) Workshop Schedule

Ms. G. Cummins (WHC) stated the NOD Workshops are a couple weeks behind. A workshop was scheduled for December 19, 1995, to review Chapters 2 and 7 and unresolved Part A (Chapter 1) issues.

4. RCRA TOPICS - NOD WORKSHOP

- NOD Five Remaining Issues Response Letter

Ms. A. Crowell (RL) provided Ecology with the "Draft Responses to 5 remaining NODs" (Attachment 5). Ms. Cummins instructed attendees to review it in preparation for the next meeting.

- Chapter 1 - Draft LLBG Part A Rev. 8

Mr. N. Hepner (Ecology) had questions regarding the Draft Part A. He questioned the design capacity increase. Ms. Crowell identified the maps and calculations used for the capacity which helped to clarify the increase.

Mr. Hepner was concerned the leachate storage design capacity was not large enough. He indicated WHC should not have to pump

24 hours a day. Mr. K. Johnson (WHC) and Mr. D. Pratt (WHC) agreed to review what is presently available and calculate what additional tank storage would be needed. The revised leachate storage tank capacity will be provided at the December 19th workshop.

Mr. Hepner made reference to the qualifying codes for F039. The language in the LLBG Part A states that only F001 through F005 will be used. Ms. Crowell said the delisting petition for the 200 Area Effluent Treatment Facility would probably not be amended. She added that the fiscal year work plan has a task of looking at alternate ways to handle leachate, and should be completed by March. Ms. Crowell stated there is a problem with restrictions on where leachate can be sent. Mr. B. Barnes (WHC) said a sentence would have to be deleted from the Part A to solve this problem. It was agreed that the language would be reworded to allow more freedom to add other listed waste numbers (e.g., "U," "P," and other "F").

Mr. Hepner asked if covers were being installed over the leachate storage tanks. Messrs. Johnson and Pratt informed Mr. Hepner that the tanks were being covered, and that they had received the necessary approvals from the Fire Department, the hygienists, etc.

A copy of the Part A reflecting these proposed modifications will be made available at the December 19th workshop for discussion, along with Chapters 2 and 7.

5. GENERAL TOPICS

- **Past Action Items**

UMM Meeting:

Action item 10-27-93:1, Ms. Cummins asked if an update on pump and treat status is still helpful at the Unit Manager Meetings. It was decided the action item would be closed and an item on groundwater monitoring status would be added to the agenda as needed.

Action item 11-1-95:1, On scheduling a technical meeting to discuss Response Action Plan engineering technology, a discussion is planned for December 19, 1995.

Action item 11-1-95:2, a draft letter approving Response Action Plan will be complete after December 19, 1995.

NOD Resolution Meeting:

Action item 11-1-95:1, the White Paper on the November 23, 1987 date for regulatory authority of mixed waste was delivered to the respective legal departments. Ms. Cummins proposed this action be closed, but Mr. Hepner stated that by December 19th, Ecology legal department will provide their input.

Action item 11-1-95:2, Ms. Cummins stated that Mr. R. Bowman (WHC) had started work on informing the RIPI Council of the lead shielding issue.

Action item 11-1-95:3, Ms. Cummins stated that 12 working draft copies were sent to Ecology on November 28, 1995. This action item is closed--no plan to do a presentation.

- **New Action Items**

  Look at the amount of storage tanks currently being used and calculate what would be realistically needed.

  Revise the Part A to be discussed at the December 19th workshop.

6. **SCHEDULE NEXT MEETING**

- **Tentative Date**

  A workshop was scheduled for December 19, 1995, at 7:30 a.m. The next Unit Managers Meeting was scheduled for January 16, 1996.

- **Proposed Topics**

  Proposed topics for discussion include: (1) closeout of Chapters 1, 2, and 7; (2) action leakage rate, and (3) provide comments on draft Mod letter.

Attachment 3

LOW-LEVEL BURIAL GROUNDS
UNIT MANAGERS MEETING
2440 STEVENS CTR., ROOM 2100
RICHLAND, WASHINGTON

December 6, 1995
2:00 p.m. - 4:00 p.m.

Attendance List

Name	Organization	Phone #
JoAnn McCoy	WHC	372-3596
Brett M. Barnes	WHC-GWAS	376-3640
GLORIA CUMMINS	WHC	372-2484
NORM Hepner	ECOLOGY	736-3048
Kevin Johnson	WHC	373-2188
Tony MIKARWS	DOE	376-8981
Gary Hendricks	GSSC	946-3687
RB MERCER	WHC	376-8945
AK Cornell	DOE/WPD	372-2346
DA Pratt	WHC	373-2464

Attachment 4

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
2440 Stevens Ctr., Room 2100
Richland, Washington

December 6, 1995
2:00 p.m. - 4:00 p.m.

Action Items

UMM Meeting:

Action Item	Description
10-27-93:1	Schedule a technical issues meeting for RCRA/CERCLA integration and discussion of pump and treat evaluations. **CLOSED**
11-01-95:1	RL/WHC will schedule a technical meeting to discuss the Response Action Plan engineering technology within the next month. **OPEN**
11-01-95:2	Ecology will write a letter approving the Response Action Plan **OPEN**

NOD Meeting:

11-01-95:1	Forward White Paper on 11/87 date to respective legal departments for resolution. **OPEN**
11-01-95:2	Arrange for discussion on lead shielding at the RIPI council meeting. **OPEN**
11-01-95:3	Provide Hanford Facility Permit General Information Volume Presentation to Ecology. **CLOSED**

Attachment 5

LOW-LEVEL BURIAL GROUNDS
Unit Managers Meeting
2440 Stevens Ctr., Room 2100
Richland, Washington

December 6, 1995
2:00 p.m. - 4:00 p.m.

DRAFT RESPONSES TO 5 REMAINING NODs

DRAFT Responses to 5 remaining NODs.

1. Waste Acceptance Criteria -- In the response to Notice of Deficiency (NOD) #14, Ecology was informed that there is a new, state-of-the-art portable high energy radiography unit which was to be tested early in 1994 for its capability to detect liquids in lead-shielded waste packages. A report and current status of this technology should be provided. Additionally, provide an estimate of the number of packages containing lead as shielding and the percentage of these packages that will be assessed for presence of liquids.

   Although NOD #14 was originally limited to detecting liquids that may inadvertently get into the trenches, it is applicable to all packages. In the Hanford RCRA Permit, we are requiring the 305-B and 616 Storage Units to perform limited waste verification on 5% of shipments generated on-site. (See Conditions III.1.B.f., III.1.B.n., III.2.B.d., and III.2.B.f.). It is proposed that on-site waste received at the LLBG also be subject to 5 % verification, and that off-site waste be subject to 10 % verification. It is also proposed that the Submarine Reactor Compartments (SRCs) be exempt from physical verification at the Hanford Site since the U.S. Department of Energy (DOE) performs verification at the storage units.

   <u>RL Response to #1:</u>

   y The portable high energy radiography unit which was utilized by an WHC subcontractor to support Tank Farms Backlog Waste designation preformed well. Current plans are to equip the Waste Receiving and Processing (WRAP) Module 1, when operational, with two radiography technologies (linear array and real time) that will be used in waste verification for both low-level and mixed waste. The linear array provides a full-length image of a drum and the real time provides a 22.86 centimeter (9 inch) closeup view of any suspect items or areas within the drum. The box system in WRAP Module 1 only has real time radiography. The extent to which either of these systems can penetrate lead shielding depends on thickness, but in general lead shielding prevents quality radiographic review.

   y An estimate of the number of packages that contain lead as shielding is difficult to provide as shielding is incorporated into the packaging on an as needed basis. The vast majority of RCRA regulated waste received for disposal at the LLBG which contain lead as shielding will be in the form of Naval vessel reactor compartments or SRCs. The second major grouping of lead shielded waste is non-RCRA radioactive waste only (i.e. low level). The final grouping of waste containing lead as shielding is RCRA regulated mixed waste. This is anticipated to be a very small percentage (less than 1% by weight) of the total waste which contains lead as shielding.

   In responding to Ecology's request for a percentage of lead shielded containers that will be assessed for the presence of liquids, this also is difficult number to provide, however waste acceptance criteria is in place (WHC-EP-0063) which clearly states that containers with free

liquids are not acceptable for disposal in the LLBGs. Verification of these containers will be governed by waste acceptance criteria and verification requirements as well as ALARA considerations.

y Ecology notes in their letter that it is proposed that on-site waste receipts be subject to a 5% verification requirement while off-site receipts are proposed to be subject to 10% verification. It should be noted that Washington State Dangerous Waste Regulations (WAC 173-303) do not specify specific waste verification requirements, but rather require the owner/operator to confirm his knowledge about a dangerous waste...to insure that the waste is managed properly. Currently, RL is fulfilling this requirement by performing waste verification on 5% for the waste packages received at the Low-Level Burial Grounds. The waste verification program is described in WHC-IP-1159, Verification Program Manual for Solid Waste Disposal Facilities. Based on waste projections for FY 1996, approximately 200 waste packages will be undergo NDE at TRUSAF and 10 packages will be opened at T Plant. Where ALARA is a concern, verification might be accomplished at the point of generation.

The proposed off-site 10% verification requirements does not appear to be regulatorily based. DOE is interested in Ecology's regulatory basis for this proposal, as well as Ecology's cost benefit analysis and evaluation of furthering the protection of the environment. DOE is willing to discuss any proposal that makes sense and improves the utilization of tax payer funding.

2. Use of Unlined Trenches -- There is a need to discuss the continued use of the unlined trenches in the LLBG for mixed waste disposal. DOE has used unlined trenches to dispose of mixed waste consistent with a January 26, 1988, strategy letter (see Appendix 4D of LLBG Permit Application). However, since that letter, more options have become available for mixed waste storage and disposal such as the lined LLBG trenches, grout vaults, and the Central Waste Complex.

   Furthermore, DOE is assessing other disposal needs and options through a "Direct Disposal Options" team. Ecology proposes that the 1988 strategy be revised to reflect the approved final product of the Direct Disposal Options team. Since an agreed plan for using unlined trenches will probably not be attained by October 1995, we propose that the text of the permit application be modified to state that the use of unlined trenches will be based upon the strategy in Appendix 4D. This will allow an extra year to resolve this issue as a new strategy can be inserted into Appendix 4D just prior to DOE resubmitting the application in October 1996.

   The following issues were raised through previous NODs and should be considered in developing the new strategy:

- Quantities and descriptions of mixed waste packages currently disposed in the trenches,
- Intent and need for using existing remote handled mixed waste trenches, and
- Need for liner and leachate collection systems.

In the past, Ecology has stated that a single liner and leachate collection for "drag off" and other existing trenches be used for mixed waste disposal after permitting (Federal Register 50, page 28708, column 3). Ecology understands that only one existing "drag-off" trench has previously accepted mixed waste (trench 9 of 218-E-10). Additionally, Ecology also requested that DOE identify which trenches received mixed waste after November 23, 1987. Ecology now proposes that we not attempt to establish the date of waste placement for each trench, but instead, focus on if, when, and how we will allow the continued use of unlined trenches. (Based on NOD Comments 1, 15, 16, and 122). The strategy developed will be the key element in addressing these questions.

RL Response:

DOE-RL has revised its projected future need for RCRA mixed waste disposal, and as such has decided to pursue final status RCRA permitting on only 3 of the available 8 burial grounds. None of the 5 burial grounds for which final status permitting is no longer sought have received RCRA regulated waste since the November 23, 1987 date referred to by Ecology.

In this revised strategy, DOE anticipates all disposal of RCRA regulated waste will be in fully compliant, lined trenches. If unique circumstances arise in which the placement of a RCRA regulated waste into an unlined trench made sense and was protective of human health and the environment, DOE will consult with Ecology and seek approval prior to any such disposal.

A draft LLBG disposal strategy letter currently is attached and will formally transmitted to Ecology prior to the January 1996 NOD workshop.

3. Vadose Zone Monitoring -- A vadose zone monitoring program should be included in the permit application. WAC 173-303-645 (9) (a) (ii) specifies evaluating the existence of waste constituents in the unsaturated zone beneath the waste management area. The appropriate approach includes characterizing the unsaturated zone, then modeling the migration of identified constituents (Based on NOD Comment 179).

We anticipate that a vadose zone monitoring plan could not be prepared by October 1995. Therefore, we recommend that our discussions focus on the need, both regulatorily and technically, for such a plan. If Ecology determines such a need exists, the application need only state that a vadose zone monitoring plan be developed and commit to a compliance schedule for developing and implementing such a plan.

RL Response to #3:

DOE is willing to discuss any proposal that makes sense and improves the utilization of tax payer funding. However, where proposals are not regulatorily based, there needs to be clear evidence as to the benefit. As there are no regulatory drivers for vadose zone monitoring and the three burial grounds identified in the Part B Permit Application all have a RCRA-compliant groundwater monitoring systems, some additonal benefit needs to be available for this to "make sense".

Currently DOE is engaged in a restructuring of the overall Hanford Site Groundwater Monitoring approach and integration between RCRA/CERCLA monitoring programs. This restructuring is certain to impact the LLBG and any detailed discussion on LLBG groundwater or vadose zone monitoring prior to this groups development of a path forward would be premature and counterproductive. Additionally, RL is working with Ecology in regards to integration of 200-ZP-1 Pump and Treat Activities and RCRA monitoring at the 218-W-4C Burial Ground.

4. Trench Closure Timing, Design, and Integration -- Ecology is primarily concerned that there is unnecessary delay in covering unlined trenches containing mixed waste until DOE fills unused portions of unlined trenches with radioactive wastes. Closure schedule, interim covers, order of filling trenches, covering units with unfilled trenches, delaying covering because of waste retrieval needs, difficulty in covering because of overlap onto existing structures, etc., need to be fully identified, examined and finalized where possible for the permit application.

   We propose that DOE funding be aimed at expediting the covering of unlined trenches. Additionally, a thorough review should be completed of the filling sequence to assess the possibility of eliminating non-mixed waste areas from the application by altering the trench filling sequence (Based on NOD Comments 210 and 225). It is anticipated that some of these issues can be resolved by October 1995.

<u>RL Response to #4:</u>
RL recognizes the concerns raised in this issue. There are some factors, however, that sufficiently mitigate Ecology's concerns. As you know, the LLBG are located in a semi-arid environment. The region's negative evapotranspiration rate reduces the potential of liquids from seeping into the soil. Additionally, no releases from the LLBG to the environment have been detected since completion of the RCRA-compliant ground water monitoring system seven years ago. Furthermore, temporary closure would provide no greater protection to human health and the environment than the management practices currently in place, and are a costly interim measure.

Consequently, RL intends to close the burial grounds upon completion of the following activities:

- y Retrievable TRU waste would be removed
- y Trenches containing removed TRU would be refilled with LLW
- y The burial ground would be filled to capacity
- y An assessment would be conducted to determine if closure of the burial ground will impact operable units, buildings, or other structures and their operation

y Closure caps or other approved closure technologies would be evaluated to assure adequate protection to human health and the environment per unit cost.

- Coordination with the closure of the inactive burial grounds.

5. Submarine Reactor Compartment (SRC) Performance Plan -- Ecology will be meeting with the DOE and U.S. Navy to discuss the need for the SRC Performance Plan. At this time, the SRC Performance Plan should be finalized. Ecology proposes exploring alternative actions (e.g. interim cover, etc) in lieu of a performance demonstration. It is expected that this issue can be resolved with DOE prior to October 1995, for incorporation into the application.

   Additionally, Ecology maintains that the liner exemption request for the SRC trench should be a part of the application and not a "supplement" to the application. Approval of the liner exemption request would then be obtained concurrently with permit issuance. This issue can be resolved prior to October 1995.

   <u>RL response to be provided in the formal submittal.</u>

Mr. Doug R. Sherwood
Hanford Project Manager
U.S. Environmental Protection Agency
Region 10
712 Swift Boulevard, Suite 5
Richland, Washington 99352

Mr. Michael A. Wilson, Program Manager
Nuclear and Mixed Waste Program
State of Washington
Department of Ecology
Post Office Box 47600
Olympia, Washington 98504-7600

Dear Messrs. Sherwood and Wilson:

STRATEGY LETTER FOR THE DISPOSAL OF MIXED WASTE IN THE LOW-LEVEL BURIAL GROUNDS

In response to a letter from Mr. N. T. Hepner, State of Washington Department of Ecology (Ecology), to Mr. C. E. Clark, U.S. Department of Energy, Richland Operations Office (RL), "Five Remaining LLBG Notices of Deficiency," dated June 1, 1995, requested that RL develop a disposal strategy for mixed waste disposal in unlined trenches of the Low-Level Burial Grounds (LLBG). A disposal strategy is included with this correspondence. This disposal strategy supersedes a previous disposal strategy letter from Mr. R. D. Izatt, RL, and Mr. R. E. Lerch, Westinghouse Hanford Company (WHC), to Mr. R. S. Stanley, Ecology, and Mr. J. O'Hara, U.S. Environmental Protection Agency, "Hanford Solid Radioactive Mixed Waste Storage Facility Strategy," dated January 26, 1988.

The LLBG are identified as a landfill, divided into eight burial grounds. Six burial grounds are located in the 200 West Area and two burial grounds are located in the 200 East Area. In 1988, the Hanford Facility had extremely limited Resource Conservation and Recovery Act (RCRA) storage or minimum technical standard (MTS) facilities for mixed waste disposal. The January 26, 1988, letter provided the Hanford Facility with operating flexibility to safely handle mixed waste. Today, the LLBG include RCRA compliant double-lined trenches with leachate collection and removal systems

that meet or exceed the Title 40, Code of Federal Regulations (CFR), Part 264 MTS, and unlined trenches of various sizes and depths for radioactive only waste. All mixed waste destined for disposal in lined trenches will meet land disposal restriction requirements in Title 40, CFR, Part 268. In short, the operation of lined and unlined trenches will be in compliance with the Title 40, CFR and the Washington Administrative Code 173-303 regulations.

Should you have any questions regarding the LLBG disposal strategy, please contact Mr. R. F. Guercia, RL, on (509) 376-5494 or Mr. C. E. Clark, RL, on (509) 376-9333.

Sincerely,

Thomas K. Teynor, Director
Waste Program Division

Enclosure:
Disposal Strategy for Unlined
Trenches of the LLBG

cc w/encl:
R. Bowman, WHC
D. Duncan, EPA
W. Hamilton, Jr., WHC
N. Hepner, Ecology
M. Jaraysi, Ecology
R. Jim, YIN
D. Lundstrom, Ecology
R. Pierce, WHC
D. Powaukee, NPT
S. Price, WHC
J. Wilkinson, CTUIR
Administrative Records, H6-08

0045914

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

NOV 0 7 1996

96-SWT-333

Mr. Moses N. Jaraysi
200 Area Unit Supervisor
Nuclear Waste Program
State of Washington
Department of Ecology
1315 West Fourth Avenue
Kennewick, Washington 99336-6018

Mr. Joseph J. Witczak
Unit Supervisor
Regulatory and Technical Support
State of Washington
Department of Ecology
P.O. Box 47600
Olympia, Washington 98505-7600

Dear Messrs. Jaraysi and Witczak:

A FINAL REPORT: LABORATORY TESTING OF GEOMEMBRANE FOR WASTE CONTAINMENT ENVIRONMENTAL PROTECTION AGENCY METHOD 9090

Enclosed is the final report titled "Laboratory Testing of Geomembrane for Waste Containment EPA Method 9090" and Engineering Data Transmittal. This report was prepared to assist the State of Washington, Department of Ecology (Ecology) with the Resource Conservation and Recovery Act permitting efforts for the Low-Level Burial Grounds, located in the 200 East and 200 West Areas of the Hanford Facility. In addition, a supporting document entitled, WHC-SD-WM-TI-714, "High-Density Polyethylene Liner Chemical Compatibility for Radioactive Mixed Waste Trenches, Revision 0," provides a list of compatible and incompatible chemicals and a compilation of various available literature regarding chemical compatibility of high-density polyethylene liners.

NOV 1996
RECEIVED
EDMC

NOV 0 7 1996

Should you have any questions regarding the final report, please contact Cliff Clark, RL on (509) 376-9333, or William Adair, FDH on (509) 376-0428.

Sincerely,

James E. Rasmussen

James E. Rasmussen, Director
Environmental Assurance, Permits,
and Policy Division
DOE Richland Operations Office

William D. Adair

William D. Adair, Director
Environmental Protection
Responsible Party for
Fluor Daniel Hanford, Inc.

Enclosure:
"A Final Report: Laboratory Testing of Geomembrane for Waste Containment EPA Method 9090," and WHC-SD-WM-TI-714, "High-Density Polyethylene Liner Chemical Compatibility for Radioactive Mixed Waste Trenches"

cc w/encl:
EDMC, H6-08
R. Jim, YIN
C. G. Mattsson, FDH
R. Pierce, RFSH
D. Powaukee, NPT
S. Price, FDH
J. Wilkinson, CTUIR

cc w/o encl:
W. D. Adair, FDH
D. Sherwood, EPA

AUG 21 1995

ENGINEERING DATA TRANSMITTAL

1. EDT № 612438

2. To: (Receiving Organization) Solid Waste Management	3. From: (Originating Organization) Solid Waste Management	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Solid Waste Disposal	6. Cog. Engr.: KM McDonald	7. Purchase Order No.: N/A
8. Originator Remarks: This EDT is for the approval and release of the attached HDPE liner chemical compatibility document.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: 218-W-5, RMW Trenches
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date:

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-WM-TI-714	ALL	0	High-Density Polyethylene Liner Chemical Compatibility for Radioactive Mixed Waste Trenches	ESQ	1/2	1	

16. KEY

Approval Designator (F)	Reason for Transmittal (G)		Disposition (H) & (I)	
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment	4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
1	1	Cog.Eng. KM McDonald	[signature]	8/11/95	T4-03	[illegible]	[signature]		T4-03	3	
1	1	Cog. Mgr. DB Powell	[signature]	8/14/95	T4-03						
1	1	QA DL Vance	[signature]	8/11/95	T4-GL						
1	1	Safety ML Graham	[signature]	8/11/95							
1	1	Env. SE Campbell	[signature]	8/11/95	T4-05						
3	4	RL Mangum	[signature]	8/14/95	T4-03						
3	1	NP Willis	[signature]	8/14/95	T3-04						

18.	19.	20.	21. DOE APPROVAL (if required)
KM McDonald [signature] 8/11/95 Signature of EDT Originator Date	Authorized Representative for Receiving Organization Date	DB Powell [signature] 8/14/95 Cognizant Manager Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

THIS PAGE INTENTIONALLY
LEFT BLANK

AUG 21 1995

ENGINEERING DATA TRANSMITTAL

1. EDT № 612438

2. To: (Receiving Organization) Solid Waste Management	3. From: (Originating Organization) Solid Waste Management	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Solid Waste Disposal	6. Cog. Engr.: KM McDonald	7. Purchase Order No.: N/A
8. Originator Remarks: This EDT is for the approval and release of the attached HDPE liner chemical compatibility document.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: 218-W-5, RMW Trenches
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date:

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-WM-TI-714	ALL	0	High-Density Polyethylene Liner Chemical Compatibility for Radioactive Mixed Waste Trenches	ESQ	1/2	1	

16. KEY

Approval Designator (F)	Reason for Transmittal (G)		Disposition (H) & (I)	
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment	4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
1	1	Cog.Eng. KM McDonald	[signature]	8/11/95	T4-03	Whitlock, RW			T4-03	3	
1	1	Cog. Mgr. DB Powell	[signature]	8/14/95	T4-03						
1	1	QA DL Vance	[signature]	8/11/95	T4-01						
1	1	Safety ML Graham	[signature]	8/11/95							
1	1	Env. SE Campbell	[signature]	8/11/95	T4-05						
3	4	RL Mangum	[signature]	8/14/95	T4-03						
3	1	NP Willis	[signature]	8/14/95	T3-04						

18.	19.	20.	21. DOE APPROVAL (if required)
KM McDonald [signature] 8/11/95 Signature of EDT Originator Date	Authorized Representative for Receiving Organization Date	DB Powell [signature] 8/14/95 Cognizant Manager Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (04/94) GEF097

BD-7400-172-1

THIS PAGE INTENTIONALLY
LEFT BLANK

RELEASE AUTHORIZATION

Document Number:	WHC-SD-WM-TI-714, REV 0
Document Title:	High-Density Polyethylene Liner Chemical Compatibility for Radioactive Mixed Waste Trenches
Release Date:	8/21/95

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Kara M. Broz 8/21/95

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy. Available in paper copy. Printed in the United States of America. To obtain copies of this report, contact:

Westinghouse Hanford Company - Document Control Services
P.O. Box 1970, Mailstop H6-08, Richland, WA 99352
Telephone: (509) 372-2420; Fax: (509) 376-4989

Permission to use the Copyrighted information in this document has been granted by G.S.E Lining Technology. Documentation has been archived with the Information Release Request at Central Files.

THIS PAGE INTENTIONALLY
LEFT BLANK

SUPPORTING DOCUMENT

1. Total Pages 93

2. Title

HIGH-DENSITY POLYETHYLENE LINER CHEMICAL COMPATIBILITY FOR RADIOACTIVE MIXED WASTE TRENCHES

3. Number

WHC-SD-WM-TI-714

4. Rev No.

0

5. Key Words

High-Density Polyethylene, HDPE, Liner, Leachate, Compatibility, Trench 31, Trench 34, RMW Disposal

6. Author

Name: KM McDonald

Signature 8/11/95

Organization/Charge Code 87250/A7D38

7. Abstract

This document provides a compilation of various available literature regarding chemical compatibility of the high-density polyethylene (HDPE) liners in the mixed waste trenches. A list is provided of chemicals which have been shown to be compatible with the liner material under the expected conditions. A list is also provided of incompatible chemicals. A justification is provided for accepting the fact that the results of chemical compatibility testing performed on the 80 mil liner are equally applicable to the thinner liner materials.

8. RELEASE STAMP

OFFICIAL RELEASE BY WHC

DATE AUG 21 1995

2

A-6400-073 (08/94) WEF124

THIS PAGE INTENTIONALLY
LEFT BLANK

HIGH-DENSITY POLYETHYLENE LINER CHEMICAL COMPATIBILITY FOR RADIOACTIVE MIXED WASTE TRENCHES

1.0 INTRODUCTION

This document consists of a compilation of chemical compatibility data for high-density polyethylene (HDPE). It serves the purpose of providing a technical justification for allowing or disallowing various chemicals as waste constituents in waste destined for disposal in one of the radioactive mixed waste (RMW) trenches. Approval or disapproval of a specific chemical is based on compatibility of the resultant waste leachate with the trench liner. Chemicals which will be specifically examined for compatibility in this study include those chemicals from currently projected waste streams.

Specific compatibility information or concentration limits are given in the literature for many chemical constituents, but not all. Where data is not available on a specific constituent, conservative estimates of chemical behavior can be determined by relating the chemical to a similar chemical (same chemical family, similar reactivity behavior) for which specific information is known. Chemicals which are listed as being incompatible are noted as such because there is a definite reference in the literature to that constituent's incompatibility with HDPE.

Liner thickness has been the source of considerable discussion. The importance of liner thickness on test results is discussed, with the conclusion that the acceptability of a given chemical is not dependent upon liner thickness.

This document, and the list of compatible and incompatible chemicals should not be considered all inclusive. There are many other chemicals in existence which are compatible, and probably many which are incompatible. None are currently expected in any of the waste streams projected for the RMW trenches. Other chemicals which may be presented in the future for inclusion in the RMW trenches should be evaluated based on the same criteria that are used in this study.

2.0 BACKGROUND

The RMW trenches which are currently under consideration are Burial Ground 218-W-5, Trenches 31 and 34. It is possible that at a future date, other RMW trenches will be completed. If they are of a design similar to trenches 31 and 34, this analysis should still apply.

The trenches consist of a double lined, RCRA complaint landfill for disposal of solid mixed waste. The landfills have an earthen cover layer over a primary liner. The primary liner is a single HDPE geomembrane draining to a sump. Beneath the primary layer, a secondary HDPE liner provides containment and leak detection capabilities, and also drains to a sump. Located under the secondary layer is a low-permeability soil layer.

Code of Federal Regulations Title 40 (40 CFR) Section 264.301 states that the leachate collection and removal system must be constructed of materials that are "chemically resistant to the waste managed in the landfill and the leachate expected to be generated...." Washington Administrative Code (WAC) 173-303-665 contains similar requirements.

This document provides the data and discussion necessary to show that the liner does indeed provide proper chemical resistance to the expected chemical constituents.

3.0 METHODOLOGY

This study surveys the available data on chemical compatibility with the HDPE liners in the RMW trenches, and makes recommendations as to what chemicals can be considered compatible, and what chemicals should be restricted from disposal in the trenches. Some of the data which was utilized includes EPA 9090 testing on the liner material conducted on behalf of Westinghouse Hanford Company, Manufacturers chemical resistance data for HDPE, and published literature regarding chemical concentrations in leachate.

This report will provide an analysis for each compatible chemical, based on the above mentioned data, and based on expected concentrations in the leachate. The latter is in turn dependent upon the waste form and the solubility of the chemical constituent in the leachate. A summary and recommendations will be included to complete the study.

4.0 FINDINGS AND ANALYSIS

4.1 Chemical Interactions

HDPE is a polymeric "chain link" of ethylene molecules. Although it is very resistant to most chemicals, any chemical reacts with other chemicals to varying degrees, according to certain predictable behavior. There are three basic models of interaction between polymeric materials and other chemicals [Rodriguez, 1989; Cole Parmer, 1993]. These are:

1. Chemical attack on the polymer chain. These attacks can include oxidation; reaction of functional groups in or on the polymer chain; and depolymerization. These can result in a reduction in physical properties.

2. Physical change. This may include absorption of solvents, resulting in softening and swelling of the plastic; permeation of solvent through the plastic; or dissolution in a solvent.

3. Stress cracking from interaction of a "stress cracking agent" with external stresses.

4.2 Liner Thickness

All of the above mentioned chemical interactions are dependent upon properties of the resin (polymer and additives) from which the liner is constructed, and are not dependent upon the thickness of the liner. EPA 9090 testing and other testing for chemical compatibility are aimed at determining effects of chemicals on the liner, not on a specific liner thickness. Thus the 60 mil liner which lines the trench and the 80 mil liner which lines the loadout pad, if made of a similar resin, will behave similarly in chemical compatibility tests. The SLT HyperFlex® geomembranes used in the RMW trenches have been certified by the manufacturer (Appendix E) to be made from the same resin specification (97-98% polyethylene, 2-3% carbon black for uv stability). The chemical compatibility behavior of both liners will be identical. The results of testing performed on one liner are equally valid on the other liner.

It should be noted that the liner **thickness** used in various applications (i.e., trench lining or pad lining) was determined based on structural strength requirements or other similar criteria, not on compatibility. The liner **material** was chosen based on compatibility. In cases where liner material (resin composition) is identical, chemical compatibility tests performed on a fabric of one thickness are equally applicable to a fabric of another thickness, and should be treated as such.

4.3 Assumptions

4.3.1 Temperature

Temperature of the liners is expected to remain between 35-55 F. The liners are not exposed to direct sunlight or ambient external air temperatures.

4.3.2 Concentration

Concentration of contaminants in the leachate will be significantly less than the concentration of the constituent in the waste stream. Because the leachate will consist of mostly water, those contaminants of greatest concern are those which are water soluble. Non water-soluble organic constituents that are released to the soil will tend to remain suspended in the soil matrix. Wentz [1989] indicates that wastes which are either water reactive or water soluble will tend to migrate downward through the landfill as a constituent of the leachate.

Unpublished leachate characterizations from municipal landfills were used to verify the expected concentrations of organics in the leachate. Data from Homestand Land Corp. Greentree Landfill indicate a total organic carbon (TOC) content of 3075 mg/l (average of two samples). Data from Valley Landfill in Irwin, PA, indicate a TOC of 666 mg/l (average of two samples). Data from the Chambers/Geotechnical leachate samples indicate a TOC of 156 mg/l (average of two samples). In no case was the concentration of any single constituent (other than water) greater than 1000 mg/l. This data represents actual data from municipal landfills. The waste is not fixed or otherwise stabilized as will be the waste in the RMW trenches.

HyperFlex is a Registered Trademark of SLT NORTH AMERICA, INC.

4.4 Compatible Chemicals

The following sections list the chemicals which have been determined to be compatible with the HDPE liner under the expected conditions and the specific sources on which the determination was based. Except where noted, compatibility listed in the following paragraphs is the compatibility of HDPE with chemicals full strength (100% concentration) or where appropriate as a saturated solution in water. In general, compatibility charts list a chemical as either having full compatibility, limited application acceptable, or not recommended for use, at a given temperature. Factors such as concentration directly affect the liner's performance against the given chemical. Where limited application is acceptable (at full strength), the bulk of data suggests that for the very limited concentrations expected in the leachate, no incompatibility issue exists. Unless there is evidence to the contrary, chemicals for which the liner material provides limited resistance are acceptable under the expected liner/leachate conditions.

4.4.1 1-Hexanol

Appendix C reports hexanol as being fully compatible up to 140 °F. WHC [1995] reports that an organic solution which included 0.8 wt% hexanol was acceptable.

4.4.2 1,1,1-Trichloroethane

Appendix B reports that limited application of trichloroethane is acceptable. Appendix D shows that trichloroethane is compatible to a concentration of 2000 mg/l. WHC [1995] reports that trichloroethane was shown to be acceptable up to at least 0.2 wt%.

4.4.3 1,2-Dichloroethene

Appendix C reports that dichloroethene (dichloroethylene) is fully compatible up to 120 °F. Appendix D reports that dichloroethene is compatible to a concentration of at least 2000 mg/l.

4.4.4 1,3-Dichlorobenzene

Appendix B does not list the 1,3- isomer of dichlorobenzene (i.e., *meta*-), but does list the 1,2- and the 1,4- isomers (i.e., *ortho*- and *para*-, respectively). The behavior is expected to be similar. Appendix B reports that limited application of these two isomers is acceptable. Concentrated 1,2-dichlorobenzene may have some effects but only after long term (7 days) exposure. Concentrated 1,4-dichlorobenzene will have little or no effect even after 30 days of exposure. Appendix C reports dichlorobenzene (all isomers) as compatible to at least 120 °F. Appendix D shows that dichlorobenzene (all isomers) is compatible to at least 2000 mg/l. Dichlorobenzene was specifically considered in the WHC [1995] testing, and was found to be compatible to a concentration of at least 0.2 wt%.

4.4.5 1,4-Dichlorobenzene

See Section 4.4.4

4.4.6 2-Butoxyethanol

Although 2-butoxyethanol is not listed specifically in any of the available data, its behavior in association with the HDPE liner can be inferred from comparing it with chemicals of similar behavior. A common name for 2-butoxyethanol is ethylene glycol monobutyl ether. Thus 2-butoxyethanol will have some reactivity characteristics common to ethers and others common to the alcohol/glycol group. Appendix B reports ethylene glycol methyl ether as being fully compatible with HDPE. There is no reason to believe that the behavior of ethylene glycol monobutyl ether, with respect to HDPE, would be significantly different. See also Section 4.4.63, Ethylene Glycol.

4.4.7 2-Propanol

Although 2-propanol is not listed specifically in any of the available data, its behavior in association with the HDPE liner can be inferred from comparing it with chemicals of similar behavior. Appendix C reports that 1-propanol (propyl alcohol, type I) is fully compatible with HDPE to at least 140 °F. There is no reason to believe that the behavior of 2-propanol, with respect to HDPE, would be significantly different. Numerous other alcohols were also found to be compatible with the liner, most notably butanol (See Section 4.4.8).

4.4.8 2-Butanol

Appendix A reports that butanol (butyl alcohol), at 100% concentration, is compatible with HDPE. Appendix B confirms this, listing specifically *n*-butyl alcohol, *sec*-butyl alcohol, and *tert*-butyl alcohol. Appendix C agrees that butyl alcohol is fully compatible to 140 °F. Appendix D states that butyl alcohol is compatible at least to a concentration of 500,000 mg/l. 2-butanol was included in the WHC [1995] testing as the organic solution matrix (89.35 wt%), and was found to be satisfactory.

4.4.9 2-Butanone (Methyl Ethyl Ketone)

Appendix B shows that MEK is fully compatible with HDPE. Appendix C shows full compatibility up to a temperature of 73 °F. Appendix D indicates that MEK is compatible up to 200,000 mg/l.

4.4.10 2-Chloroethyl Ether

WHC [1995] testing showed that 2-chloroethyl ether is compatible with HDPE up to a concentration of 0.2 wt%. It can be inferred that the behavior of 2-chloroethyl ether ($ClCH_2CH_2OCH_2CH_2Cl$) would be similar to that of 2-chloroethyl vinyl ether ($CH_2{=}CHOCH_2CH_2Cl$), for which Appendix D shows compatibility up to at least 2,000 mg/l. Further, 2-chloroethyl ether is insoluble in water, and thus its concentration in the leachate is expected to

be even smaller than most other constituents. In light of the above, 2-chloroethyl ether is considered to be compatible with the liner system.

4.4.11 2-Chlorophenol

Appendix D shows that 2-chlorophenol is compatible with HDPE up to a concentration of at least 2,000 mg/l. This is within the limit expected to be encountered by the liner.

4.4.12 2-Hexanone

Although 2-hexanone (methyl butyl ketone, or MNBK) is not listed specifically in any of the attached data, its behavior in association with the HDPE liner can be inferred from comparing it with chemicals of similar behavior. Methyl isobutyl ketone (MIBK) is the closest comparison available. See Section 4.2.74, Methyl Isobutyl Ketone. There is no reason to believe that the behavior of 2-hexanone (MNBK) with respect to the HDPE liner would be significantly different than that of MIBK. See also Section 4.4.9, 2-Butanone.

4.4.13 2-Methylnaphthalene (Coal Tar)

All of the coal tar derivatives are polyaromatic hydrocarbons, with various attachments to the ring structure. Their behavior as a group or as individuals will be similar. Those for which data exist provide the following. Appendix D lists acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3,c,d)pyrene, and phenanthrene, and states that all are compatible at least to a concentration of 2000 mg/l. There is no reason to suspect that any other coal tar derivatives would exhibit significantly different behavior with respect to the HDPE liners.

4.4.14 2-Nitrophenol

Although 2-nitrophenol is not listed specifically in any of the available data, its behavior in association with the HDPE liner can be inferred from comparing it with chemicals of similar behavior. 2-Nitrophenol will exhibit some combination of the traits of nitrobenzene and phenol. Appendix B reports that limited application is acceptable below 20°. In addition, Appendix C reports that nitrobenzene is acceptable up to 73 °F. Appendix D indicates that nitrobenzene is acceptable up to 100,000 mg/l. See also Section 4.4.85, Phenol.

4.4.15 2,4-D

Although 2,4-dichlorophenoxyacetic acid (2,4-D) is not listed specifically in any of the available data, its behavior in association with the HDPE liner can be inferred from comparing it with chemicals of similar behavior. 2,4-D may exhibit some traits of acetic acid, dichlorobenzene, and possibly chloroacetic acid. Acetic acid is listed in Appendix A as being compatible at 20°C (68°F). Appendix B reports that acetic acid is completely compatible at concentrations

less than 50%. Appendix C indicates that any concentration of acetic acid is compatible up to 73°F. Appendix D indicates a concentration of 500,000 mg/l acetic acid is acceptable.

Appendix A shows that a chloroacetic acid solution is compatible. Appendix B states that chloroacetic acid is acceptable. Appendix C states that a 50% solution of chloroacetic acid is compatible up to a temperature of 120°F.

See also Section 4.4.56, Dichlorobenzene.

4.4.16 3,5-Dimethyl Pyridine

Although 3,5-dimethyl pyridine is not listed specifically in any of the available data, its behavior in association with the HDPE liner can be inferred from comparing it with chemicals of similar behavior. Based on the structure of 3,5-dimethyl pyridine, it would exhibit behavior that is a hybrid of xylene and pyridine.

Pyridine is listed in Appendix A as being compatible at 100% concentration, up to a temperature of 20°C. Appendix C indicates that pyridine is compatible up to 73°F. Appendix D shows that pyridine is compatible to a concentration of 100,000 mg/l.

Although Appendix D indicates that the use of 100% xylene with polyethylene is not recommended, Appendix A indicates that limited use of 100% xylene is possible with HDPE. One limitation recommended is concentration. Appendix B shows that little or no damage should be expected from constant exposure of 100% xylene for 30 days. Appendix D looked at a leachate with a xylene concentration of 5000 mg/l and found no problems.

Based on the above, and the fact that concentration of the organic constituent, 3,5-dimethyl pyridine, pyridine, and xylene are found to be acceptable under the foreseeable RMW trench conditions.

4.4.17 4-Chloro-3-Methylphenol

Although 4-chloro-3-methylphenol is not listed specifically in any of the available data, its behavior in association with the HDPE liner can be inferred from comparing it with chemicals of similar behavior. Based on the structure of 4-chloro-3-methylphenol, it would exhibit behavior that is a hybrid of 2-chlorophenol (See Section 4.4.11) and toluene (See Section 4.4.106) or possibly cresol (See Section 4.4.20).

4.4.18 4-Chloroaniline

Although 4-chloroaniline is not listed specifically in any of the available data, its behavior in association with the HDPE liner can be inferred from comparing it with chemicals of similar behavior. Based on the structure of 4-chloroaniline, it would exhibit behavior that is a hybrid of aniline and a chlorobenzene derivative (See Section 4.4.4).

Aniline is given in Appendix A as being fully compatible up to 20°C. This is consistent with Appendix B, fully compatible up to 20°C. Appendix C reports that aniline is compatible up to 73°F.

4.4.19 4-Methyl-2-Pentanone

See Section 4.4.74, Methyl Isobutyl Ketone.

4.4.20 4-Methylphenol - cresol

Appendix A indicates that limited use of a saturated solution of cresol (as cresylic acid) is possible with HDPE. One limitation recommended is concentration. Appendix B indicates that limited application of cresol (100%) is acceptable. Appendix C shows that Cresol (90%) is compatible up to 73°F, and that a 50% solution of cresylic acid is also acceptable with some limitations. Appendix D shows that no liner compatibility problems should be expected as long as the concentration of cresol is kept below 100,000 mg/l. See also Section 4.4.85, Cresol.

4.4.21 4,4'-DDD

1,1-Bis(4-chlorophenyl)-2,2-dichloroethane (4,4'-DDD) is shown in Appendix D to be compatible with the HDPE liners up to a concentration of 2000 mg/l.

4.4.22 4,4'-DDE

2,2-Bis(4-chlorophenyl)-1,1-dichloroethene (4,4'-DDE) is shown in Appendix D to be compatible with the HDPE liners up to a concentration of 2000 mg/l.

4.4.23 Acenaphthene (coal tar)

See Section 4.4.13, 2-Methylnaphthalene.

4.4.24 Acetone

Appendix A indicates that limited use of 100% acetone is possible up to 140°F. Appendix B shows that acetone is completely compatible with the HDPE up to 50°C. Appendix C indicates that limited application of 100% acetone is possible up to 73°F. Appendix D shows that acetone is compatible with the liner up to a concentration of 200,000 mg/l. WHC [1995] testing indicates that 4 wt% acetone showed no compatibility problems. Under the conditions expected in the RMW trenches, there is no reason to believe that the concentrations of acetone would be deleterious to the liners.

4.4.25 Acetonitrile

Appendix B reports that acetonitrile is completely compatible with the HDPE liners. In addition, WHC [1995] testing shows that a leachate containing 0.8 wt% acetonitrile produced no deleterious effects.

4.4.26 Aldrin

Appendix D reports that aldrin is acceptable up to a concentration of 2000 mg/l in the leachate. This is within the limit expected to be encountered by the liner.

4.4.27 Aliquat 336

WHC [1995] testing shows that a leachate containing 0.8 wt% Aliquat 336 (Methyltrioctylammonium chloride) produced no deleterious effects on the HDPE liners.

4.4.28 Aluminum Nitrate

Appendix B reports that aluminum salts in general are completely compatible with the HDPE liners. Appendix C indicates that a saturated solution of aluminum nitrate is compatible up to a temperature of 140°F. Appendix D indicates that "metals, salts, nutrients" are acceptable up to a concentration of 500,000 mg/l. WHC [1995] indicates that an acidic solution of 37.5 wt% aluminum nitrate was tested and produced no deleterious effects.

4.4.29 Ammonia

Appendix A indicates completed compatibility with the HDPE liners for both liquid ammonia and a saturated ammonia solution. Appendix B is in agreement, adding various ammonium salts as being completely compatible.

4.4.30 Anthracene (coal tar)

See Section 4.4.13, 2-Methylnaphthalene.

4.4.31 Arochlor (includes all PCBs)

Arochlor is a common name for polychlorinated biphenyls, or PCBs. Appendix D indicates that PCB is acceptable up to 2000 mg/l. WHC [1995] reports that 0.2 wt% Aroclor 1242 (42% chlorine) was tested and found to be acceptable.

4.4.32 Benzaldehyde

According to Appendix A, benzaldehyde is acceptable in a 100% concentration at 20°C. Appendix B indicates full compatibility. Appendix C indicates full compatibility of a 10% solution up to 73°F.

4.4.33 Benzene

Appendix A reports that limited use of benzene is possible up to 140°F. Appendix B indicates that little or no effects were seen after 30 days exposure of 100% benzene at temperatures up to 50°C. Appendix C indicates that limited use of benzene is possible up to 120°F. Appendix D indicates that benzene is acceptable up to 2000 mg/l. Under the conditions expected in the RMW trenches, there is no reason to believe that the concentrations of benzene would be deleterious to the liners.

4.4.34 Benzo(a)anthracene (coal tar)

See Section 4.4.13, 2-Methylnaphthalene.

4.4.35 Benzo(a)pyrene (coal tar)

See Section 4.4.13, 2-Methylnaphthalene.

4.4.36 Benzo(b)fluoranthene (coal tar)

See Section 4.4.13, 2-Methylnaphthalene.

4.4.37 Benzo(g,h,i)perylene (coal tar)

See Section 4.4.13, 2-Methylnaphthalene.

4.4.38 Benzoic Acid

According to Appendix A, a saturated solution of benzoic acid is acceptable for used with HDPE up to 60°C. Appendix B reports complete compatibility up to 50°. Appendix C indicates complete compatibility up to 140°F.

4.4.39 Benzyl Alcohol

Appendix B indicates that limited application of benzyl alcohol (100%) is acceptable below 20°C. Appendix C indicates full compatibility up to 140°F. WHC [1995] reports that up to 0.4 wt%, the use of benzyl alcohol is acceptable under the expected conditions.

4.4.40 Bis (2-ethylhexyl) phthalate

Appendix D indicates that bis(2-ethylhexyl)phthalate is acceptable up to a concentration of 2000 mg/l.

4.4.41 Butoxyglycol

Butoxyglycol is not listed specifically in any of the available literature on HDPE compatibility. Its behavior can be inferred by comparison with chemicals of a similar nature. Butoxyglycol belongs to the alcohol/glycol family and its behavior with respect to HDPE would be similar to that of ethylene glycol. See Section 4.4.63, Ethylene Glycol.

4.4.42 Butraldehyde

Butraldehyde is not listed specifically in any of the available literature on HDPE compatibility. Its behavior can be inferred by comparison with chemicals of a similar nature. Butraldehyde belongs to the aldehyde group. Its behavior with respect to HDPE can be most reasonably compared to that of benzaldehyde. See Section 4.4.32, Benzaldehyde.

4.4.43 Butyl Alcohol

According to Appendix A, butyl alcohol (butanol) is acceptable in all concentrations below 60°C. Appendix B list the different butyl alcohol isomers (*n*-, *sec*-, and *tert*-) and indicates that all are completely compatible below 50°C. Appendix C indicates complete compatibility below 140°F. Appendix D shows that butyl alcohol is acceptable up to a concentration of 500,000 mg/l. Most significantly, a butanol matrix (89.35 wt%) was used in one of the organic solutions utilized in WHC 9090 testing.

4.4.44 Butylbenzylphthalate

Appendix D reports that leachate containing 200,000 mg/l of butylbenzylphthalate was compatible with the HDPE liner.

4.4.45 Cadmium Nitrate

Leachate containing 0.003 wt% cadmium nitrate was tested [WHC, 1995] and found to be acceptable with respect to liner compatibility. This may seem to be a small concentration, however, based on limited quantities of cadmium in potential waste and the limited solubility in anything except a strongly acidic solution, greater concentrations are not expected.

4.4.46 Carbazole

Appendix B lists carbazole as being completely compatible with HDPE up to 50°C.

4.4.47 Carbon Tetrachloride

Appendix A reports that limited use of carbon tetrachloride in conjunction with a HDPE liner is acceptable up to 20°C. Appendix B indicates that little or no effects were seen on HDPE after 30 days constant exposure to 100% carbon tetrachloride. Appendix C indicates that limited use of carbon tetrachloride is possible up to 73°F. Appendix D indicates that a 2000 mg/l concentration of carbon tetrachloride in leachate was acceptable with the HDPE liner. WHC [1995] reports that 0.2 wt% carbon tetrachloride was tested with acceptable results.

4.4.48 Carbon Disulfide

Although Appendix B indicates that full strength carbon disulfide is not recommended for continuous use with HDPE liners, Appendix A indicates that limited use of carbon disulfide (100%) is acceptable up to 20°C. Appendix C also indicates that limited use is possible up to 140°F. Based on the fact that carbon disulfide is not soluble in water, the concentrations of carbon disulfide are expected to be extremely small. Carbon disulfide is acceptable for disposal in the RMW trenches; there is no reason to believe that the expected concentrations of carbon disulfide would be deleterious to the liners.

4.4.49 Chloroform

Although Appendix A indicates that chloroform (100%) is not recommended for use with HDPE, Appendix B indicates that little or no effect was seen after 30 days of constant exposure, as long as the temperature is maintained below 20°C. Appendix C indicates that limited use chloroform is acceptable up to 120°F. Appendix D indicates that leachate containing 2000 mg/l chloroform was acceptable. Based on expected conditions, there is no reason to believe that the concentrations of chloroform would be deleterious to the liners.

4.4.50 Crysene (coal tar)

See Section 4.4.13, 2-Methylnaphthalene.

4.4.51 Cupric Nitrate

Appendix C indicates that copper (II) nitrate (cupric) is completely compatible up to 140°F. In addition, leachate containing 0.24 wt% cadmium nitrate was tested [WHC 1995] and found to be acceptable with respect to liner compatibility. This wt% is equal to approximately 2000 mg/l. Based on limited quantities of copper in potential waste and the limited solubility of copper in anything except a strongly acidic solution, greater concentrations are not expected.

4.4.52 Cyclohexane

Appendix B reports that limited use of cyclohexane with HDPE is possible as long as the temperature is maintained below 20°C. Appendix C indicates that cyclohexane is completely compatible up to 120°F. WHC [1995] reports that a 0.05 wt% solution of cyclohexane was tested with acceptable results.

4.4.53 Di-n-butyl-phthalate

Appendix C reports that dibutylphthalate is acceptable up to 73°F. Appendix D indicates that a solution containing 100,000 mg/l dibutylphthalate is acceptable. See also similar behavior of dioctylphthalate, Section 4.4.54; and diethyl phthalate, Section 4.4.58.

4.4.54 Di-n-octyl-phthalate

Appendix A indicates that dioctylpthalate is acceptable up to a temperature of 20°C. Appendix C indicates complete compatibility up to 73°F. WHC [1995] indicates that a leachate containing 0.2 wt% dioctyl phthalate was tested with acceptable results. See also similar behavior of dibutylphthalate, Section 4.4.53; and diethylphthalate, Section 4.4.58.

4.4.55 Dibenzofuran

Dibenzofuran is not listed specifically in any of the available literature on HDPE compatibility. Its behavior can be inferred by comparison with chemicals of a similar nature. Chemicals of a similar nature for which data exists

include diphenyl oxide, phenanthrene, and tetrahydrofuran. The behavior of dibenzofuran should consist of some combination of the traits of these three chemicals. Diphenyl oxide is listed in Appendix C as compatible up to 73°F. See also Section 4.4.84, Phenanthrene; and Section 4.4.105, Tetrahydrofuran.

4.4.56 Dichlorobenzene

See Section 4.4.4, 1,3-Dichlorobenzene.

4.4.57 Dieldrin

Dieldrin is a chlorinated pesticide. Appendix D shows that dieldrin is acceptable up to a concentration of 2000 mg/l.

4.4.58 Diethylphthalate

Appendix D indicates that diethylphthalate is acceptable to a concentration of 100,000 mg/l. See also similar behavior of dibutylphthalate, Section 4.4.53; and dioctylphthalate, Section 4.4.54.

4.4.59 Dioctylphthalate

See Section 4.4.54, Di-n-octyl-phthalate.

4.4.60 EDTA, Disodium salt

WHC [1995] reports that a 5 wt% solution of ethylene diamine tetracetic acid (EDTA), Disodium salt was tested with acceptable results. Also, Appendix C indicates that ethylene diamine is acceptable up to 140°F.

4.4.61 Endrin

Endrin is a pesticide. Appendix D shows that endrin is acceptable up to a concentration of 2000 mg/l.

4.4.62 Ethylbenzene

Appendix B indicates that ethylbenzene can be used below 20°C with little or no effects on the HDPE liner after 30 days of constant exposure. Appendix C indicates that limited use of ethylbenzene is possible up to 73°F. Appendix D indicates that ethylbenzene is acceptable in concentrations up to 2000 mg/l.

4.4.63 Ethylene Glycol

Appendix B indicates reports complete compatibility of ethylene glycol with HDPE. Appendix C indicates complete compatibility up to a temperature of 140°F. Appendix D indicates that a 500,000 mg/l solution of "antifreeze" yielded acceptable compatibility results. WHC [1995] reports that a leachate containing 0.8 wt% ethylene glycol was tested with acceptable results.

4.4.64 Ferric Nitrate

Appendix A indicates complete compatibility of ferric nitrate with HDPE. Appendix C indicates complete compatibility up to a temperature of 140°F. WHC [1995] reports that a leachate containing 8.1 wt% ferric nitrate was tested with acceptable results.

4.4.65 Fluoranthene (coal tar)

See Section 4.4.13, 2-Methylnaphthalene.

4.4.66 Fluorene (coal tar)

See Section 4.4.13, 2-Methylnaphthalene.

4.4.67 gamma-Chlordane

Appendix D indicates that chlordane is acceptable up to a concentration of 2000 mg/l.

4.4.68 Heptachlor

Appendix D indicates that heptachlor is acceptable up to a concentration of 2000 mg/l.

4.4.69 Indeno(1,2,3-cd)pyrene

See Section 4.4.13, 2-Methylnaphthalene.

4.4.70 Lanthanum Nitrate

WHC [1995] reports that a leachate containing 0.43 wt% lanthanum nitrate was tested with acceptable results. This wt% equates to approximately 4300 mg/l.

4.4.71 Mercuric Nitrate

Appendix A reports complete compatibility of mercuric nitrate with HDPE. Leachate containing 0.003 wt% mercuric nitrate was tested [WHC, 1995] and found to be acceptable with respect to liner compatibility.

4.4.72 Methoxydiglycol

Methoxydiglycol (diethylene glycol) is not listed specifically in any of the available literature on HDPE compatibility. Its behavior can be inferred by comparison with chemicals of a similar nature. Methoxydiglycol belongs to the alcohol/glycol family and its behavior with respect to HDPE would be similar to that of ethylene glycol. See Section 4.4.63, Ethylene Glycol.

4.4.73 Methyl n-Propyl Ketone

Appendix B reports that Methyl n-Propyl Ketone (2-Pentanone) is compatible with HDPE up to 20°C. See also similar chemical behavior of methyl isobutyl ketone (Section 4.4.74) and 2-butanone (Section 4.4.9).

4.4.74 Methyl Isobutyl Ketone (Hexone)

Methyl Isobutyl Ketone (4-Methyl-2-Pentanone, or MIBK) is listed in Appendix B as being completely compatible at 20°C. Appendix C indicates that MIBK is compatible to 73°F. Appendix D shows that MIBK is compatible to a concentration of 500,000 mg/l..

4.4.75 Methyl Ethyl Ketone

See Section 4.4.9, 2-butanone.

4.4.76 Methylene Chloride

Appendix A reports that limited use of methylene chloride (100%) with HDPE is acceptable below 20°C. Appendix B indicates that (100%) methylene chloride can be used below 20°C with little or no effects on the HDPE liner after 30 days of constant exposure. Appendix C indicates that limited use of methylene chloride is acceptable below 140°F. Appendix D shows that methylene chloride is compatible to a concentration of 2000 mg/l. WHC [1995] reports that a 0.2 wt% solution of methylene chloride was tested with acceptable results.

4.4.77 Methyloxytriglycol

Methyloxytriglycol (triethylene glycol) is not listed specifically in any of the available literature on HDPE compatibility. Its behavior can be inferred by comparison with chemicals of a similar nature. Methyloxytriglycol belongs to the alcohol/glycol family and its behavior with respect to HDPE would be similar to that of ethylene glycol. See Section 4.4.63, Ethylene Glycol.

4.4.78 n-Butyl Acetate

Appendix B reports complete compatibility of n-butyl acetate up to 20°C. Appendix C reports complete compatibility up to 73°F. WHC [1995] reports that a 0.5 wt% solution was tested with HDPE liners with acceptable results.

4.4.79 N-Nitrosodiphenylamine

N-Nitrosodiphenylamine is not listed specifically in any of the available literature on HDPE compatibility. Its behavior can be inferred by comparison with chemicals of a similar nature. Chemicals of similar nature for which data exists are N-nitrosodimethylamine and N-nitrosodi-n-propylamine. Appendix D reports that both are compatible to 100,000 mg/l.

4.4.80 Naphthalene

Appendix C reports that naphthalene is completely compatible up to 73°C. Appendix D reports that a leachate containing 2000 mg/l naphthalene was acceptable. WHC [1995] reports that a leachate containing 0.2 wt% naphthalene was tested and found to be acceptable.

4.4.81 Nitric Acid

Appendix A reports that nitric acid in concentrations less than 25% is fully compatible with the HDPE liners, and concentrations up to 50% are compatible if temperature is maintained below 20°C. Appendix B indicates that concentrations of nitric acid less than 10% are fully compatible, with restrictions for 50% and 70% concentrations. Appendix C reports that concentrations less than 30% are fully compatible to 140°F. Appendix D reports that a concentration of 500,000 mg/l nitric acid was found to be acceptable. WHC [1995] reports that a solution (pH = 2.0) of various metal salts in 1.25 wt% nitric acid was tested and found to be acceptable.

4.4.82 Pentachlorophenol

Appendix D reports that a leachate containing 100,000 mg/l pentachlorophenol was found to be acceptable.

4.4.83 Pentane

Appendix C reports that limited use of pentane is acceptable below 120°F. WHC [1995] reports that a leachate containing 0.2 wt% pentane was tested and found to be acceptable.

4.4.84 Phenathrene (coal tar)

See Section 4.4.13, 2-Methylnaphthalene.

4.4.85 Phenol

Appendix A reports that a phenol solution is fully compatible with HDPE. Appendix B reports that little or no effects were seen when phenol crystals were exposed to HDPE for 30 days. Appendix C reports that phenol is completely compatible up to 140°F. Appendix D reports that a leachate containing 100,000 mg/l phenol was found to be acceptable.

4.4.86 Potassium Ferrocyanide

Appendix A reports that a saturated solution of potassium ferrocyanide is fully compatible with HDPE. Appendix C reports that potassium ferrocyanide is fully compatible up to a temperature of 140°F. WHC [1995] reports that a leachate containing 0.005 wt% potassium ferrocyanide was tested and found to be acceptable.

4.4.87 Potassium Permanganate

Appendix A reports that a 20% solution of potassium permanganate is fully compatible with HDPE. Appendix C reports that a 25% solution of potassium permanganate is fully compatible up to a temperature of 140°F. Appendix D reports that "strong oxidizers" of which potassium permanganate is specified, are compatible up to concentrations of 1000-500,000 mg/l. WHC [1995] reports that a leachate containing 0.4 wt% potassium permanganate was tested and found to be acceptable.

4.4.88 Pyrene (coal tar)

See Section 4.4.13, 2-Methylnaphthalene.

4.4.89 Sodium Arsenate

WHC [1995] reports that a solution (Ph = 12.5) with a concentration of 0.002 wt% sodium arsenate was tested with the HDPE liner and found to be acceptable.

4.4.90 Sodium Bicarbonate

Appendix A reports complete compatibility of HDPE with a saturated sodium bicarbonate solution. Appendix C reports complete compatibility of sodium bicarbonate up to a temperature of 140°F.

4.4.91 Sodium Carbonate

Appendix A reports complete compatibility of HDPE with a saturated sodium carbonate solution. Appendix C reports complete compatibility of sodium carbonate up to a temperature of 140°F.

4.4.92 Sodium Chloride

Appendix A reports complete compatibility of HDPE with a saturated sodium chloride solution. Appendix C reports complete compatibility of sodium chloride up to a temperature of 140°F. WHC [1995] reports that a solution (pH = 12.5) with a concentration of 0.2 wt% sodium chloride was tested with the HDPE liner and found to be acceptable.

4.4.93 Sodium Dihydrogen Phosphate

Appendix A reports complete compatibility of HDPE with a saturated sodium dihydrogen phosphate (shown as sodium biphosphate) solution. Appendix C reports complete compatibility of three forms of sodium phosphate (acid, alkaline, and neutral) up to a temperature of 140°F. WHC [1995] reports that a solution (pH = 12.5) with a concentration of 0.2 wt% sodium dihydrogen phosphate (monohydrated) was tested with the HDPE liner and found to be acceptable.

4.4.94 Sodium Fluoride

Appendix A reports complete compatibility of HDPE with a saturated sodium fluoride solution. Appendix C reports complete compatibility of sodium fluoride up to a temperature of 140°F.

4.4.95 Sodium Molybdate

WHC [1995] reports that a solution (pH = 2.0) with a concentration of 0.24 wt% sodium molybdate was tested with the HDPE liner and found to be acceptable.

4.4.96 Sodium Nitrate

Appendix A reports complete compatibility of HDPE with a saturated sodium nitrate solution. Appendix C reports complete compatibility of sodium nitrate up to a temperature of 140°F.

4.4.97 Sodium Nitrite

Appendix A reports complete compatibility of HDPE with a saturated sodium nitrite solution. Appendix C reports complete compatibility of sodium nitrite up to a temperature of 140°F. WHC [1995] reports that a solution (pH = 12.5) with a concentration of 1 wt% sodium nitrite was tested with the HDPE liner and found to be acceptable.

4.4.98 Sodium Silicate

Appendix C reports complete compatibility of sodium silicate up to a temperature of 140°F. WHC [1995] reports that a solution (pH = 12.5) with a concentration of 0.1 wt% sodium silicate was tested with the HDPE liner and found to be acceptable.

4.4.99 Sodium Sulfate

Appendix A reports complete compatibility of HDPE with a saturated sodium sulfate solution. Appendix C reports complete compatibility of sodium sulfate up to a temperature of 140°F.

4.4.100 Sodium Sulfide

Appendix A reports complete compatibility of HDPE with a saturated sodium sulfide solution. Appendix C reports complete compatibility of sodium sulfide up to a temperature of 140°F. WHC [1995] reports that a solution (pH = 12.5) with a concentration of 0.005 wt% sodium sulfide was tested with the HDPE liner and found to be acceptable.

4.4.101 Sodium Tetraborate

WHC [1995] reports that a solution (pH = 12.5) with a concentration of 0.5 wt% sodium tetraborate was tested with the HDPE liner and found to be acceptable.

4.4.102 Sodium Hydroxide

Appendix A reports complete compatibility of HDPE with both a 40% solution and a saturated solution of sodium hydroxide. Appendix B reports complete compatibility of sodium hydroxide. Appendix C reports complete compatibility of sodium hydroxide up to a temperature of 140°F. Appendix D reports that a 500,000 mg/l concentration of sodium hydroxide was found to be acceptable. WHC [1995] reports that a solution (pH = 12.5) with a concentration of approximately 0.2 wt% sodium hydroxide was tested with the HDPE liner and found to be acceptable.

4.4.103 Tetrachloroethene

Appendix C indicates that limited use of tetrachloroethene (tetrachloroethylene) is acceptable below 140°F. Appendix D reports that a 2000 mg/l concentration of tetrachloroethene was found to be acceptable. WHC [1995] reports that a solution with a concentration of approximately 0.2 wt% tetrachloroethene was tested with the HDPE liner and found to be acceptable.

4.4.104 Tetradecane

Tetradecane is not listed specifically in any of the available literature on HDPE compatibility. Its behavior can be inferred by comparison with chemicals of a similar nature. Tetradecane is an aliphatic hydrocarbon (C14) and its behavior with respect to HDPE would be similar to that of other aliphatic hydrocarbons. Appendix B reports complete compatibility of HDPE with n-octane, a C8 aliphatic hydrocarbon. Appendix D reports that 500,000 mg/l concentrations of each heptane, hexane, and octane were found to be acceptable.

4.4.105 Tetrahydrofuran

Appendix B indicates that 100% tetrahydrofuran can be used below 20°C with little or no effects on the HDPE liner after 30 days of constant exposure. Appendix C indicates that limited use of tetrahydrofuran is possible up to 73°F.

4.4.106 Toluene

Appendix A reports that limited application of toluene (100%) with HDPE is acceptable below 20°C. Appendix B indicates that toluene can be used below 20°C with little or no effects on the HDPE liner after 30 days of constant exposure. Appendix C indicates that limited use of toluene is acceptable up to 120°F. Appendix D reports that a 5,000 mg/l concentration of toluene was found to be acceptable. WHC [1995] reports that a solution with a concentration of approximately 0.5 wt% toluene was tested with the HDPE liner and found to be acceptable.

4.4.107 Tributyl Phosphate

Appendix C reports complete compatibility of tributyl phosphate. WHC [1995] reports that a solution with a concentration of approximately 0.2 wt% tributyl phosphate was tested with the HDPE liner and found to be acceptable.

4.4.108 Trichloroethene

Appendix B indicates that limited use of trichloroethene (trichloroethylene) with HDPE is acceptable as long as the temperature is maintained below 20°C. Appendix C indicates that limited use of trichloroethene is acceptable up to 120°F. Appendix D reports that a 2000 mg/l concentration of trichloroethene was found to be acceptable.

4.4.109 Trichloroethylene

See Section 4.4.108, Trichloroethene.

4.4.110 Tridecane

Tridecane is not listed specifically in any of the available literature on HDPE compatibility. Its behavior can be inferred by comparison with chemicals of a similar nature. Tridecane is an aliphatic hydrocarbon (C13) and its behavior with respect to HDPE would be similar to that of other aliphatic hydrocarbons. Appendix B reports complete compatibility of HDPE with n-octane, a C8 aliphatic hydrocarbon. Appendix D reports that 500,000 mg/l concentrations of each heptane, hexane, and octane were found to be acceptable.

4.4.111 Triglyme

Triglyme (triethylene glycol dimethyl ether) is not listed specifically in any of the available literature on HDPE compatibility. Its behavior can be inferred by comparison with chemicals of a similar nature. Triglyme belongs to the ether family with some glycol/alcohol characteristics possible.

Appendix B reports ethylene glycol methyl ether as being fully compatible with HDPE. Appendix A and Appendix B both report that limited use of diethyl ether is acceptable for temperatures below 20°C. Appendix C reports that limited use is acceptable for temperatures below 140°F. See also Section 4.4.63, Ethylene Glycol.

4.4.112 Vinyl Chloride

Appendix D reports that a 2000 mg/l concentration of each vinyl chloride was found to be acceptable.

4.4.113 Zinc Nitrate

Appendix C reports full compatibility between HDPE and zinc nitrate. Appendix D reports that metals, and salts (zinc nitrate is a metal salt) are acceptable

up to 500,000 mg/l. WHC [1995] reports that a solution (pH = 2.0) with a concentration of approximately 2.97 wt% sodium hydroxide was tested with the HDPE liner and found to be acceptable.

4.5 Incompatible Chemicals

The following list of chemicals are reported in at least one of the reference sources to be incompatible with the HDPE liner material. Unless there is evidence to the contrary, these chemicals should be considered unacceptable for RMW trench waste.

4.5.1 Amyl Chloride

Appendix B reports limited compatibility of amyl chloride below 20°C. Appendix C indicates limited compatibility below 73°F.

4.5.2 Aqua Regia

Appendix A reports that full strength aqua regia (hydrochloric and nitric acid; 3:1) is unacceptable for use with HDPE. Appendix C indicates that aqua regia is unacceptable.

4.5.3 Bromic Acid

Appendix C reports that bromic acid is unacceptable.

4.5.4 Bromobenzene

Appendix B reports limited compatibility of bromobenzene below 20°C.

4.5.6 Bromoform

Appendix B reports that bromobenzene is unacceptable for use with HDPE.

4.5.7 Calcium Bisulfite

Appendix C reports that calcium bisulfite is unacceptable.

4.5.8 Calcium Sulfide

Appendix A reports limited compatibility of calcium sulfide.

4.5.9 Diethyl Benzene

Appendix B reports limited compatibility of diethyl benzene.

4.5.10 Diethyl ether

Appendix A, Appendix B, and Appendix C all report limited compatibility of diethyl ether.

4.5.11 Elemental Bromine

Appendix A reports that bromine in a gaseous, dry form and in a liquid form are incompatible with the HDPE liner material. Appendix B reports limited compatibility of bromine. Appendix C indicates that bromine vapor (25%), bromine liquid, and saturated bromine water are incompatible.

4.5.12 Elemental Chlorine

Appendix A reports limited compatibility for gaseous, dry chlorine and for a saturated aqueous chlorine solution. Appendix B reports complete compatibility of a 10% chlorine in air (below 20°C) and limited compatibility of 10% chlorine (moist). Appendix C indicates limited compatibility of chlorine gas with moisture contents from 0-50+ ppm, incompatibility of liquid chlorine, and full compatibility (up to 140°F) of a saturated aqueous chlorine solution.

4.5.13 Elemental Fluorine

Appendix A reports that gaseous fluorine is incompatible with the HDPE liner material. Appendix B indicates limited compatibility. Appendix C indicates limited compatibility of a dry fluorine gas, and incompatibility of wet fluorine gas.

4.5.14 Ethyl Chloride

Appendix B reports limited compatibility of ethyl chloride. Appendix C indicates limited compatible of ethyl chloride up to 73°C.

4.5.15 Ethylene Trichloride

Appendix A indicates that ethylene trichloride is unacceptable.

4.5.16 Nitrobenzene

Appendix B reports limited compatibility of nitrobenzene. Appendix C indicates that nitrobenzene is compatible to 73°F.

4.5.17 Perchloroethylene

Appendix B indicates incompatibility of perchloroethylene with HDPE. Appendix C reports limited compatibility up to 120°F.

4.5.18 Propylene Dichloride

Appendix C indicates the incompatibility of propylene dichloride.

4.5.19 Sulfur Trioxide

Appendix A reports that 100% sulfur trioxide is incompatible with HDPE liner material. Appendix C indicates that both wet and dry sulfur trioxide gases are incompatible.

4.5.20 Sulfuric Acid (fuming)

Appendix A indicates that fuming (100%) sulfuric acid is incompatible. Appendix C indicates that fuming sulfuric shows limited compatibility. It should be noted that all lesser concentrations of fuming show limited to full compatibility. It is very unlikely that even if fuming sulfuric were included in a waste that it could reach the liner without being diluted by the leachate (mostly water).

4.5.21 Thionyl Chloride

Appendix A indicates limited compatibility of thionyl chloride with HDPE. Appendix B and Appendix C both report that thionyl chloride is incompatible.

4.5.22 Vinylidene Chloride

Appendix B reports limited compatibility of vinylidene chloride.

5.0 RECOMMENDATIONS

It has been shown that technical justification exists for allowing the above list of chemicals (Sections 4.4.1 through 4.4.113) as waste constituents in waste destined for disposal in one of the radioactive mixed waste (RMW) trenches. It has also been shown that justification exists for disallowing other chemicals (Sections 4.5.1 through 4.5.22). Approval or disapproval of a specific chemical is based on compatibility of the resultant waste leachate with the trench liner. The chemicals which have been shown to be compatible under the prescribed conditions should be allowed by the Hanford Site Solid Waste Acceptance Criteria [WHC, 1993]. Many of those chemicals listed as incompatible may actually be acceptable under the expected conditions, however, until such time as evidence can be presented which shows that they are compatible, they should be disallowed in the in the Waste Acceptance Criteria.

The acceptability of a given chemical was shown to be independent of liner thickness. The liner thickness used in various applications (i.e., trench lining or pad lining) were determined based on structural strength requirements or other criteria. In cases where liner material (resin composition) is identical, chemical compatibility tests performed on a fabric of one thickness are equally applicable to a fabric of another thickness, and should be treated as such.

This document, and the list of compatible and incompatible chemicals should not be considered all inclusive. There are many other chemicals in existence which are compatible, and probably many which are incompatible. None are

currently expected in any of the waste streams projected for the RMW trenches. Other chemicals which may be presented in the future for inclusion in the RMW trenches should be evaluated based on the same criteria that are used in this study.

6.0 REFERENCES

Cole Parmer, "Chemical Resistance of Plastic Resins," Cole Parmer Instrument Company, 7425 N. Oak Park Ave, Niles IL, 60714, (800) 323-4320, 1993 catalog, pages 776-777.

EPA, 1980. "A Method for Determining the Compatibility of Hazardous Wastes," EPA-600/2-80-076, April 1980.

Phillips Petroleum, "Chemical Resistance Tables," (Included as Appendix C).

Rodriguez, F., "Principles of Polymer Systems," Hemisphere Publishing Corporation, New York, NY, 1989.

SLT North America, Inc., [1990a], "Form R Manufacturers Liner/Leachate Limits," SLT North America, Inc., 200 S. Trade Center Parkway, Conroe, TX 77385, (713) 350-1813, 1990. (Included as Appendix D).

SLT North America, Inc., [1990b], "HDPE Chemical Resistance Table," SLT North America, Inc., 200 S. Trade Center Parkway, Conroe, TX 77385, (713) 350-1813, 1990. (Included as Appendix A).

WHC-EP-0063-4, "Hanford Site Solid Waste Acceptance Criteria," [1993].

WHC-SD-W025-TRP-001, Rev. 0, [1991], "Geosynthetic Liner/Leachate Compatibility Testing in Support of Project W-025 RMW Land Disposal Facility."

WHC-SD-WM-TRP-237, Rev. 0, [1995], "Laboratory Testing of Geomembrane for Waste Containment EPA Method 9090."

APPENDIX A

GSE LINING TECHNOLOGY, INC.
(FORMERLY SLT NORTH AMERICA)
CHEMICAL RESISTANCE TABLE

THIS PAGE INTENTIONALLY
LEFT BLANK

GSE™

GSE Lining Technology, Inc.

19103 Gundle Road
Houston, Texas 77073
800-435-2008
713-443-8564
Fax: 713-875-6010

Chemical Resistance

Listed below are test results reported by the supplier of the high-density polyethylene resin used to manufacture GSE™ liner. The high-density polyethylene is resistant to the chemicals listed. The degree of chemical attack on any material is influenced by a number of variable factors and their interaction, including temperature, pressure, size of area under attack, exposure duration and the like. Where liner will be exposed to a mixture of chemicals, it is recommended that tests be performed for liner resistance to that chemical mixture. Therefore, these ratings are offered as a guide only.

Abbreviations

S = Satisfactory
L = Limited application possible
U = Unsatisfactory
— = Not tested

Concentration

sat. sol. = Saturated aqueous solution, prepared at 20°C (68°F)
sol. = aqueous solution with concentration above 10% but below saturation level
dil. sol. = diluted aqueous solution with concentration below 10%
cust. conc. = customary service concentration

Medium	Concentration	Resistance at 20°C (68°F)	Resistance at 60°C (140°F)
A			
Acetic acid	100%	S	L
Acetic acid	10%	S	S
Acetic acid anhydride	100%	S	L
Acetone	100%	L	L
Adipic acid	sat. sol.	S	S
Allyl alcohol	96%	S	S
Aluminum chloride	sat. sol.	S	S
Aluminum fluoride	sat. sol.	S	S
Aluminum sulfate	sat. sol.	S	S
Alums	sol.	S	S
Ammonia, aqueous	dil. sol.	S	S
Ammonia, gaseous dry	100%	S	S
Ammonia, liquid	100%	S	S
Ammonium chloride	sat. sol.	S	S
Ammonium fluoride	sol.	S	S
Ammonium nitrate	sat. sol.	S	S
Ammonium sulfate	sat. sol.	S	S
Ammonium sulfide	sol.	S	S
Amyl acetate	100%	S	L
Amyl alcohol	100%	S	L
Aniline	100%	S	L
Antimony trichloride	90%	S	S
Arsenic acid	sat. sol.	S	S
Aqua regia	$HCl-HNO_3$ 3/1	U	U
B			
Barium carbonate	sat. sol.	S	S
Barium chloride	sat. sol.	S	S
Barium hydroxide	sat. sol	S	S
Barium sulfate	sat. sol	S	S
Barium sulfide	sol.	S	S
Benzaldehyde	100%	S	L
Benzene	—	L	L
Benzoic acid	sat. sol.	S	S
Beer	—	S	S
Borax	sat. sol.	S	S
Boric acid	sat. sol	S	S
Bromine, gaseous dry	100%	U	U
Bromine, liquid	100%	U	U
Butane, gaseous	100%	S	S
Butanol	100%	S	S
Butyric acid	100%	S	L
C			
Calcium carbonate	sat. sol.	S	S
Calcium Chlorate	sat. sol.	S	S
Calcium Chloride	sat. sol.	S	S
Calcium hydroxide	sat. sol.	S	S
Calcium hypochlorite	sol.	S	S
Calcium nitrate	sat. sol.	S	S
Calcium sulfate	sat. sol	S	S
Calcium sulfide	dil. sol.	L	L
Carbon dioxide, gaseous dry	100%	S	S
Carbon disulfide	100%	L	U
Carbon monoxide	100%	S	S
Chloracetic acid	sol.	S	S
Carbon tetrachloride	100%	L	U
Chlorine, aqueous solution	sat. sol.	L	U
Chlorine, gaseous dry	100%	L	U
Chloroform	100%	U	U
Chromic acid	20%	S	L
Chromic acid	50%	S	L
Citric acid	sat. sol.	S	S
Copper chloride	sat. sol.	S	S
Copper nitrate	sat. sol.	S	S
Copper sulfate	sat. sol.	S	S
Cresylic acid	sat. sol.	L	—
Cyclohexanol	100%	S	S
Cyclohexanone	100%	S	L
D			
Decahydronaphthalene	100%	S	L
Dextrine	sol.	S	S
Diethyl ether	100%	L	—
Dioctylphthalate	100%	S	L
Dioxane	100%	S	S
E			
Ethane diol	100%	S	S
Ethanol	40%	S	L
Ethyl acetate	100%	S	U
Ethylene trichloride	100%	U	U
F			
Ferric chloride	sat. sol.	S	S
Ferric nitrate	sol.	S	S
Ferric sulfate	sat. sol.	S	S
Ferrous chloride	sat. sol.	S	S
Ferrous sulfate	sat. sol.	S	S
Fluorine, gaseous	100%	U	U
Fluosilicic acid	40%	S	S
Formaldehyde	40%	S	S
Formic acid	50%	S	S
Formic acid	98-100%	S	S
Furfuryl alcohol	100%	S	L
G			
Gasoline	—	S	L
Glacial acetic acid	96%	S	L
Glucose	sat. sol.	S	S
Glycerine	100%	S	S
Glycol	sol.	S	S
H			
Heptane	100%	S	U
Hydrobromic acid	50%	S	S
Hydrobromic acid	100%	S	S
Hydrochloric acid	10%	S	S
Hydrochloric acid	concentrated	S	S
Hydrocyanic acid	10%	S	S
Hydrofluoric acid	4%	S	S
Hydrofluoric acid	60%	S	L
Hydrogen	100%	S	S
Hydrogen peroxide	30%	S	S
Hydrogen peroxide	90%	S	U

GSE™

GSE Lining Technology, Inc.

Medium	Concentration	Resistance at 20 °C (68 °F)	Resistance at 60 °C (140 °F)
Hydrogen sulfide, gaseous	100%	S	S
L			
Lactic acid	100%	S	S
Lead acetate	sat. sol.	S	—
M			
Magnesium carbonate	sat. sol.	S	S
Magnesium chloride	sat. sol.	S	S
Magnesium hydroxide	sat. sol.	S	S
Magnesium nitrate	sat. sol.	S	S
Maleic acid	sat. sol.	S	S
Mercuric chloride	sat. sol.	S	S
Mercuric cyanide	sat. sol.	S	S
Mercuric nitrate	sol.	S	S
Mercury	100%	S	S
Methanol	100%	S	S
Methylene chloride	100%	L	—
Milk	—	S	S
Molasses	cust. conc.	S	S
N			
Nickel chloride	sat. sol.	S	S
Nickel nitrate	sat. sol.	S	S
Nickel sulfate	sat. sol.	S	S
Nicotinic acid	dil. sol.	S	—
Nitric acid	25%	S	S
Nitric acid	50%	S	U
Nitric acid	75%	U	U
Nitric acid	100%	U	U
O			
Oils and grease	—	S	L
Oleic acid	100%	S	L
Oxalic acid	sat. sol.	S	S
Oxygen	100%	S	L
Ozone	100%	L	U
P			
Petroleum	—	S	L
Phenol	sol.	S	S
Phosphoric acid	50%	S	L
Phosphoric acid	95%	S	S
Phosphorus trichloride	100%	S	L
Photographic developer	cust. conc.	S	S
Picric acid	sat. sol.	S	—
Potassium bicarbonate	sat. sol.	S	S
Potassium bisulfide	sol.	S	S
Potassium bromate	sat. sol.	S	S
Potassium bromide	sat. sol.	S	S
Potassium carbonate	sat. sol.	S	S
Potassium chlorate	sat. sol.	S	S
Potassium chloride	sat. sol.	S	S
Potassium chromate	sat. sol.	S	S
Potassium cyanide	sol.	S	S
Potassium dichromate	sat. sol.	S	S
Potassium ferricyanide	sat. sol.	S	S
Potassium ferrocyanide	sat. sol.	S	S
Potassium fluoride	sat. sol.	S	S
Potassium hydroxide	10%	S	S
Potassium hydroxide	sol.	S	S
Potassium hypochlorite	sol.	S	L
Potassium nitrate	sat. sol.	S	S
Potassium orthophosphate	sat. sol.	S	S
Potassium perchlorate	sat. sol.	S	S
Potassium permanganate	20%	S	S
Potassium persulfate	sat. sol.	S	S
Potassium sulfate	sat. sol.	S	S
Potassium sulfite	sol.	S	S
Propionic acid	50%	S	S
Propionic acid	100%	S	L

Medium	Concentration	Resistance at 20 °C (68 °F)	Resistance at 60 °C (140 °F)
Pyridine	100%	S	L
Q			
Quinol (Hydroquinone)	sat. sol.	S	S
S			
Salicylic acid	sat. sol.	S	S
Silver acetate	sat. sol.	S	S
Silver cyanide	sat. sol.	S	S
Silver nitrate	sat. sol.	S	S
Sodium benzoate	sat. sol.	S	S
Sodium bicarbonate	sat. sol.	S	S
Sodium biphosphate	sat. sol.	S	S
Sodium bisulfite	sol.	S	S
Sodium bromide	sat. sol.	S	S
Sodium carbonate	sat. sol.	S	S
Sodium chlorate	sat. sol.	S	S
Sodium chloride	sat. sol.	S	S
Sodium cyanide	sat. sol.	S	S
Sodium ferricyanide	sat. sol.	S	S
Sodium ferrocyanide	sat. sol.	S	S
Sodium fluoride	sat. sol.	S	S
Sodium hydroxide	40%	S	S
Sodium hydroxide	sat. sol.	S	S
Sodium hypochlorite	15% active chlorine	S	S
Sodium nitrate	sat. sol.	S	S
Sodium nitrite	sat. sol.	S	S
Sodium orthophosphate	sat. sol.	S	S
Sodium sulfate	sat. sol.	S	S
Sodium sulfide	sat. sol.	S	S
Sulfur dioxide, dry	100%	S	S
Sulfur trioxide	100%	U	U
Sulfuric acid	10%	S	S
Sulfuric acid	50%	S	S
Sulfuric acid	98%	S	U
Sulfuric acid	fuming	U	U
Sulfurous acid	30%	S	S
T			
Tannic acid	sol.	S	S
Tartaric acid	sol.	S	S
Thionyl chloride	100%	L	U
Toluene	100%	L	U
Triethylamine	sol.	S	L
U			
Urea	sol.	S	S
Urine	—	S	S
W			
Water	—	S	S
Wine vinegar	—	S	S
Wines and liquors	—	S	S
X			
Xylene	100%	L	L
Y			
Yeast	sol.	S	S
Z			
Zinc carbonate	sat. sol.	S	S
Zinc chloride	sat. sol.	S	S
Zinc (II) chloride	sat. sol.	S	S
Zince (IV) chloride	sat. sol.	S	S
Zinc oxide	sat. sol.	S	S
Zinc sulfate	sat. sol.	S	S

Specific immersion testing should be undertaken to ascertain the suitability of chemicals not listed above with reference to special requirements.

(S) Satisfactory: *Liner material is compatible to the given reagent at the given concentration and temperature. No mechanical or chemical degradation is encountered.*
(L) Limited Application Possible: *Liner material may encounter some attack. Factors such as concentration, pressure and temperature directly affect liner performance against the given media. Application is, however, possible under less severe conditions, e.g. lower concentration, secondary containment, additional liner protection, etc.*
(U) Unsatisfactory: *Liner material is not compatible to the given reagent at the given concentration and temperture. Mechanical and/or chemical degradation is encountered.*
(—) Not tested

This data is provided for informational purposes only and is not intended as a warranty or guarantee. GSE assumes no liability in connection with the use of this data.

APPENDIX B

COLE PARMER INSTRUMENT COMPANY
CHEMICAL RESISTANCE OF PLASTIC RESINS

THIS PAGE INTENTIONALLY
LEFT BLANK

Appendix B was not reproduced due to copyright restrictions. For the complete text of Appendix B see:

Cole Parmer, "Chemical Resistance of Plastic Resins," Cole Parmer Instrument Company, 7425 N. Oak Park Ave, Niles IL, 60714, (800) 323-4320, 1993 catalog, pages 776-777.

A copy of the Cole Parmer catalog can be obtained using their toll-free number, 1-800-323-4340.

THIS PAGE INTENTIONALLY
LEFT BLANK

APPENDIX C

PHILLIPS PETROLEUM
CHEMICAL RESISTANCE TABLES

THIS PAGE INTENTIONALLY
LEFT BLANK

Attachment III

CHEMICAL RESISTANCE TABLES
(NON-PRESSURE) APPLICATIONS

Chemicals and Formula	Concentration	Plastics at Maximum Operating Temperature (°F)					
		ABS	CPVC	PP	PVC	PE	PB
Acetaldehyde CH_3CHO	Con.	--	N	140	N	C to 73	C to 73
	Aq. of 40%	--	N	--	C to 73	R to 73	--
Acetamide CH_3CONH_2	5%	120	--	140	--	140	--
Acetic Acid CH_3COOH	vapor	120	180	180	140	140	140
	25%	N	180	180	140	140	140
Acetic Acid CH_3COOH	60%	N	N	180	73	73	73
Acetic Acid CH_32COOH	85%	N	N	120	73	73	73
Acetic Acid CH_3COOH	glacial	N	N	120	73	73	73
Acetic Anhydride $(CH_3CO)_2O$	--	N	N	73	N	73	140
Acetone CH_3COCH_3	--	N	N	73	N	C to 73	140
Acetophenone $C_6H_5COCH_3$	--	N	--	120	--	73	--
Acetyl Chloride CH_3COCl	--	N	N	--	N	--	--
Acetylene $HC{=}CH$	gas 100%	73	N	73	N	73	C to 73
Acetylnitrile	--	--	N	--	N	--	--
Acrylic Acid $H_2C{:}CHCOOH$	97%	--	--	--	N	140	--
Acrylonitrile $H_2C{:}CHCN$	--	--	N	--	N	140	--
Adipic Acid $COOH(CH_2)_4COOH$	sat'd	--	180	140	140	140	73

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Operating Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Allyl Alcohol $CH_2=CHCH_2OH$	96%	--	R to 73/N to 180	140	R to 73/C to 140	140	140
Allyl Chloride CH_2CHCH_2Cl	--	--	N	--	N	C to 73	140
Aluminum Acetate $Al(C_2H_3O_2)_3$	sat'd	--	--	--	--	--	--
Aluminum Ammonium Sulfate (Alum) $AlNH_4(SO_4)_2 12H_2O$	sat'd	--	180	140	140	140	--
Aluminum Chloride Aqueous $AlCl_2$	sat'd	160	180	180	140	140	140
Aluminum Fluoride Anhydrous AlF_3	sat'd	160	180	180	73	140	140
Aluminum Hydroxide $AlO_3 \cdot 3H_2O$	sat'd	160	180	180	140	140	140
Aluminum Nitrate $Al(NO_3)_3 \cdot 9H_2O$	sat'd	--	180	180	140	140	140
Aluminum Oxychloride	--	--	180	180	140	--	140
Aluminum Potassium Sulfate (Alum) $AlK(SO_4)_2 \cdot 12H_2O$	sat'd	160	180	140	140	140	--
Aluminum Sulfate (Alum) $Al_2(SO_4)_3$	sat'd	160	180	140	140	140	C to 73
Ammonia Anhydrous NH_3	--	--	--	--	--	--	--
Ammonia Gas NH_3	100%	N	180	140	140	140	140
Ammonia Liquid NH3	100%	160	73	140	N	140	73
Ammonium Acetate $NH4(C_2H_3O_2)$	sat'd	120	180	73	140	140	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Ammonium Bifluoride NH_4HF_2	sat'd	--	180	180	140	--	140
Ammonium Bisulfide $(NH_4)HS$	--	--	--	--	140	--	--
Ammonium Carbonate $(NH_4)HCO_3$ o $(NH_4)CO_2NH_2$	sat'd	--	180	212	140	140	140
Ammonium Chloride NH_4Cl	sat'd	120	180	212	140	140	140
Ammonium Dichromate $(NH_4)_2Cr_2O_7$	--	--	73	--	73	--	--
Ammonium Fluoride NH_4F	10%	120	180	212	140	140	--
Ammonium Fluoride NH_4F	25%	120	180	212	R to 73/C to 140	140	73
Ammonium Hydroxide	10%	120	N	212	140	140	140
Ammonium Nitrate NH_4NO_3	sat'd	120	180	212	140	140	140
Ammonium Persulphate $(NH_4)_2S_2O_8$	--	--	180	140	140	--	140
Ammonium Phosphate (Monobasic) $NH_4H_2PO_4$	all	120	R to 73/C to 180	212	140	140	140
Ammonium Sulfate $(NH_4)_2SO_4$	--	120	180	212	140	140	140
Ammonium Sulfide $(NH_4)_2S$	dilute	120	180	212	140	140	140
Ammonium Thiocyanate NH_4SCN	50-60%	120	180	212	140	140	140
Amyl Acetate $CH_3COOC_5H_{11}$	--	N	N	N	N	73	--
Amyl Alcohol $C_5H_{11}OH$	--	--	N	--	N	140	140

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PS
n-Amyl Chloride $CH_3(CH_2)_3CH_2Cl$	--	N	N	N	N	C to 73	--
Aniline $C_6H_5NH_2$	--	N	N	--	N	73	C to 140
Aniline Chlorohydrate	--	--	N	--	N	C to 73	N
Aniline Hydrochloride $C_6H_5NH_2oHCl$	sat'd	--	N	--	N	140	N
Anthraquinone $C_6H_5(CO)_2C_6H_5$	--	--	180	--	140	C to 73	C to 73
Anthraquinone Sulfonic Acid $C_{14}H_7O_2oSO_3Ho3H_2O$	--	--	180	73	140	140	C to 73
Antimony Trichloride $SbCl_3$	sat'd	--	180	140	140	140	140
Aqua Regia (Nitrohydrochloric Acid)	--	N	R to 73	N	C to 73	N	N
Argon	dry	--	--	--	--	--	--
Arsenic Acid $H_3AsO_4o1/2H_2O$	80%	--	180	140	140	140	140
Aryl Sulfonic Acid $C_6H_5SO_3H$	--	--	180	--	140	73	--
Asphalt	--	--	N	73	N	73	140
Barium Carbonate $BaCO_3$	sat'd	120	180	140	140	140	140
Barium Chloride $BaCl_2o2H_2O$	sat'd	120	180	140	140	140	140
Barium Hydroxide $Ba(OH)_2$	sat'd	73	180	140	140	140	140
Barium Nitrate $Ba(NO_3)_2$	sat'd	73	180	140	73	140	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F)					
		ABS	CPVC	PP	PVC	PE	PB
Barium Sulfate $BaSO_4$	sat'd	73	180	140	140	140	140
Barium Sulfide BaS	sat'd	73	180	140	140	140	140
Beer	--	120	180	180	140	140	140
Beet Sugar Liquors	--	--	180	180	140	73	140
Benzaldehyde C_6H_5CHO	10%	N	R to 73/N to 140	73	R to 73/N to 140	73	C to 73
Benzene C_6H_6	--	N	N	N	N	C to 120	N
Benzene Sulfonic Acid $C_6H_5SO_3H$	10%	--	180	180	140	R to 73	--
	10%+	--	N	--	N	--	--
Benzoic Acid C_6H_5COOH	all	160	180	73	140	140	140
Benzyl Alcohol $C_6H_5CH_2OH$	--	--	N	120	N	140	--
Bismuth Carbonate $(BiO)_2CO_3$	--	--	180	180	140	140	140
Black Liquor	sat'd	--	180	140	140	120	140
Bleach	5% Active Cl_2	--	180	120	140	140	--
Bleach	12% Active Cl_2	73	180	120	140	73	140
Blood	--	--	--	--	--	--	--
Borax $Na_2B_4O_7 \cdot 10H_2O$	sat'd	160	180	212	140	140	140
Boric Acid H_3BO_3	sat'd	160	180	212	140	140	140

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Brake Fluid	--	--	--	140	--	140	--
Brine	sat'd	--	180	140	140	140	140
Bromic Acid $HBrO_3$	--	--	180	N	140	N	140
Bromine Br_2	liquid	73	N	N	N	N	N
Bromine Br2	vapor 25%	--	180	N	140	N	--
Bromine Water	cold sat'd	--	180	N	140	N	C to 73
Bromobenzene C_6H_5Br	--	--	--	--	N	--	--
Bromotoluene $C_6H_5CH_2B_2$	--	--	--	C	N	--	--
Butadiene $H_2C{:}CHHC{:}CH_2$	50%	--	180	N	140	73	--
Butane C_4H_{10}	50%	--	180	140	140	140	N
Butyl Acetate $CH_3COOCH(CH_3)(C_2H_5)$	--	N	N	C to 73	N	73	C to 73
Butyl Alcohol $CH_3(CH_2)_2CH_2OH$	--	--	C to 73	180	140	140	140
Butyl Cellosolve $HOCH_2CH_2OC_4H_9$	--	--	N	--	73	--	--
n-Butyl Chloride C_4H_9Cl	--	N	--	--	--	--	--
Butylene (C) $CH_3CH{:}CHCH_3$	Liquid	--	--	N	140	120	--
Butyl Phenol $C_4H_9C_6H_9OH$	--	--	N	C to 73	73	73	--
Butyl Phthalate	--	--	--	180	--	--	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Butyl Stearate	--	--	--	--	73	--	--
Butynediol $HOCH_2C{:}CCH_2OH$	--	--	--	--	73	--	--
Butyric Acid $CH_3CH_2CH_2COOH$	--	N	N	180	73	73	73
Cadmium Cyanide $Cd(CN)_2$	--	--	180	--	140	--	--
Calcium Bisulfide $Ca(HS)_2 \cdot 6H_2O$	--	--	73	--	N	--	--
Calcium Bisulfite $Ca(HSO_3)_2$	--	--	180	180	140	N	140
Calcium Carbonate $CaCO_3$	--	--	180	180	140	140	140
Calcium Chlorate $Ca(ClO_3)_2 \cdot 2H_2O$	--	--	180	180	140	140	140
Calcium Chloride $CaCl_2$	--	120	180	180	140	140	140
Calcium Hydroxide $Ca(OH)_2$	--	160	180	180	140	140	140
Calcium Hypochlorite $Ca(OCl)_2$	30%	160	180	140	140	140	140
Calcium Nitrate $Ca(NO_3)_2$	--	--	180	180	140	140	140
Calcium Oxide CaO	--	--	--	--	140	140	--
Calcium Sulfate $CaSO_4$	--	100	180	180	140	140	140
Camphor $C_{10}H_{16}O$	--	N	--	73	73	73	--
Cane Sugar Liquors $C_{12}H_{22}O_{11}$	--	--	180	180	140	140	150

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Caprylic Acid $CH_3(CH_2)_6COOH$	--	--	--	--	--	--	--
Carbitol	--	--	--	--	73	--	--
Carbon Dioxide CO_2	Dry 100%	160	180	140	140	140	--
Carbon Dioxide CO_2	Wet	160	180	140	140	140	140
Carbon Disulfide CS_2	--	N	N	N	N	C to 140	--
Carbon Monoxide CO	Gas	--	180	180	140	140	140
Carbon Tetrachloride CCl_4	--	N	N	N	73	C to 73	N
Carbonic Acid H_2CO_3	Sat'd	--	185	180	140	140	140
Castor Oil	--	--	C to 180	140	140	73	140
Caustic Potash KOH	50%	160	180	180	140	140	73
Caustic Soda NaOH (Sodium Hydroxide)	Up to 40%	160	180	180	140	140	73
Cellosolve $ClCH_2COOH$	--	--	N	73	73	C to 120	140
Cellosolve Acetate $CH_3COOCH_2CH_2OC_2H_5$	--	--	--	73	73	--	--
Chloral Hydrate $CCl_3CH(OH)_2$	All	--	180	C to 73	140	120	140
Chloramine NH_2Cl	Dilute	--	--	73	73	73	--
Chloric Acid $HClO_3 \cdot 7H_2O$	10%	--	180	73	140	73	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Chloric Acid $HClO_3 \cdot 7H_2O$	20%	--	185	73	140	73	--
Chlorine Gas (Dry) (Moisture Content)	0-20 PPM	N	C to 73	N	C to 73	C to 73	--
Chlorine Gas (Moisture Content)	20-50 PPM	N	N	N	N	C to 73	--
Chlorine Gas (Moisture Content)	50 + PPM	N	N	N	N	C to 73	--
Chlorine	Liquid	N	N	N	N	N	--
Chlorinated Water	10 PPM	--	180	180	140	140	140
Chlorinated Water	Sat'd	--	180	180	140	C to 120	140
Chloroacetic Acid $CH_2ClCOOH$	50%	N	180	C to 73	140	120	N
Chloroacetyl Chloride $ClCH_2COCl$	--	--	--	--	73	--	--
Chlorobenzene C_6H_5Cl	Dry	N	N	73	N	C to 120	N
Chlorobenzyl Chloride $ClC_6H_4CH_2Cl$	--	--	N	--	N	C to 120	--
Chloroform $CHCl_3$	Dry	N	N	N	N	C to 120	C to 73
Chloropicrin CCl_3NO_2	--	--	--	--	N	73	--
Chlorosulfonic Acid $ClSO_2OH$	--	--	73	N	73	C to 120	N
Chromic Acid H_2CrO_4	10%	73	180	140	140	73	140
romic Acid $_2CrO_4$	30%	N	180	73	140	73	140

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Chromic Acid H_2CrO_4	40%	N	180	73	140	73	73
Chromic Acid H_2CrO_4	50%	N	C to 140	73	N	73	N
Chromium Potassium Sulfate $CrK(SO_4)_2 \cdot 12H_2O$	--	--	73	--	73	--	--
Citric Acid $C_6H_8O_7$	Sat'd	160	180	140	140	140	140
Coconut Oil	--	--	C to 180	73	140	73	140
Coffee	--	--	180	140	140.	140	--
Coke Oven Gas	--	--	--	73	140	140	--
Copper Acetate $Cu(C_2H_3O_2)_2 \cdot H_2O$	Sat'd	--	73	73	73	--	--
Copper Carbonate $CuCO_3$	Sat'd	--	180	--	140	140	--
Copper Chloride $CuCl_2$	Sat'd	73	180	140	140	140	140
Copper Cyanide $Cu(CN)_2$	--	--	180	--	140	140	140
Copper Fluoride $CuF_2 \cdot 2H_2O$	2%	--	180	73	140	140	140
Copper Nitrate $CU(NO_3)_2 \cdot 3H_2O$	30%	--	180	140	140	140	140
Copper Sulfate $CuSO_4 \cdot 5H_2O$	Sat'd	120	180	120	140	140	140
Corn Oil	--	--	C to 180	73	140	120	--
Corn Syrup	--	--	185	140	140	140	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F)					
		ABS	CPVC	PP	PVC	PE	PB
Cottonseed Oil	--	120	C to 180	140	140	140	140
Creosote	--	--	N	73	N	140	--
Cresol $CH_3C_6H_4OH$	90%	N	N	R to 73	N	73	N
Cresylic Acid	50%	--	180	--	140	C to 73	N
Croton Aldehyde $CH_3CH{:}CHCHO$	--	--	N	C to 73	N	--	--
Crude Oil	--	--	180	140	140	C to 120	C to 73
Cumene $C_6H_5CH(CH_3)_2$	--	--	--	--	--	--	--
Cupric Fluoride CuF_2	--	--	180	--	140	140	--
Cupric Sulfate $CuSO_4 \cdot 5H_2O$	Sat'd	100	180	73	140	140	--
Cuprous Chloride CuCl	Sat'd	70	180	--	140	140	--
Cyclohexane C_6H_{12}	--	73	N	N	N	120	--
Cyclohexanol $C_6H_{11}OH$	--	C to 120	N	140	N	73	C to 73
Cyclohexanone $C_6H_{10}O$	--	N	N	73	N	120	N
Decahydronapthalene $C_{10}H_{18}$	--	--	--	--	--	--	--
Detergents (Heavy Duty)	--	--	C to 180	180	140	140	--
Dextrin (Starch Gum)	Sat'd	--	180	140	140	140	140
Dextrose	--	--	180	140	140	140	140

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Diacetone Alcohol $CH_3COCH_2C(CH_3)_2OH$	--	--	N	120	N	--	--
Dibutoxyethyl Phthalate $C_6H_4(COOO_2H_2OC_4H_9)_2$	--	--	N	--	N	--	--
n-Dibutyl Ether $C_4H_9OC_4H_9$	--	--	--	--	--	73	--
Dibutyl Phthalate $C_6H_4(COOC_4H_9)_2$	--	N	N	73	N	73	--
Dibutyl Sebacate $C_4H_9OCO(CH_2)_8OCOC_4H_9$	--	--	--	73	73	73	--
Dichlorobenzene $C_6H_4Cl_2$	--	N	N	C to 73	N	C to 120	--
Dichloroethylene $C_2H_2Cl_2$	--	--	--	C to 73	N	C to 120	--
Diesel Fuels	--	--	180	140	140	73	C to 73
Diethylamine $C_4H_{10}NH$	--	N	N	--	N	C to 120	N
Diethyl Cellosolve $HOCH_2CH_2OC_2H_6$	--	--	--	--	--	--	--
Diethyl Ether $C_4H_{10}O$	--	N	N	73	73	C to 140	--
Diglycolic Acid $O(CH_2COOH)_2$	Sat'd	--	180	140	140	140	140
Dimethylamine $(CH_3)_2NH$	--	--	--	73	140	73	N
Dimethyl Formamide $HCON(CH_3)_2$	--	N	N	180	N	120	--
Dimethylhydrazine $(CH_3)_2NNH_2$	--	--	--	--	N	--	--
Dimethyl Phthalate $C_6H_4(COOC_9H_{19})$	--	--	--	--	--	C to 73	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Dioctyl Phthalate $C_6H_4(COOC_8H_{17})_2$	--	N	N	C to 73	N	73	C to 73
Dioxane $O:(CH_2)_4:O$	--	C	--	C to 140	N	140	--
Diphenyl Oxide $(C_6H_5)_2O$	Sat'd	--	--	--	--	73	--
Disodium Phosphate Na_2HPO_4	--	--	180	140	140	140	140
Dow Therm A	--	--	--	--	N	--	--
Ether ROR	--	N	N	C to 73	N	73	N
Ethyl Acetate $CH_3COOC_2H_5$	--	N	N	C to 140	N	73	C to 73
Ethyl Acetoacetate $CH_3COCH_2COOC_2H_5$	--	N	N	--	N	--	--
Ethyl Acrylate $CH_2:CHCOOC_2H_5$	--	--	N	--	N	--	--
Ethyl Alcohol (Ethanol) C_2H_5OH	--	--	C to 140	140	140	140	140
Ethyl Benzene $C_6H_5C_2H_5$	--	--	--	C to 73	N	C to 73	--
Ethyl Chloride C_2H_5Cl	Dry	--	N	C to 73	N	C to 73	--
Ethyl Chloroacetate $CCH_2ClCO_2C_2H_5$	--	--	--	--	N	--	--
Ethylene Bromide $BrCH_2CH_2Br$	Dry	--	N	--	N	--	N
Ethylene Chloride $ClCH_2CH_2Cl$	Dry	N	N	C to 73	N	C to 140	--
Ethylene Chlorohydrin $ClCH_2CH_2OH$	--	--	N	73	N	--	N

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Ethylene Diamine $NH_2CH_2CH_2NH_2$	--	N	--	73	N	140	--
Ethylene Dichloride $C_2H_4Cl_2$	Dry	N	N	C to 140	N	C to 73	140
Ethylene Glycol CH_2OHCH_2OH	--	73	C to 180	212	140	140	140
Ethylene Oxide CH_2CH_2O	--	--	N	C to 73	N	73	--
Ethyl Ether $(C_2H_5)_2O$	--	--	N	N	N	N	N
Ethyl Formate $HCOOC_2H_5$	--	--	--	--	--	--	--
2-Ethylhexanol $CH_3(CH_2)_3CHC_2H_5CH_2OH$	--	--	--	--	--	73	--
Ethyl Mercaptan C_2H_5SH	--	--	--	--	--	--	--
Ethyl Oxalate $(COOC_2H_5)_2$	--	--	--	--	--	--	--
Fatty Acids R-COOH	--	160	73	120	140	120	150
Ferric Chloride (Aqueous) $FeCl_3$	Sat'd	120	180	140	140	140	150
Ferric Hydroxide $Fe(OH)_3$	Sat'd	160	180	140	140	140	--
Ferric Nitrate $Fe(NO_3)_3\ 9H_2O$	Sat'd	160	180	140	140	140	140
Ferric Sulfate $Fe_2(SO_4)_3$	--	160	180	140	140	140	140
Ferrous Chloride $FeCl_2$	Sat'd	160	180	140	140	140	140

-- (A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Ferrous Hydroxide $Fe(OH)_2$	Sat'd	160	180	140	140	140	--
Ferrous Nitrate $Fe(NO_3)_2$	--	160	180	140	140	140	--
Ferrous Sulfate $FeSO_4$	--	160	180	140	140	140	140
Ferrous Chloride $FeCl_2$	Sat'd	160	180	140	140	140	140
Fish Oil	--	--	180	180	140	140	140
Flue Gas	--	--	--	--	--	--	--
Fluoboric Acid HBF_4	--	--	73	73	140	140	140
Fluorine Gas (Dry) F_2	100%	--	73	N	73	C to 73	C to 73
Fluorine Gas (Wet) F_2	--	N	73	N	73	N	N
Fluosilicic Acid H_2SiF_6	30%	--	120	--	--	--	--
Fluosilicic Acid H_2SiF_6	50%	--	73	73	140	140	140
Formaldehyde HCHO	Dilute	160	73	140	140	140	140
Formaldehyde HCHO	35%	160	C to 73	140	140	140	140
Formaldehyde HCHO	37%	160	C to 73	140	140	140	140
Formaldehyde HCHO	50%	--	C to 73	--	140	140	140
Formic Acid HCOOH	--	N	73	140	73	140	150
[illegible]son 11	100%	N	73	N	140	73	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Freon 12	100%	--	73	73	140	73	150
Freon 21	100%	--	--	N	N	C to 120	--
Freon 22	100%	--	73	73	N	C to 120	--
Freon 113	100%	--	--	N	140	73	--
Freon 114	100%	--	--	N	140	73	--
Fructose $C_6H_{12}O_6$	--	73	180	180	140	140	140
Furfural C_4H_3OCHC	--	N	N	N	N	C to 140	--
Gallic Acid $C_6H_2(OH)_3CO_2HOH_2C$	--	--	73	--	140	73	--
Gasoline, Leaded*	--	N	N	N	140	73	N
Gasoline, Unleaded*	--	N	N	N	140	73	N
Gasohol*	--	N	N	N	140	73	N
Gasoline, Sour*	--	N	N	N	140	73	N
Gelatin	--	--	180	180	140	140	140
Glauber's Salt $Na_2SO_4 \cdot 10H_2O$	--	--	--	--	--	--	--
Glucose $C_6H_{12}O_6 \cdot H_2O$	--	120	180	212	140	140	140
Glue	--	--	--	140	140	140	--
Glycerine $C_3H_5(OH)_3$	--	140	180	212	140	140	140
Glycol $OHCH_2CH_2OH$	--	--	C to 180	212	140	140	--

* See Note on Page 4.

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Glycol Amine	--	--	--	--	--	--	--
Glycolic Acid $OHCH_2COOH$	Sat'd	--	180	73	140	140	--
Glyoxal CHCCHO	--	--	--	--	--	140	--
Grape Sugar	--	--	180	--	140	--	--
Grease	--	--	--	--	--	--	--
Green Liquor	--	160	180	--	140	--	140
Gypsum $CaSO_4 \cdot H_2O$	Slurry	--	--	--	--	--	--
Heptane (Type I) C_7H_{16}	--	73	180	N	140	73	N
n-Hexane C_6H_{14}	--	C	73	73	73	--	--
Hexanol, Tertiary Type I $CH_3(CH_2)_4CH_2OH$	--	--	180	--	140	140	140
Hydraulic Oil (Petroleum)	--	--	--	--	73	73	--
Hydrazine H_2NNH_2	--	--	--	73	N	--	--
Hydrobromic Acid HBr	20%	73	73	140	140	140	140
Hydrobromic Acid HBr	50%	N	--	120	--	140	--
Hydrochloric Acid HCl	10%	C to 120	180	140	140	140	140
Hydrochloric Acid HCl	30%	C to 73	140	140	140	140	140

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F)					
		ABS	CPVC	PP	PVC	PE	PB
Hydrocyanic Acid HCN	--	160	180	73	140	140	140
Hydrofluoric Acid HF	Dilute	73	73	180	73	140	140
Hydrofluoric Acid HF	30%	N	73	140	73	140	140
Hydrofluoric Acid HF	50%	N	N	73	73	120	140
Hydrofluoric Acid HF	100%	N	N	C to 73	N	120	--
Hydrofluosilic Acid	50%	N	140	--	140	140	--
Hydrogen	Gas	--	73	140	140	140	140
Hydrogen Cyanide HCN	--	--	--	73	140	--	--
Hydrogen Fluoride Anhydrous	--	--	C	73	N	--	--
Hydrogen Peroxide H_2O_2	50%	--	180	73	140	140	N
Hydrogen Peroxide H_2O_2	90%	--	180	C to 73	140	73	N
Hydrogen Phosphide (Type 1) PH3	--	--	73	--	140	140	140
Hydrogen Sulfide H_2S	Dry	--	180	150	140	140	140
Hydrogen Sulfide H_2S	Wet	--	180	--	140	140	--
Hydrogen Sulfite H_2SO_3	10%	--	--	--	--	140	--
Hydroquinone $C_6H_4(OH)_2$	Sat'd	--	180	--	140	140	140

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
droxylamine Sulfate $(NH_2OH)_2H_2SO_4$	--	--	180	--	140	140	--
Hypochlorous Acid HOCl	10%	73	180	73	140	140	140
Inks	--	--	--	140	--	140	--
Iodine I_2	10%	N	73	73	N	C to 120	N
Iron Phosphate	--	--	--	--	--	--	--
Isobutane $(CH_3)_2CHCH_3$	--	--	--	--	--	--	--
Isobutyl Alcohol $(CH_3)_2CHCH_2OH$	--	C to 73	--	73	--	140	--
Isooctane $(CH_3)_3CCH_2CH(CH_3)_2$	--	--	--	C to 73	--	73	--
opropyl Acetate $COOCH(CH_3)_2$	--	N	--	--	--	73	--
Isopropyl Alcohol $(CH_3)_2CHOH$	--	--	C to 180	212	140	140	140
Isopropyl Chloride $CH_3CHClCH_3$	--	--	--	--	--	--	--
Isopropyl Ether $(CH_3)_2CHOCH(CH_3)_2$	--	--	N	C to 73	N	73	--
JP-3 Fuel*	--	--	--	--	--		
JP-4 Fuel*	--	--	73	C to 73	140	73	--
JP-5 Fuel*	--	--	73	C to 73	140	73	--
JP-6 Fuel*	--	--	--	--	--	--	--
Isophorone $C(O)CHO(CH_3)CH_2C(CH_3)_2CH_2$	--	--	--	--	--	--	--

e Note on Page 4.

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Kelp Slurry	--	--	--	--	--	--	--
Kerosene*	--	73	73	C to 140	140	C to 140	C to 73
Ketchup	--	--	--	--	73	--	--
Ketones	--	N	N	C to 73	N	73	--
Kraft Liquors	--	73	180	--	140	120	140
Lactic Acid $CH_3CHOHCOOH$	25%	73	180	212	140	140	140
Lactic Acid $CH_3CHOHCOOH$	80%	N	73	140	73	140	--
Lard Oil	--	--	180	--	140	120	73
Latex	--	--	--	140	--	140	--
Lauric Acid $CH_3(CH_2)_{10}COOH$	--	--	180	140	140	120	--
Lauryl Chloride (Type 1) $C_{12}H_{25}Cl$	--	--	73	--	140	120	73
Lead Acetate $Pb(C_2H_3O_2)_2 \cdot 3H_2O$	Sat'd	--	180	180	140	140	140
Lead Chloride $PbCl_2$	--	--	180	140	140	120	--
Lead Nitrate $Pb(NO_3)_2$	Sat'd	--	180	140	140	120	--
Lead Sulfate $PbSO_4$	--	--	180	140	140	120	--
Lemon Oil	--	--	--	C to 73	--	--	--
Ligroin	--	--	--	140	--	--	--

*See Note on page 4.

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Lime Slurry	--	--	--	--	--	140	--
Lime Sulfur	--	--	73	73	73	120	140
Linoleic Acid $CH_3(CH_2)_4HC{:}CHCH_2CH{:}CH(CH_2)_7COOH$	--	--	180	180	140	--	73
Linoleic Oil (Type I)	--	--	--	--	140	--	73
Linseed Oil	--	73	C to 180	140	140	73	150
Liqueurs	--	--	--	140	140	120	140
Lithium Bromide LiBr	--	--	--	140	140	140	--
Lithium Chloride LiCl	--	--	--	140	140	120	--
Lithium Hydroxide LiOH	--	--	--	140	--	120	--
Lubricating Oil (ASTM #1)	--	--	180	C to 140	140	73	140
Lubricating Oil (ASTM #2)	--	--	180	C to 140	140	73	140
Lubricating Oil (ASTM #3)	--	--	180	C to 140	140	73	140
Ludox	--	--	--	--	--	--	--
Magensium Carbonate $MgCO_2$	--	120	180	212	140	140	140
Magnesium Chloride $MgCl_2$	Sat'd	120	180	140	140	140	140
Magnesium Citrate $MgHC_6H_5O_7 \cdot 5H_2O$	--	--	180	--	140	140	--
Magnesium Fluoride MgF_2	--	--	--	--	--	--	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Magnesium Hydroxide $Mg(OH)_2$	Sat'd	160	180	180	140	140	140
Magnesium Nitrate $Mg(NO_3)_2 \cdot 2H_2O$	--	160	180	212	140	140	140
Magnesium Oxide MgO	--	160	--	--	--	--	--
Magnesium Sulfate $MgSO_4 \cdot 7H_2O$	--	160	180	212	140	140	140
Maleic Acid $HOOCCH{:}CHCOOH$	Sat'd	160	180	140	140	140	140
Malic Acid $COOHCH_2CH(OH)COOH$	--	--	180	140	140	140	140
Manganese Sulfate $MnSO_4 \cdot 4H_2O$	--	--	180	180	140	140	--
Mercuric Chloride $HgCl_2$	--	--	180	180	140	140	140
Mercuric Cyanide $Hg(CN)_2$	Sat'd	--	180	140	140	140	140
Mercuric Sulfate $HgSO_4$	Sat'd	--	180	140	140	140	--
Mercurous Nitrate $HgNO_3 \cdot 2H_2O$	Sat'd	--	180	140	140	140	140
Mercury Hg	--	--	180	140	140	140	140
Methane CH_4	--	N	73	73	140	120	--
Methanol (Methyl Alcohol) CH_3OH	--	--	N	180	140	140	140
Methoxyethyl Oleate $CH_3OCH_2CH_2OOCC_{17}H_{33}$	--	--	--	--	73	--	--
Methyl Acetate $CH_3CO_2CH_3$	--	N	N	140	N	C to 120	--

(A Number) = Resistant to Temperature Indicated. C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Methyl Acetone C_3H_6O	--	--	--	--	--	--	--
Methyl Acrylate $CH_2{:}CHCOOCH_3$	Tech. Pure	--	--	--	--	140	--
Methyl Amine CH_3NH_2	--	--	N	N	N	--	--
Methyl Bromide CH_3Br	--	--	N	N	N	C to 73	--
Methyl Cellosolve $HOCH_2CH_2OCH_3$	--	--	N	73	N	C to 120	--
Methyl Chloride CH_3Cl	Dry	N	N	N	N	C to 120	N
Methyl Chloroform CH_3CCl	--	N	N	C to 73	N	C to 120	--
Methyl Ethyl Ketone (MEK) $CH_3COC_2H_5$	--	N	N	73	N	73	73
Methyl Formate $HCOOCH_3$	--	--	--	--	--	--	--
Methyl Isobutyl Carbinol $(CH_3)_2CHCH_2CH(CH_3)OH$	--	--	--	--	N	--	--
Methyl Isobutyl Ketone $(CH_3)_2CHCH_2COCH_3$	--	N	N	73	N	73	--
Methyl Isopropyl Ketone $CH_3COCH(CH_3)_2$	--	--	N	--	N	73	--
Methyl Methacrylate $CH_2{:}C(CH_3)COOH_3$	--	--	--	--	73	140	--
Methyl Sulfate $(CH_3)_2SO_4$	--	--	73	C to 73	73	140	--
Methylene Bromide CH_2Br_2	--	--	N	N	N	C to 120	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Methylene Chloride CH_2Cl_2	--	--	N	N	N	C to 140	73
Methylene Chlorobromide CH_2ClBr	--	--	--	--	N	--	--
Methylene Iodide CH_2I_2	--	--	--	N	N	C to 120	--
Methysulfuric Acid CH_3HSO_4	--	--	180	140	140	--	--
Milk	--	160	180	212	140	140	140
Mineral Oil	--	73	180	C to 140	140	73	C to 73
Molasses	--	--	--	140	140	140	140
Monochloroacetic Acid $CH_2ClCOOH$	50%	--	--	140	140	140	--
Monochlorobenzene C_6H_5Cl	Tech. Pure	--	--	73	N	C to 120	--
Monoethanolamine $HOCH_2CH_2NH_2$	--	--	--	--	N	--	--
Motor Oil	--	--	180	C to 140	140	140	--
Morpholine C_4H_8ONH	--	--	--	140	--	140	--
Naphtha	--	--	73	73	140	73	73
Naphthalene $C_{10}H_8$	--	--	N	73	N	73	73
Natural Gas	--	73	--	73	140	140	73
Nickel Acetate $Ni(OOCH_3)_2 \cdot 4H_2O$	--	--	--	--	73	--	140
Nickel Ammonium Sulfate $NiSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$	--	--	--	--	--	--	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PS
Nickel Chloride $NiCl_2$	Sat'd	160	180	180	140	140	140
Nickel Nitrate $Ni(NO_3)_2 \cdot 6H_2O$	Sat'd	160	180	180	140	140	140
Nickel Sulfate $NiSO_4$	Sat'd	160	180	180	140	140	140
Nicotine $C_{10}H_{14}N_2$	--	--	180	--	140	140	140
Nicotinic Acid C_5H_4NCOOH	--	--	180	--	140	140	140
Nitric Acid HNO_3	10%	C to 73	180	180	140	140	C to 73
Nitric Acid HNO_3	30%	N	R to 73/C to 180	140	140	140	N
Nitric Acid HNO_3	40%	N	R to 73/C to 180	73	140	73	N
Nitric Acid HNO_3	50%	N	73	N	100	73	N
Nitric Acid HNO_3	70%	N	73	N	73	C to 73	N
Nitric Acid HNO_3	100%	N	N	N	N	N	N
Nitrobenzene $C_6H_5NO_2$	--	N	N	C to 140	N	73	--
Nitroethane $CH_3CH_2NO_2$	Tech. Pure	--	--	--	--	--	--
Nitrogen Gas N_2	--	--	--	--	--	--	--
Nitroglycerine $CH_2NO_3CHNO_3CH_2NO_3$	--	--	--	--	N	73	--
Nitroglycol	--	--	--	--	N	--	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Nitromethane CH_3NO_2	Tech. Pure	--	--	--	--	--	--
Nitrous Acid HNO_2	10%	--	180	C to 73	140	73	--
Nitrous Oxide N_2O	--	--	73	73	73	73	--
n-Octane CH_8H_{18}	--	--	C to 73	--	--	--	--
Oleic Acid $CH_3(CH_2)_7CH:CH(CH_2)_7COOH$	--	160	180	73	140	C to 140	150
Oleum $xH_2SO_4oySO_3$	--	N	N	N	N	N	N
Olive Oil	--	160	C to 180	73	140	140	--
[illegible]lic Acid $xCCOOHo2H_2O$	50%	160	180	140	140	140	140
Oxygen Gas O_2	--	160	180	N	140	140	--
Ozone O_3	--	--	180	C to 73	140	C to 120	--
Palm Oil	--	--	--	73	--	140	--
Palmitic Acid $CH_3(CH_2)_{14}COOH$	10%	73	73	180	140	120	150
Palmitic Acid $CH_3(CH_2)_{14}COOH$	70%	--	73	180	73	120	--
Paraffin $C_{36}H_{74}$	--	73	180	140	140	C to 140	--
Peanut Oil	--	--	C to 180	140	--	--	--
Pentane $_3(CH_2)_3CH_3$	--	N	C to 180	N	C to 140	C to 120	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Peracetic Acid CH_3COOOH	40%	--	N	--	73	73	--
Perchloric Acid (Type I) $HClO_4$	15%	--	140	140	73	140	C to 73
Perchloric Acid (Type I) $HClO_4$	70%	73	180	C to 73	73	73	N
Perchloroethylene $Cl_2C{:}CCl_2$	--	N	C to 180	C to 73	C to 140	C to 120	--
Perphosphate	--	--	73	140	73	--	--
Phenol C_6H_5OH	--	N	73	73	73	140	73
Phenylhydrazine $C_6H_5NHNH_2$	--	--	N	N	N	C to 120	--
Phosphate Esters	--	--	--	--	--	--	-
Phosphoric Acid H_3PO_4	10%	--	180	212	140	140	140
Phosphoric Acid H_3PO_4	50%	73	180	212	140	140	73
Phosphoric Acid H_3PO_4	85%	--	180	212	140	73	--
Phosphoric Anhydride P_2O_5	--	--	73	73	73	--	--
Phosphorous (Red)	--	--	--	--	73	140	--
Phosphorous (Yellow)	--	--	--	--	73	140	--
Phosphorous Pentoxide P_2O_5	--	--	73	73	73	140	--
Phosphorous Trichloride PCl_3	--	--	N	73	N	120	C to 73

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Photographic Solutions	--	--	180	140	140	140	140
Phtalic Acid $C_6H_4(COOH)_2$	--	--	--	140	C to 140	140	--
Picric Acid $C_6H_2(NO_2)_3OH$	10%	N	N	73	N	73	73
Pine Oil	--	--	--	140	--	73	--
Plating Solutions (Brass)	--	--	180	140	140	140	C to 73
Plating Solutions (Cadmium)	--	--	180	140	140	140	C to 73
Platings Solutions (Chrome)	--	--	180	140	140	140	C to 73
Platings Solutions (Copper)	--	--	180	140	140	140	C to 73
Platings Solutions (Gold)	--	--	180	140	140	140	C to 73
Platings Solutions (Lead)	--	--	180	140	140	140	C to 73
Platings Solutions (Nickel)	--	--	180	140	140	140	C to 73
Platings Solutions (Rhodium)	--	--	180	140	140	140	C to 73
Platings Solutions (Silver)	--	--	180	140	140	140	C to 73
Platings Solutions (Tin)	--	--	180	140	140	140	C to 73
Platings Solutions (Zinc)	--	--	180	140	140	140	C to 73
Polysulfide Liquor	--	--	--	--	--	--	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Polyvinyl Acetate	--	--	--	--	--	--	--
Potash (Aq) KOH	Sat'd	--	180	--	140	140	--
Potassium Alum $ALK(SO_4)_2 \cdot 12H_2O$	--	--	180	--	140	140	--
Potassium Aluminum Sulphate	--	--	180	180	140	--	C to 73
Potassium Amyl Xanthate	--	--	--	--	73	--	--
Potassium Bicarbonate $KHCO_3$	Sat'd	--	180	140	140	140	140
Potassium Bichromate $K_2Cr_2O_7$	Sat'd	--	180	140	140	--	C to 73
Potassium Bisulfate $KHSO_4$	--	--	180	212	140	140	--
Potassium Borate $K_2B_4O_7 \cdot 5H_2O$	--	--	180	140	140	140	140
Potassium Bromate $KBrO_3$	--	--	180	212	140	140	140
Potassium Bromide KBr	--	--	180	212	140	140	140
Potassium Carbonate K_2CO_3	--	73	180	180	140	140	140
Potassium Chlorate $KClO_3$ (Aqueous)	--	160	180	212	140	140	140
Potassium Chloride KCl	--	160	180	212	140	140	140
Potassum Chromate K_2CrO_4	--	--	180	212	140	140	140
Potassium Cyanide KCN	--	--	180	180	140	140	140

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Potassium Dichromate $K_2Cr_2O_7$	Sat'd	--	180	180	140	140	140
Potassium Ethyl Xanthate $KS_2COC_2H_5$	--	--	--	--	73	--	--
Potassium Ferricyanide $K_3Fe(CN)_6$	--	--	180	180	140	140	140
Potassium Ferroycanide $K_4Fe(CN)_6 \cdot 3H_2O$	--	--	180	180	140	140	--
Potassium Fluoride KF	--	--	180	180	140	140	140
Potassium Hydroxide KOH	25%	160	180	212	140	140	140
Potassium Hyprochlorite KClO	--	160	180	--	140	120	--
Potassium Iodide KI	--	--	180	73	73	140	--
Potassium Nitrate KNO_3	--	160	180	140	140	140	140
Potassium Perborate	--	--	180	140	140	140	140
Potassium Perchlorate $KClO_4$	--	--	180	140	140	140	140
Potassium Permanganate $KMnO_4$	10%	--	180	73	140	140	140
Potassium Permanganate $KMnO_4$	25%	--	180	73	73	140	--
Potassium Persulfate $K_2S_2O_8$	--	--	180	140	140	140	140
Potassium Sulfate K_2SO_4	--	160	180	180	140	140	140
Potassium Sulfide K_2S	--	--	--	140	--	140	140

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Potassium Sulfite $K_2SO_3 \cdot 2H_2O$	--	--	--	140	--	140	--
Potassium Tripolyphosphate $K_5P_3O_{10}$	--	--	--	--	--	--	--
Propane C_3H_8	--	--	73	73	140	140	73
Propargyl Alcohol $HC{:}CCH_2OH$	--	--	180	140	140	140	140
Propionic Acid $CH_3CH_2CO_2H$	--	N	N	140	--	140	--
Propyl Acetate $C_3H_7OOCCH_3$	--	--	--	--	--	--	--
Propyl Alcohol (Type I) $CH_3CH_2CH_2OH$	--	73	C to 73	140	140	140	140
Propyl Bromide $_3CH_2CH_2Br$	--	--	--	--	--	--	--
Propylene Dichloride $CH_3CHClCH_2Cl$	100	--	N	N	N	N	--
Propylene Oxide CH_3CHCH_2O	--	--	N	73	N	140	--
n-Propyl Nitrate $C_3H_7NO_3$	--	--	--	--	--	--	--
Pyridine $N(CH)_4CH$	--	--	N	C to 140	N	73	--
Pyrogallic Acid $C_6H_3(OH)_3$	--	--	--	--	73	--	--
Pyrrole $CHNH(CH)_2CH$	--	--	--	--	--	--	--
Quinone $C_6H_4O_2$	--	--	--	140	--	140	--
Rayon Coagulating Bath	--	--	180	--	140	140	140

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Salicylaldehyde C_6H_4OHCHO	--	--	--	73	N	120	--
Salicylic Acid $C_6H_4(OH)(COOH)$	--	--	--	140	140	140	--
Selenic Acid, Aq. H_2SeO_4	--	--	180	--	140	140	140
Silicic Acid $SiO_2 o n H_2O$	--	--	180	140	140	140	140
Silicone Oil	--	--	180	212	73	73	--
Silver Chloride AgCl	--	160	180	140	140	--	--
Silver Cyanide AgCN	--	--	180	180	140	140	140
Silver Nitrate $AgNO_3$	--	160	180	180	140	140	C to 73
Silver Sulfate Ag_2SO_4	--	160	180	140	140	140	C to 73
Soaps	--	73	180	140	140	140	140
Sodium Acetate $NaC_2H_3O_2$	Sat'd	--	180	212	140	140	140
Sodium Alum $AlNa(SO_4)_2 o 12H_2O$	--	--	180	--	140	--	--
Sodium Aluminate $Na_2Al_2O_3$	Sat'd	--	--	--	140	--	--
Sodium Benzoate C_6H_5COONa	--	--	180	140	140	140	140
Sodium Bicarbonate $NaHCO_3$	--	73	180	212	140	140	140
Sodium Bichromate $Na_2Cr_2O_7 o 2H_2O$	Sat'd	--	180	--	140	--	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Sodium Bisulfate $NaHSO_4$	--	73	180	140	140	140	140
Sodium Bisulfite $NaHSO_3$	--	--	180	140	140	140	--
Sodium Borate (Borax) $Na_2B_4O_7 \cdot 10H_2O$	Sat'd	160	180	180	140	140	140
Sodium Bromide NaBr	Sat'd	120	180	140	140	140	140
Sodium Carbonate Na_2CO_3	--	73	180	212	140	140	140
Sodium Chlorate $NaClO_3$	Sat'd	--	73	140	73	140	140
Sodium Chloride NaCl	--	120	180	212	140	140	140
Sodium Chlorite $NaClO_2$	25%	--	73	73	N	140	--
Sodium Chromate $Na_2CrO_4 \cdot 10H_2O$	--	120	--	140	--	140	--
Sodium Cyanide NaCN	--	--	180	180	140	140	140
Sodium Dichromate $Na_2Cr_2O_7 \cdot 2H_2O$	20%	--	180	180	140	140	140
Sodium Ferricyanide $Na_3Fe(CN)_6 \cdot 2H_2O$	Sat'd	--	180	140	140	140	140
Sodium Ferrocyanide $Na_3Fe(CN)_6 \cdot 10H_2O$	Sat'd	--	180	140	140	140	140
Sodium Fluoride NaF	--	120	180	180	140	140	140
Sodium Hydroxide NaOH	15%	120	180	212	140	140	140

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Sodium Hydroxide NaOH (Caustic Soda)	30%	120	180	212	140	140	140
Sodium Hydroxide NaOH	50%	120	180	212	140	140	140
Sodium Hydroxide NaOH	70%	120	180	212	140	140	140
Sodium Hypochlorite NaOClo$5H_2O$	--	120	180	73	73	140	140
Sodium Iodide NaI	--	--	--	--	140	--	--
Sodium Metaphosphate $(NaPO_3)n$	--	--	180	120	140	--	--
Sodium Nitrate $NaNO_3$	Sat'd	160	180	180	140	140	140
Sodium Nitrite $NaNO_2$	--	160	180	73	140	140	140
Sodium Palmitrate $CH_3(CH_2)_{14}COONa$	5%	--	180	140	140	--	--
Sodium Perborate $NaBO_2o3H_2O$	--	120	180	73	140	73	--
Sodium Perchlorate $NaClO_4$	--	--	180	212	140	140	--
Sodium Peroxide Na_2O_2	10%	--	180	--	140	140	--
Sodium Phosphate NaH_2PO_4	Acid	120	180	212	140	140	140
Sodium Phosphate NaH_2PO_4	Alkaline	120	180	212	140	140	--
Sodium Phosphate NaH_2PO_4	Neutral	120	180	212	140	140	--
Sodium Silicate $2Na_2OoSiO_2$	--	--	180	140	140	140	140

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Plastics at Maximum Temperature (°F)

Chemicals and Formula	Concentration	ABS	CPVC	PP	PVC	PE	PB
Sodium Sulfate Na_2SO_4	Sat'd	160	180	212	140	140	140
Sodium Sulfide Na_2S	--	160	180	212	140	140	140
Sodium Sulfite Na_2SO_3	--	160	180	212	140	140	140
Sodium Thiosulphate $Na_2S_2O_3 \cdot 5H_2O$	--	--	180	180	140	140	140
Sour Crude Oil	--	--	--	140	140	--	--
Soybean Oil	--	--	--	73	--	140	--
Stannic Chloride $SnCl_4$	--	--	180	140	140	140	140
Stannous Chloride $SnCl_2$	15%	120	180	140	140	140	140
Starch	--	--	180	140	140	140	--
Steam (Low Pressure)	--	--	--	--	--	--	--
Steam (Med. Pressure)	--	--	--	--	--	--	--
Steam (High Pressure)	--	--	--	--	--	--	--
Stearic Acid $CH_3(CH_2)_{16}COOH$	--	--	180	73	140	120	150
Stoddard's Solvent	--	--	N	--	N	73	140
Styrene $(C_6H_5CHCH_2)n$	--	--	--	73	--	C to 73	--
Succinic Acid $CO_2H(CH_2)_2CO_2H$	--	--	180	140	140	140	--
Sugar $C_6H_{12}O_6$	Aq.	--	180	--	140	140	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Sulfamic Acid NSO_3NH_2	20%	--	N	180	N	--	--
Sulfate Liquors (Oil)	6%	--	180	140	140	--	--
Sulfite Liquors	6%	73	180	--	140	140	--
Sulfur S	--	--	180	212	140	140	140
Sulfur Chloride S_2Cl_2	--	--	--	C to 73	--	--	--
Sulfur Dioxide SO_2	Gas Dry	N	73	140	140	140	--
Sulfur Dioxide SO_2	Gas Wet	N	N	140	73	120	73
Sulfur Trioxide SO_3	Gas Dry	--	--	--	140	N	--
Sulfur Trioxide SO_3	Gas Wet	--	N	--	73	N	--
Sulfuric Acid H_2SO_4	Up to 30%	120	180	180	140	140	140
Sulfuric Acid H_2SO_4	50%	73	180	140	140	120	C to 73
Sulfuric Acid H_2SO_4	60%	C to 73	180	73	140	120	C to 73
Sulfuric Acid H2SO4	70%	C to 73	180	73	140	120	C to 73
Sulfuric Acid H2SO4	80%	C to 73	180	73	140	120	N
Sulfuric Acid H_2SO_4	90%	C to 73	150	73	73	120	N
Sulfuric Acid H_2SO_4	93%	N	140	C to 73	73	C to 73	N

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Sulfuric Acid H_2SO_4	94%	N	130	C to 73	N	C to 73	N
Sulfuric Acid H_2SO_4	95%	N	130	C to 73	N	C to 73	N
Sulfuric Acid H_2SO_4	96%	N	130	C to 73	N	C to 73	N
Sulfuric Acid H_2SO_4	98%	N	130	C to 73	N	C to 73	N
Sulfuric Acid H_2SO_4	100%	N	N	C to 73	N	C to 73	N
Sulfurous Acid H_2SO_3	--	--	180	140	140	140	140
Tall Oil	--	--	180	180	140	120	--
Tannic Acid $C_{76}H_{52}O_{46}$	10%	N	180	73	140	140	140
Tanning Liquors	--	160	180	73	140	120	140
Tar	--	--	N	--	N	--	--
Tartaric Acid $HOOC(CHOH)_2COOH$	--	160	180	140	140	140	140
Terpineol $C_{10}H_{17}OH$	--	--	--	--	C to 140	--	--
Tetrachloroethane $CHCl_2CHCl_2$	--	--	--	C to 73	C to 140	C to 120	--
Tetrachloroethylene $Cl_2C{:}CCl_2$	--	N	--	C to 73	--	--	--
Tetraethyl Lead $Pb(C_2H_5)_4$	--	--	73	73	73	--	--
Tetrahydrofuran C_4H_8O	--	N	N	C to 73	N	C to 73	C to 73
Tetralin $C_{10}H_{12}$	--	--	N	N	N	--	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Tetra Sodium Pyrophosphate $Na_4P_2O_7 \cdot 10H_2O$	--	--	--	--	140	--	--
Thionyl Chloride $SOCl_2$	--	--	N	N	N	N	140
Thread Cutting Oils	--	--	73	73	73	--	--
Titanium Tetrachloride $TiCl_4$	--	--	--	140	C to 73	120	
Toluene (Toluol) $CH_3C_6H_5$	--	N	N	C to 73	N	C to 120	N
Tomato Juice	--	--	180	212	140	140	--
Transformer Oil	--	--	180	73	140	120	--
Transformer Oil DTE/30	--	--	180	--	140	120	--
ributyl Citrate	--	--	--	C to 73	73	C to 120	--
Tributyl Phosphate $(C_4H_9)_3PO_4$	--	--	N	C to 140	N	73	--
Trichloroacetic Acid CCl_3COOH	50%	--	--	140	140	140	--
Trichloroethylene $CHCl:CCl_2$	--	N	N	N	N	C to 120	N
Triethanolamine $(HOCH_2CH_2)_3N$	--	C to 73	73	140	73	73	73
Triethylamine $(C_2H_5)_3N$	--	--	--	N	140	73	--
Trimethylpropane $(CH_2OH)_3C_3H_5$	--	--	--	140	73	C to 120	--
Trisodium Phosphate $Na_3PO_4 \cdot 12H_2O$	--	73	180	140	140	140	140
Tung Oil	--	--	--	--	--	--	--

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
Turpentine	--	N	73	N	140	C to 120	C to 73
Urea $CO(NH_2)_2$	--	--	180	180	140	140	140
Urine	--	160	180	180	140	140	140
Varish	--	--	--	--	--	--	--
Vaseline (Petroleum Jelly)	--	--	N	140	N	120	--
Vegetable Oil	--	--	C to 180	140	140	140	--
Vinegar	--	73	150	140	140	140	140
Vinyl Acetate $CH_3COOCH{:}CH_2$	--	--	N	73	N	140	--
Water, Acid Mine H_2O	--	160	180	140	140	140	180
Water, Deionized H_2O	--	160	180	140	140	140	180
Water, Distilled H_2O	--	160	180	212	140	140	180
Water, Potable H_2O	--	160	180	212	140	140	180
Water, Salt H_2O	--	160	180	212	140	140	180
Water, Sea H_2O	--	160	180	212	140	140	180
Water, Soft H2O	--	160	180	212	140	140	180
Water, Waste H_2O	160	73	180	212	140	140	180
Whiskey	--	--	180	140	140	140	140

(A Number) = Resistant to Temperature Indicated C = Limited Resistance N = Not Resistant

Chemicals and Formula	Concentration	Plastics at Maximum Temperature (°F) ABS	CPVC	PP	PVC	PE	PB
White Liquor	--	73	180	--	140	--	--
Wine	--	73	180	140	140	140	140
Xylene (Xylol) $C_6H_4(CH_3)_2$	--	N	N	N	N	N	N
Zinc Acetate $Zn(C_2H_3O_2)_2 \cdot 2H_2O$	--	--	180	--	--	--	--
Zinc Carbonate $ZnCO_3$	--	--	--	140	--	140	--
Zinc Chloride $ZnCl_2$	--	120	180	180	140	140	--
Zinc Nitrate $Zn(NO_3)_2 \cdot 6H_2O$	--	160	180	180	140	140	140
Zinc Sulfate $ZnSO_4 \cdot 7H_2O$	--	160	180	212	140	140	140

(A Number) = Resistant to Temperature Indicated L = Limited Resistance N = Not Resistant

APPENDIX D

SLT NORTH AMERICA
FORM R MANUFACTURERS LINER/LEACHATE LIMITS

THIS PAGE INTENTIONALLY
LEFT BLANK

Attachment IV

SLT North America - Form R Manufacturers Liner/Leachate Limits

Chemical Compatibility of HDPE Geomembrane

Following are my comments and evaluation of the compatibility of SLT HyperFlex® for the chemicals and situations listed.

SLT does not have specific test data defining limits for all of the materials listed. I am sure that no one has such a comprehensive set of data for any polyethylene, much less a specific polyethylene.

In a landfill application, the liner may be exposed to any combination of the listed materials as well as others. The total potential effect on the liner by combinations of materials may, in some instances, be additive. In other instances, multiple or repeatitive exposure may promote stress cracking even though normal testing does not indicate any effect.

Most testing is conducted utilizing an evaluation procedure that rates the material based on physical properties such as weight gain, softening and other characteristics that do not necessarily define the ability of the membrane to perform its function as a significant barrier to the escape of the contained materials.

As a result, I can only offer my best judgement based on experience. I also reviewed data and solicited opinions from others with experience and knowledge of polyethylene. I have tried to be conservative.

To the best of my knowledge, SLT polyethylene geomembranes have never demonstrated a failure to provide continuing containment of landfill leachates due to lechate content. It is extremely unlikely that a landfill will have a leachate that is so different it will be detrimental to SLT HyperFlex®.

If you have a question or concern about my response or my evaluation of a specific material, please contact me.

W.W. "Bill" Walling
SLT North America, Inc.
Director Engineering Services

Aromatic Halogenated Hydrocarbons

Aromatic Halogenated Hydrocarbons tend to be adsorbed into polyethylene where they may function as a plasticizer. As a result, the polyethylene may swell and become softer and more elastic. These effects are generally reversible if the exposure is terminated.

Since polyethylene consists of a range of molecular weight molecules and somewhat different branching arrangements, some lower density polyethylenes may contain fractions that are extractable. Some types of chemical stabilizers and processing aids may also be extractable.

These above noted effects increase with increasing temperature. Softening, swelling and increased elasticity may rapidly reduce the usefulness of polyethylene as a structural component such as, for example, use as a pressure pipe. Generally, these effects do not seriously effect the performance of polyethylene as a containment membrane.

SLT HyperFlex® polyethylene geomembranes are manufactured from a narrow molecular weight range resin designed to minimize the possibility of extractable fractions and maximize the resistance to stress cracking.

Aliphatic Halogenated Hydrocarbons

Similar effects as for Aromatic Halogenated Hydrocarbons but generally less severe. Some materials having little or no effect.

Aromatic Hydrocarbons

Again similar to Aromatic Halogenated Hydrocarbons but generally less severe. Many materials having no significant effect.

Aliphatic Hydrocarbons

Again similar, but with further reductions of general severity. Most materials having no significant effect.

Volatile and Semivolatile Organics

These are mostly covered by the previously noted comments about hydrocarbons.

Oil and Grease

Mineral, vegetable and animal oils, fats or grease generally have no significant effect.

Strong Oxidizers - Generally no significant effect.

Acids - Generally no significant effect.

Dissolved Metals, Salts and Nutrients - Generally no effect.

FORM R
LINER COMPATABILITY

PARAMETER CLASSIFICATION	PARAMETER	MANUFACTURER'S LINER/LEACHATE LIMIT mg/l (ppm)
Aromatic Halogenated Hydrocarbons	polychlorinated biphenyl	(2000)
	aldrin	(2000)
	dichlorobenzene	(2000)
	hexachlorobenzene	(2000)
	pentachlorobenzene	(2000)
	trichlorobenzene	(2000)
	tetrachlorobenzene	(2000)
	2-chloronaphthalene	(2000)
	chloronaphthalene	(2000)
	chlorobenzene	(2000)
	4,4-DDT	(2000)
	4,4-DDE	(2000)
	4,4-DDD	(2000)
Aliphatic Halogenated Hydrocarbons	bromoform	(2000)
	carbon tetrachloride	(2000)
	chlorodibromomethane	(2000)
	chloroethane	(2000)
	chloroform	(2000)
	dichlorobromomethane	(2000)
	dichlorodifluoromethane	(2000)
	dichloroethane	(2000)
	dichloropropane	(2000)
	dichloroethene	(2000)
	ethylene chloride	(2000)
	ethylene dichloride	(2000)
	hexachloroethane	(2000)
	methyl bromide	(2000)
	methyl chloride	(2000)
	methylene chloride	(2000)
	tetrachloroethane	(2000)
	tetrachloroethene	(2000)
	trichloroethane	(2000)
	trichloroethene	(2000)
	trichlorofluoromethane	(2000)
	vinyl chloride	(2000)

TEMPERATURE 70°

FORM R

LINER COMPATABILITY

PARAMETER CLASSIFICATION	PARAMETER	MANUFACTURER'S LINER/LEACHATE LIMIT mg/l
Aromatic Hydrocarbons	acenapthene	(2000)
	acenaphthylene	(2000)
	anthracene	(2000)
	benzene	(2000)
	benzo(a)anthracene	(2000)
	benzo(a)pyrene	(2000)
	benzo(g,h,i)perylene	(2000)
	benzo(k)fluoranthene	(2000)
	3,4–benzoflouranthene	(2000)
	chrysene	(2000)
	dibenzo(a,h)anthracene	(2000)
	ethyl benzene	(2000)
	flouranthene	(2000)
	flourene	(2000)
	ideno(1,2,3,c,d)pyrene	(2000)
	naphthalene	(2000)
	phenanthrene	(2000)
	pyrene	(2000)
	styrene	(5000)
	toluene	(5000)
	xylene	(5000)
Aliphatic Hydrocarbons	heptane	(500,000)
	hexane	(500,000)
	octane	(500,000)

TEMPERATURE 70°

FORM R
LINER COMPATABILITY

PARAMETER CLASSIFICATION	PARAMETER	MANUFACTURER'S LINER/LEACHATE LIMIT mg/l
Volatile & Semivolatile Organics	acrolein	(200,000)
	acrylonitrile	(200,000)
	acetone	(200,000)
	amyl acetate	(200,000)
	benzidine	(200,000)
	butyl alcohol	(500,000)
	bis(2-chloroethoxy)methane	(2,000)
	bis(2-chloroethosy)ether	(2,000)
	bis(2-chloroisopropy)ether	(2,000)
	bis(2-etylhexyl)pththalate	(2,000)
	4-bromophenyl phenyl ether	(2,000)
	butyl benzyl phthalate	(200,000)
	cresol	(100,000)
	chlordane	(2,000)
	alpha-BHC	(2,000)
	beta-BHC	(2,000)
	gamma-BHC	(2,000)
	delta-BHC	(2,000)
	dieldrin	(2,000)
	dichlorobenzidine	(2,000)
	diethyl phthalate	(100,000)
	dibutyl phthalate	(100,000)
	dimethyl phthalate	(100,000)
	isobutyl alchohol	(500,000)
	isopropyl alcohol	(500,000)
	methyl alcohol	(500,000)
	2-chloroethyl vinyl ether	(2,000)
	2-chlorophenol	(2,000)
	dichlorophenol	(2,000)
	dimethyl phenol	(2,000)
	dinitro-o-cresol	(2,000)
	dinitrophenol	(2,000)
	dinitrotoluene	(2,000)
	diphenylhydrazine	(2,000)
	ethyl acetate	(100,000)
	ethyl ether	(2,000)
	ethyl glycol	(500,000)
	endosulfan	(2,000)
	endrin	(2,000)
	formaldehyde	(200,000)
	heptachlor	(2,000)
	hexachlorocyclopentadiene	(2,000)
	hexachlorobutadiene	(2,000)
	isophorone	(2,000)
	methyl ethyl ketone	(200,000)

TEMPERATURE 70°

FORM R
LINER COMPATABILITY

PARAMETER CLASSIFICATION	PARAMETER	MANUFACTURER'S LINER/LEACHATE LIMIT mg/l
Volatile & Semivolotile Organics (cont.)	methyl isobutyl ketone	(500,000)
	nitrophenol	(100,000)
	N-nitrosodimethylamine	(100,000)
	N-nitrosodi-n-propylamine	(100,000)
	nitrobenzene	(100,000)
	pentachlorophenol	(100,000)
	phenol	(100,000)
	pyridine	(100,000)
	toxaphene	(100,000)
	trichlorophenol	(100,000)
	2,4,5-TP(silvex)	(?)

TEMPERATURE 70°

LINER COMPATABILITY

PARAMETER CLASSIFICATION	PARAMETER	MANUFACTURER'S LINER/LEACHATE LIMIT mg/l
Acids & Bases	acetic acid	500,000
	chromic acid	100,000
	citric acid	500,000
	hydrobromic acid	100,000
	hydrochloric acid	350,000
	hydrocyanic acid	100,000
	hydrofluoric acid	750,000
	nitric acid	500,000
	picric acid	500,000
	phosphoric acid	500,000
	perchloric acid	500,000
	sulfuric acid	500,000
	potassium hydroxide	500,000
	sodium hydroxide	500,000
Products & Various Substances	antifreeze	500,000
	asphalt	500,000
	cresols	100,000
	crude oil	500,000
	diesel fuel	500,000
	fatty acids	500,000
	freon	500,000
	fuel oil	500,000
	gasoline	500,000
	hydraulic oil	500,000
	kerosene	500,000
	lacquers	500,000
	lubricating oil	500,000
	mineral spirits	500,000
	naphtha	500,000
	paraffin	500,000
	transformer oil	500,000
Miscellaneous	pH	0.5–13.0 pH unit
	strong oxidizers*	1000–500,000
	metals, salts, nutrients	500,000

*potassium permaganate, potassium dichromate, chlorine, peroxides

TEMPERATURE 70°

THIS PAGE INTENTIONALLY
LEFT BLANK

APPENDIX E

VENDOR CERTIFICATIONS

THIS PAGE INTENTIONALLY
LEFT BLANK

SLT® NORTH AMERICA, INC.
A SUBSIDIARY OF SLT ENVIRONMENTAL, INC.
200 SOUTH TRADE CENTER PARKWAY
CONROE, TEXAS 77385
TEL: (713) 350-1813
SALES FAX: (409) 273-2266
ADMIN. FAX: (409) 273-3808

16 August 1994

Scott Matthews
Golder and Associates
Re: SLT Job # 94-9538

Fax: 509/373-9484

Certification

The undersigned, being qualified and authorized to do so hereby certifies that SLT HyperFlex® is made of high quality, virgin polyethylene resin. The resin used for manufacturing all HyperFlex geomembranes was developed for the express purpose of geomembrane production and is supplied by a single reisn manufacturer to one, consistent specification. All material refered to as SLT HyperFlex has been made with this resin.

Further, due to the consistency of raw materials used in the production of HyperFlex, all HyperFlex material exhibits similar physical properties and chemical resistance.

Matthew W. Adams
Chemist

DOCUMENT:CERT9538_7

SLT® NORTH AMERICA, INC.

A SUBSIDIARY OF
SLT ENVIRONMENTAL, INC.

300 SOUTH TRADE CENTER PARKWAY
CONROE, TEXAS 77385

TEL: (713) 350-1813
SALES FAX: (409) 273-2266
ADMIN. FAX: (409) 273-3808

16 August 1994

Scott Matthews
Golder and Associates
Re: SLT Job # 94-9538

Fax: 509/373-9484

Certification

The undersigned, being qualified and authorized to do so hereby certifies that SLT HyperFlex® is made of high quality, virgin polyethylene resin. The finished product is composed of 97-98 % polyethylene and 2-3 % carbon black for uv stability. SLT has adhered to this formulation for all material carrying the HyperFlex trade name.

Matthew W. Adams
Chemist

TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

June 06, 1995

Mr. John Fleming
Westinghouse Hanford Company
PO Box 1970
Richland, WA 99352

Dear Mr. Fleming:

As requested by your staff, this letter is to clarify the relationship between the thickness of a geomembrane and its chemical resistance.

A geomembrane's resistance to change as a function of chemical exposure is related to its component resin package (polymer and additives) and its density. A thinner geomembrane made from the same resin package and having the same density will generally exhibit the same resistance to change as a function of chemical exposure.

I trust this information serves your needs. If you have any questions or require any additional information, please don't hesitate to call me (800 880-8378).

Sincerely,

Sam R. Allen
Program Manager: Geosynthetics Testing Technologies

cc: Rick Thomas
Technical Director

9063 Bee Caves Road • Austin, TX 78733-6201 • (512) 263-2101 • FAX 263-2558 • 1-800-880-T-E-S-T

THIS PAGE INTENTIONALLY
LEFT BLANK

MAY 15 1995 (21) Sta. 21

ENGINEERING DATA TRANSMITTAL

1. EDT № 611724

2. To: (Receiving Organization) Solid Waste Management	3. From: (Originating Organization) TRI\Environmental Inc. 87250	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: W-025 & W-025A	6. Cog. Engr.: R. W. Whitlock A7A48	7. Purchase Order No.: N/A
8. Originator Remarks: This EDT is for release of the "A Final Report: Laboratory Testing of Geomembrane for Waste Containment EPA Method 9090, March 1995". This report is for the Low-Level Burial Grounds Mixed Waste Disposal Trenches 31 and 34.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: 218-W-5 Burial Ground
11. Receiver Remarks: None.		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: ASAP

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-WM-TRP-237		0	Laboratory Testing of Geomembrane for Waste Containment EPA Method 9090	N/A	2	N/A	N/A

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 4. Review 2. Release 5. Post-Review 3. Information 6. Dist. (Receipt Acknow. Required)	1. Approved 4. Reviewed no/comment 2. Approved w/comment 5. Reviewed w/comment 3. Disapproved w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature (M) MSIN	(L) Date	(J) Name	(K) Signature (M) MSIN	(L) Date	(G) Reason	(H) Disp.
6	1	Cog. Eng. R.W. Whitlock	RWhitlock	5/5/95	Central Files (2)	L8-04			
6	1	Cog. Mgr. D.B. Powell	DBPowell						
		QA							
		Safety							
		Env. S.E. Campbell	SE Campbell	5/9/95					
		Brett M. Barnes		5/5/95					
		OSTI (2)		L8-07					

18.	19.	20.	21. DOE APPROVAL (if required)
RWhitlock 5/5/95 Signature of EDT Originator Date	Authorized Representative for Receiving Organization Date	DBPowell Cognizant Manager Date 5/10/95	Ctrl. No. [ ] Approved [ ] Approved w/comments [ ] Disapproved w/comments

BD-7400-172-2 (04/94) GEF097

BD-7400-172-1

RELEASE AUTHORIZATION

Document Number:	WHC-SD-WM-TRP-237, Rev. 0
Document Title:	LABORATORY TESTING OF GEOMEMBRANE FOR WASTE CONTAINMENT EPA METHOD 9090
Release Date:	5/11/95

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Chris Willingham

C. Willingham 5/11/95

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy. Available in paper copy and microfiche. Printed in the United States of America. Available to the U.S. Department of Energy and its contractors from:

U.S. Department of Energy
Office of Scientific and Technical Information (OSTI)
P.O. Box 62
Oak Ridge, TN 37831
Telephone: (615) 576-8401

Available to the public from: U.S. Department of Commerce
National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
Telephone: (703) 487-4650

SUPPORTING DOCUMENT

1. Total Pages 97

2. Title

A Final Report: Laboratory Testing of Geomembrane for Waste Containment EPA Method 9090, March 1995

3. Number

WHC-SD-WM-TRP-237

4. Rev No.

0

5. Key Words

Trench 31, Trench 34, Low-Level Burial Grounds, EPA, Method 9090, geomembrane, HDPE

6. Author

Name: Roger W. Whitlock

R Whitlock 5/8/95

Signature

Organization/Charge Code 87250/A7A48

7. Abstract

This document determines the chemical compatibility of one geomembrane and one seamed geomembrane with four synthetically generated leachates.

8. RELEASE STAMP

OFFICIAL RELEASE BY WHC (21)

DATE MAY 15 1995

Sta. 21

A-6400-073 (08/94) WEF124

A Final Report:

Laboratory Testing of Geomembrane for Waste Containment EPA Method 9090

March 1995

Submitted to:
Westinghouse Hanford Company
Procurement & Materials Management
Building 1163
2355 Stevens Drive
Richland, Washington 99352

Attn: Mr. John Fleming

Submitted by:

TRI/Environmental, Inc.
9063 Bee Caves Rd.
Austin, Texas 78733

FOREWORD

The testing reported herein is based upon accepted industry practice as well as the test method listed. TRI/Environmental Inc. (TRI) neither accepts responsibility for nor makes claim as to the final use and purpose of the materials tested.

Tests were performed under laboratory conditions and not under actual usage conditions. TRI can give no conclusions as to the serviceability, life expectancy or general durability of the products tested when used in a lining and/or leachate collection system.

1.0 INTRODUCTION

This report describes the work performed by TRI/Environmental, Inc. (TRI) to determine the chemical compatibility of one geomembrane and one seamed geomembrane with four synthetically generated leachates. The objective was to determine the resistance of the geomembrane to changes caused by exposure to the leachates. Changes in physical and mechanical properties were measured after exposure to the leachates at 23°C and 50°C for 30, 60, 90 and 120 days. Exposures were performed in accordance with the exposure regimen specified in United States Environmental Protection Agency (EPA) Method 9090A.

Methods, results and discussion are provided in the sections which follow. Test results are provided in the Tables of Results which accompany this report.

2.0 METHODS

2.1 Materials

Table 1 lists products selected for evaluation in this chemical compatibility study..

Table 1. List of geomembranes evaluated in chemical compatibility study

Geosynthetic	Source
80 mil smooth HDPE geomembrane	Westinghouse Hanford Co.
80 mil HDPE seamed geomembrane (double track welds)	Westinghouse Hanford Co.

2.2Leachate

The waste leachates were synthetically generated from neat chemicals purchased by TRI. TRI's analytical staff performed the generation of leachates by adding appropriate amounts of chemicals to result in the solutions outlined in tables 1 through 4.

Leachates were generated in 100 liter stainless steel containers by successive addition of chemicals to the specified base. Upon completion of the additions, the containers were capped and rotated on a drum roller for 2 hours. The drums were then allowed to rest undisturbed for a period of 6 hours. The resulting supernatant liquid was then transferred directly into the exposure vessels via leachate transfer pumps.

Table 2. Organic Solution in Butanol

Compound	mg/Kg	Percent by Weight
Acetone	40,000	4
Acetonitrile	8,000	0.8
Aliquat 336	8,000	0.8
Benzyl Alcohol	4,000	0.4
(2-chloroethyl) ether	2,000	0.2
2-Butanol		Matrix
Carbon Tetrachloride	2,000	0.2
Cyclohexane	500	0.05
Dichlorobenzene	2,000	0.2
Dioctyl Phthalate	2,000	0.2
Ethylene Glycol	8,000	0.8
1-Hexanol	8,000	0.8
Methylene Chloride	2,000	0.2
n-Butyl Acetate	5,000	0.5
Napthalene	2,000	0.2
Pentane	2,000	0.2
PCB - Aroclor 1242 Mix	2,000	0.2
Toluene	5,000	0.5
Tributyl Phosphate	2,000	0.2
Trichloroethane	2,000	0.2
Trichloroethylene	2,000	0.2
2-Butanol		89.35

Table 3. Organic Solution in Water

Compound	mg/Kg	Percent by Weight
EDTA, Disodium Salt	50,000	5
Phenol	50,000	5
Water	14,400	90

Table 4. Metals in Nitric Acid Solution

Compound	mg/Kg	Percent by Weight
Aluminum Nitrate-9-Water	375,000	37.5
Cadium Nitrate-4-Water	30.8125	0.003
Calcium Nitrate-4-Water	236,000	23.6
Cupric Nitrate-3-Water	24,000	0.24
Ferric Nitrate-9-Water	80,812.5	8.08
Lanthanum Nitrate-6-Water	4,300	0.43
Mercuric Nitrate-1-Water	34.3125	0.003
Nitric Acid	12,500	1.25
Potassium Permanganate	4,000	0.4
Sodium Molybdate-2-Water	2,400	0.24
Zinc Nitrate-6-Water	29,700	2.97
Water		28.25

Table 5. Alkaline Solution

Compound	mg/Kg	Percent by Weight
Sodium Arsenate	20	0.002
Sodium Chloride	2,000	0.2
Sodium Dihydrogen Phosphate-1-Water	2,000	0.2
Potassium Ferrocyanide	50	0.005
Sodium Hydroxide	1875	.2875
Sodium Nitrite	10,000	1
Sodium Silicate	1,000	0.1
Sodium Sulfide	50	.005
Sodium Tetraborate	5,000	0.5
Water		97,613

2.3 Exposure Conditions

Geomembrane and seamed geomembrane specimens were exposed to the leachates following the specifications of EPA Method 9090A as they relate to exposure to waste fluids. The tanks used for these exposures were maintained at 23 ± 2°C and 50 ± 2°C throughout the 120-day exposure period. Tanks were constructed from chemically resistant glass, fitted with stirrers and heated with a circulating hot water heat exchanger system. The 50°C tanks were sealed with a lid, and a reflux condenser was installed to minimize loss of volatile leachate components.

2.4 Testing Procedures

Table 6 lists tests performed on the HDPE geomembrane and seamed geomembrane. The number of test replicates was doubled for baseline determinations on unexposed material.

Table 6. Tests performed on HDPE geomembrane

PROPERTY	TEST METHOD	NO. OF SPECIMENS
Thickness	EPA Method 9090	All
Mass	EPA Method 9090	All
Dimensions (Length & Width)	EPA Method 9090	All
Hardness	ASTM D 2240, Durometer D	2
Volatile Content	SW 870, Appendix IIID	2
Extractable Content	SW 870, Appendix IIIE	2
Specific Gravity	ASTM D792, Method A	3
Tear Resistance (MD & TD)	ASTM D 1004	3
Tensile Properties:	ASTM D638, Dumbbell	
Strength @ Yield & Beak		3
Strain @ Yield & Break		3
Strength @ 100 & 200% Strain		3
Tensile Set after Break		3
Modulus of Elasticity (2% secant modulus) (MD & TD)	ASTM D 882 (modified)	3
Hydrostatic Resistance	ASTM D751, Method A Procedure 1	3
Puncture Resistance	FTMS 101C, Meth. 2065	3
Seam Tests:		
Peel Mode	ASTM D413*	3
Shear Mode	ASTM D3083*	3

* As modified by NSF 54, Appendix A

Where appropriate testing was performed in both the machine and transverse directions.

3.0 Results and Discussion

Test results are presented in the Tables of Results which are included with this report. EPA Method 9090A is provided as an Appendix.

In considering these results, it must be determined through engineering judgment whether observed differences in the value of test results measured before and after immersion are due to product variability, unidentified factors relating to the test procedure, or leachate interaction with the products. Any significant chemical interaction with leachate would be expected to result in degradation trends which are consistent across the various properties being evaluated, and not isolated to one set of test results only. However, with each type of material there may be specific properties which are highly sensitive to leachate-induced effects. These factors must be considered in evaluating the various test results for a given product.

Also of critical importance is the issue of product variability. With geomembranes, a range of physical and mechanical index test values covering 15% or more of the average is not uncommon. This can be traced to variability inherent in the product, and the randomness associated with the onset of failure under the specified testing conditions. However, in chemical compatibility testing the statistical sampling of a broad range of manufactured product is not possible. Therefore, the small size of the sample population tested at each time point must be taken into consideration. The criteria to be applied in evaluating data measured before and after leachate immersion should be that property changes, if observed, are consistent and so great that product variability and experimental factors can be ruled out.

In this report, standard deviations (STD) are reported for most measurements involving three or more replicate specimens. In statistics, the standard deviation is defined as root of the mean squared deviations of individual test results about the mean value. The standard deviation is a quantitative measure of variability within a group of measurements.

One related measure of variability observed within a sample set, relative to the magnitude of the mean value itself, is the *coefficient of variation or variance* (COV). The coefficient of variance is defined as the standard deviation divided by the mean associated with a group of specimens, and may be expressed as a percentage. The COV provides an indication of what proportion of the mean value may be attributable to random experimental factors or product variability. It is useful to consider apparent changes in property values against the criterion of COV since observed changes which fall below the COV may not be significant. This approach was used in preparing the tables in the next sections.

The term *range* refers to the difference between the extreme highest and lowest points within a group of measured values. Considering range as a percentage of the mean values provides another measure of variability within a dataset.

In the tables, the high and low extremes for percentage change in mean values are listed for comparison against COV and range as a percentage of mean from the baseline sample group. The high and low percentage changes are the extremes from data measured at 30, 60, 90 and 120 days.

3.1 HDPE Geomembrane Exposed to Organic Solution in Butanol

Table 7 illustrates the range of variability in baseline data compared with some of the observed changes in average test values measured after immersion for the HDPE geomembrane versus organic solution in butanol.

Table 7. Baseline coefficients of variation and range of percentage change results for 80 mil HDPE Geomembrane versus Organic Solution in Butanol

Test	Baseline COV (%)	Baseline Range as % of Mean	High Observed % Change	Low Observed % Change
Stress at yield (MD)	1	3	-2	-12
Stress at break (MD)	10	26	+15	-2
Elongation at yield (MD)	8	20	+28	+5
Elongation at break (MD)	9	23	+15	-15
Modulus (MD)	5	15	+36	-2
Tear strength (MD)	1	1	+18	+7
Puncture Resistance	2	7	+10	-11
Hydrostatic Resistance	1	3	+5	-7
Seam Peel Adhesion	2	5	-3	-14
Shear Seam Strength	0	1	-11	-13

3.2 HDPE Geomembrane Exposed to Organic Solution in Water

Table 8 illustrates the range of variability in baseline data compared with some of the observed changes in average test values measured after immersion for the HDPE geomembrane versus organic solution in water.

Table 8. Baseline coefficients of variation and range of percentage change results for 80 mil HDPE Geomembrane versus Organic Solution in Water

Test	Baseline COV (%)	Baseline Range as % of Mean	High Observed % Change	Low Observed % Change
Stress at yield (MD)	1	3	+3	-8
Stress at break (MD)	10	26	+18	+1
Elongation at yield (MD)	8	20	+13	-8
Elongation at break (MD)	9	23	+20	-20
Modulus (MD)	5	15	+42	-2
Tear strength (MD)	1	1	+18	+12
Puncture Resistance	2	7	+21	-1
Hydrostatic resistance	1	3	+4	-2
Seam Peel Adhesion	2	5	0	-16
Shear Seam Strength	0	1	-13	-6

3.3 HDPE Geomembrane Exposed to Water Based Mixture of Metal Nitrates and Nitric Acid

Table 9 illustrates the range of variability in baseline data compared with some of the observed changes in average test values measured after immersion for the HDPE geomembrane versus the water based mixture of metal nitrates and nitric acid.

Table 9. Baseline coefficients of variation and range of percentage change results for 80 mil HDPE Geomembrane versus Water Based Mixture of Metal Nitrates and Nitric Acid

Test	Baseline COV (%)	Baseline Range as % of Mean	High Observed % Change	Low Observed % Change
Stress at yield (MD)	1	3	+4	-13
Stress at break (MD)	10	26	+19	-1
Elongation at yield (MD)	8	20	+8	-8
Elongation at break (MD)	9	23	+20	-19
Modulus (MD)	5	15	+28	-13
Tear strength (MD)	1	1	+11	+20
Puncture Resistance	2	7	+3	+6
Hydrostatic resistance	1	3	+4	-3
Seam Peel Adhesion	2	5	-6	-11
Shear Seam Strength	0	1	-3	-10

3.4 HDPE Geomembrane Exposed to Sodium Hydroxide Solution

Table 10 illustrates the range of variability in baseline data compared with some of the observed changes in average test values measured after immersion for the HDPE geomembrane versus the sodium hydroxide solution.

Table 10. Baseline coefficients of variation and range of percentage change results for 80 mil HDPE Geomembrane versus Sodium Hydroxide Solution

Test	Baseline COV (%)	Baseline Range as % of Mean	High Observed % Change	Low Observed % Change
Stress at yield (MD)	1	3	+2	-8
Stress at break (MD)	10	26	+22	0
Elongation at yield (MD)	8	20	+10	-10
Elongation at break (MD)	9	23	+22	-22
Modulus (MD)	5	15	+21	-6
Tear strength (MD)	1	1	+20	+11
Puncture Resistance	2	7	+4	0
Hydrostatic resistance	1	3	+2	-4
Seam Peel Adhesion	2	5	-2	-10
Shear Seam Strength	0	1	-6	-11

4.0 CONCLUSION

Because of random variability inherent in the geomembrane studied, results for most index mechanical property tests may be expected to vary within the $\pm$ 10-15% about the mean baseline values. Certain measurements are subject to greater random variability. These include modulus of elasticity (because of the visco-elastic properties of HDPE which cause uncertainty in the determination of the best linear fit), and tensile elongation at break and tensile set after break (attributed to the element of randomness associated with the initiation of tear upon failure). As a general rule, individual sample means showing changes within this range after exposure should not be considered significant, unless there is a pattern or trend which would suggest a time-dependent degradation process. Any loss of performance attributed to chemical interaction should be consistent across measurements of several physical and mechanical index properties, and would be expected to show changes outside the range of expected variability.

In this study, while changes in certain measured physical and mechanical properties were noted for the geomembrane, the effects of product variability and experimental factors could not be ruled out as causes. In the opinion of the authors, the data, considered together, do not support the conclusion that observed changes were consistently and uniformly caused by the test exposures.

TRI/Environmental, Inc. is pleased to have been selected to participate in this project. We trust that the information provided in this report meets your requirements for technical documentation of this chemical compatibility study. Please do not hesitate to call if we may provide any further information.

Respectfully submitted,

Sam R. Allen

Sam R. Allen
Program Manager: Geosynthetics Technologies

TRI/Environmental, Inc.

APPENDIX A - TEST RESULTS

This section includes generated test data provided in both tabular and graphical form. Each graph is represented by a series of "I" beam plots. Each "I" beam represents a single test population and illustrates the high and low value as the end points, and the mean as a central box on the beam.

At each testing period, two "I" beams are shown. The left beam represents the 23°C exposed specimens while the right beam represents the 50°C specimens. The initial "I" beam represents the baseline or unexposed test specimens. Only machine direction test specimens were plotted.

EPA METHOD 9090 TEST RESULTS

80 mil NATIONAL SEAL SMOOTH HDPE GEOMEMBRANE EXPOSED TO ORGANIC SOLUTION IN BUTANOL

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Butanol

MDN
Quality Review

Report Date: March 06, 1995

Exposure Time and Temperature

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
GEOMEMBRANE: 80 mil SMOOTH HDPE									
Tensile Properties:									
Tensile Stress @ Yield (psi)	2488	2202	2293	2105	2046	2359	2449	2293	2257
ASTM D638	2439	2241	2232	2221	2174	2396	2379	2286	2272
Machine Direction	2439	2277	2253	2279	2238	2350	2393	2333	2244
	2476								
	2415								
	2415								
Average	2445	2240	2259	2202	2153	2368	2407	2304	2258
STD	28	31	25	72	80	20	30	21	11
Coefficient of Variation	1	1	1	3	4	1	1	1	1
% Change		-8	-8	-10	-12	-3	-2	-6	-8
Tensile Strength @ Break (psi)	4537	4905	5073	4882	4793	4960	5381	4850	3923
ASTM D638	4232	4916	4939	4698	4802	5343	5130	4791	5284
Machine Direction	5195	5060	4928	4188	4333	5174	5375	4860	5268
	4282								
	4146								
	5341								
Average	4622	4960	4980	4522	4643	5159	5295	4834	4825
STD	474	71	66	238	219	157	117	30	638
Coefficient of Variation	10	1	1	5	5	3	2	1	13
Change		7	8	-2	0	12	15	5	4
Tensile Properties:									
Elongation @ Yield (%)	20	22	22	23	28	27	25	22	23
ASTM D638	18	22	22	26	18	22	27	20	22
Machine Direction	22	20	23	23	29	25	25	21	22
	22								
	20								
	18								
Average	20	21	22	24	25	25	26	21	22
STD	2	1	0	1	5	2	1	1	0
Coefficient of Variation	8	4	2	6	20	8	4	4	2
% Change		7	12	20	25	23	28	5	12

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Butanol

Report Date: March 06, 1995

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
		Exposure Time and Temperature							
Elongation @ Break (%)	795	918	918	861	910	833	794	701	570
ASTM D638	748	901	931	830	866	880	756	682	743
Machine Direction	905	984	919	753	790	769	874	694	756
	751								
	735								
	924								
Average	810	934	923	815	855	827	808	692	690
STD	77	36	6	45	50	45	49	8	85
Coefficient of Variation	9	4	1	6	6	5	6	1	12
% Change		15	14	1	6	2	-0	-14	-15
Set after Break (%)	682	685	728	696	696	705	739	611	510
ASTM D638	689	690	712	685	758	745	712	589	635
Machine Direction	656	697	695	652	672	770	702	606	617
	678								
	684								
	719								
Average	685	691	712	678	709	740	718	602	587
STD	19	5	13	19	36	27	16	8	55
Coefficient of Variation	3	1	2	3	5	4	2	2	9
% Change		1	4	-1	4	8	5	-12	-14
Stress @ 100% Elongation (psi)	1841	1679	1756	1659	1678	1838	1851	1749	1765
ASTM D638	1841	1735	1745	1721	1698	1808	1890	1776	1777
Machine Direction	1805	1711	1723	1744	1728	1820	1789	1796	1745
	1841								
	1793								
	1829								
Average	1825	1708	1741	1708	1701	1822	1843	1774	1762
STD	19	23	14	36	20	12	42	19	13
Coefficient of Variation	1	1	1	2	1	1	2	1	1
% Change		-6	-5	-6	-7	-0	1	-3	-3

Page 2 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Butanol

MDN
Quality Review

Report Date: March 06, 1995

Exposure Time and Temperature

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Stress @ 200% Elongation (psi)	1902	1714	1805	1729	1747	1812	1838	1797	1804
ASTM D638	1854	1771	1805	1767	1720	1781	1808	1831	1835
Machine Direction	1817	1735	1747	1813	1809	1771	1820	1830	1808
	1866								
	1854								
	1878								
Average	1862	1740	1786	1770	1759	1788	1822	1819	1816
STD	26	24	27	34	37	17	12	16	14
Coefficient of Variation	1	1	2	2	2	1	1	1	1
% Change		-7	-4	-5	-6	-4	-2	-2	-2
Tensile Properties:									
Tensile Stress @ Yield (psi)	2524	2288	2253	2149	2265	2326	2420	2221	2224
ASTM D638	2398	2265	2226	2141	2217	2350	2464	2207	2232
Transverse Direction	2349	2293	2268	2094	2226	2381	2440	2229	2180
	2313								
	2439								
	2313								
Average	2389	2275	2249	2128	2236	2352	2441	2219	2212
STD	75	13	17	24	21	23	18	9	23
Coefficient of Variation	3	1	1	1	1	1	1	0	1
% Change		-5	-6	-11	-6	-2	2	-7	-7
Tensile Strength @ Break (psi)	5341	4122	4916	4977	5289	5269	5093	4748	5182
ASTM D638	5205	4675	4679	4905	5458	5252	4972	4600	5161
Transverse Direction	5169	4976	4939	4905	5262	5402	4918	4781	4829
	5253								
	5366								
	5253								
Average	5265	4591	4845	4929	5336	5308	4994	4710	5057
STD	70	354	118	34	87	67	73	79	162
Coefficient of Variation	1	8	2	1	2	1	1	2	3
% Change		-13	-8	-6	1	1	-5	-11	-4

Page 3 of 9

Project: Westinghouse File: West-L31.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Butanol

Report Date: March 06, 1995

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
		Exposure Time and Temperature							
Tensile Properties:									
Elongation @ Yield (%)	20	22	23	25	25	25	23	21	22
ASTM D638	20	22	22	25	25	21	22	22	24
Transverse Direction	22	23	23	25	28	24	21	21	23
	20								
	20								
	20								
Average	20	22	23	25	26	23	22	21	23
STD	1	0	0	0	1	2	1	0	1
Coefficient of Variation	4	2	2	0	5	7	4	2	4
% Change		10	11	23	28	15	8	5	13
Elongation @ Break (%)	946	776	945	931	975	899	927	704	759
ASTM D638	951	896	906	910	1006	904	914	677	751
Transverse Direction	936	944	941	910	1105	915	900	713	716
	928								
	938								
	930								
Average	938	872	931	917	1029	906	914	698	742
STD	8	71	17	10	55	7	11	15	19
Coefficient of Variation	1	8	2	1	5	1	1	2	3
% Change		-7	-1	-2	10	-3	-3	-26	-21
Set after Break (%)	724	606	718	696	752	840	729	628	641
ASTM D638	743	635	721	728	759	810	745	602	622
Transverse Direction	729	610	732	696	755	795	659	629	604
	738								
	740								
	731								
Average	734	617	724	708	755	815	711	620	622
STD	7	13	6	14	3	19	37	12	15
Coefficient of Variation	1	2	1	2	0	2	5	2	2
% Change		-16	-1	-4	3	11	-3	-16	-15

Page 4 of 9

Project: Westinghouse File: West-L41.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Butanol

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Stress @ 100% Elongation (psi)	1854	1707	1735	1678	1723	1748	1866	1710	1732
ASTM D638	1795	1699	1655	1706	1687	1853	1835	1718	1748
Transverse Direction	1807	1732	1732	1718	1702	1819	1804	1730	1693
	1771								
	1829								
	1783								
Average	1807	1713	1707	1701	1704	1807	1835	1719	1724
STD	28	14	37	17	15	44	25	8	23
Coefficient of Variation	2	1	2	1	1	2	1	0	1
% Change		-5	-5	-6	-6	0	2	-5	-5
Stress @ 200% Elongation (psi)	1902	1732	1711	1724	1747	1714	1866	1749	1786
ASTM D638	1855	1735	1690	1800	1783	1735	1835	1763	1781
Transverse Direction	1831	1744	1742	1788	1738	1779	1803	1780	1738
	1795								
	1866								
	1843								
Average	1849	1737	1714	1771	1756	1743	1835	1764	1768
STD	33	5	21	33	19	27	26	13	22
Coefficient of Variation	2	0	1	2	1	2	1	1	1
% Change		-6	-7	-4	-5	-6	-1	-5	-4
Modulus of Elasticity:									
STM D882 (psi)	17074	17658	15695	20243	24923	16819	16604	16063	16667
Machine Direction	16042	15187	18903	20563	19481	16051	16602	16441	17160
	17873	15941	15985	20194	22508	16534	14746	16747	16985
	18446								
	15839								
	15205								
Average	16380	16282	16881	20333	22304	16468	16051	16417	16937
STD	868	1266	1774	200	2727	388	1134	343	250
Coefficient of Variation	5	8	11	1	12	2	7	2	1
% Change		-1	3	24	36	1	-2	0	3

Page 5 of 9

Project: Westinghouse File: West-L51.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Butanol

Report Date: March 06, 1995

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
		Exposure Time and Temperature							
Modulus of Elasticity:									
ASTM D882 (psi)	15951	15802	15400	21233	21364	17275	16023	16140	16588
Transverse Direction	15098	16069	15678	26037	17744	17640	15514	16511	16675
	15218	17324	16289	22132	22363	16756	15507	16286	16885
	15247								
	15180								
	15402								
Average	15349	16398	15789	23134	20490	17224	15681	16312	16649
STD	311	813	455	2554	2430	444	296	187	53
Coefficient of Variation	2	5	3	11	12	3	2	1	0
% Change		7	3	51	33	12	2	6	8
Indentation Hardness:									
Reading	57	56	56	56	58	56	56	61	55
ASTM D2240	50	58	57	58	58	58	58	60	58
(with TYPE D DUROMETER)	54	57	57	59	58	59	59	61	58
	50	59	57	59	56	58	58	60	59
	52	58	56	58	57	57	57	61	59
	55								
	58								
	58								
	58								
	54								
Average	55	58	57	58	57	58	58	61	58
STD	3	1	1	1	1	1	1	1	2
Coefficient of Variation	6	2	1	2	2	2	2	1	3
% Change		5	4	6	5	5	5	11	6
Specific Gravity:									
ASTM D792, Method A	0.948	0.935	0.929	0.944	0.942	0.936	0.947	0.941	0.946
	0.942	0.942	0.936	0.944	0.943	0.942	0.943	0.944	0.949
	0.937	0.940	0.940	0.946	0.946	0.940	0.943	0.944	0.947
	0.945								
	0.937								
	0.949								
Average	0.943	0.939	0.935	0.945	0.944	0.939	0.944	0.943	0.947
STD	0.005	0.004	0.006	0.001	0.002	0.003	0.002	0.002	0.002
Coefficient of Variation	1	0	1	0	0	0	0	0	0
% Change		-0.42	-0.85	0.18	0.07	-0.39	0.14	0.00	0.46
Environmental Stress Crack Resistance:									
ASTM D1693, Condition B									
Machine Direction (% Failed)	N/A	0	0	0	0	0	0	0	0
Transverse Direction (% Failed)	N/A	0	0	0	0	0	0	0	0

Page 6 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Butanol

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Puncture Resistance:									
Load @ Rupture (lbs)	121	119	120	117	112	113	112	132	132
FTMS 101C Method 2065	119	119	120	118	108	116	107	136	130
	124	118	120	117	113	115	107	135	133
	119								
	121								
	127								
Average	122	119	120	117	111	115	109	134	132
STD	3	0	0	0	2	1	2	2	1
Coefficient of Variation	2	0	0	0	2	1	2	1	1
% Change		-3	-2	-4	-9	-6	-11	10	8
Strain @ Rupture (in)	0.28	0.26	0.43	0.28	0.39	0.24	0.23	0.29	0.31
FTMS 101C Method 2065	0.25	0.26	0.42	0.30	0.42	0.28	0.41	0.28	0.29
	0.40	0.26	0.42	0.33	0.44	0.27	0.28	0.32	0.44
	0.24								
	0.24								
	0.40								
Average	0.30	0.26	0.42	0.30	0.42	0.26	0.31	0.30	0.35
STD	0.07	0.00	0.00	0.02	0.02	0.02	0.08	0.02	0.07
Coefficient of Variation	23	0	1	7	5	6	25	6	19
% Change		-14	40	1	38	-13	2	-2	15
Volatiles and Extractables:									
lachine Diameter Change (%)	-0.25	-0.10	-0.22	-0.38	-0.43	-1.28	-1.18	-0.57	-0.88
W 870 - Appendix III-D	-0.25	-0.30	-0.37	-0.48	-0.30	-1.45	-1.13	-0.53	-1.03
	-0.42								
	-0.38								
Average	-0.33	-0.20	-0.30	-0.43	-0.36	-1.36	-1.15	-0.55	-0.96
STD	0.08	0.10	0.08	0.05	0.06	0.09	0.02	0.02	0.08
Volatiles and Extractables:									
Transverse Diameter Change (%)	0.28	0.12	-0.05	0.10	0.03	0.25	0.18	0.13	0.10
SW 870 - Appendix III-D	-0.03	0.08	0.05	0.00	-0.18	0.10	0.25	-0.13	-0.10
	0.33								
	0.20								
Average	0.20	0.10	0.00	0.05	-0.08	0.18	0.21	0.00	0.00
STD	0.14	0.02	0.05	0.05	0.10	0.08	0.04	0.13	0.10
% Volatiles	0.04	0.25	0.34	0.24	0.36	0.78	0.48	0.54	0.27
SW 870 - Appendix III-D	0.04	0.28	0.39	0.30	0.32	0.81	0.46	0.49	0.27
	0.04								
	0.04								
Average	0.04	0.27	0.37	0.27	0.34	0.80	0.48	0.52	0.27
STD	0.00	0.02	0.02	0.03	0.02	0.02	0.00	0.03	0.00
% Extractables	0.06	0.62	0.98	0.63	1.12	0.20	1.13	0.44	1.06
SW 870 - Appendix III-D	0.07	0.61	0.91	0.57	0.92	0.16	1.11	0.52	1.03
	0.08								
	0.07								
verage	0.07	0.62	0.95	0.60	1.02	0.18	1.12	0.48	1.06
STD	0.01	0.01	0.03	0.03	0.10	0.02	0.01	0.04	0.03

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Butanol

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Tear Resistance:									
ASTM D1004	58	69	65	65	66	63	64	66	67
(lbs)	59	71	66	65	65	63	64	66	67
Machine Direction	58	67	66	65	66	62	64	66	67
	59								
	58								
	59								
Average	59	69	66	65	66	63	64	66	67
STD	1	2	1	0	1	1	0	0	0
Coefficient of Variation	1	3	1	0	1	1	0	0	0
% Change		18	12	11	12	7	9	13	15
Tear Resistance:									
ASTM D1004	56	69	66	66	66	62	62	66	66
(lbs)	56	66	63	65	65	62	63	66	66
Transverse Direction	57	71	65	64	65	62	63	66	65
	58								
	58								
	57								
Average	57	69	65	65	65	62	63	66	66
STD	1	3	2	1	1	0	1	0	1
Coefficient of Variation	2	4	2	2	1	0	1	0	1
% Change		20	13	14	15	9	10	18	15
Hydrostatic Resistance:									
ASTM D751	595	595	590	570	580	565	560	600	665
(psi)	595	585	595	580	575	575	550	600	605
	590	590	600	570	575	570	550	590	600
	605								
	595								
	590								
Average	595	590	595	573	577	570	553	597	623
STD	5	5	5	6	3	5	6	6	36
Coefficient of Variation	1	1	1	1	1	1	1	1	6
% Change		-1	0	-4	-3	-4	-7	0	5
Hydrostatic Resistance:									
ASTM D751	11.90	13.44	13.50	9.97	8.31	12.31	7.00	10.38	8.75
time to burst (sec)	12.62	13.35	12.84	7.63	8.28	8.31	7.88	10.21	11.50
	12.44	13.72	11.53	9.78	8.76	9.58	6.78	10.59	10.94
	12.63								
	11.50								
	12.03								
Average	12.19	13.50	12.62	8.13	8.45	10.07	7.22	10.39	10.40
STD	0	0	1	1	0	2	1	0	1
Coefficient of Variation	4	1	8	14	3	20	8	2	14
% Change		11	4	-25	-31	-17	-41	-15	-15

Page 8 of 9

Project: Westinghouse File: West-L81.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Butanol

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Seam Peel Adhesion:									
ASTM D4437 (lbs)	153	138	138	136	138	140	134	147	151
	157	130	135	134	139	143	143	144	158
	154	132	139	141	141	141	132	139	148
	155	139	136	131	136	143	143	147	153
	155	137	141	135	140	138	131	148	143
	161	133	137	127	138	141	144	140	148
	154								
	154								
	153								
	154								
	160								
	153								
Average	155	135	138	134	139	141	138	144	150
STD	3	3	2	4	2	2	6	4	5
Coefficient of Variation	2	2	1	3	1	1	4	2	3
% Change		-13	-11	-14	-11	-9	-11	-7	-3
Failure Mode (FTB = All Film Tear Bond)	FTB	FTB	FTB	FTB	FTB	FTB	FTB	FTB	FTB
Shear Seam Strength:									
Shear Seam Strength (lbs)	168	150	147	150	152	146	143	150	145
ASTM D4437	168	150	146	148	149	147	147	151	149
	168	149	147	148	149	147	146	149	153
	167								
	169								
	167								
Average	168	150	147	149	150	147	145	150	149
STD	1	0	0	1	1	0	2	1	3
Coefficient of Variation	0	0	0	1	1	0	1	1	2
% Change		-11	-13	-11	-11	-13	-13	-11	-11

Page 9 of 9

Project: Westinghouse File: West-L91.WB1

EPA METHOD 9090 TEST RESULTS

80 mil NATIONAL SEAL SMOOTH HDPE GEOMEMBRANE EXPOSED TO ORGANIC SOLUTION IN WATER

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Water

MDN
Quality Review

Report Date: March 06, 1995

Exposure Time and Temperature

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
GEOMEMBRANE: 80 mil SMOOTH HDPE									
Tensile Properties:									
Tensile Stress @ Yield (psi)	2488	2432	2296	2310	2256	2465	2363	2273	2353
ASTM D638	2439	2321	2293	2326	2233	2442	2607	2320	2379
Machine Direction	2439	2383	2321	2261	2233	2449	2557	2264	2423
	2476								
	2415								
	2415								
Average	2445	2379	2303	2299	2241	2452	2509	2286	2385
STD	28	45	13	28	11	10	105	25	29
Coefficient of Variation	1	2	1	1	0	0	4	1	1
% Change		-3	-6	-6	-8	0	3	-7	-2
Tensile Strength @ Break (psi)	4537	5272	5160	5701	5442	4936	5303	4848	4783
ASTM D638	4232	5160	4810	5012	5198	5481	5201	5133	5009
Machine Direction	5195	5148	5111	5557	5756	5241	5028	4811	4258
	4262								
	4146								
	5341								
Average	4822	5193	4960	5423	5485	5219	5177	4864	4683
STD	474	56	249	297	228	223	114	202	315
Coefficient of Variation	10	1	5	5	4	4	2	4	7
% Change		12	7	17	18	13	12	5	1
Tensile Properties:									
Elongation @ Yield (%)	20	22	22	18	20	22	21	23	18
ASTM D638	18	20	20	22	23	21	21	20	18
Machine Direction	22	22	22	22	25	21	20	21	19
	22								
	20								
	18								
Average	20	21	21	21	23	21	21	21	18
STD	2	1	1	2	2	0	0	1	0
Coefficient of Variation	8	4	4	9	9	2	2	6	3
% Change		7	7	3	13	7	3	7	-8

Page 1 of 9

Project: Westinghouse File: West-L12.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Water

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Elongation @ Break (%)	795	944	925	966	1000	709	748	673	685
ASTM D638	748	816	843	901	948	808	721	733	678
Machine Direction	905	921	921	956	975	753	698	704	593
	751								
	735								
	924								
Average	810	927	896	941	974	757	722	703	645
STD	77	12	38	29	21	40	20	24	37
Coefficient of Variation	9	1	4	3	2	5	3	3	6
% Change		14	11	16	20	-7	-11	-13	-20
Set after Break (%)	682	733	722	704	752	715	739	580	588
ASTM D638	689	724	686	689	713	800	712	649	592
Machine Direction	656	708	715	698	745	725	702	613	591
	678								
	684								
	719								
Average	685	722	708	697	737	747	718	614	590
STD	19	10	16	6	17	38	16	26	2
Coefficient of Variation	3	1	2	1	2	5	2	5	0
% Change		5	3	2	8	9	5	-10	-14
Stress @ 100% Elongation (psi)	1841	1827	1785	1701	1698	1891	1820	1713	1811
ASTM D638	1841	1778	1756	1756	1698	1830	1934	1791	1806
Machine Direction	1805	1753	1753	1682	1721	1840	1919	1730	1837
	1841								
	1793								
	1829								
Average	1825	1786	1758	1713	1706	1854	1891	1745	1819
STD	19	31	5	31	11	27	51	33	13
Coefficient of Variation	1	2	0	2	1	1	3	2	1
% Change		-2	-4	-6	-7	2	4	-4	-0

Page 2 of 9

Project: Westinghouse File: West-L22.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Water

Report Date: March 06, 1995

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
		Exposure Time and Temperature							
Stress @ 200% Elongation (psi)	1902	1827	1728	1724	1767	1854	1821	1760	1853
ASTM D638	1854	1815	1780	1779	1787	1833	1934	1825	1864
Machine Direction	1817	1802	1790	1670	1756	1782	1919	1768	1879
	1866								
	1854								
	1878								
Average	1862	1815	1786	1724	1763	1823	1891	1784	1885
STD	26	10	27	44	5	30	50	29	11
Coefficient of Variation	1	1	2	3	0	2	3	2	1
% Change		-3	-5	-7	-5	-2	2	-4	0
Tensile Properties:									
Tensile Stress @ Yield (psi)	2524	2293	2288	2326	2317	2070	2282	2305	2381
ASTM D638	2388	2272	2247	2306	2378	2197	2301	2276	2321
Transverse Direction	2349	2268	2093	2165	2386	2174	2323	2295	2382
	2313								
	2439								
	2313								
Average	2389	2278	2209	2266	2360	2147	2305	2292	2361
STD	75	11	84	72	31	55	13	12	29
Coefficient of Variation	3	0	4	3	1	3	1	1	1
% Change		-5	-8	-5	-1	-10	-4	-4	-1
Tensile Strength @ Break (psi)	5341	5073	5150	5733	4854	4963	5303	5187	5151
ASTM D638	5205	4778	4988	5682	5329	5480	5201	5038	5169
Transverse Direction	5169	4829	4767	4741	5277	5241	5028	4777	5226
	5253								
	5366								
	5253								
Average	5285	4893	4968	5452	5153	5228	5177	5001	5189
STD	70	129	157	506	213	211	114	169	31
Coefficient of Variation	1	3	3	9	4	4	2	3	1
% Change		-7	-6	4	-2	-1	-2	-5	-1

Page 3 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Water

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Tensile Properties:									
Elongation @ Yield (%)	20	20	22	20	23	22	21	20	19
ASTM D638	20	20	22	18	22	20	21	21	20
Transverse Direction	22	20	22	20	22	21	21	20	20
	20								
	20								
	20								
Average	20	20	22	19	22	21	21	20	20
STD	1	0	0	1	0	1	0	0	0
Coefficient of Variation	4	0	0	5	2	4	0	2	2
% Change		-2	8	-5	10	3	3	0	-3
Elongation @ Break (%)	946	928	955	978	868	883	945	754	748
ASTM D638	951	876	936	998	954	902	968	748	749
Transverse Direction	936	895	953	895	951	811	825	706	743
	928								
	938								
	930								
Average	938	900	948	957	924	865	913	736	747
STD	8	21	9	45	40	39	63	21	3
Coefficient of Variation	1	2	1	5	4	5	7	3	0
% Change		-4	1	2	-1	-8	-3	-22	-20
Set after Break (%)	724	742	738	759	739	745	729	658	643
ASTM D638	743	708	693	751	732	785	745	653	617
Transverse Direction	729	692	722	736	704	725	658	631	649
	738								
	740								
	731								
Average	734	714	716	749	725	752	711	647	636
STD	7	21	19	10	15	25	37	12	14
Coefficient of Variation	1	3	3	1	2	3	5	2	2
% Change		-3	-2	2	-1	2	-3	-12	-13

Page 4 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Water

MDN
Quality Review

Report Date: March 06, 1995

Exposure Time and Temperature

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Stress @ 100% Elongation (psi)	1854	1732	1737	1733	1780	1807	1907	1748	1760
ASTM D638	1795	1753	1741	1729	1756	1897	1826	1760	1774
Transverse Direction	1807	1732	1593	1718	1771	1873	1862	1729	1805
	1771								
	1829								
	1783								
Average	1807	1739	1690	1727	1769	1859	1865	1746	1780
STD	28	10	69	5	10	38	33	13	19
Coefficient of Variation	2	1	4	0	1	2	2	1	1
% Change		-4	-6	-4	-2	3	3	-3	-1
Stress @ 200% Elongation (psi)	1902	1768	1750	1756	1817	1829	1907	1790	1814
ASTM D638	1855	1790	1778	1785	1793	1794	1826	1788	1814
Transverse Direction	1831	1780	1851	1741	1771	1882	1862	1800	1854
	1795								
	1886								
	1843								
Average	1849	1779	1726	1754	1794	1835	1865	1793	1827
STD	33	9	54	10	19	36	33	5	19
Coefficient of Variation	2	1	3	1	1	2	2	0	1
% Change		-4	-7	-5	-3	-1	1	-3	-1
Modulus of Elasticity:									
ASTM D882 (psi)	17074	17467	16658	21298	24374	17463	16604	17359	16723
Machine Direction	16042	16507	15812	23056	22986	17119	16802	16170	17440
	17673	14551	15673	25471	19580	16795	14746	17610	17558
	16448								
	15839								
	15205								
Average	16380	16175	16048	23275	22313	17126	16051	17046	17240
STD	888	1486	533	2095	2487	334	1134	769	452
Coefficient of Variation	5	9	3	9	11	2	7	5	3
% Change		-1	-2	42	36	5	-2	4	5

Page 5 of 9

Project: Westinghouse File: West-L52.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Water

Report Date: March 06, 1995

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
		Exposure Time and Temperature							
Modulus of Elasticity:									
ASTM D882 (psi)	15951	15096	15531	24694	19265	19902	15225	16844	16865
Transverse Direction	15098	15040	14589	28700	20720	19599	16129	16521	16346
	15218	15090	17146	25018	21187	18522	15338	16831	16343
	15247								
	15180								
	15402								
Average	15349	15075	15755	26137	20391	19341	15564	16732	16518
STD	311	31	1293	2225	1002	725	493	183	301
Coefficient of Variation	2	0	8	9	5	4	3	1	2
% Change		-2	3	70	33	26	1	9	8
Indentation Hardness:									
Reading	57	53	56	58	61	59	59	61	60
ASTM D2240	50	52	57	62	62	58	58	61	60
(with TYPE D DUROMETER)	54	55	55	59	60	57	57	61	60
	50	56	55	59	61	58	58	60	62
	52	52	55	60	61	57	58	61	61
	55								
	58								
	58								
	58								
	54								
Average	55	54	56	60	61	58	58	61	61
STD	3	2	1	2	1	1	1	0	1
Coefficient of Variation	6	3	2	3	1	1	1	1	1
% Change		-2	2	9	12	6	6	11	11
Specific Gravity:									
ASTM D792, Method A	0.948	0.939	0.948	0.941	0.947	0.940	0.942	0.946	0.942
	0.942	0.942	0.947	0.942	0.951	0.940	0.944	0.946	0.946
	0.937	0.945	0.939	0.943	0.950	0.946	0.940	0.946	0.945
	0.945								
	0.937								
	0.949								
Average	0.943	0.942	0.945	0.942	0.949	0.942	0.942	0.946	0.944
STD	0.005	0.003	0.005	0.001	0.002	0.003	0.002	0.000	0.002
Coefficient of Variation	1	0	1	0	0	0	0	0	0
% Change		-0.11	0.18	-0.11	0.67	-0.11	-0.11	0.32	0.14
Environmental Stress Crack Resistance:									
ASTM D1693, Condition B									
Machine Direction (% Failed)	N/A	0	0	0	0	0	0	0	0
Transverse Direction (% Failed)	N/A	0	0	0	0	0	0	0	0

Page 6 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Water

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Puncture Resistance:									
Load @ Rupture (lbs)	121	121	124	121	125	120	118	143	147
FTMS 101C Method 2065	119	122	124	121	127	125	125	143	148
	124	121	125	119	125	123	125	147	147
	119								
	121								
	127								
Average	122	121	124	120	126	123	123	144	147
STD	3	0	0	1	1	2	3	2	0
Coefficient of Variation	2	0	0	1	1	2	3	1	0
% Change		-0	2	-1	3	1	1	18	21
Strain @ Rupture (in)	0.28	0.26	0.43	0.32	0.40	0.29	0.27	0.52	0.49
FTMS 101C Method 2065	0.25	0.26	0.43	0.35	0.41	0.41	0.44	0.50	0.46
	0.40	0.28	0.40	0.37	0.44	0.28	0.48	0.50	0.50
	0.24								
	0.24								
	0.40								
Average	0.30	0.26	0.42	0.35	0.42	0.33	0.40	0.51	0.48
STD	0.07	0.00	0.01	0.02	0.02	0.06	0.09	0.01	0.02
Coefficient of Variation	23	0	3	6	4	18	23	2	4
% Change		-14	39	15	38	8	31	68	60
Volatiles and Extractables:									
Machine Diameter Change (%)	-0.25	-0.65	-0.08	-0.28	-0.15	-0.93	-0.10	-1.52	-3.40
SW 870 - Appendix III-D	-0.25	0.20	-0.28	0.18	-0.42	-0.60	-0.40	-2.40	-6.48
	-0.42								
	-0.38								
Average	-0.33	-0.23	-0.18	-0.05	-0.29	-0.86	-0.25	-1.96	-4.93
STD	0.08	0.43	0.10	0.23	0.14	0.06	0.15	0.44	1.53
Volatiles and Extractables:									
Transverse Diameter Change (%)	0.28	0.00	0.35	0.13	0.08	0.35	-0.20	0.22	-0.43
SW 870 - Appendix III-D	-0.03	0.15	0.10	0.10	0.05	0.38	0.13	-0.05	-0.60
	0.33								
	0.20								
Average	0.20	0.08	0.23	0.11	0.06	0.36	-0.04	0.09	-0.52
STD	0.14	0.08	0.12	0.01	0.01	0.01	0.16	0.14	0.09
% Volatiles	0.04	0.06	0.11	0.09	0.09	0.19	0.22	0.18	0.21
SW 870 - Appendix III-D	0.04	0.05	0.12	0.09	0.13	0.19	0.24	0.19	0.22
	0.04								
	0.04								
Average	0.04	0.06	0.12	0.09	0.11	0.19	0.23	0.19	0.22
STD	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.01	0.01
% Extractables	0.06	0.20	0.18	0.19	0.30	0.06	0.04	0.12	0.15
SW 870 - Appendix III-D	0.07	0.20	0.24	0.17	0.27	0.05	0.04	0.15	0.11
	0.08								
	0.07								
Average	0.07	0.20	0.21	0.18	0.29	0.06	0.04	0.14	0.13
STD	0.01	0.00	0.03	0.01	0.01	0.00	0.00	0.02	0.02

Page 7 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Water

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Tear Resistance:									
ASTM D1004	58	68	69	68	68	65	65	67	69
(lbs)	59	70	68	68	68	65	67	68	69
Machine Direction	58	69	69	67	69	66	67	67	69
	59								
	58								
	59								
Average	59	69	69	68	68	65	66	67	69
STD	1	1	1	1	1	1	1	1	0
Coefficient of Variation	1	1	1	1	1	1	2	1	0
% Change		18	17	16	17	12	13	15	18
Tear Resistance:									
ASTM D1004	56	68	67	68	67	65	65	67	68
(lbs)	56	70	71	67	67	64	65	68	68
Transverse Direction	57	68	67	68	66	64	66	68	68
	58								
	58								
	57								
Average	57	69	68	68	67	64	65	68	68
STD	1	1	2	1	1	1	1	1	0
Coefficient of Variation	2	2	3	1	1	1	1	1	0
% Change		20	20	19	17	13	15	19	19
Hydrostatic Resistance:									
ASTM D751	595	600	615	600	590	580	590	620	615
(psi)	595	590	615	590	600	590	585	620	620
	590	595	605	590	595	580	580	610	620
	605								
	595								
	590								
Average	595	595	612	593	595	583	585	617	618
STD	5	5	6	6	5	6	5	6	3
Coefficient of Variation	1	1	1	1	1	1	1	1	0
% Change		0	3	-0	0	-2	-2	4	4
Hydrostatic Resistance:									
ASTM D751	11.90	13.85	11.75	7.75	10.22	7.43	6.72	9.97	11.78
time to burst (sec)	12.62	12.78	12.06	9.79	7.66	8.97	6.75	13.16	8.22
	12.44	13.37	12.69	8.53	8.28	6.82	6.96	10.83	11.22
	12.63								
	11.50								
	12.03								
Average	12.19	13.27	12.17	8.89	8.72	7.74	6.81	11.25	10.41
STD	0	0	0	1	1	1	0	2	2
Coefficient of Variation	4	3	4	12	15	14	2	15	18
% Change		9	-0	-29	-28	-36	-44	-8	-15

Page 8 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Organic Solution in Water

Report Date: March 06, 1995

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
		Exposure Time and Temperature							
Seam Peel Adhesion:									
ASTM D4437 (lbs)	153	137	150	137	122	137	146	154	161
	157	146	147	138	139	146	152	153	149
	154	135	145	134	131	128	127	152	151
	155	136	127	140	140	146	151	158	162
	155	136	144	141	112	145	139	157	160
	161	138	146	139	137	148	150	153	148
	154								
	154								
	153								
	154								
	160								
	153								
Average	155	136	143	138	130	142	144	155	155
STD	3	4	7	2	10	7	9	2	6
Coefficient of Variation	2	3	5	2	8	5	6	1	4
% Change		-11	-8	-11	-16	-9	-7	-0	-0
Failure Mode (FTB = All Film Tear Bond)	FTB	FTB	FTB	FTB	FTB	FTB	FTB	FTB	FTB
Shear Seam Strength:									
Shear Seam Strength (lbs)	168	156	152	154	155	153	143	159	158
ASTM D4437	168	157	153	153	155	154	147	159	159
	168	157	153	155	155	155	146	150	156
	167								
	169								
	167								
Average	168	157	153	154	155	154	145	156	158
STD	1	0	0	1	0	1	2	4	1
Coefficient of Variation	0	0	0	1	0	1	1	3	1
% Change		-7	-9	-8	-8	-8	-13	-7	-6

Page 9 of 9

EPA METHOD 9090 TEST RESULTS

80 mil NATIONAL SEAL SMOOTH HDPE GEOMEMBRANE EXPOSED TO WATER BASED MIXTURE OF METAL NITRATES IN NITRC ACID

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Water Based Mixture of Metal Nitrates and Nitric Acid

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
GEOMEMBRANE: 80 mil SMOOTH HDPE									
Tensile Properties:									
Tensile Stress @ Yield (psi)	2488	2093	2390	2463	2287	2521	2524	2520	2391
ASTM D638	2439	2115	2427	2258	2281	2481	2441	2531	2381
Machine Direction	2439	2195	2415	2244	2256	2461	2435	2544	2397
	2476								
	2415								
	2415								
Average	2445	2134	2411	2322	2275	2488	2467	2532	2390
STD	28	44	15	100	13	25	41	10	7
Coefficient of Variation	1	2	1	4	1	1	2	0	0
% Change		-13	-1	-5	-7	2	1	4	-2
Tensile Strength @ Break (psi)	4537	4767	5610	6244	5425	4388	3254	5202	4837
ASTM D638	4232	4897	5683	5415	4831	5072	5030	4874	4725
Machine Direction	5195	4851	4878	4878	4600	5323	5393	5484	4470
	4282								
	4146								
	5341								
Average	4622	4838	5390	5512	4952	4921	4559	5180	4677
STD	474	54	383	562	348	404	935	241	154
Coefficient of Variation	10	1	7	10	7	8	21	5	3
% Change		5	17	19	7	6	-1	12	1
Tensile Properties:									
Elongation @ Yield (%)	20	22	20	20	20	21	20	19	19
ASTM D638	18	23	22	22	20	21	21	19	18
Machine Direction	22	20	20	17	20	18	20	19	18
	22								
	20								
	18								
Average	20	22	21	20	20	20	20	19	18
STD	2	1	1	2	0	1	0	0	0
Coefficient of Variation	8	6	5	10	0	7	2	0	3
% Change		8	3	-2	0	0	2	-5	-8

Page 1 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Water Based Mixture of Metal Nitrates and Nitric Acid

Report Date: March 06, 1995

MDN
Quality Review

Test Parameters	Baseline	Exposure Time and Temperature 30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Elongation @ Break (%)	795	953	1006	1024	919	830	771	708	652
ASTM D638	748	933	1030	954	909	729	701	662	663
Machine Direction	905	926	884	931	881	767	760	742	645
	751								
	735								
	924								
Average	810	937	973	970	903	775	744	704	653
STD	77	11	64	40	16	42	31	33	7
Coefficient of Variation	9	1	7	4	2	5	4	5	1
% Change		16	20	20	12	-4	-8	-13	-19
Set after Break (%)	682	708	756	713	684	680	568	620	573
ASTM D638	689	718	759	729	711	709	689	570	586
Machine Direction	656	744	732	711	679	703	714	540	553
	678								
	684								
	719								
Average	685	723	749	718	691	697	657	577	571
STD	19	15	12	8	14	12	64	33	14
Coefficient of Variation	3	2	2	1	2	2	10	6	2
% Change		6	9	5	1	2	-4	-16	-17
Stress @ 100% Elongation (psi)	1841	1593	1780	1793	1701	1858	1849	1863	1807
ASTM D638	1841	1713	1756	1719	1674	1850	1886	1838	1846
Machine Direction	1805	1655	1780	1633	1811	1773	1921	1862	1788
	1841								
	1793								
	1829								
Average	1825	1654	1772	1715	1662	1827	1879	1854	1814
STD	19	49	11	85	38	38	31	12	24
Coefficient of Variation	1	3	1	4	2	2	2	1	1
% Change		-9	-3	-6	-9	0	3	2	-1

Page 2 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Water Based Mixture of Metal Nitrates and Nitric Acid

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Stress @ 200% Elongation (psi)	1902	1651	1805	1829	1724	1811	1849	1897	1856
ASTM D638	1854	1747	1768	1617	1707	1813	1866	1890	1895
Machine Direction	1817	1736	1805	1689	1677	1813	1922	1908	1833
	1866								
	1854								
	1878								
Average	1862	1711	1793	1712	1703	1812	1879	1898	1861
STD	26	43	17	86	19	1	31	7	26
Coefficient of Variation	1	3	1	5	1	0	2	0	1
% Change		-8	-4	-8	-9	-3	1	2	-0
Tensile Properties:									
Tensile Stress @ Yield (psi)	2524	2305	2395	2373	2273	2450	2442	2384	2376
ASTM D638	2398	2390	2341	2410	2302	2457	2391	2394	2370
Transverse Direction	2349	2341	2407	2410	2314	2421	2415	2399	2362
	2313								
	2439								
	2313								
Average	2389	2345	2381	2398	2296	2443	2416	2392	2368
STD	75	35	29	17	17	16	21	6	6
Coefficient of Variation	3	1	1	1	1	1	1	0	0
% Change		-2	-0	0	-4	2	1	0	-1
Tensile Strength @ Break (psi)	5341	5024	5235	5783	5693	5034	5206	5194	4012
ASTM D638	5205	4463	5415	5229	5000	5343	4878	5430	5272
Transverse Direction	5169	5122	5556	5265	5058	4981	4631	4862	4535
	5253								
	5366								
	5253								
Average	5265	4870	5402	5426	5584	5119	4905	5162	4606
STD	70	290	131	253	392	180	236	233	517
Coefficient of Variation	1	6	2	5	7	3	5	5	11
% Change		-7	3	3	6	-3	-7	-2	-13

Page 3 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Water Based Mixture of Metal Nitrates and Nitric Acid

Report Date: March 06, 1995

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
		Exposure Time and Temperature							
Tensile Properties:									
Elongation @ Yield (%)	20	20	20	17	18	19	21	18	19
ASTM D638	20	20	20	18	17	19	22	18	18
Transverse Direction	22	20	22	17	20	24	18	18	19
	20								
	20								
	20								
Average	20	20	21	17	18	21	20	18	19
STD	1	0	1	0	1	2	2	0	0
Coefficient of Variation	4	0	5	3	7	11	8	0	3
% Change		-2	2	-15	-10	2	0	-11	-8
Elongation @ Break (%)	946	934	958	1081	1012	944	855	745	587
ASTM D638	951	812	1015	946	1053	897	902	761	757
Transverse Direction	936	928	1032	968	952	847	886	699	649
	928								
	938								
	930								
Average	938	891	1002	998	1006	896	874	735	664
STD	8	56	32	59	41	40	20	26	70
Coefficient of Variation	1	6	3	6	4	4	2	4	11
% Change		-5	7	6	7	-4	-7	-22	-29
Set after Break (%)	724	687	719	767	748	749	775	635	531
ASTM D638	743	699	762	711	783	780	710	730	640
Transverse Direction	729	722	754	739	759	739	720	610	570
	738								
	740								
	731								
Average	734	703	745	739	763	756	735	658	580
STD	7	15	19	23	15	17	29	52	45
Coefficient of Variation	1	2	3	3	2	2	4	8	8
% Change		-4	1	1	4	3	0	-10	-21

Page 4 of 9

Project: Westinghouse File: West-L43.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Water Based Mixture of Metal Nitrates and Nitric Acid

MDN
Quality Review

Report Date: March 06, 1995

Exposure Time and Temperature

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Stress @ 100% Elongation (psi)	1854	1756	1778	1735	1636	1731	1871	1794	1755
ASTM D638	1795	1732	1756	1735	1709	1807	1887	1851	1829
Transverse Direction	1807	1756	1765	1735	1721	1750	1858	1776	1814
	1771								
	1829								
	1783								
Average	1807	1748	1766	1735	1689	1763	1872	1807	1799
STD	28	11	9	0	38	32	12	32	32
Coefficient of Variation	2	1	1	0	2	2	1	2	2
% Change		-3	-2	-4	-7	-2	4	0	-0
Stress @ 200% Elongation (psi)	1902	1793	1778	1887	1659	1825	1887	1851	1825
ASTM D638	1855	1805	1793	1795	1744	1843	1857	1878	1863
Transverse Direction	1831	1780	1815	1795	1744	1817	1871	1826	1870
	1795								
	1866								
	1843								
Average	1849	1793	1795	1759	1716	1828	1872	1852	1853
STD	33	10	15	51	40	11	12	21	20
Coefficient of Variation	2	1	1	3	2	1	1	1	1
% Change		-3	-3	-5	-7	-1	1	0	0
Modulus of Elasticity:									
STM D882 (psi)	17074	14985	14545	18719	21249	17769	16980	16498	16184
achine Direction	16042	14957	13661	18990	21051	15943	15851	16979	17319
	17673	14952	14385	19007	20532	18525	16537	16939	16501
	16448								
	15839								
	15205								
Average	16380	14965	14197	18905	20944	16746	16746	16805	16668
STD	888	18	471	162	370	933	933	267	586
Coefficient of Variation	5	0	3	1	2	6	6	2	4
% Change		-9	-13	15	28	2	2	3	2

Page 5 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Water Based Mixture of Metal Nitrates and Nitric Acid

Report Date: March 06, 1995

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
		Exposure Time and Temperature							
Modulus of Elasticity:									
ASTM D882 (psi)	15951	15585	14895	19976	17545	17769	16461	16950	17507
Transverse Direction	15098	14777	15074	18164	20248	15943	15359	16762	17446
	15218	15689	14273	19080	20413	16525	15098	16607	17201
	15247								
	15160								
	15402								
Average	15349	15350	14747	19073	19402	16746	16746	16773	17385
STD	311	499	420	906	1610	933	933	172	162
Coefficient of Variation	2	3	3	5	8	6	6	1	1
% Change		0	-4	24	26	9	9	9	13
Indentation Hardness:									
Reading	57	57	58	61	59	60	57	62	63
ASTM D2240	50	57	55	62	61	60	59	62	61
(with TYPE D DUROMETER)	54	54	57	62	62	60	59	60	63
	50	56	57	61	60	59	58	62	63
	52	55	56	59	60	61	61	61	62
	55								
	58								
	58								
	58								
	54								
Average	55	56	57	61	60	60	59	61	62
STD	3	1	1	1	1	1	1	1	1
Coefficient of Variation	6	2	2	2	2	1	3	1	1
% Change		2	4	12	11	10	8	12	14
Specific Gravity:									
ASTM D792, Method A	0.948	0.936	0.945	0.948	0.941	0.943	0.940	0.945	0.937
	0.942	0.948	0.938	0.950	0.938	0.941	0.940	0.947	0.941
	0.937	0.937	0.947	0.948	0.939	0.942	0.941	0.946	0.945
	0.945								
	0.937								
	0.949								
Average	0.943	0.940	0.943	0.949	0.939	0.942	0.940	0.946	0.941
STD	0.005	0.007	0.005	0.001	0.002	0.001	0.001	0.001	0.004
Coefficient of Variation	1	1	1	0	0	0	0	0	0
% Change		-0.28	0.04	0.60	-0.39	-0.11	-0.28	0.32	-0.21
Environmental Stress Crack Resistance:									
ASTM D1693, Condition B									
Machine Direction (% Failed)	N/A	0	0	0	0	0	0	0	0
Transverse Direction (% Failed)	N/A	0	0	0	0	0	0	0	0

Page 6 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Water Based Mixture of Metal Nitrates and Nitric Acid

Report Date: March 06, 1995

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
		Exposure Time and Temperature							
Puncture Resistance:									
Load @ Rupture (lbs)	121	126	127	129	127	127	131	131	128
FTMS 101C Method 2065	119	125	125	127	128	127	130	129	129
	124	125	124	124	126	126	128	128	127
	119								
	121								
	127								
Average	122	125	125	127	127	127	130	129	128
STD	3	0	1	2	1	0	1	1	1
Coefficient of Variation	2	0	1	2	1	0	1	1	1
% Change		3	3	4	4	4	6	6	5
Strain @ Rupture (in)	0.28	0.40	0.39	0.39	0.40	0.27	0.44	0.50	0.47
FTMS 101C Method 2065	0.25	0.28	0.42	0.33	0.42	0.40	0.47	0.44	0.45
	0.40	0.39	0.39	0.35	0.39	0.41	0.44	0.44	0.48
	0.24								
	0.24								
	0.40								
Average	0.30	0.35	0.40	0.36	0.40	0.36	0.45	0.48	0.47
STD	0.07	0.06	0.01	0.02	0.01	0.06	0.01	0.03	0.01
Coefficient of Variation	23	18	4	7	3	18	3	6	3
% Change		16	33	18	34	19	49	52	55
Volatiles and Extractables:									
Machine Diameter Change (%)	-0.25	-0.28	-0.45	-0.33	-0.13	-0.60	-0.28	-0.55	-0.38
SW 870 - Appendix III-D	-0.25	-0.18	-0.40	0.03	-0.50	-0.35	-0.18	-0.33	-0.70
	-0.42								
	-0.38								
Average	-0.33	-0.23	-0.43	-0.15	-0.31	-0.48	-0.23	-0.44	-0.54
STD	0.08	0.05	0.02	0.18	0.19	0.13	0.05	0.11	0.16
Volatiles and Extractables:									
Transverse Diameter Change (%)	0.28	0.43	0.30	0.25	0.18	0.63	0.43	0.25	0.30
SW 870 - Appendix III-D	-0.03	0.48	0.40	0.05	0.15	0.35	0.30	0.33	0.40
	0.33								
	0.20								
Average	0.20	0.46	0.35	0.15	0.16	0.49	0.36	0.29	0.35
STD	0.14	0.02	0.05	0.10	0.01	0.14	0.06	0.04	0.05
% Volatiles	0.04	0.02	0.05	0.03	0.03	0.07	0.08	0.06	0.13
SW 870 - Appendix III-D	0.04	0.02	0.04	0.03	0.04	0.06	0.09	0.05	0.03
	0.04								
	0.04								
Average	0.04	0.02	0.05	0.03	0.04	0.07	0.09	0.06	0.08
STD	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.05
% Extractables	0.06	0.15	0.14	0.10	0.15	0.08	0.07	0.03	0.04
SW 870 - Appendix III-D	0.07	0.14	0.09	0.16	0.15	0.02	0.04	0.03	0.03
	0.06								
	0.07								
Average	0.07	0.15	0.12	0.13	0.15	0.04	0.06	0.03	0.04
STD	0.01	0.00	0.03	0.03	0.00	0.02	0.02	0.00	0.01

Page 7 of 9

Project: Westinghouse File: West-L73.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Water Based Mixture of Metal Nitrates and Nitric Acid

Report Date: March 06, 1995

SRA
Quality Review

Exposure Time and Temperature

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Tear Resistance:									
ASTM D1004	58	71	71	68	69	65	65	68	69
(lbs)	59	68	67	68	70	65	64	62	70
Machine Direction	58	71	71	68	69	65	64	68	69
	59								
	58								
	59								
Average	59	70	70	68	69	65	65	68	69
STD	1	2	2	0	1	0	1	0	1
Coefficient of Variation	1	2	3	0	1	0	2	0	1
% Change		20	19	16	19	11	11	10	19
Tear Resistance:									
ASTM D1004	56	71	71	67	69	66	66	69	69
(lbs)	56	68	69	67	67	66	66	68	69
Transverse Direction	57	69	68	67	67	66	66	67	69
	58								
	58								
	57								
Average	57	69	69	67	68	66	66	68	69
STD	1	2	2	0	1	0	0	1	0
Coefficient of Variation	2	2	2	0	2	0	0	1	0
% Change		22	22	18	19	16	16	19	21
Hydrostatic Resistance:									
ASTM D751	595	610	605	600	595	570	656	610	630
(psi)	595	600	605	590	585	580	570	620	600
	590	605	615	590	590	575	570	600	625
	605								
	596								
	590								
Average	595	605	608	593	590	575	599	610	618
STD	5	5	6	6	5	5	50	10	16
Coefficient of Variation	1	1	1	1	1	1	8	2	3
% Change		2	2	-0	-1	-3	1	3	4
Hydrostatic Resistance:									
ASTM D751	11.90	12.53	14.34	10.47	10.37	9.29	8.06	6.97	10.72
time to burst (sec)	12.62	12.50	13.12	10.38	9.85	8.59	8.84	10.03	10.87
	12.44	11.72	11.75	10.72	10.37	8.63	7.44	8.38	8.26
	12.03								
	11.50								
	12.03								
Average	12.19	12.25	13.07	10.52	10.21	8.84	8.11	8.48	9.96
STD	0	0	1	0	0	0	1	2	1
Coefficient of Variation	4	4	10	2	3	4	9	18	15
% Change		1	7	-14	-16	-27	-33	-31	-18

Page 8 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Water Based Mixture of Metal Nitrates and Nitric Acid

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Seam Peel Adhesion:									
ASTM D4437 (lbs)	153	139	151	137	140	148	147	154	150
	157	147	140	143	136	150	152	153	150
	154	144	149	139	134	145	145	143	149
	155	146	140	143	137	148	153	150	145
	155	151	147	133	145	147	147	144	142
	161	147	144	131	137	149	151	151	147
	154								
	154								
	153								
	154								
	160								
	153								
Average	155	146	145	138	138	148	149	149	147
STD	3	4	4	5	4	2	3	4	3
Coefficient of Variation	2	2	3	3	3	1	2	3	2
% Change		-6	-6	-11	-11	-5	-4	-4	-5
Failure Mode (FTB = All Film Tear Bond)	FTB	FTB	FTB	FTB	FTB	FTB	FTB	FTB	FTB
Shear Seam Strength:									
Shear Seam Strength (lbs)	168	153	151	152	160	156	155	164	155
ASTM D4437	168	154	151	156	158	156	156	163	157
	168	152	152	152	158	156	156	163	155
	167								
	169								
	167								
verage	168	153	151	153	159	156	156	163	156
TD	1	1	0	2	1	0	0	0	1
Coefficient of Variation	0	1	0	1	1	0	0	0	1
% Change		-9	-10	-9	-5	-7	-7	-3	-7

Page 9 of 9

EPA METHOD 9090 TEST RESULTS

80 mil NATIONAL SEAL SMOOTH HDPE GEOMEMBRANE EXPOSED TO SODIUM HYDROXIDE SOLUTION

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Sodium Hydroxide Solution

MDN
Quality Review

Report Date: March 06, 1995

Exposure Time and Temperature

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
GEOMEMBRANE: 80 mil SMOOTH HDPE									
Tensile Properties:									
Tensile Stress @ Yield (psi)	2488	2253	2383	2489	2457	2533	2493	2469	2296
ASTM D638	2439	2209	2386	2439	2390	2504	2322	2383	2390
Machine Direction	2439	2267	2341	2519	2420	2480	2356	2416	2405
	2478								
	2415								
	2415								
Average	2445	2243	2363	2482	2422	2506	2390	2423	2364
STD	28	25	17	33	27	22	74	35	46
Coefficient of Variation	1	1	1	1	1	1	3	1	2
% Change		-8	-3	2	-1	2	-2	-1	-3
Tensile Strength @ Break (psi)	4537	5126	5531	5915	5284	5540	5288	4388	4553
ASTM D638	4232	4663	5183	6220	5146	5265	5030	4536	4838
Machine Direction	5195	5047	5488	4780	6222	5160	5518	4880	4844
	4282								
	4146								
	5341								
Average	4622	4945	5401	5638	5551	5322	5272	4801	4678
STD	474	202	155	620	478	160	199	206	119
Coefficient of Variation	10	4	3	11	9	3	4	4	3
% Change		7	17	22	20	15	14	-0	1
Tensile Properties:									
Elongation @ Yield (%)	20	20	20	17	22	21	21	18	20
ASTM D638	18	22	20	20	20	21	21	19	19
Machine Direction	22	20	22	17	18	21	24	18	19
	22								
	20								
	18								
Average	20	21	21	18	20	21	22	18	19
STD	2	1	1	1	2	0	1	0	0
Coefficient of Variation	8	5	5	8	8	0	6	3	2
% Change		3	3	-10	0	5	10	-8	-3

Page 1 of 9

Project: Westinghouse File: West-L14.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Sodium Hydroxide Solution

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Elongation @ Break (%)	795	987	1008	922	924	805	787	604	650
ASTM D638	748	881	944	984	900	767	765	626	672
Machine Direction	905	970	1001	819	1007	744	739	674	662
	751								
	735								
	924								
Average	810	946	984	908	944	772	764	635	661
STD	77	46	29	88	46	25	20	29	9
Coefficient of Variation	9	5	3	7	5	3	3	5	1
% Change		17	22	12	17	-5	-6	-22	-18
Set after Break (%)	682	702	739	718	748	778	575	628	553
ASTM D638	689	708	724	715	697	802	751	671	571
Machine Direction	656	714	728	673	779	792	712	576	570
	678								
	684								
	719								
Average	685	708	730	702	741	791	679	625	565
STD	19	5	6	21	34	10	75	39	8
Coefficient of Variation	3	1	1	3	5	1	11	6	1
% Change		3	7	3	8	15	-1	-9	-18
Stress @ 100% Elongation (psi)	1841	1632	1765	1829	1802	1916	1909	1826	1744
ASTM D638	1841	1616	1732	1780	1756	1829	1850	1838	1797
Machine Direction	1805	1651	1744	1841	1765	1817	2169	1831	1601
	1841								
	1793								
	1829								
Average	1825	1633	1747	1817	1774	1854	1976	1832	1781
STD	19	14	14	26	20	44	139	5	26
Coefficient of Variation	1	1	1	1	1	2	7	0	1
% Change		-11	-4	-0	-3	2	8	0	-2

Page 2 of 9

Project: Westinghouse File: West-L24.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Sodium Hydroxide Solution

MDN
Quality Review

Report Date: March 06, 1995

Exposure Time and Temperature

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Stress @ 200% Elongation (psi)	1902	1690	1827	1885	1815	1864	1916	1902	1800
ASTM D638	1854	1674	1756	1854	1817	1826	1829	1889	1846
Machine Direction	1817	1598	1756	1890	1840	1840	1817	1879	1845
	1866								
	1854								
	1878								
Average	1862	1687	1780	1870	1824	1843	1854	1890	1830
STD	26	10	33	15	11	16	44	9	21
Coefficient of Variation	1	1	2	1	1	1	2	0	1
% Change		-9	-4	0	-2	-1	-0	2	-2
Tensile Properties:									
Tensile Stress @ Yield (psi)	2524	2282	2354	2439	2415	2252	2315	2235	2422
ASTM D638	2398	2259	2341	2469	2439	2321	2342	2331	2464
Transverse Direction	2349	2298	2280	2427	2489	2330	2392	2395	2363
	2313								
	2439								
	2313								
Average	2389	2280	2325	2445	2448	2301	2350	2320	2416
STD	75	16	32	18	31	35	32	66	41
Coefficient of Variation	3	1	1	1	1	2	1	3	2
% Change		-5	-3	2	2	-4	-2	-3	1
Tensile Strength @ Break (psi)	5341	5012	4683	6000	5012	4818	5268	5271	5024
ASTM D638	5205	4729	4537	6333	5659	4440	5030	5349	5225
Transverse Direction	5169	5036	5390	6085	6073	4008	5518	4173	5083
	5253								
	5368								
	5253								
Average	5265	4926	4870	6139	5581	4422	5272	4931	5104
STD	70	139	372	141	437	331	199	537	87
Coefficient of Variation	1	3	8	2	8	7	4	11	2
% Change		-6	-7	17	6	-16	0	-6	-3

Page 3 of 9

Project: Westinghouse File: West-L34.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Sodium Hydroxide Solution

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Tensile Properties:									
Elongation @ Yield (%)	20	20	22	18	18	21	22	19	19
ASTM D638	20	20	22	20	20	21	23	18	21
Transverse Direction	22	22	23	18	22	24	20	18	21
	20								
	20								
	20								
Average	20	21	22	19	20	22	22	18	20
STD	1	1	0	1	2	1	1	0	1
Coefficient of Variation	4	5	2	5	8	6	6	3	5
% Change		2	10	-8	-2	8	7	-10	0
Elongation @ Break (%)	948	964	1002	977	879	810	865	737	717
ASTM D638	951	914	858	1020	988	955	926	746	745
Transverse Direction	936	951	855	990	975	890	805	596	732
	928								
	938								
	930								
Average	938	943	905	996	947	885	865	693	731
STD	8	21	69	18	49	60	49	69	11
Coefficient of Variation	1	2	8	2	5	7	6	10	2
% Change		1	-4	6	1	-6	-8	-26	-22
Set after Break (%)	724	765	707	849	709	733	739	609	610
ASTM D638	743	704	689	758	728	670	709	608	622
Transverse Direction	729	785	684	738	786	604	753	541	623
	738								
	740								
	731								
Average	734	751	693	782	741	669	734	586	618
STD	7	34	10	48	33	53	18	32	6
Coefficient of Variation	1	5	1	6	4	8	3	5	1
% Change		2	-6	6	1	-9	-0	-20	-16

Page 4 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Sodium Hydroxide Solution

MDN
Quality Review

Report Date: March 06, 1995

Exposure Time and Temperature

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Stress @ 100% Elongation (psi)	1854	1894	1768	1817	1805	1800	1840	1754	1819
ASTM D638	1795	1671	1707	1817	1854	1871	1933	1822	1843
Transverse Direction	1807	1702	1707	1744	1890	1901	1859	1835	1826
	1771								
	1829								
	1783								
Average	1807	1689	1727	1793	1850	1857	1877	1804	1829
STD	28	13	29	34	35	42	40	36	10
Coefficient of Variation	2	1	2	2	2	2	2	2	1
% Change		-7	-4	-1	2	3	4	-0	1
Stress @ 200% Elongation (psi)	1902	1753	1805	1805	1854	1763	1800	1823	1842
ASTM D638	1855	1694	1756	1876	1868	1785	1871	1892	1883
Transverse Direction	1831	1714	1732	1829	1802	1785	1901	1891	1864
	1795								
	1866								
	1843								
Average	1849	1720	1764	1837	1841	1778	1857	1869	1863
STD	33	24	30	29	28	10	42	32	17
Coefficient of Variation	2	1	2	2	2	1	2	2	1
% Change		-7	-5	-1	-0	-4	0	1	1
Modulus of Elasticity:									
ASTM D882 (psi)	17074	15237	16825	18824	18314	16835	15749	16291	16833
Machine Direction	16042	15810	16109	18056	17624	18186	16248	16550	17220
	17673	14971	16336	17521	23397	18048	16041	16665	16595
	16448								
	15839								
	15205								
Average	16380	15339	16423	18134	19778	17623	16013	16502	16883
STD	868	429	366	855	3153	858	251	192	315
Coefficient of Variation	5	3	2	4	16	5	2	1	2
% Change		-6	0	11	21	8	-2	1	3

Page 5 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Sodium Hydroxide Solution

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Modulus of Elasticity:									
ASTM D882 (psi)	15951	14691	15743	41742	24327	16387	15139	16534	15836
Transverse Direction	15098	14886	15124	17888	21269	15725	16991	17878	17149
	15218	15160	15831	17066	20590	16786	16469	17057	17933
	15247								
	15160								
	15402								
Average	15349	14912	15566	25572	22062	16299	16200	17156	16973
STD	311	236	385	14009	1991	536	955	677	1060
Coefficient of Variation	2	2	2	55	9	3	6	4	6
% Change		-3	1	67	44	6	6	12	11
Indentation Hardness:									
Reading	57	54	57	61	56	60	58	60	61
ASTM D2240	50	52	56	60	61	57	59	60	61
(with TYPE D DUROMETER)	54	50	57	61	59	58	60	60	63
	50	58	55	57	58	56	60	60	63
	52	58	55	60	56	59	59	61	61
	55								
	58								
	58								
	58								
	54								
Average	55	54	56	60	58	58	59	60	62
STD	3	4	1	2	2	2	1	0	1
Coefficient of Variation	6	7	2	3	4	3	1	1	2
% Change		-0	3	10	6	6	6	10	13
Specific Gravity:									
ASTM D792, Method A	0.948	0.945	0.935	0.951	0.939	0.941	0.941	0.950	0.941
	0.942	0.933	0.943	0.945	0.943	0.946	0.940	0.951	0.947
	0.937	0.940	0.948	0.947	0.944	0.942	0.942	0.949	0.944
	0.945								
	0.937								
	0.949								
Average	0.943	0.939	0.942	0.948	0.942	0.943	0.941	0.950	0.944
STD	0.005	0.006	0.007	0.003	0.003	0.003	0.001	0.001	0.003
Coefficient of Variation	1	1	1	0	0	0	0	0	0
% Change		-0.39	-0.11	0.49	-0.11	0.00	-0.21	0.74	0.11
Environmental Stress Crack Resistance:									
ASTM D1693, Condition B									
Machine Direction (% Failed)	N/A	0	0	0	0	0	0	0	0
Transverse Direction (% Failed)	N/A	0	0	0	0	0	0	0	0

Page 6 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Sodium Hydroxide Solution

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Puncture Resistance:									
Load @ Rupture (lbs)	121	126	122	125	123	124	127	128	127
FTMS 101C Method 2065	119	125	123	122	123	121	123	127	127
	124	122	122	121	123	122	123	125	125
	119								
	121								
	127								
Average	122	124	122	123	123	122	124	127	126
STD	3	2	0	2	0	1	2	1	1
Coefficient of Variation	2	1	0	1	0	1	2	1	1
% Change		2	0	1	1	0	2	4	4
Strain @ Rupture (in)	0.28	0.43	0.43	0.38	0.43	0.44	0.44	0.45	0.46
FTMS 101C Method 2065	0.25	0.43	0.42	0.41	0.44	0.41	0.44	0.44	0.44
	0.40	0.43	0.39	0.44	0.40	0.44	0.43	0.43	0.43
	0.24								
	0.24								
	0.40								
Average	0.30	0.43	0.41	0.41	0.42	0.43	0.44	0.44	0.44
STD	0.07	0.00	0.02	0.02	0.02	0.01	0.00	0.01	0.01
Coefficient of Variation	23	0	4	6	4	3	1	2	3
% Change		43	37	36	40	43	45	46	47
Volatiles and Extractables:									
'achine Diameter Change (%)	-0.25	-0.88	-0.13	-0.40	-0.70	-0.35	-0.80	-0.13	-0.43
,W 870 - Appendix III-D	-0.25	-0.80	-0.23	-0.53	-0.68	-0.55	-0.93	-0.08	-0.37
	-0.42								
	-0.38								
Average	-0.33	-0.84	-0.18	-0.47	-0.69	-0.45	-0.87	-0.11	-0.40
STD	0.08	0.04	0.05	0.06	0.01	0.10	0.07	0.03	0.03
Volatiles and Extractables:									
Transverse Diameter Change (%)	0.28	0.43	-0.08	0.10	0.55	0.18	0.48	0.18	0.10
SW 870 - Appendix III-D	-0.03	0.48	0.12	0.38	-0.08	0.03	0.55	0.20	0.15
	0.33								
	0.20								
Average	0.20	0.46	0.02	0.24	0.24	0.11	0.52	0.19	0.13
STD	0.14	0.02	0.10	0.14	0.31	0.08	0.04	0.01	0.02
% Volatiles	0.04	0.05	0.06	0.05	0.09	0.08	0.13	0.05	0.12
SW 870 - Appendix III-D	0.04	0.05	0.06	0.06	0.07	0.06	0.14	0.04	0.10
	0.04								
	0.04								
Average	0.04	0.05	0.06	0.06	0.08	0.06	0.14	0.05	0.11
STD	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
% Extractables	0.06	0.12	0.12	0.13	0.08	0.04	0.03	0.11	0.14
SW 870 - Appendix III-D	0.07	0.09	0.12	0.10	0.16	0.03	0.02	0.10	0.15
	0.08								
	0.07								
/erage	0.07	0.11	0.12	0.12	0.12	0.04	0.03	0.11	0.15
,TD	0.01	0.02	0.00	0.02	0.04	0.01	0.01	0.00	0.00

Page 7 of 9

Project: Westinghouse File: West-L74.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Sodium Hydroxide Solution

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Tear Resistance:									
ASTM D1004	58	70	67	68	66	66	65	68	67
(lbs)	59	69	69	68	67	64	65	68	68
Machine Direction	58	71	68	67	66	65	66	68	67
	59								
	58								
	59								
Average	59	70	68	68	66	65	65	68	67
STD	1	1	1	1	1	1	1	0	1
Coefficient of Variation	1	1	1	1	1	2	1	0	1
% Change		20	16	16	13	11	12	16	15
Tear Resistance:									
ASTM D1004	56	69	69	68	69	64	66	68	67
(lbs)	56	68	67	67	69	64	66	68	67
Transverse Direction	57	69	69	67	68	65	66	68	67
	58								
	58								
	57								
Average	57	69	68	67	69	64	66	68	67
STD	1	1	1	1	1	1	0	0	0
Coefficient of Variation	2	1	2	1	1	1	0	0	0
% Change		20	20	18	20	13	16	19	18
Hydrostatic Resistance:									
ASTM D751	595	595	600	580	600	585	570	610	600
(psi)	595	590	595	585	590	580	560	590	600
	590	595	610	590	590	580	580	620	610
	605								
	595								
	590								
Average	595	593	602	585	593	582	570	607	603
STD	5	3	8	5	6	3	10	15	6
Coefficient of Variation	1	0	1	1	1	0	2	3	1
% Change		-0	1	-2	-0	-2	-4	2	1
Hydrostatic Resistance:									
ASTM D751	11.90	12.87	11.69	8.78	10.69	7.12	7.25	11.62	7.44
time to burst (sec)	12.62	12.35	12.90	8.82	11.66	8.56	8.54	13.22	8.65
	12.44	12.84	13.63	11.58	11.46	9.79	10.10	11.48	9.75
	12.63								
	11.50								
	12.03								
Average	12.18	12.69	12.74	9.65	11.27	8.49	8.83	12.10	8.61
STD	0	0	1	2	1	1	1	1	1
Coefficient of Variation	4	2	8	17	5	16	17	8	13
% Change		4	5	-21	-6	-30	-29	-1	-29

Page 8 of 9

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Exposed to Sodium Hydroxide Solution

MDN
Quality Review

Report Date: March 06, 1995

Exposure Time and Temperature

Test Parameters	Baseline	30 Day 23C	30 Day 50C	60 Day 23C	60 Day 50C	90 Day 23C	90 Day 50C	120 Day 23C	120 Day 50C
Seam Peel Adhesion:									
ASTM D4437 (lbs)	153	139	142	138	142	150	147	159	156
	157	149	141	143	140	145	145	150	150
	154	140	140	147	137	150	146	145	158
	155	135	141	133	138	149	145	140	150
	155	134	149	145	145	151	147	148	149
	161	144	140	134	137	145	147	154	154
	154								
	154								
	153								
	154								
	160								
	153								
Average	155	140	142	140	140	148	146	149	153
STD	3	5	3	5	3	2	1	6	3
Coefficient of Variation	2	4	2	4	2	2	1	4	2
% Change		-10	-8	-10	-10	-4	-6	-4	-2
Failure Mode (FTB = All Film Tear Bond)	FTB	FTB	FTB	FTB	FTB	FTB	FTB	FTB	FTB
Shear Seam Strength:									
Shear Seam Strength (lbs)	168	157	151	154	158	157	155	156	155
ASTM D4437	168	156	151	154	156	157	155	157	155
	168	155	152	150	157	155	154	155	140
	167								
	169								
	167								
Average	168	156	151	153	157	156	155	156	150
STD	1	1	0	2	1	1	0	1	7
Coefficient of Variation	0	1	0	1	1	1	0	1	5
% Change		-7	-10	-9	-6	-7	-8	-7	-11

Page 9 of 9

EPA METHOD 9090 TEST RESULTS

GEOSYNTHETIC DIMENSIONS

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Dimensional Stability Data

Report Date: March 06, 1995

Exposure Time and Temperature

MDN
Quality Review

Test Parameters	Temp.	Baseline	30 Day Exposed	% Change	Baseline	60 Day Exposed	% Change	Baseline	90 Day Exposed	% Change	Baseline	120 Day Exposed	% Change
GEOMEMBRANE: NATIONAL SEAL 80 mil SMOOTH HDPE exposed to Organic Solution in Butanol													
Thickness (mils)	23C	85	81	-4.7	86	82	-4.7	87	83	-4.6	85	82	-3.5
	50C	85	81	-4.7	86	81	-5.8	85	81	-4.7	87	82	-5.7
Length (inches)	23C	9.98	10.01	0.3	10.09	10.11	0.2	10.08	10.15	0.7	10.04	10.09	0.5
	50C	10.15	10.20	0.5	10.02	10.06	0.4	10.03	10.07	0.4	10.01	10.07	0.6
Width (inches)	23C	7.86	7.89	0.4	7.98	8.01	0.4	7.92	7.96	0.5	8.00	8.02	0.2
	50C	7.93	7.96	0.4	7.96	8.00	0.5	7.99	8.03	0.5	7.97	8.00	0.4
Mass (g)	23C	97.82	98.43	0.6	100.29	100.95	0.7	99.60	100.73	1.1	99.79	100.76	1.0
	50C	100.44	101.38	0.9	99.59	100.72	1.1	100.18	101.70	1.5	99.37	100.90	1.5
GEOMEMBRANE: NATIONAL SEAL 80 mil SMOOTH HDPE exposed to Organic Solution in Water													
Thickness (mils)	23C	81	81	0.0	81	82	1.2	82	82	0.0	82	83	1.2
	50C	82	81	-1.2	81	81	0.0	82	82	0.0	82	82	0.0
Length (inches)	23C	10.06	10.08	0.2	10.03	10.04	0.1	10.04	10.07	0.3	10.09	10.12	0.3
	50C	10.05	10.10	0.5	10.01	10.02	0.1	10.03	10.05	0.2	9.98	10.01	0.3
Width (inches)	23C	7.97	7.99	0.3	8.02	8.04	0.2	8.01	8.06	0.6	7.97	8.01	0.5
	50C	8.03	8.03	0.0	7.92	7.93	0.1	7.97	7.96	0.1	7.89	7.93	0.5
Mass (g)	23C	100.75	100.89	0.1	101.79	101.94	0.1	101.77	101.95	0.2	101.74	101.95	0.2
	50C	101.90	102.09	0.2	99.42	99.60	0.2	101.36	101.62	0.3	99.19	99.49	0.3

Page 1 of 2

Project: Westinghouse File: West-Dim.WB1

TABLE OF CHEMICAL COMPATIBILITY TEST RESULTS
Dimensional Stability Data

Report Date: March 06, 1995

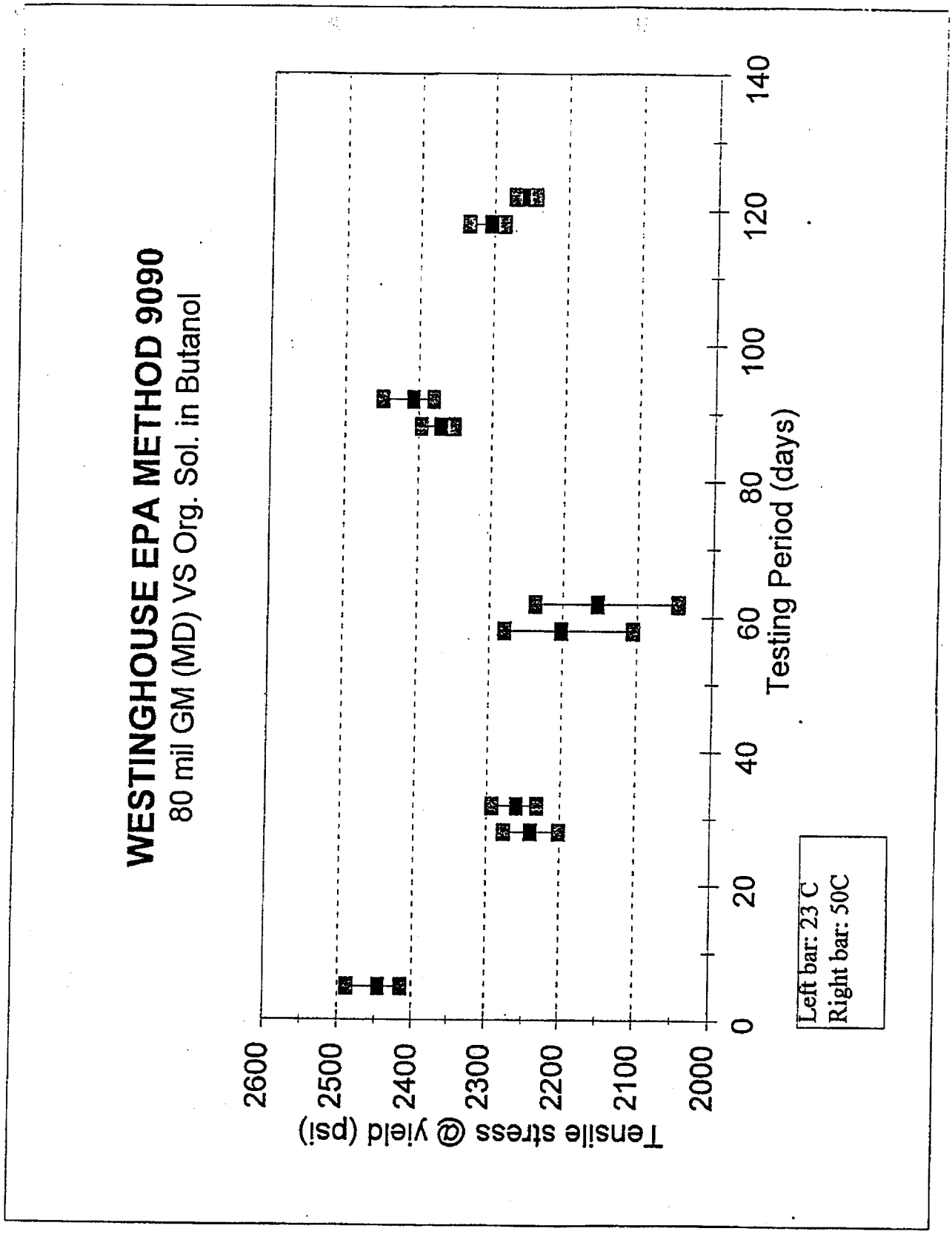
Exposure Time and Temperature

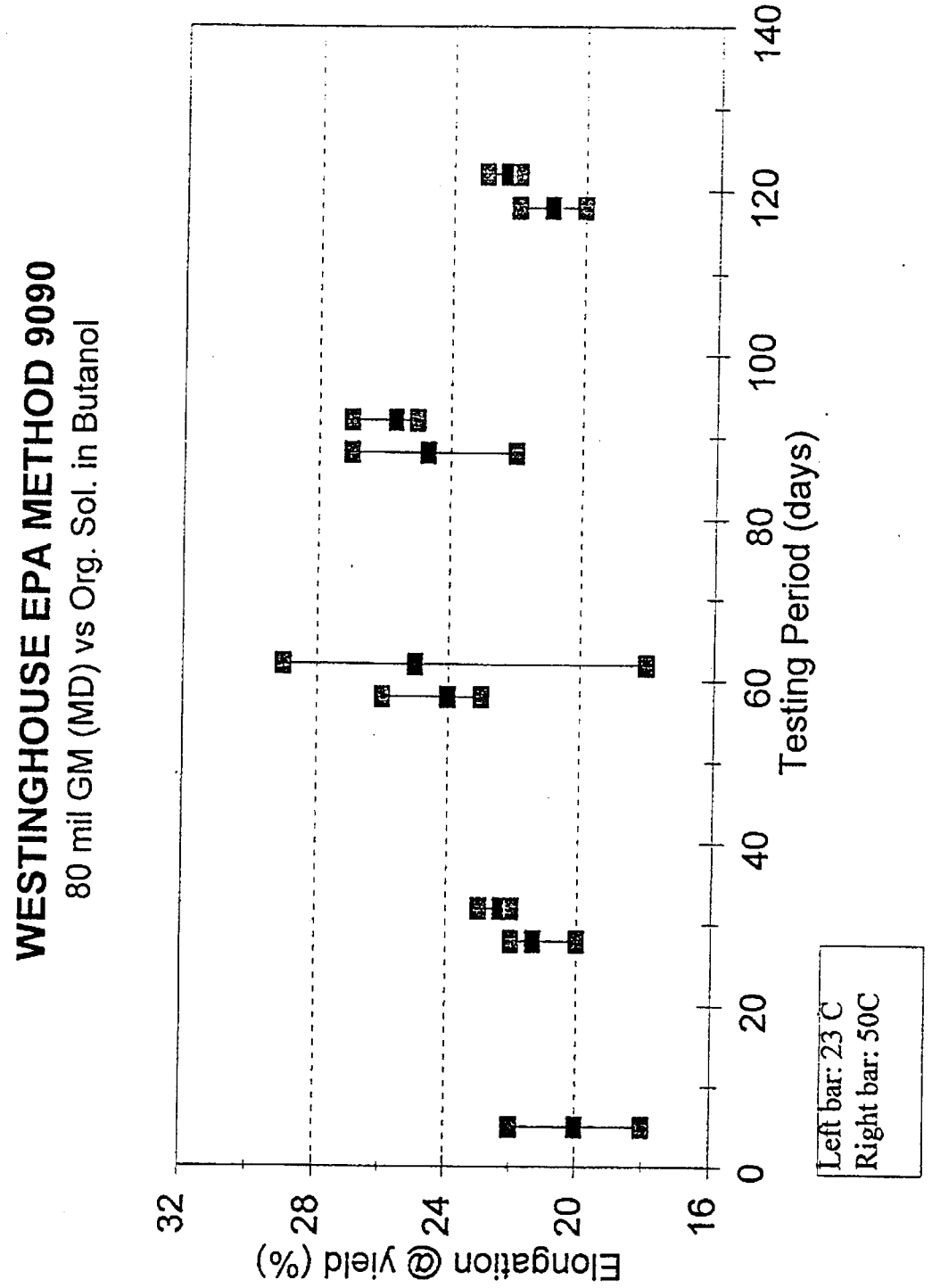
MDN
Quality Review

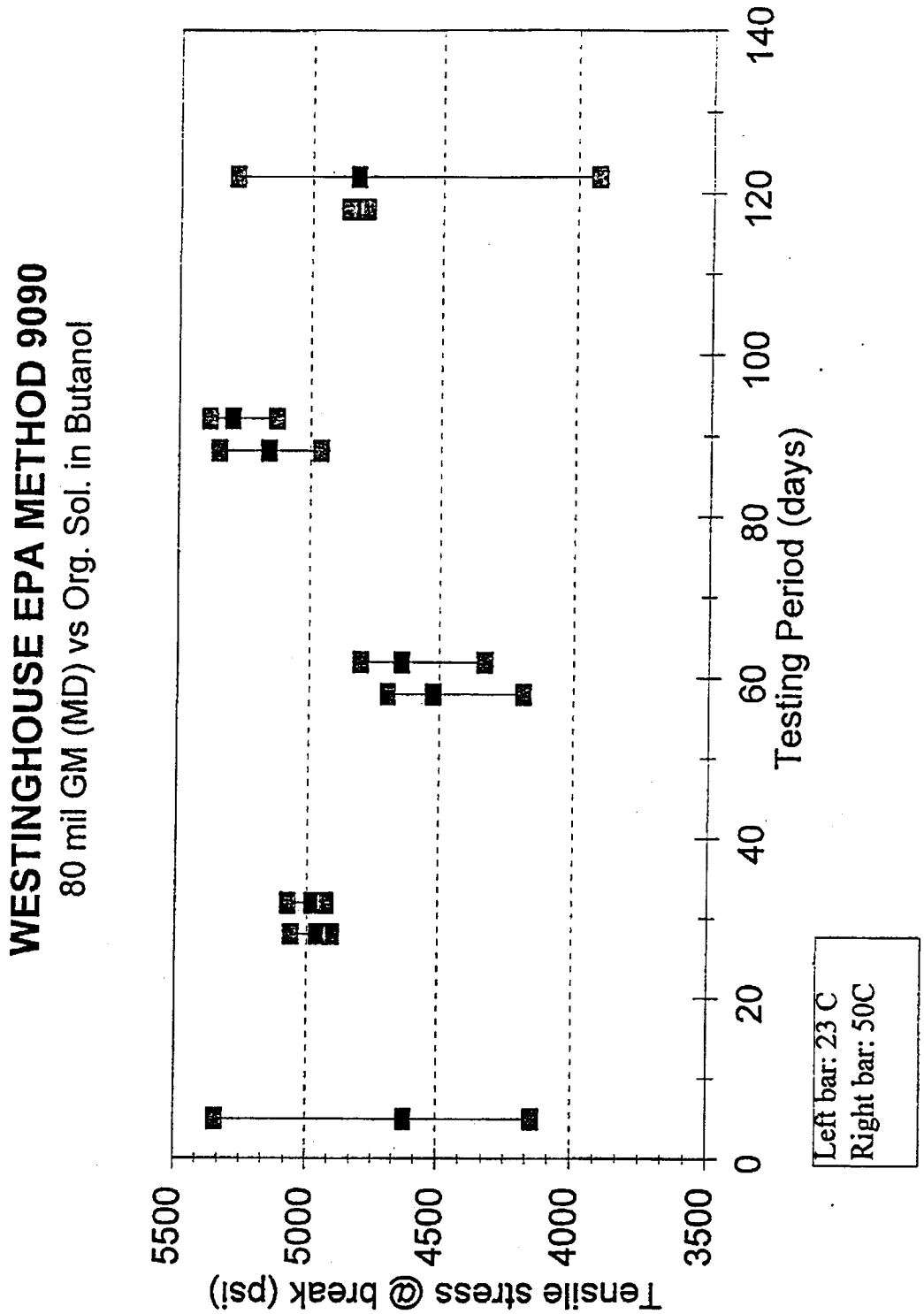
Test Parameters	Temp.	Baseline	30 Day Exposed	% Change	Baseline	60 Day Exposed	% Change	Baseline	90 Day Exposed	% Change	Baseline	120 Day Exposed	% Change
GEOMEMBRANE: NATIONAL SEAL 80 mil SMOOTH HDPE exposed to Water Based Mixture of Metal Nitrates and Nitric Acid													
Thickness (mils)	23C	82	81	-1.2	82	82	0.0	82	82	0.0	81	82	1.2
	50C	82	81	-1.2	82	82	0.0	81	81	0.0	82	82	0.0
Length (inches)	23C	10.03	10.03	0.0	10.03	10.05	0.2	10.07	10.08	0.1	9.95	9.97	0.2
	50C	10.01	10.02	0.1	10.04	10.08	0.4	10.07	9.97	-1.0	9.99	10.02	0.3
Width (inches)	23C	7.91	7.93	0.3	7.97	7.99	0.3	7.97	7.99	0.3	7.96	7.99	0.4
	50C	7.93	7.97	0.5	7.99	8.01	0.3	7.97	7.96	-0.1	7.95	7.96	0.1
Mass (g)	23C	100.12	100.18	0.1	101.28	101.33	0.0	101.67	101.74	0.1	99.40	99.47	0.1
	50C	100.69	100.72	0.0	101.68	101.74	0.1	99.52	99.67	0.2	100.23	100.28	0.0
GEOMEMBRANE: NATIONAL SEAL 80 mil SMOOTH HDPE exposed to Sodium Hydroxide Solution													
Thickness (mils)	23C	82	81	-1.2	81	81	0.0	81	81	0.0	82	83	1.2
	50C	81	81	0.0	81	81	0.0	81	80	-1.2	81	81	0.0
Length (inches)	23C	10.00	10.00	0.0	10.03	10.05	0.2	10.06	10.13	0.7	9.97	10.02	0.5
	50C	10.06	10.06	0.0	9.98	9.99	0.1	10.01	10.00	-0.1	10.03	10.06	0.3
Width (inches)	23C	8.00	8.01	0.1	8.01	8.01	0.0	8.01	8.03	0.2	7.93	7.96	0.4
	50C	7.94	7.95	0.1	8.01	8.02	0.1	7.93	7.97	0.5	7.96	7.97	0.1
Mass (g)	23C	100.85	100.82	-0.0	100.63	100.63	0.0	100.81	101.04	0.2	100.83	100.90	0.1
	50C	99.46	99.56	0.1	100.11	100.19	0.1	99.05	99.23	0.2	99.24	99.38	0.1

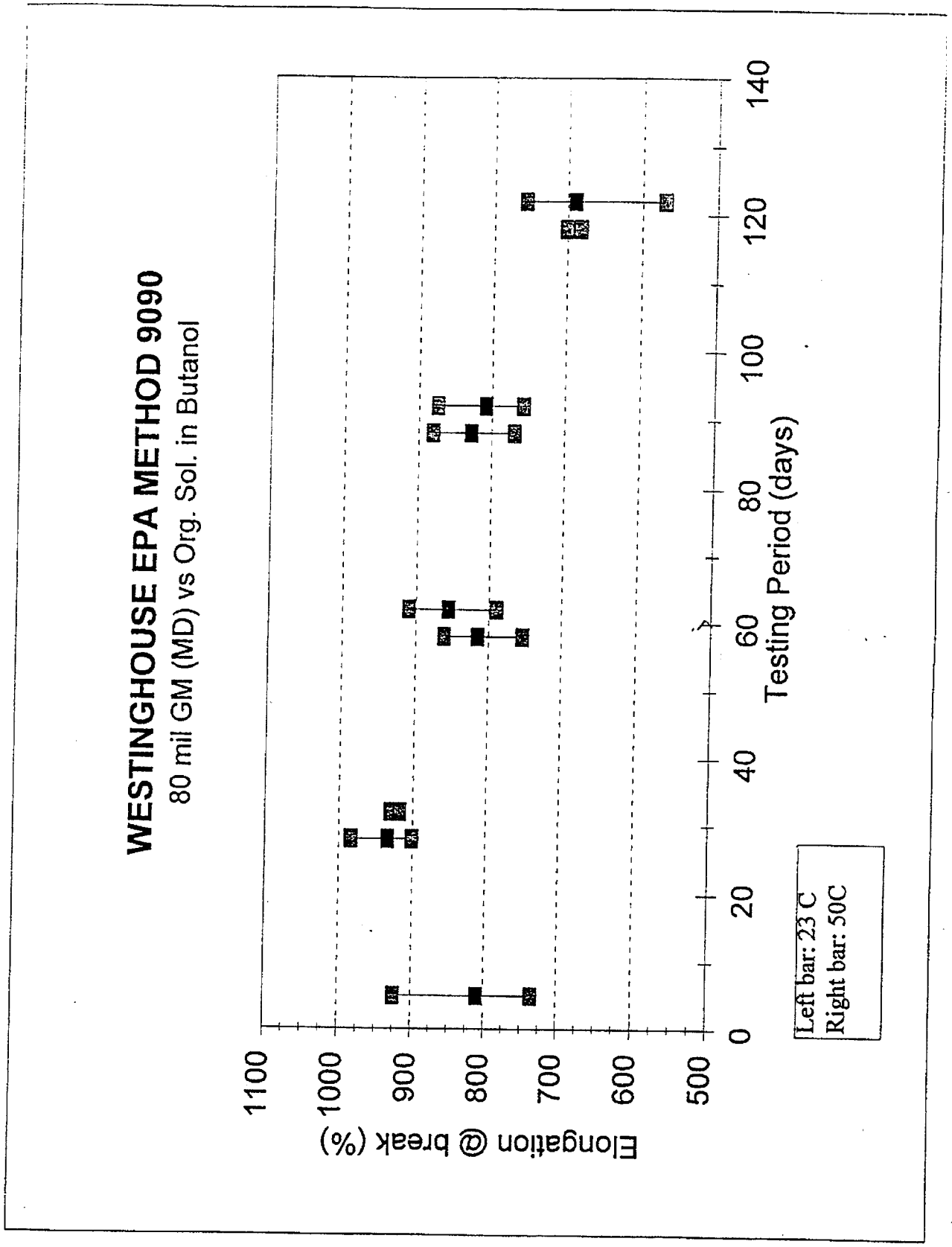
Page 2 of 2

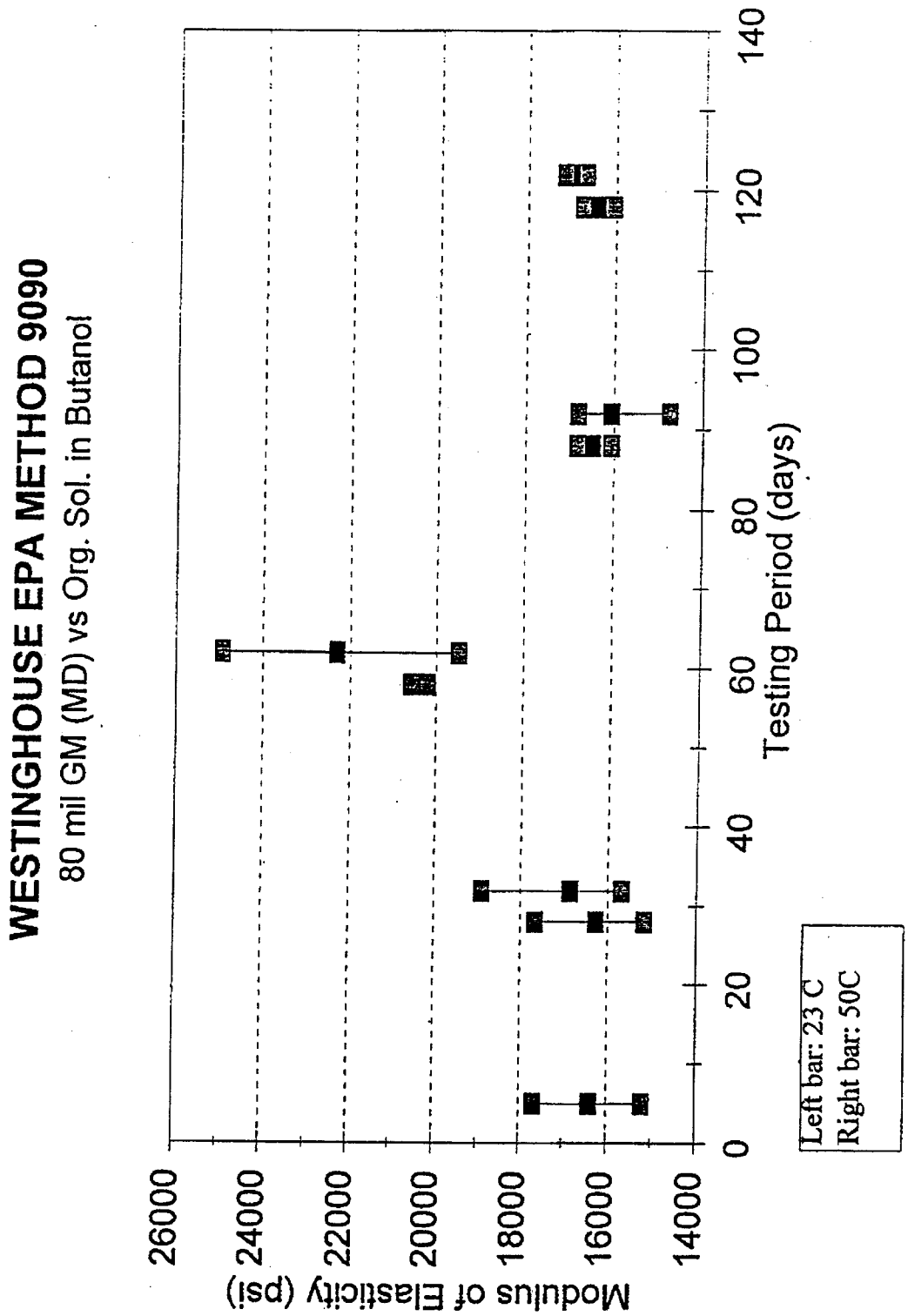
Project: Westinghouse File: West-Dim.WB1

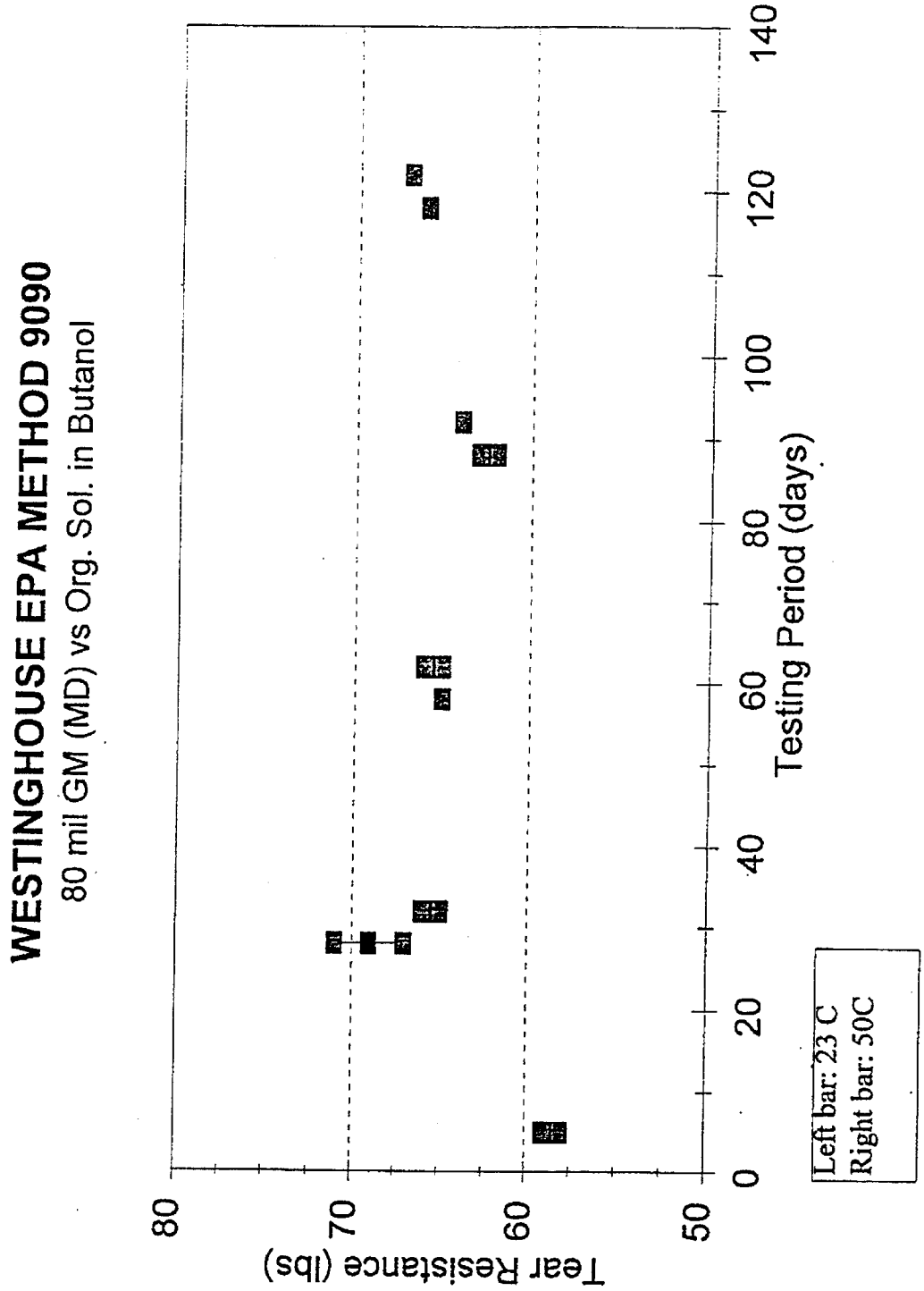

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) VS Org. Sol. in Butanol
Tensile stress @ yield (psi)
2600
2500
2400
2300
2200
2100
2000
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

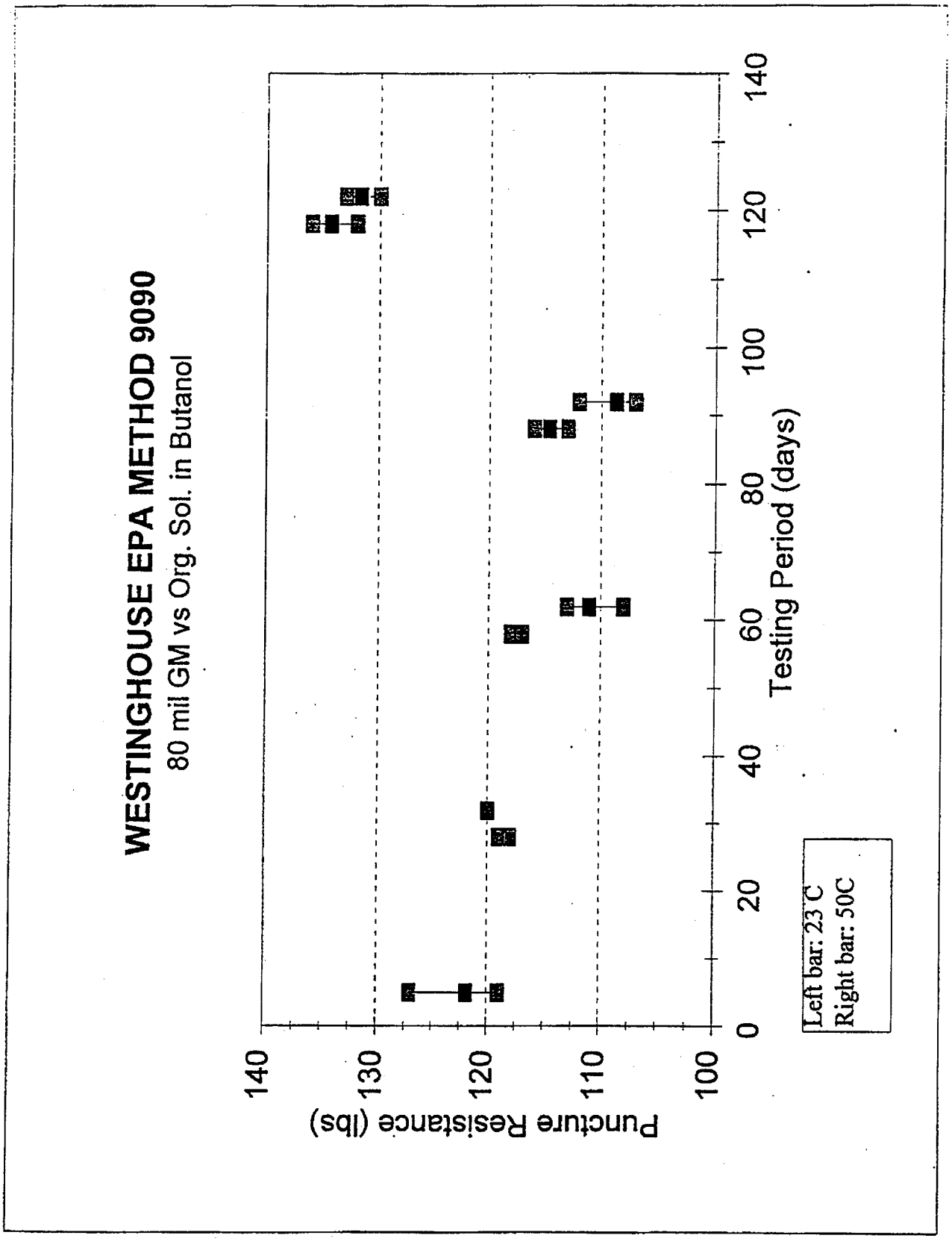

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Org. Sol. in Butanol
Elongation @ yield (%)
32
28
24
20
16
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

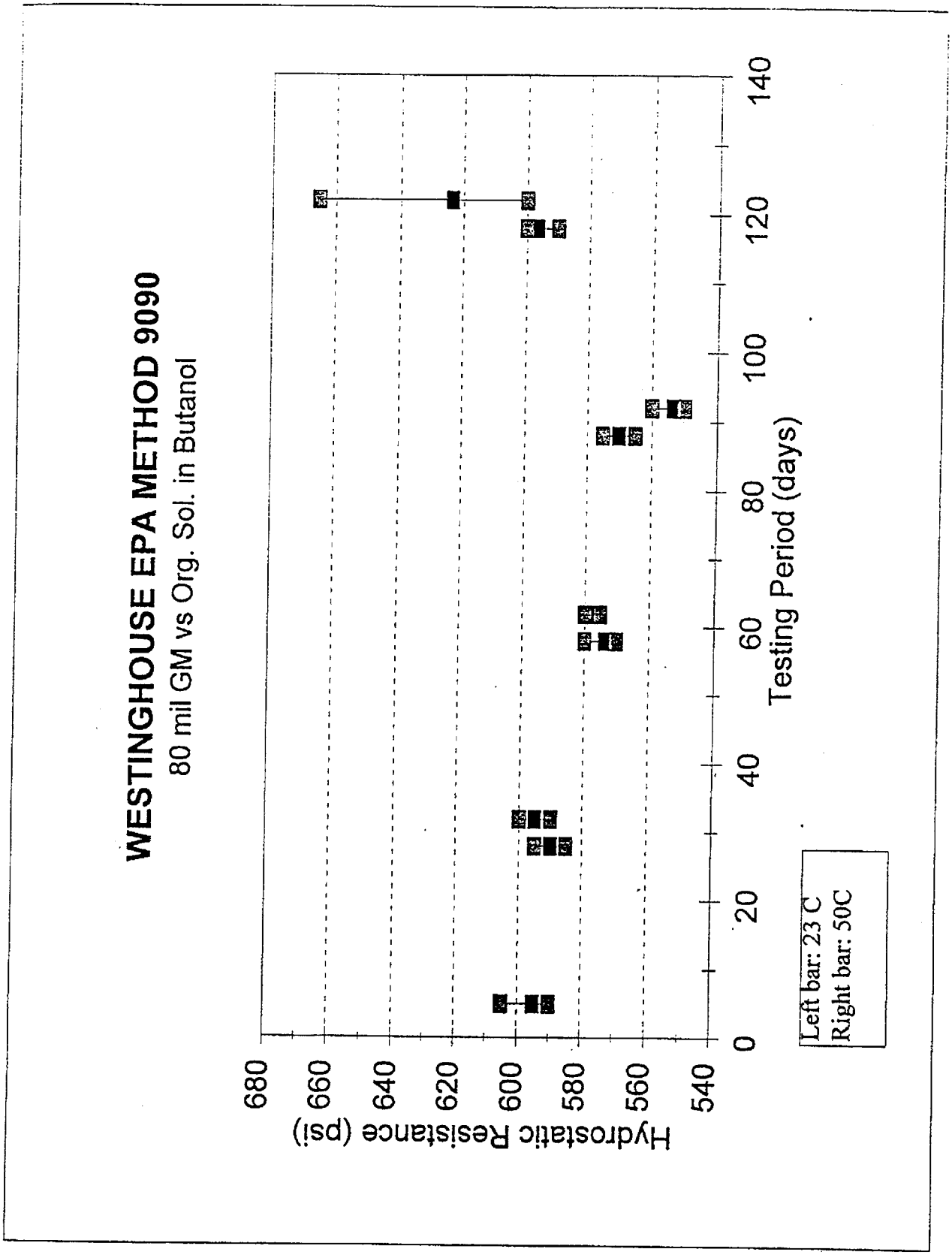

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Org. Sol. in Butanol
Tensile stress @ break (psi)
5500
5000
4500
4000
3500
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

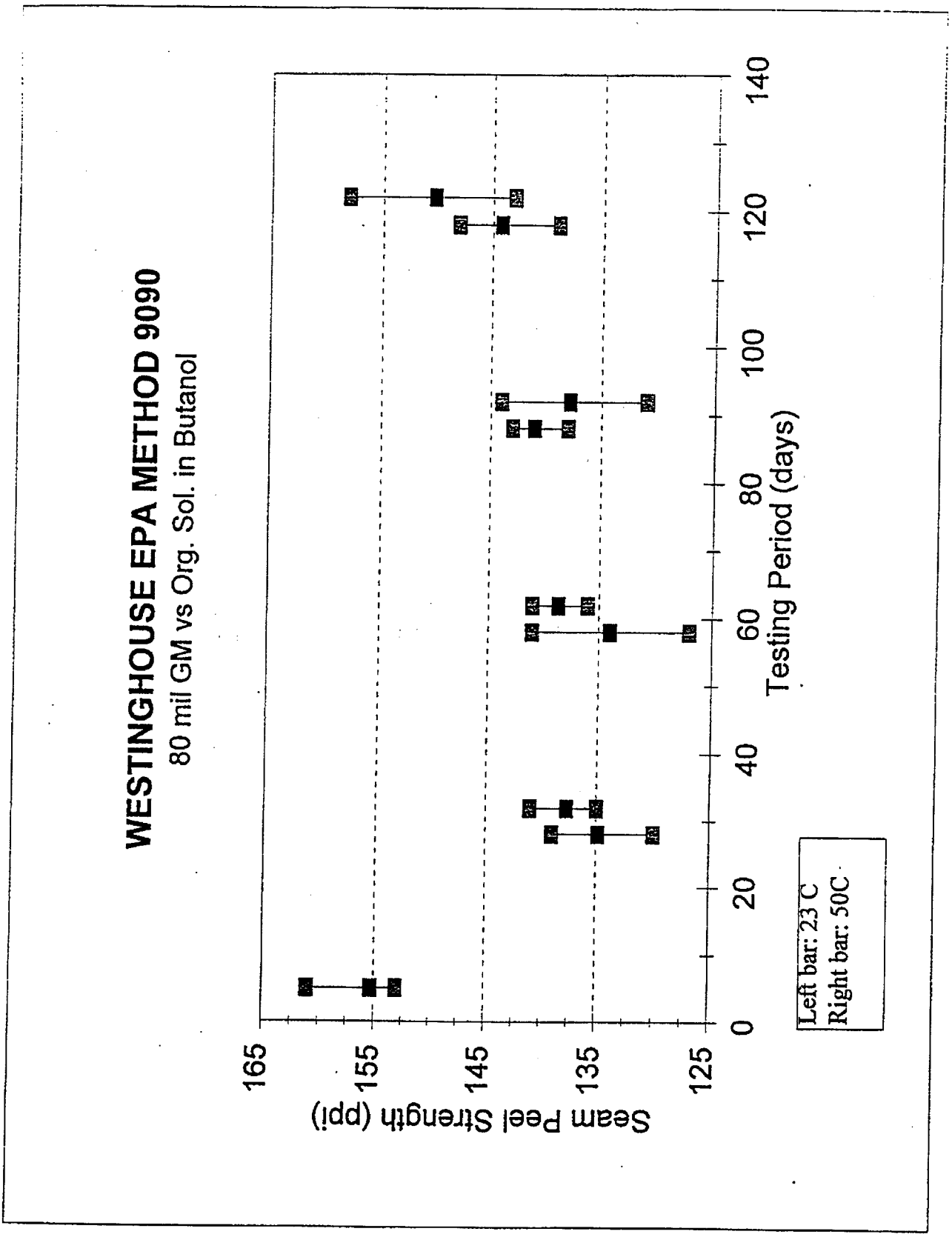

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Org. Sol. in Butanol
Elongation @ break (%)
1100
1000
900
800
700
600
500
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

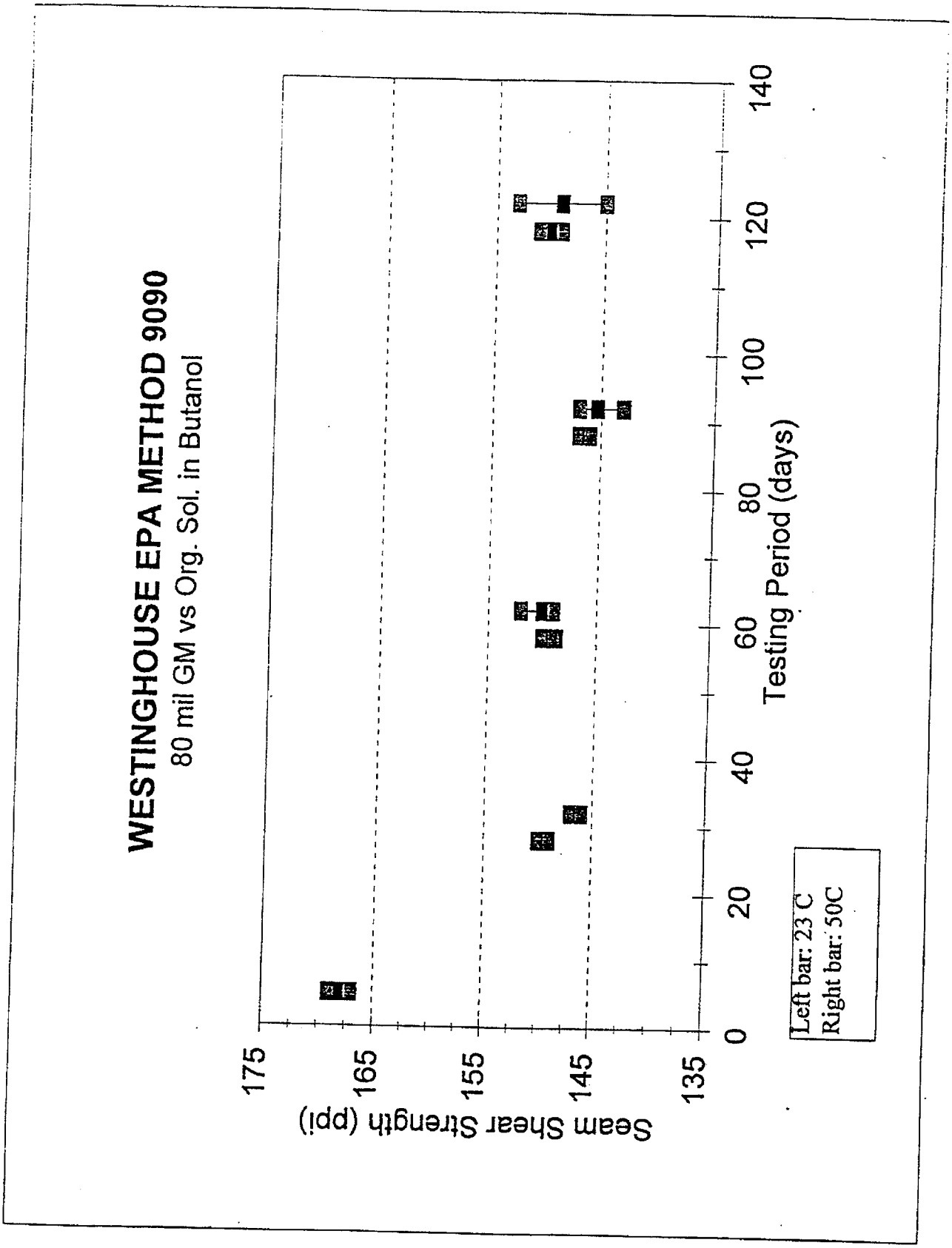

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Org. Sol. in Butanol
Modulus of Elasticity (psi)
26000
24000
22000
20000
18000
16000
14000
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

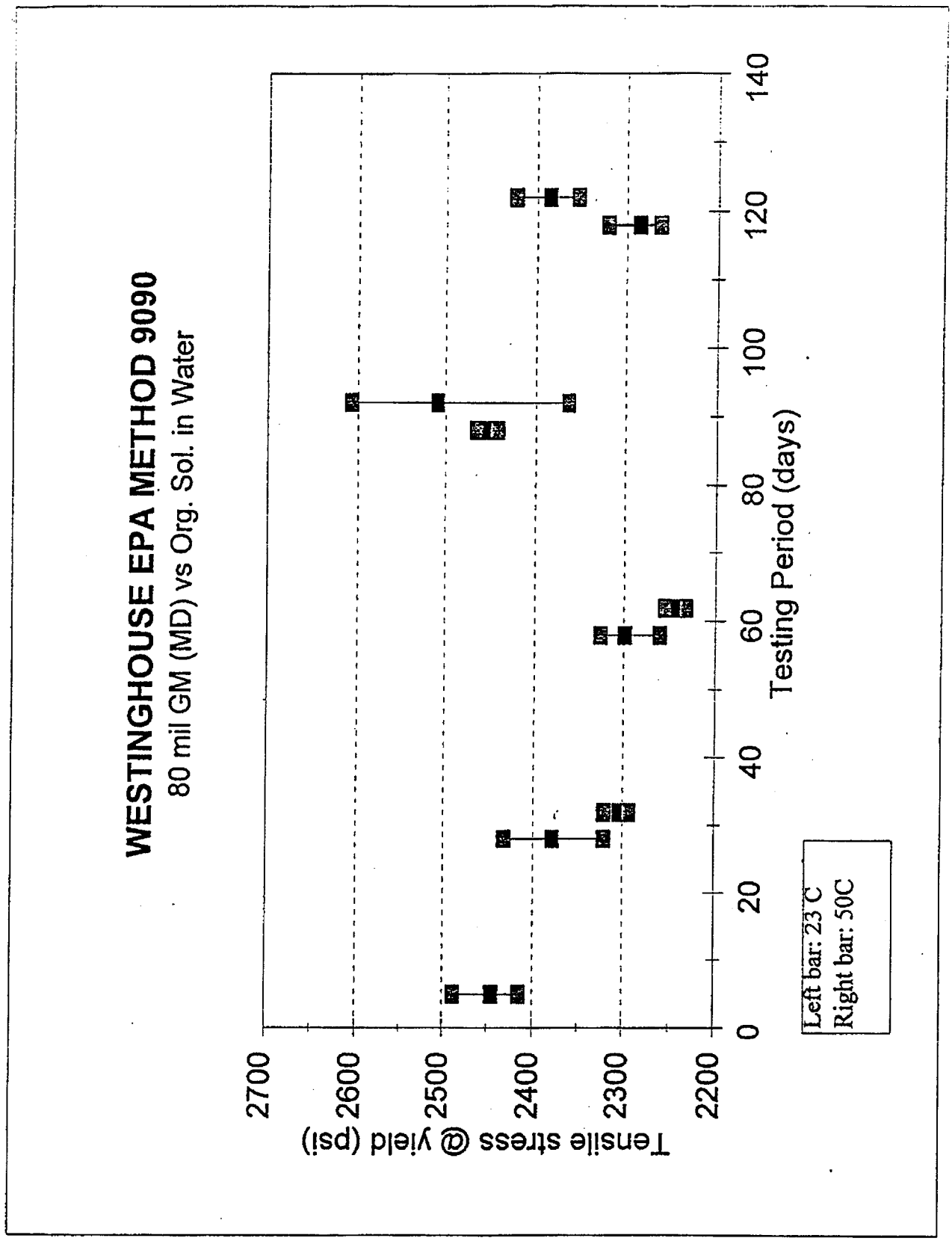

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Org. Sol. in Butanol
Tear Resistance (lbs)
80
70
60
50
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

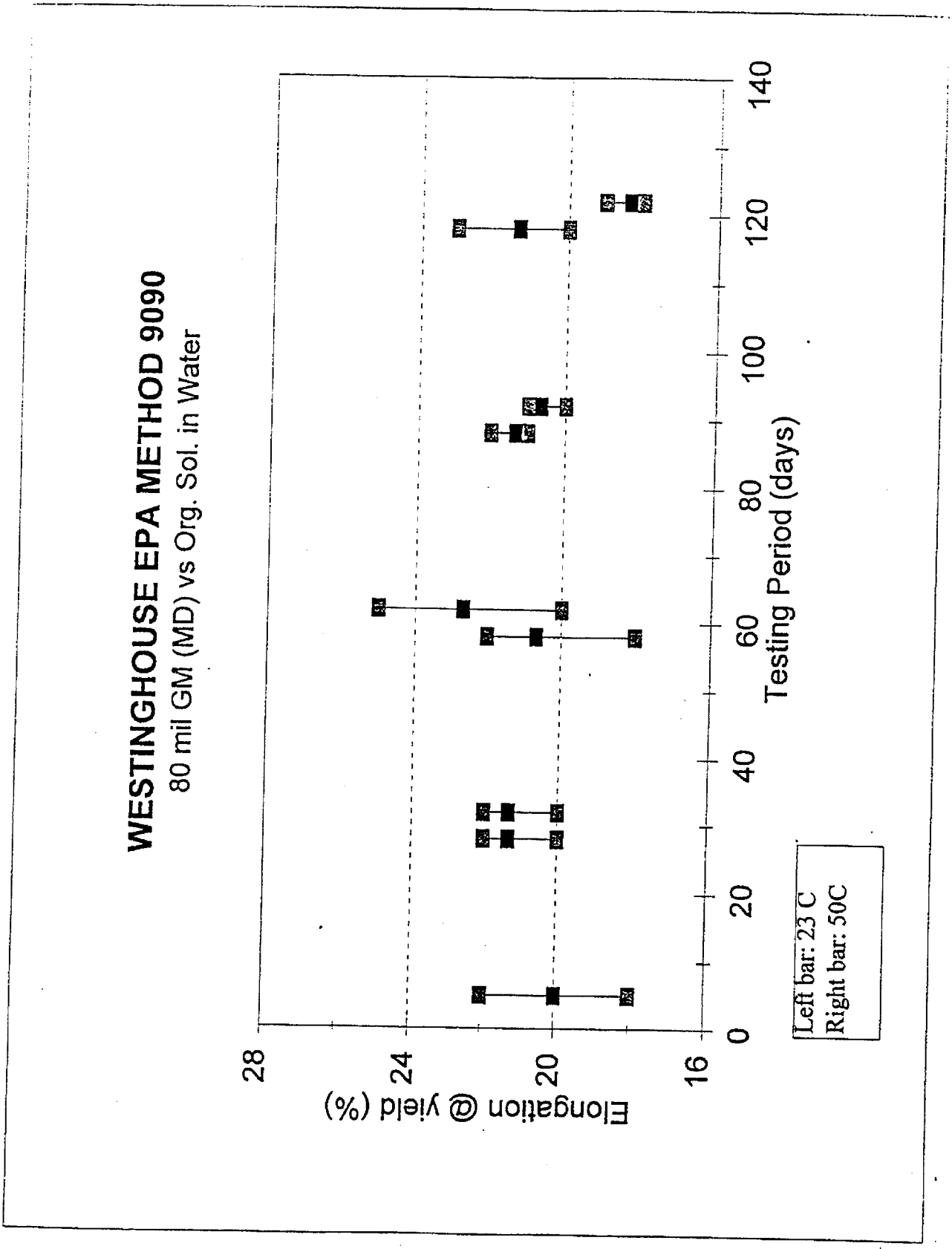

WESTINGHOUSE EPA METHOD 9090
80 mil GM vs Org. Sol. in Butanol
Puncture Resistance (lbs)
140
130
120
110
100
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

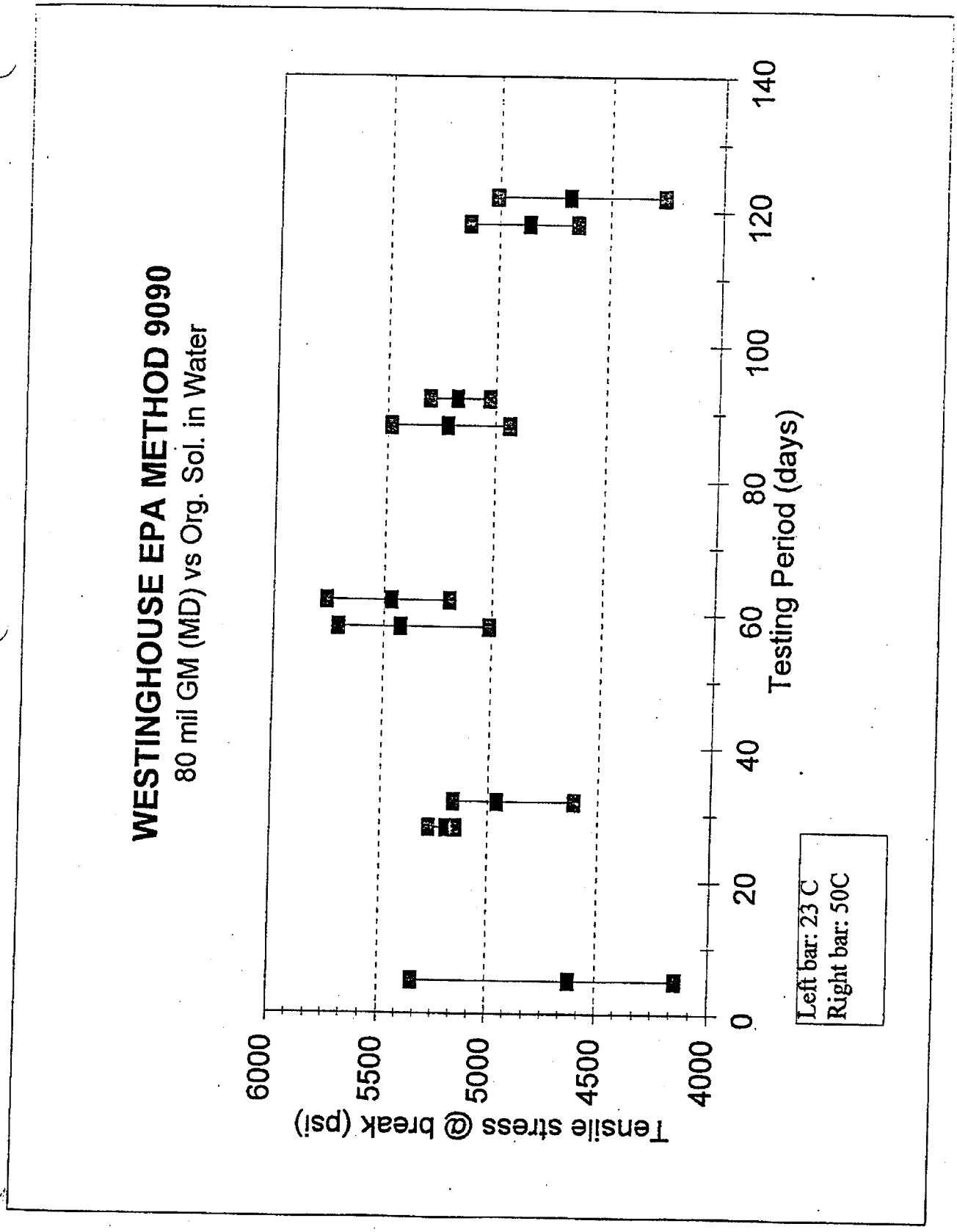

WESTINGHOUSE EPA METHOD 9090
80 mil GM vs Org. Sol. in Butanol
Hydrostatic Resistance (psi)
680
660
640
620
600
580
560
540
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

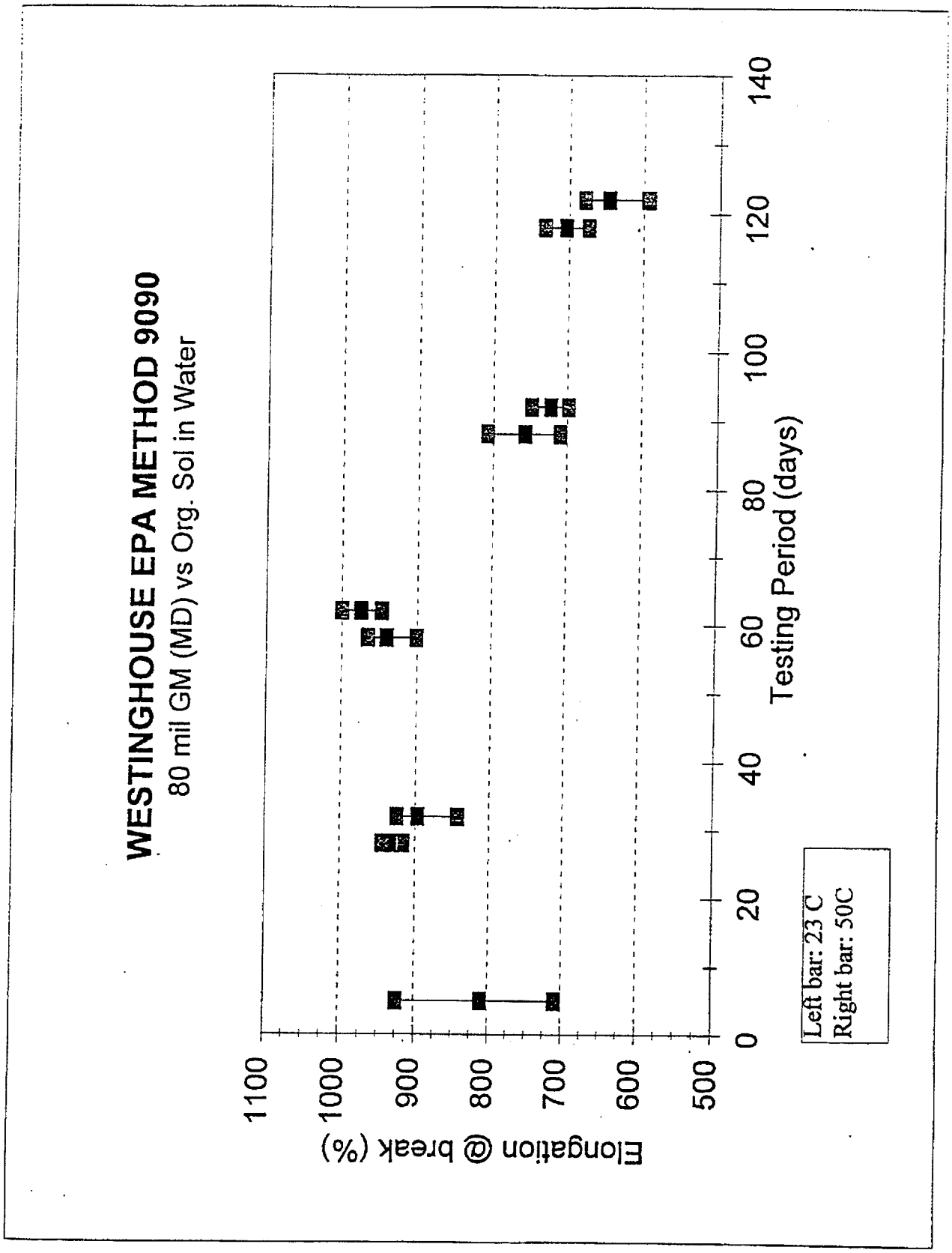

WESTINGHOUSE EPA METHOD 9090
80 mil GM vs Org. Sol. in Butanol
Seam Peel Strength (ppi)
165
155
145
135
125
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

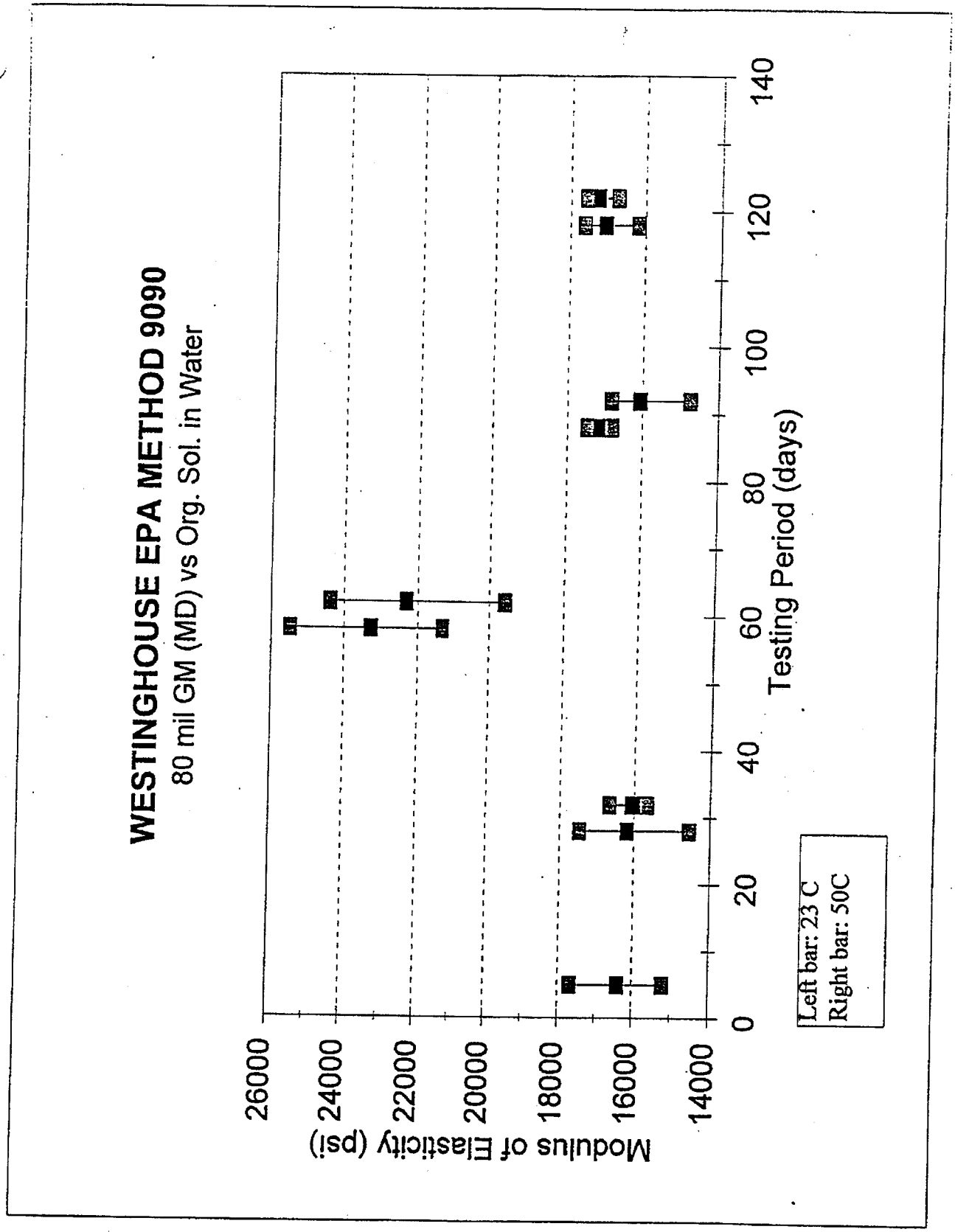

WESTINGHOUSE EPA METHOD 9090
80 mil GM vs Org. Sol. in Butanol
Seam Shear Strength (ppi)
175
165
155
145
135
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

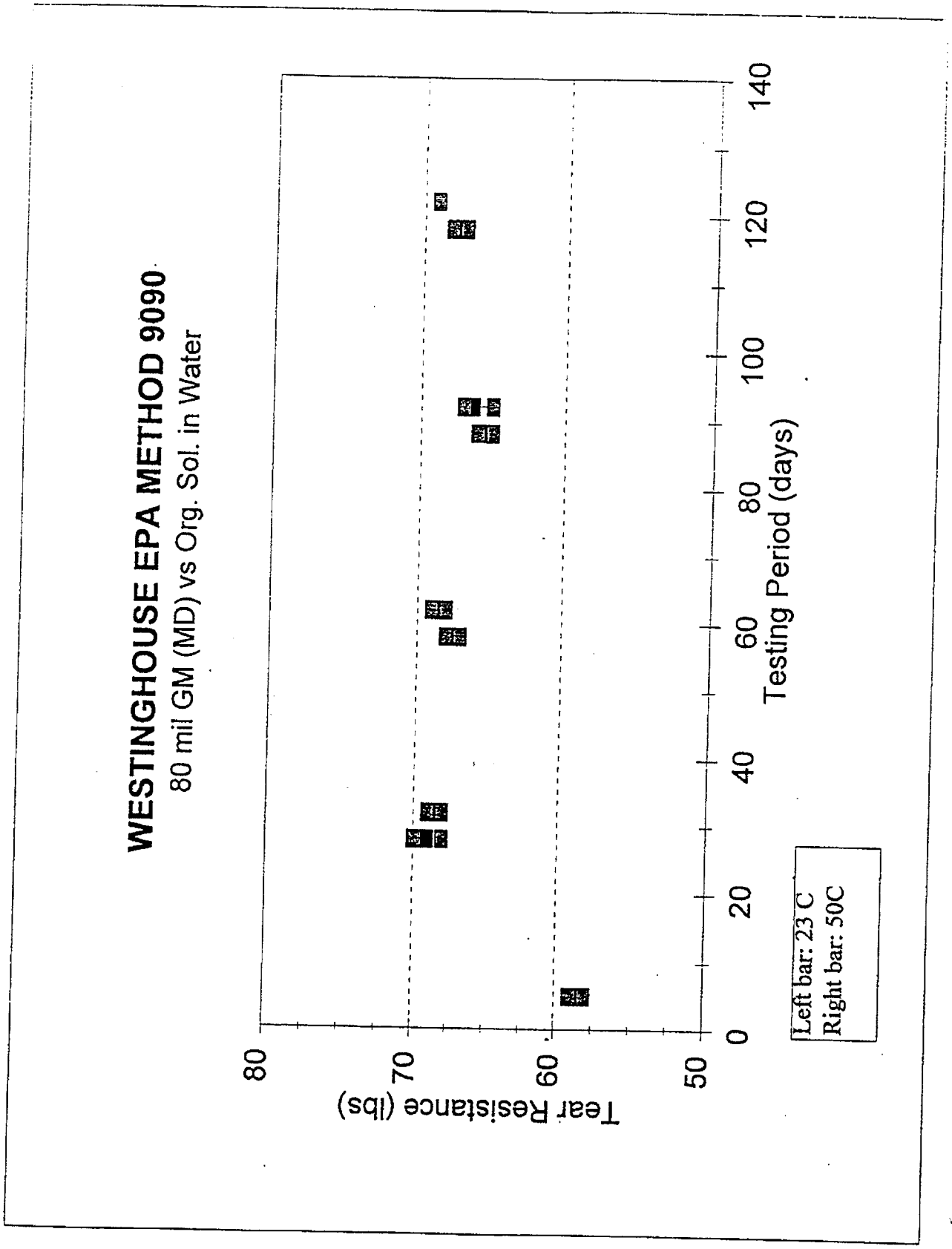

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Org. Sol. in Water
Tensile stress @ yield (psi)
2700
2600
2500
2400
2300
2200
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

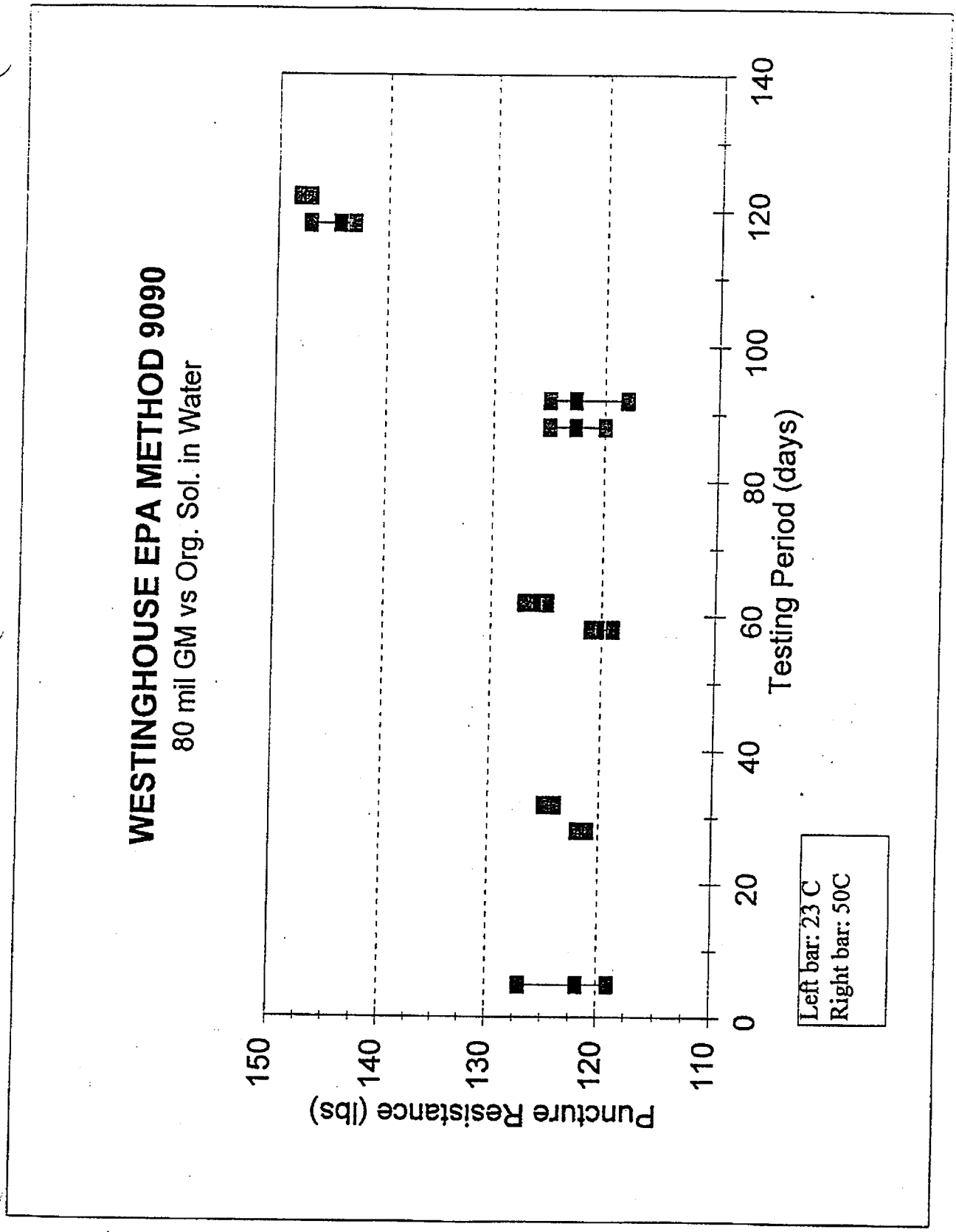

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Org. Sol. in Water
Elongation @ yield (%)
28
24
20
16
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

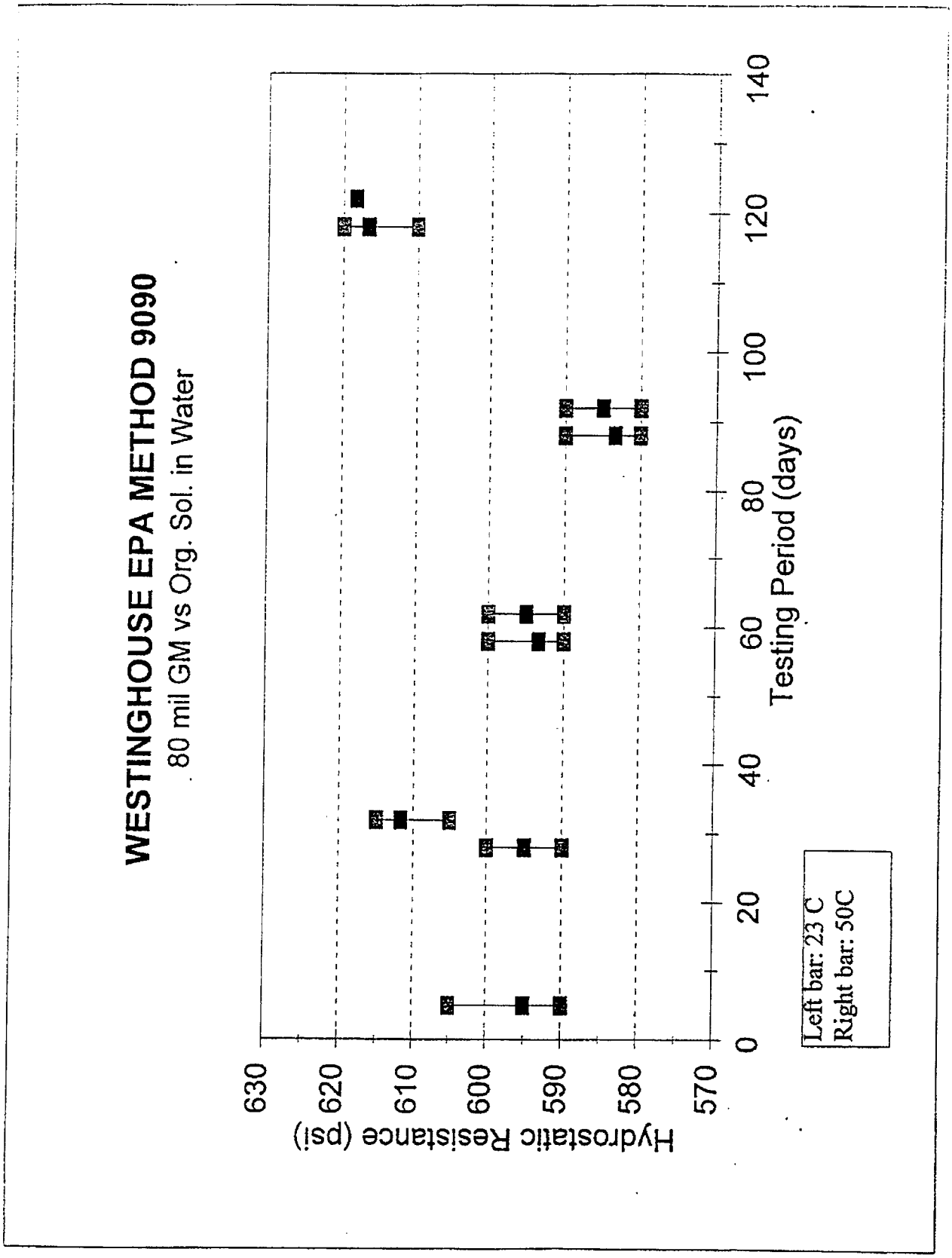

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Org. Sol. in Water
Tensile stress @ break (psi)
6000
5500
5000
4500
4000
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

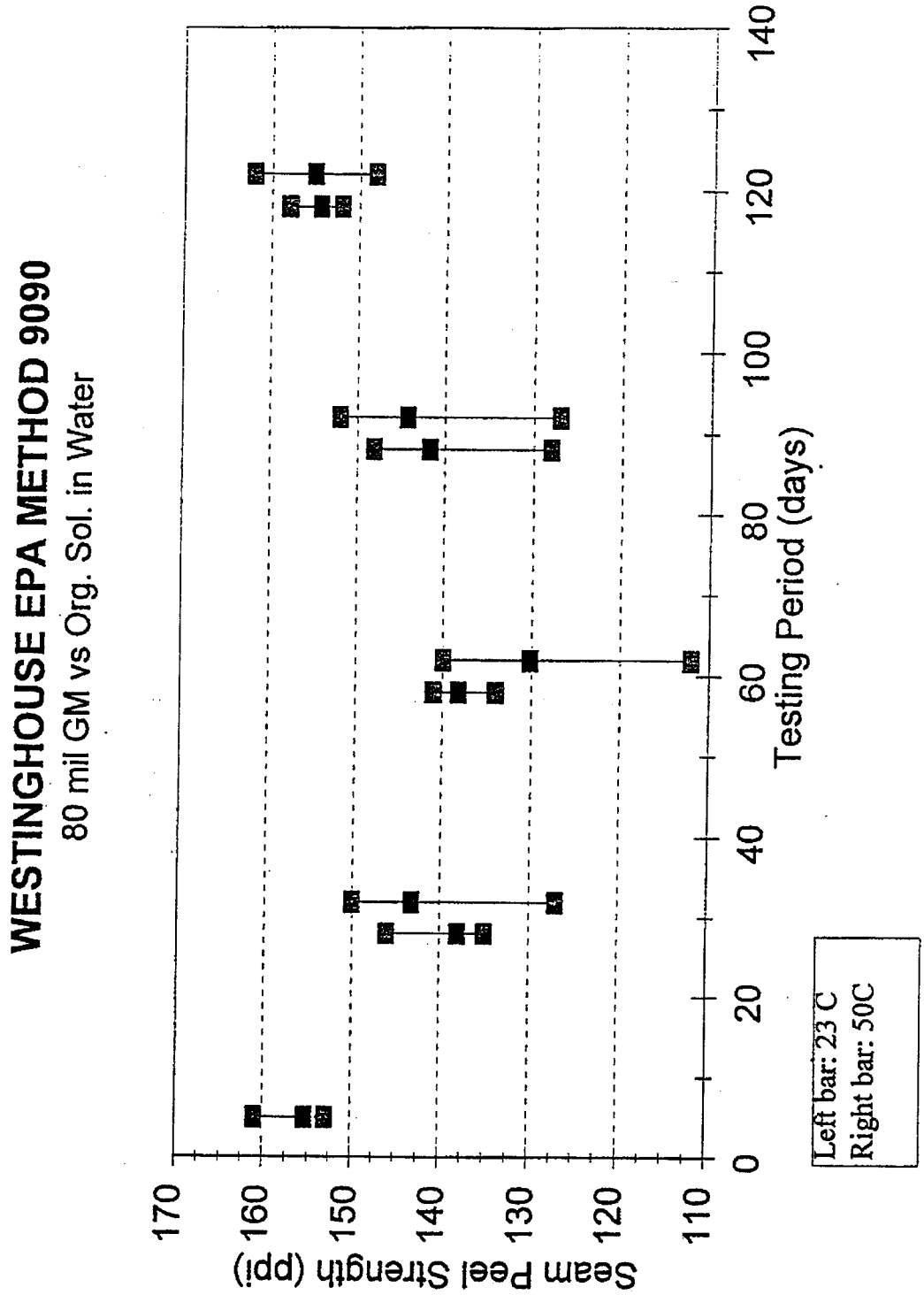

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Org. Sol in Water
Elongation @ break (%)
1100
1000
900
800
700
600
500
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

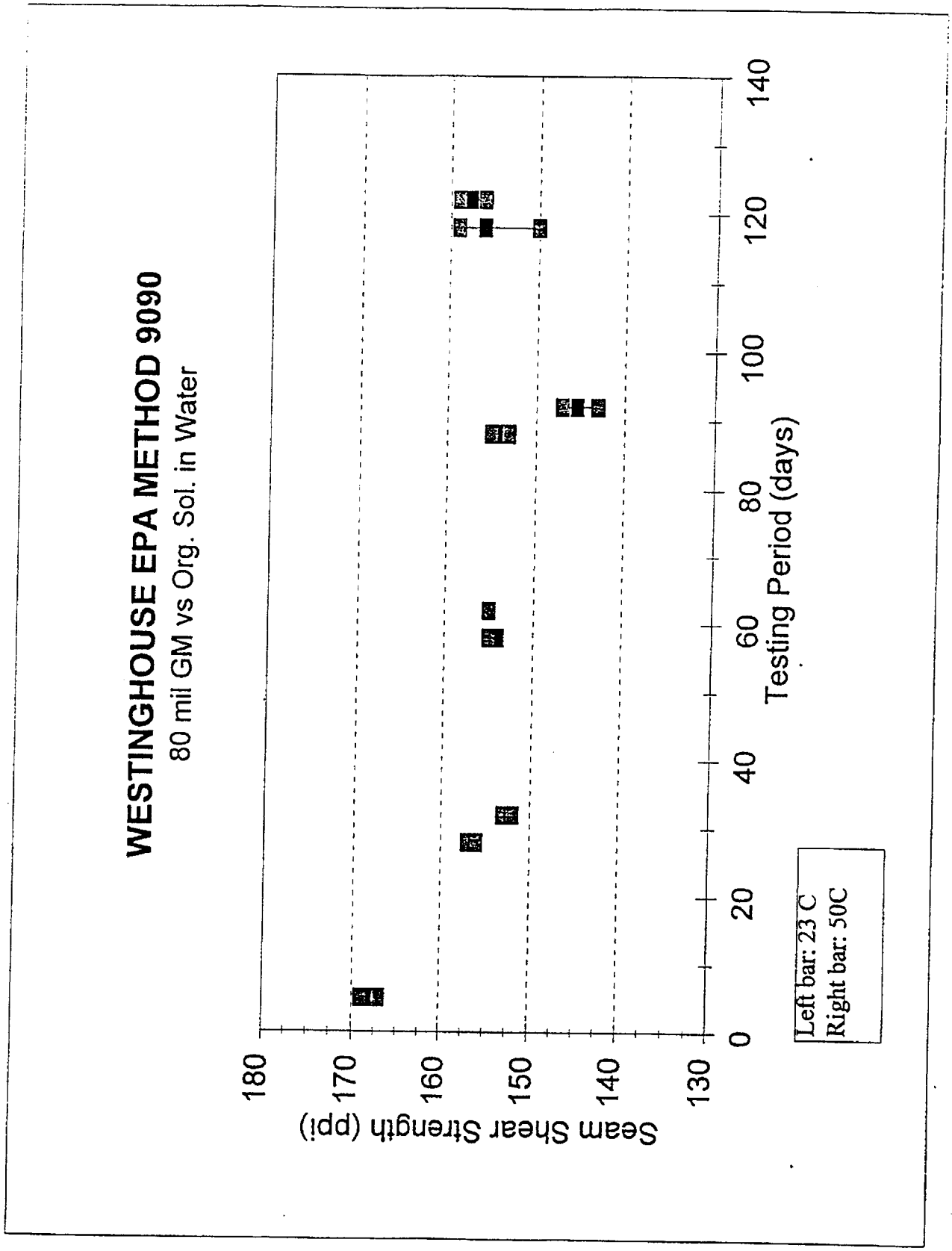

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Org. Sol. in Water
Modulus of Elasticity (psi)
26000
24000
22000
20000
18000
16000
14000
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

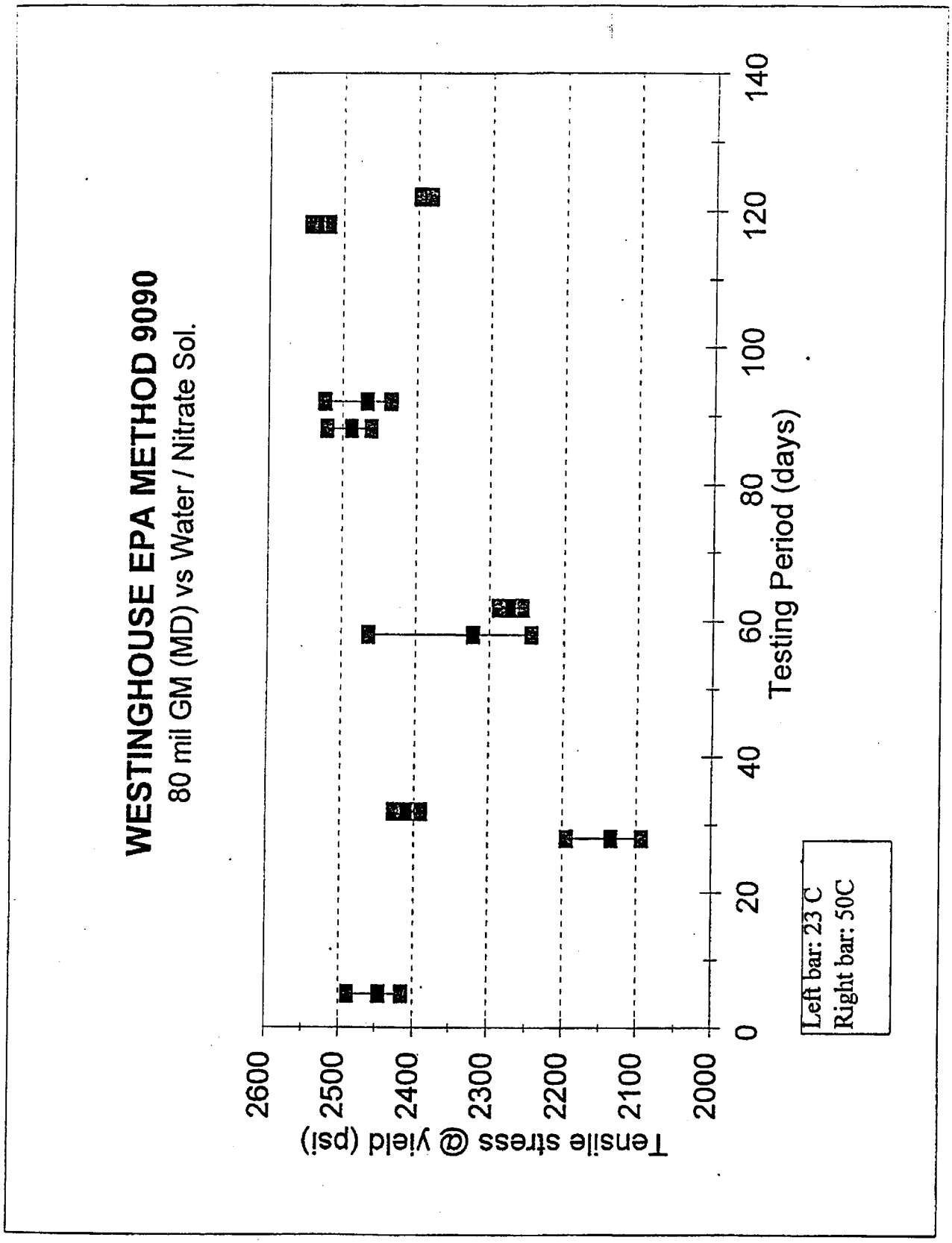

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Org. Sol. in Water
Tear Resistance (lbs)
80
70
60
50
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

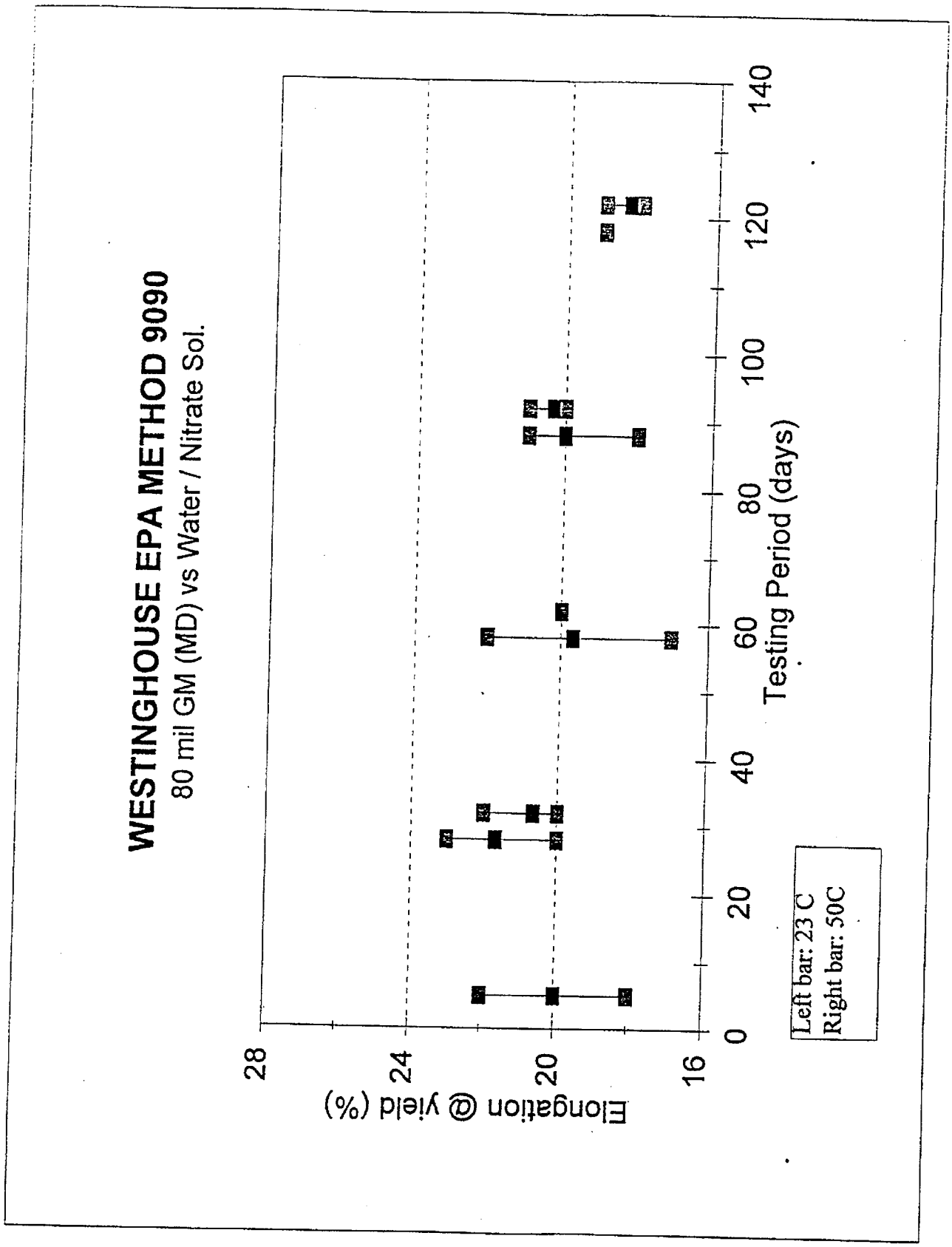

WESTINGHOUSE EPA METHOD 9090
80 mil GM vs Org. Sol. in Water
Puncture Resistance (lbs)
150
140
130
120
110
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

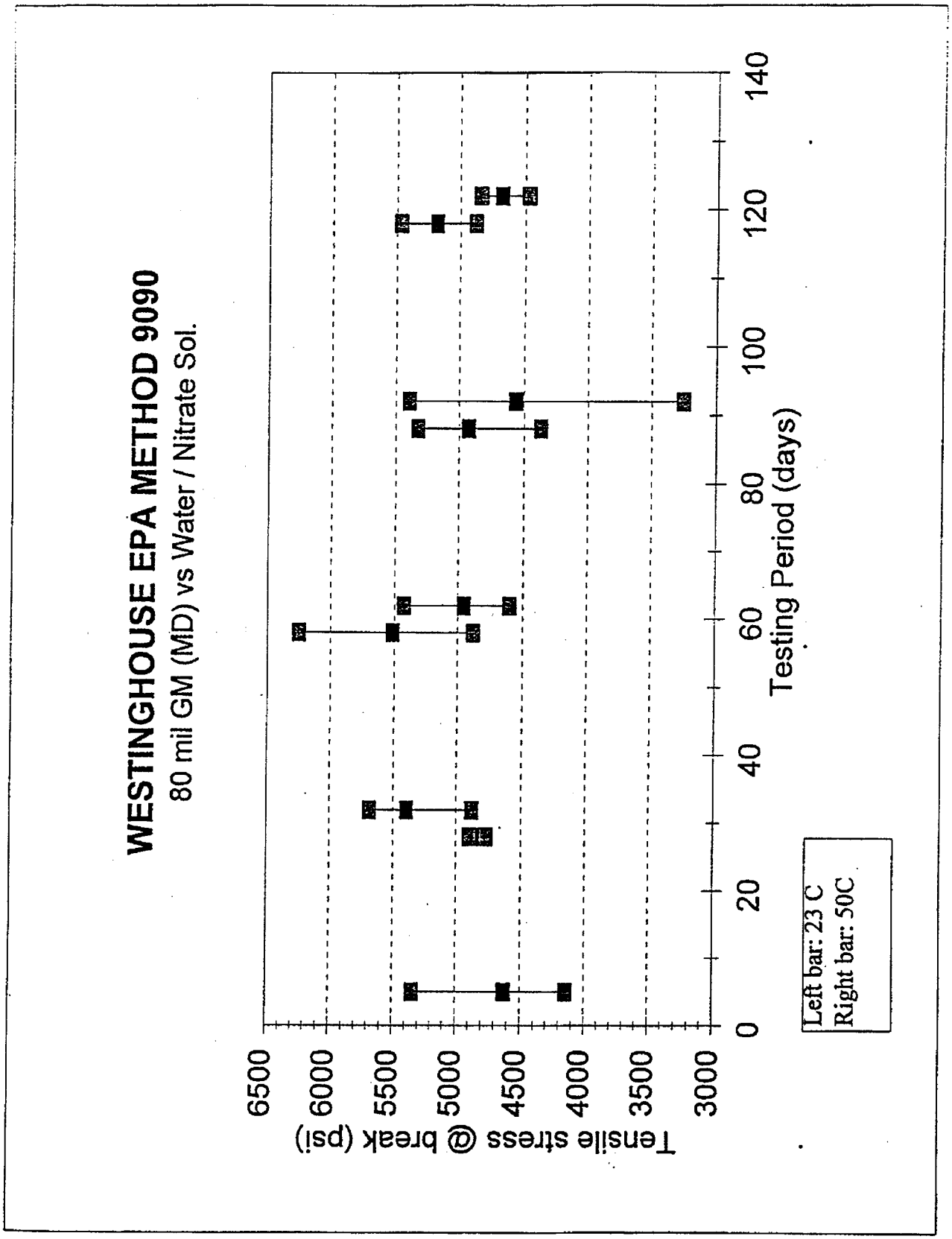

WESTINGHOUSE EPA METHOD 9090
80 mil GM vs Org. Sol. in Water
Hydrostatic Resistance (psi)
630
620
610
600
590
580
570
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

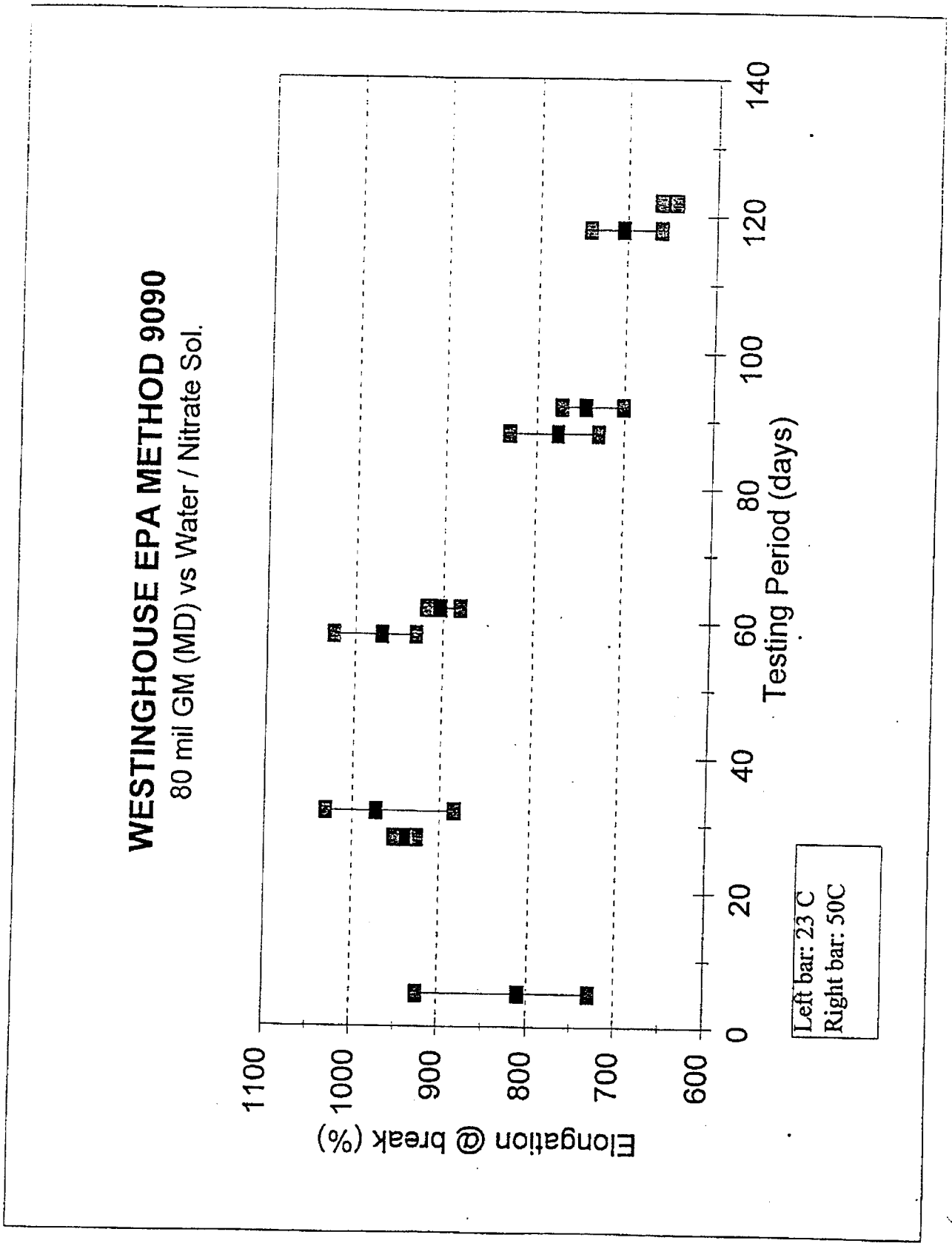

WESTINGHOUSE EPA METHOD 9090
80 mil GM vs Org. Sol. in Water
Seam Peel Strength (ppi)
170
160
150
140
130
120
110
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

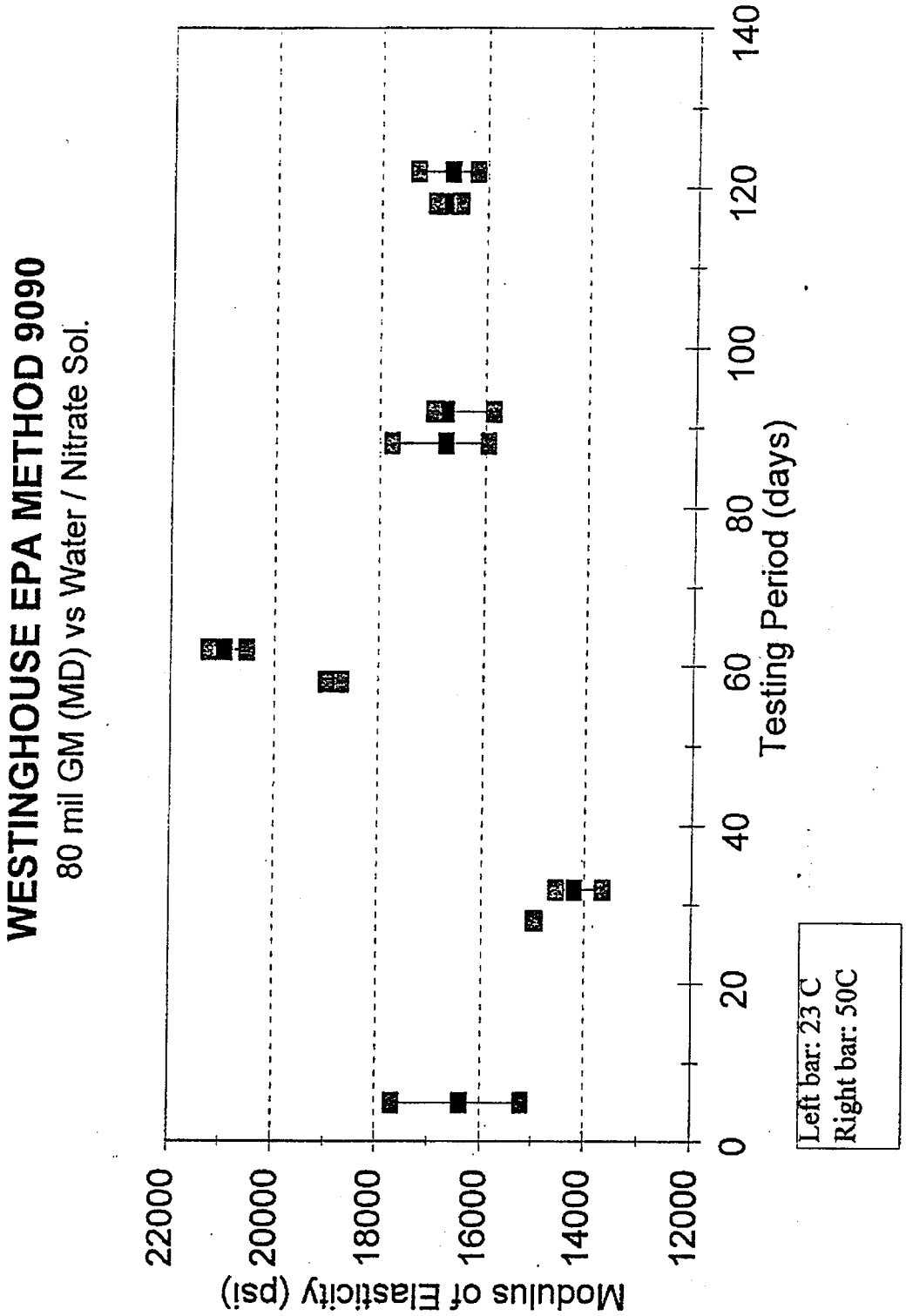

WESTINGHOUSE EPA METHOD 9090
80 mil GM vs Org. Sol. in Water
Seam Shear Strength (ppi)
180
170
160
150
140
130
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

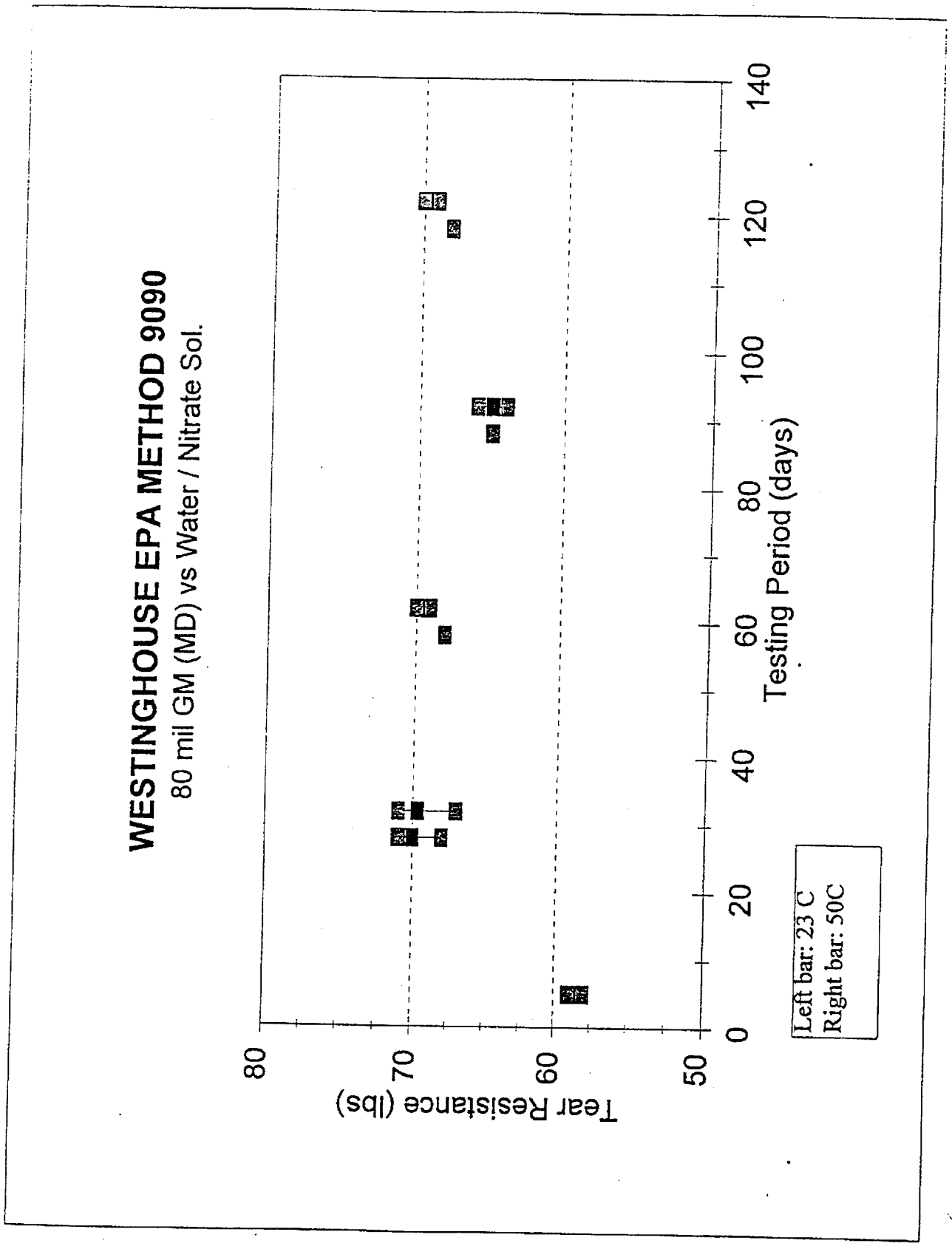

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Water / Nitrate Sol.
Tensile stress @ yield (psi)
2600
2500
2400
2300
2200
2100
2000
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

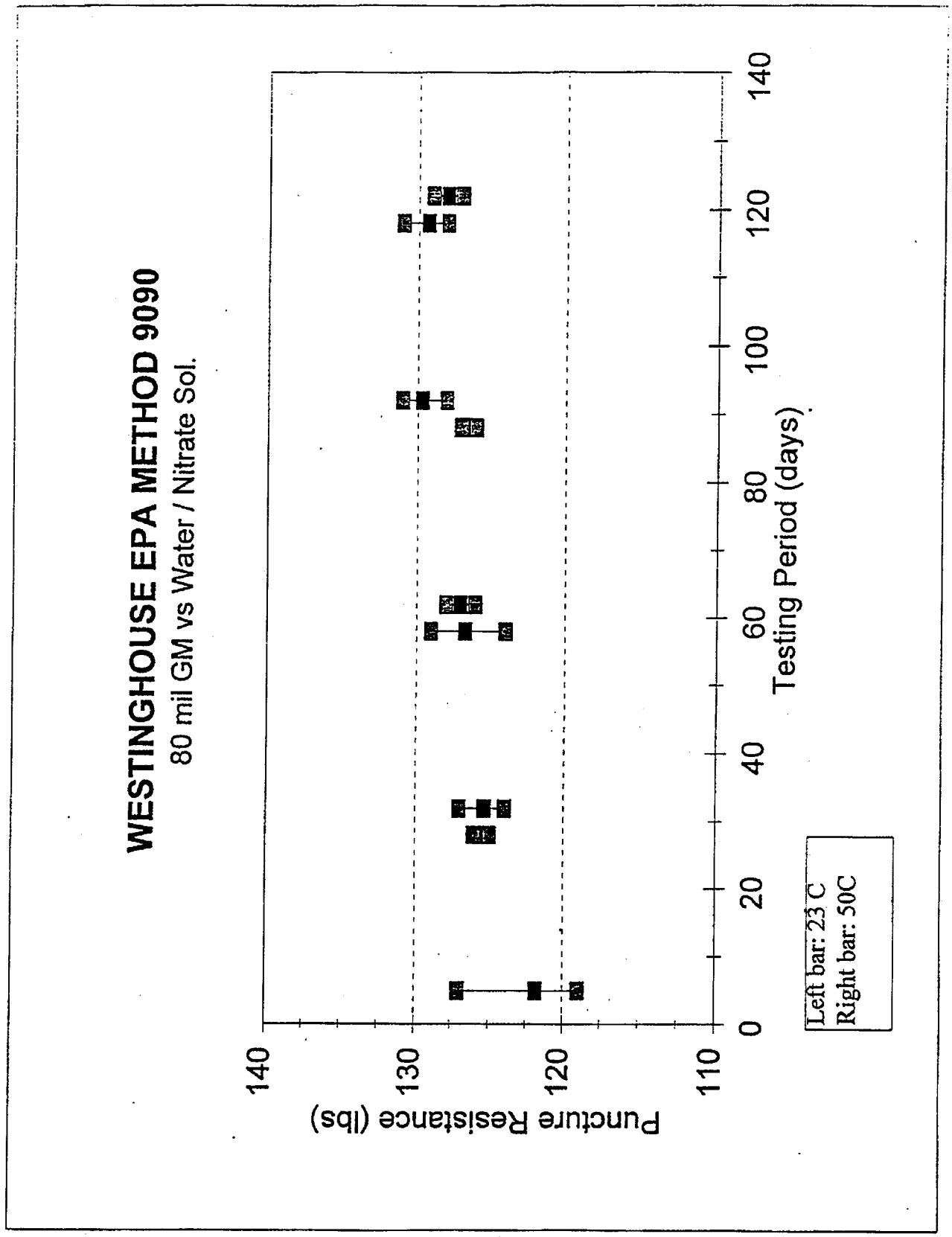

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Water / Nitrate Sol.
Elongation @ yield (%)
28
24
20
16
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

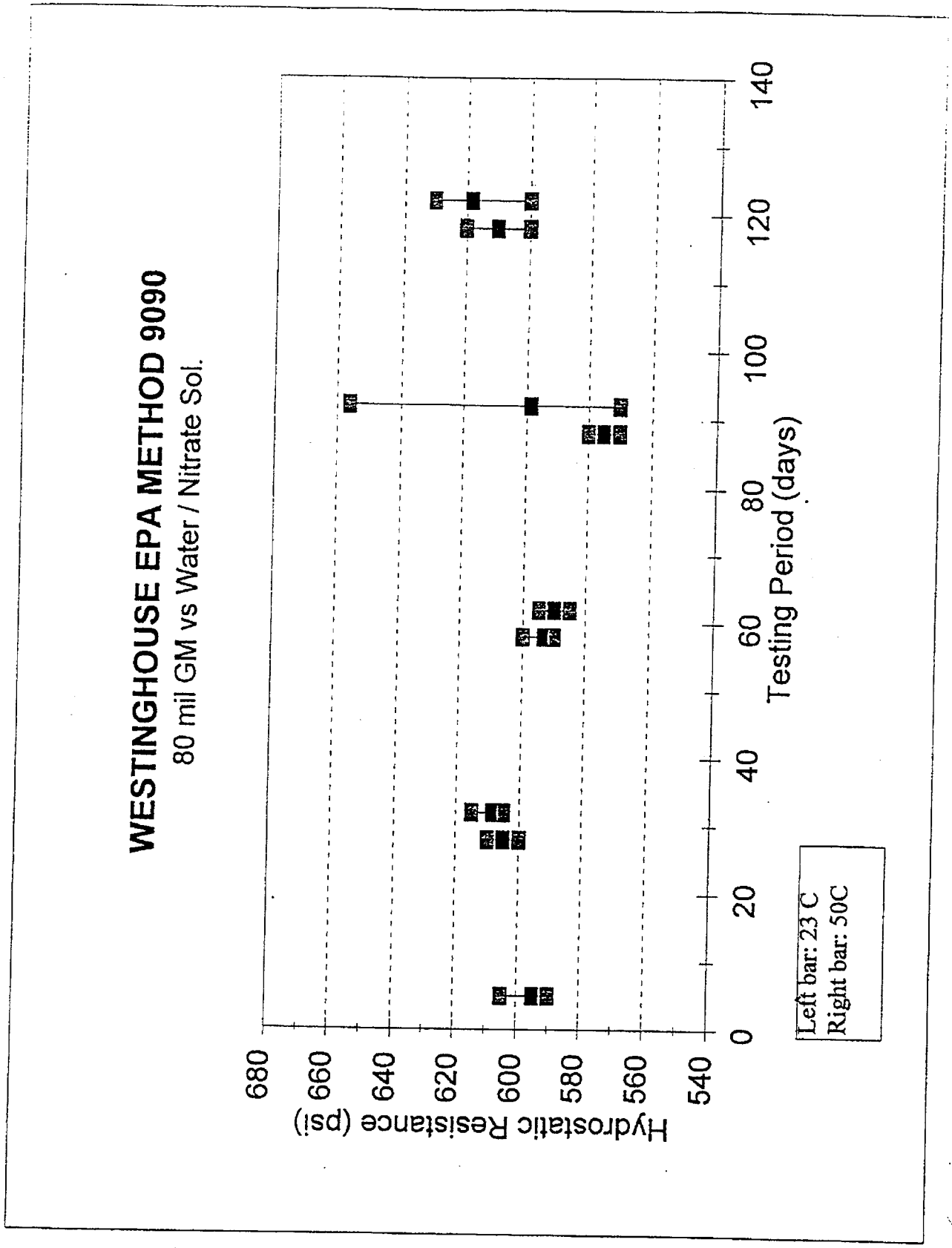

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Water / Nitrate Sol.
Tensile stress @ break (psi)
6500
6000
5500
5000
4500
4000
3500
3000
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

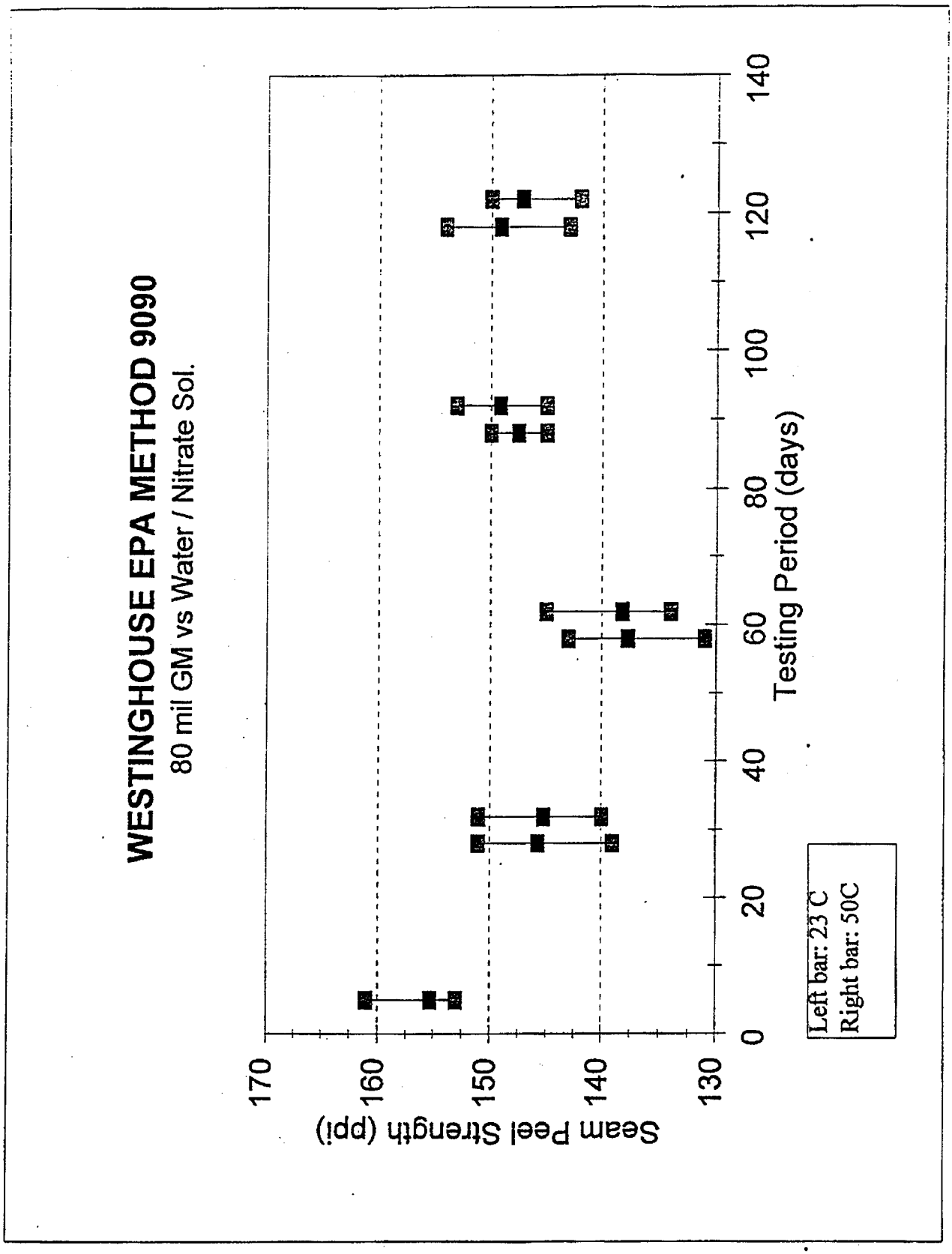

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Water / Nitrate Sol.
Elongation @ break (%)
1100
1000
900
800
700
600
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

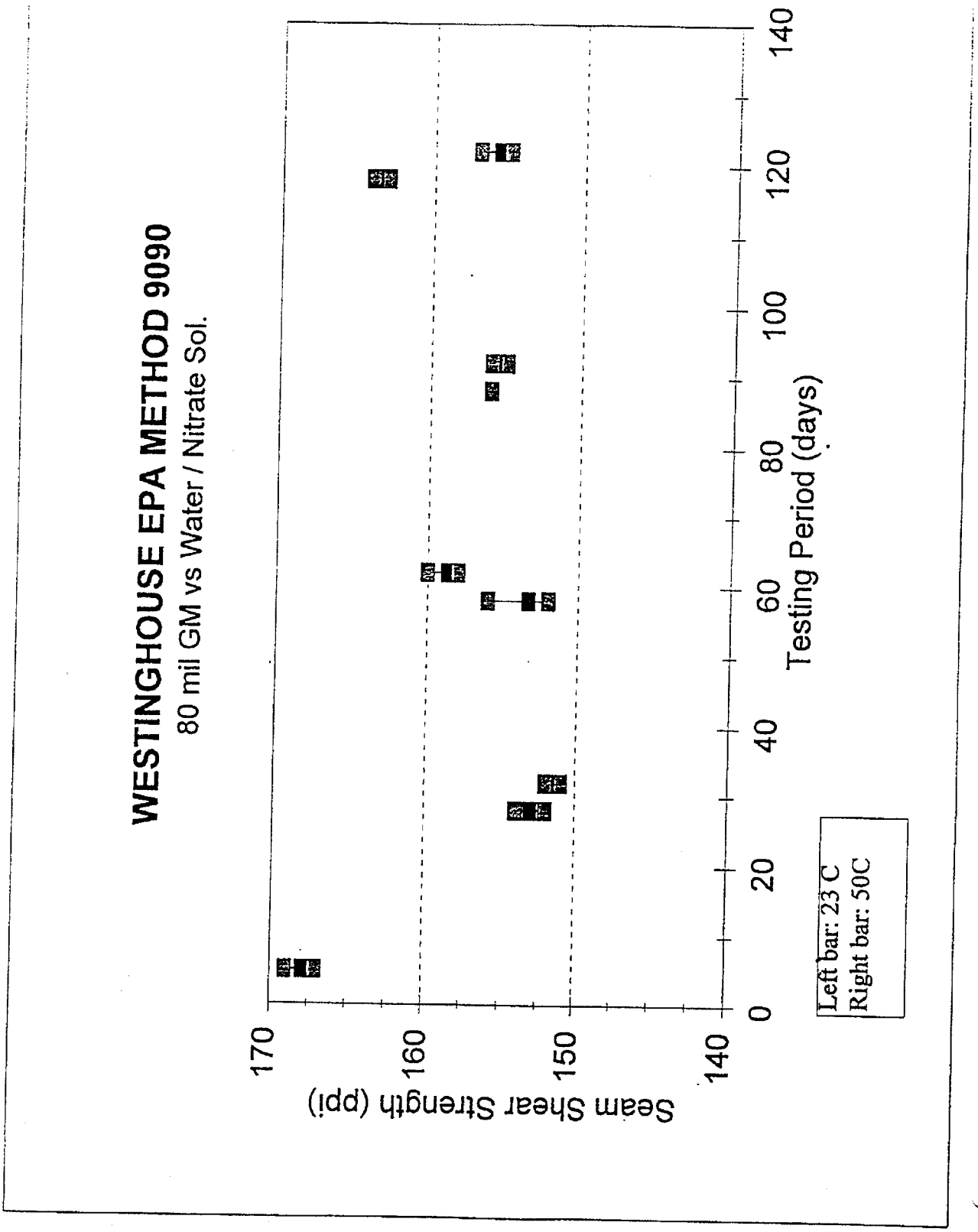

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Water / Nitrate Sol.
Modulus of Elasticity (psi)
22000
20000
18000
16000
14000
12000
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

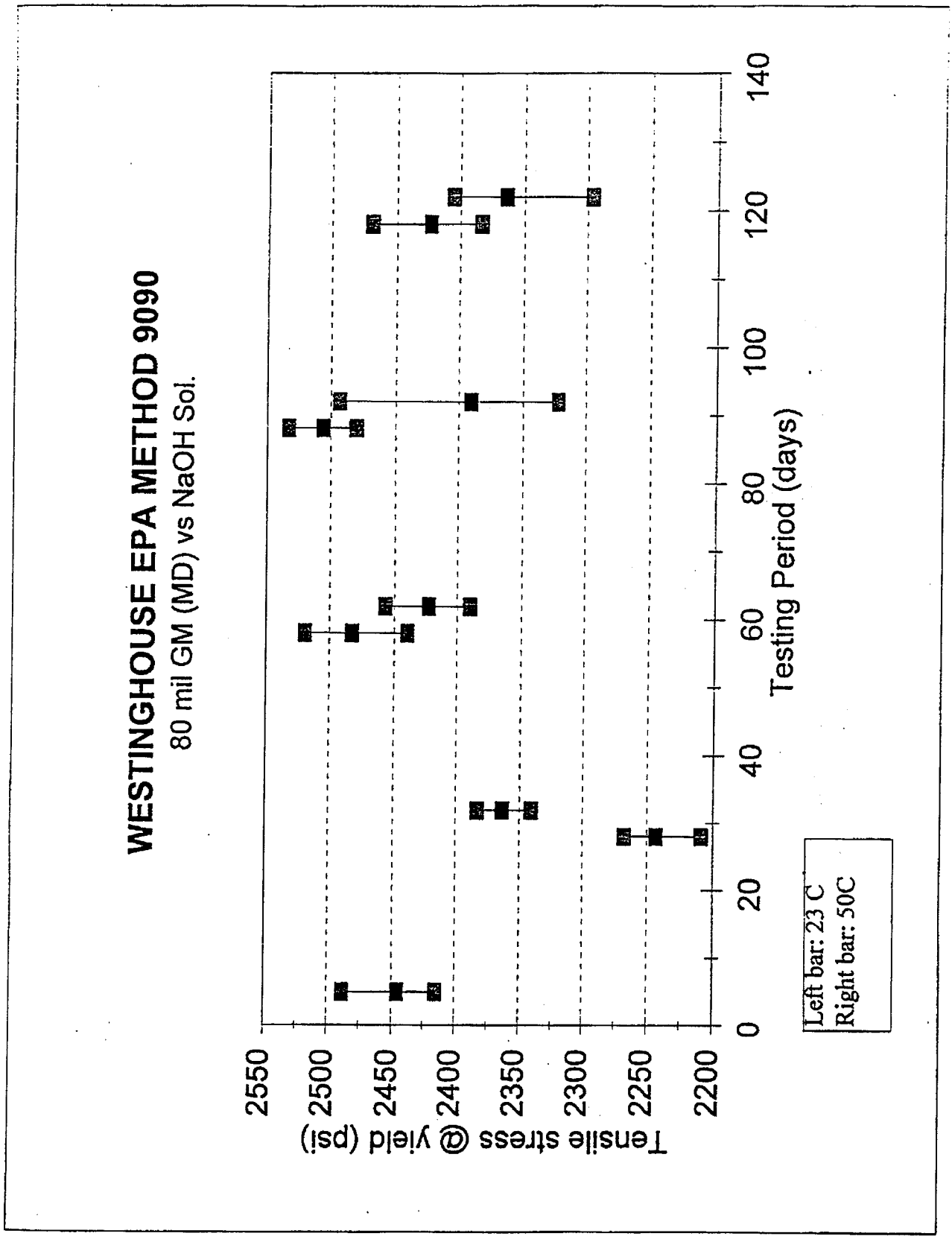

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs Water / Nitrate Sol.
Tear Resistance (lbs)
80
70
60
50
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

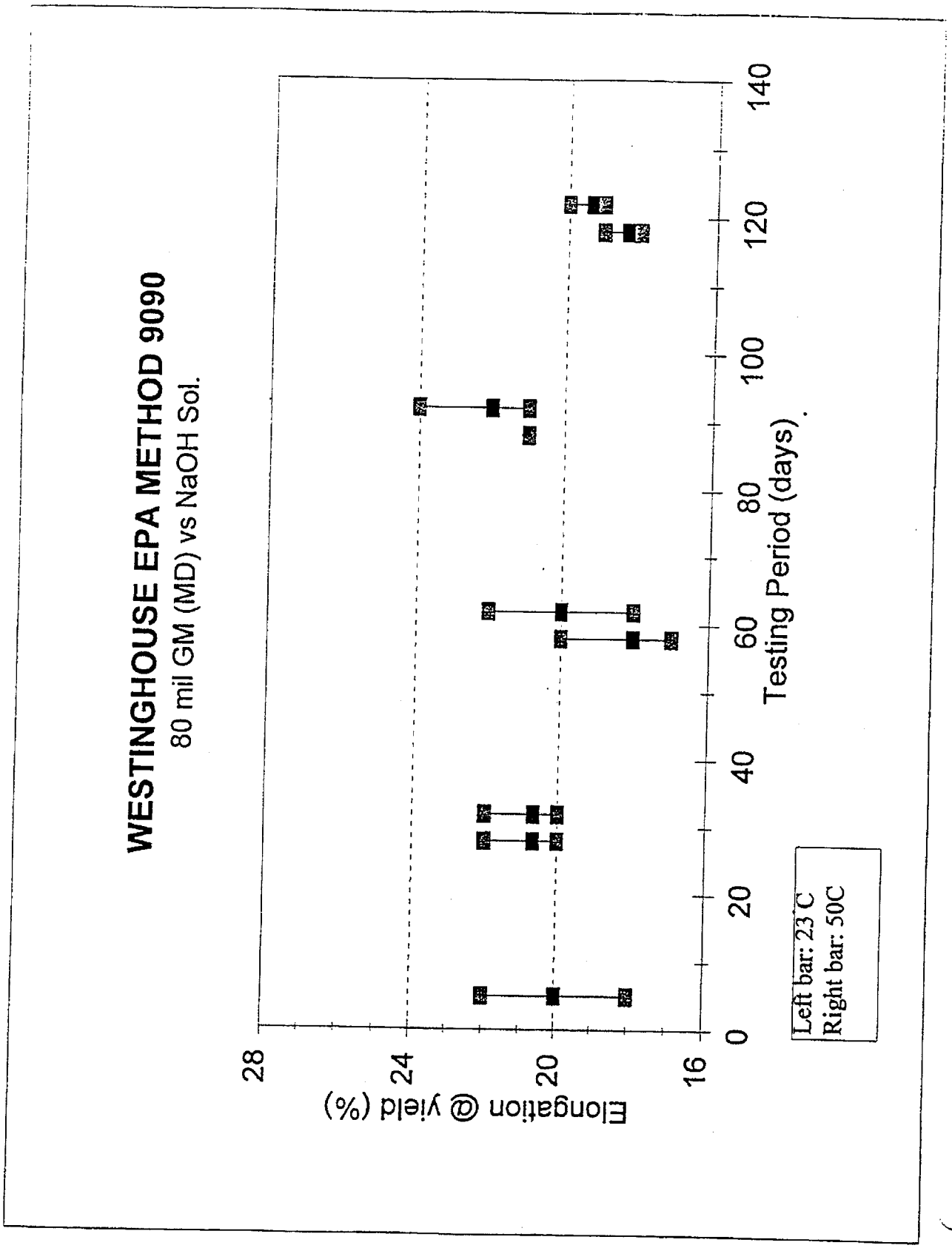

WESTINGHOUSE EPA METHOD 9090
80 mil GM vs Water / Nitrate Sol.
Puncture Resistance (lbs)
140
130
120
110
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

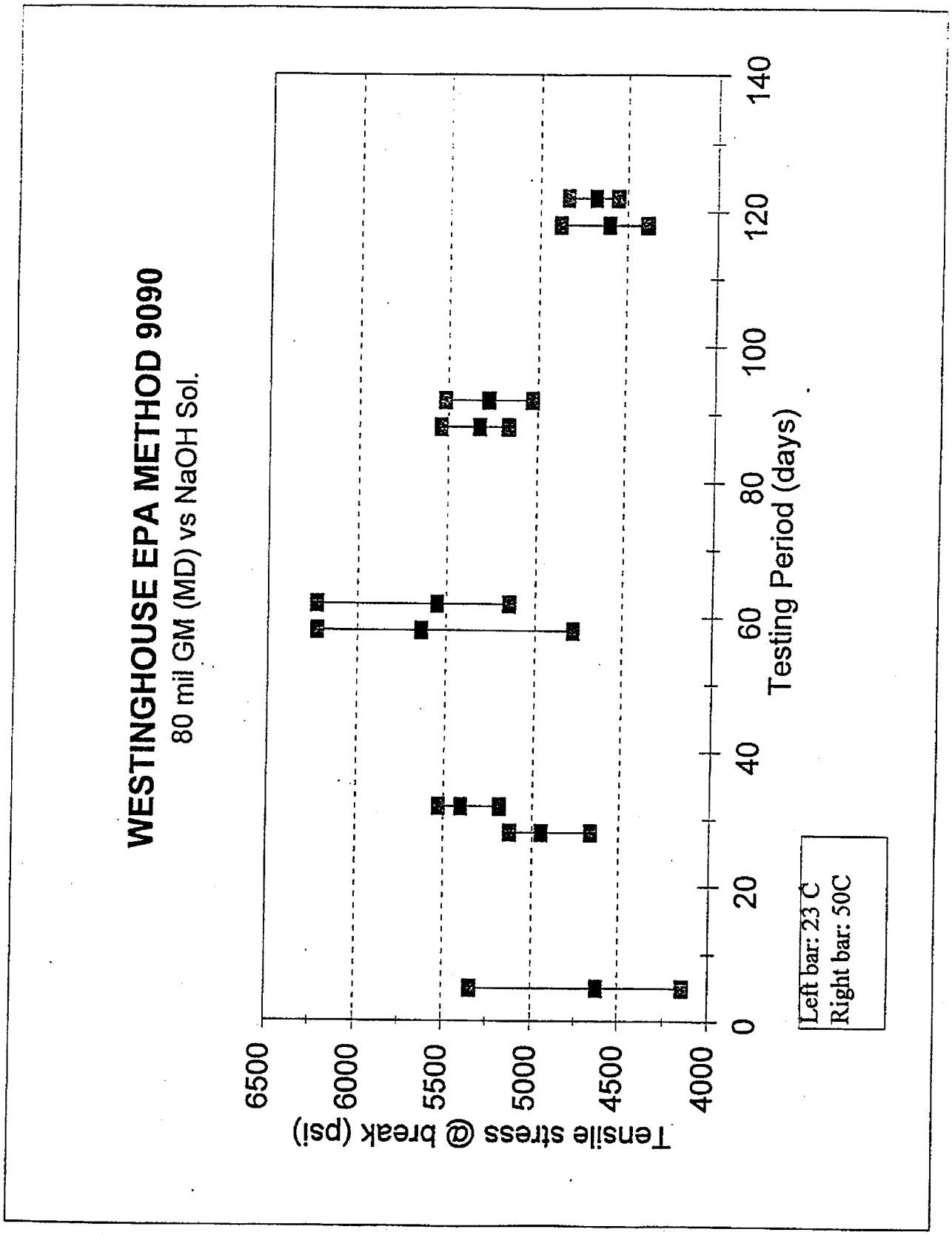

WESTINGHOUSE EPA METHOD 9090
80 mil GM vs Water / Nitrate Sol.
Hydrostatic Resistance (psi)
680
660
640
620
600
580
560
540
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

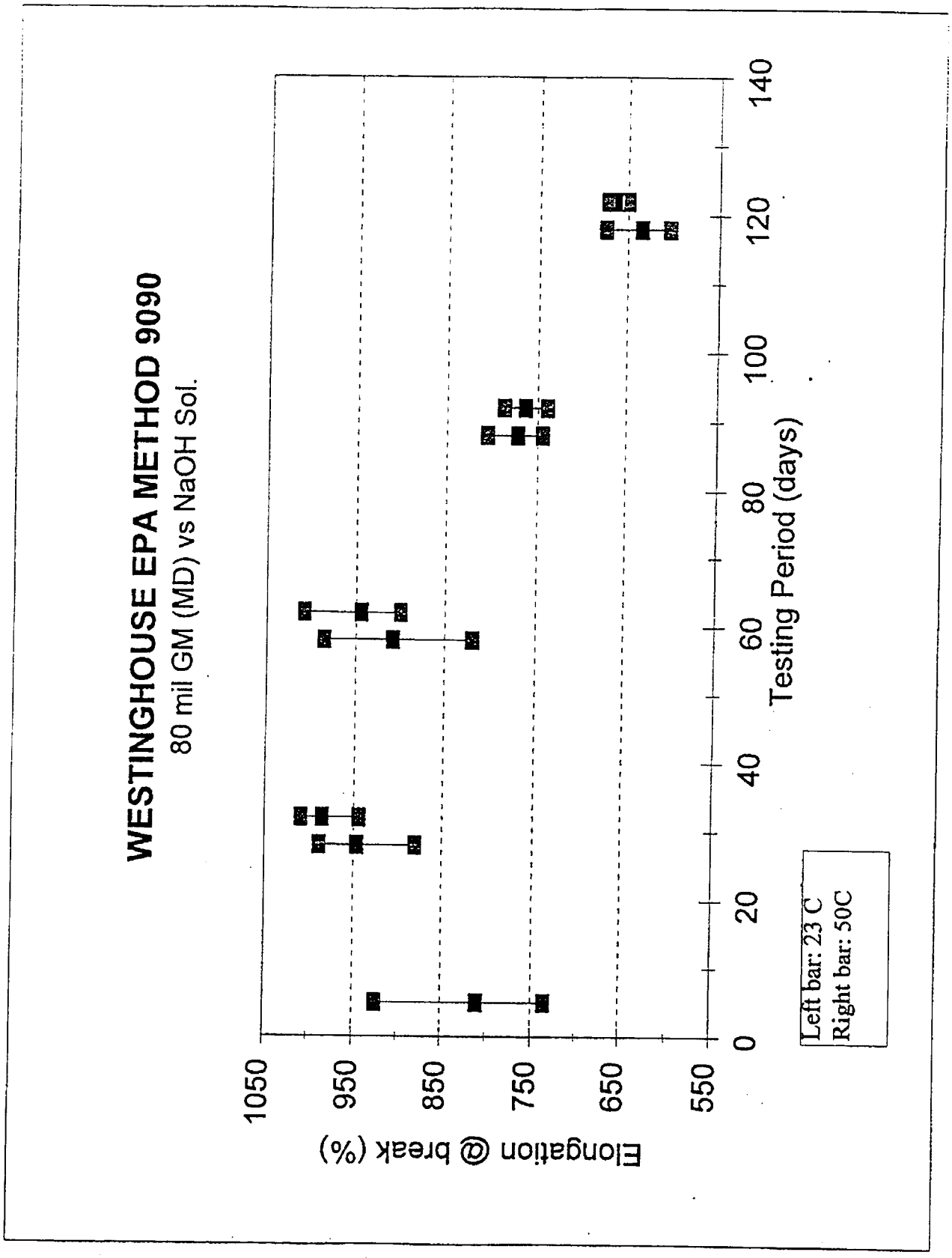

WESTINGHOUSE EPA METHOD 9090
80 mil GM vs Water / Nitrate Sol.
Seam Peel Strength (ppi)
170
160
150
140
130
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

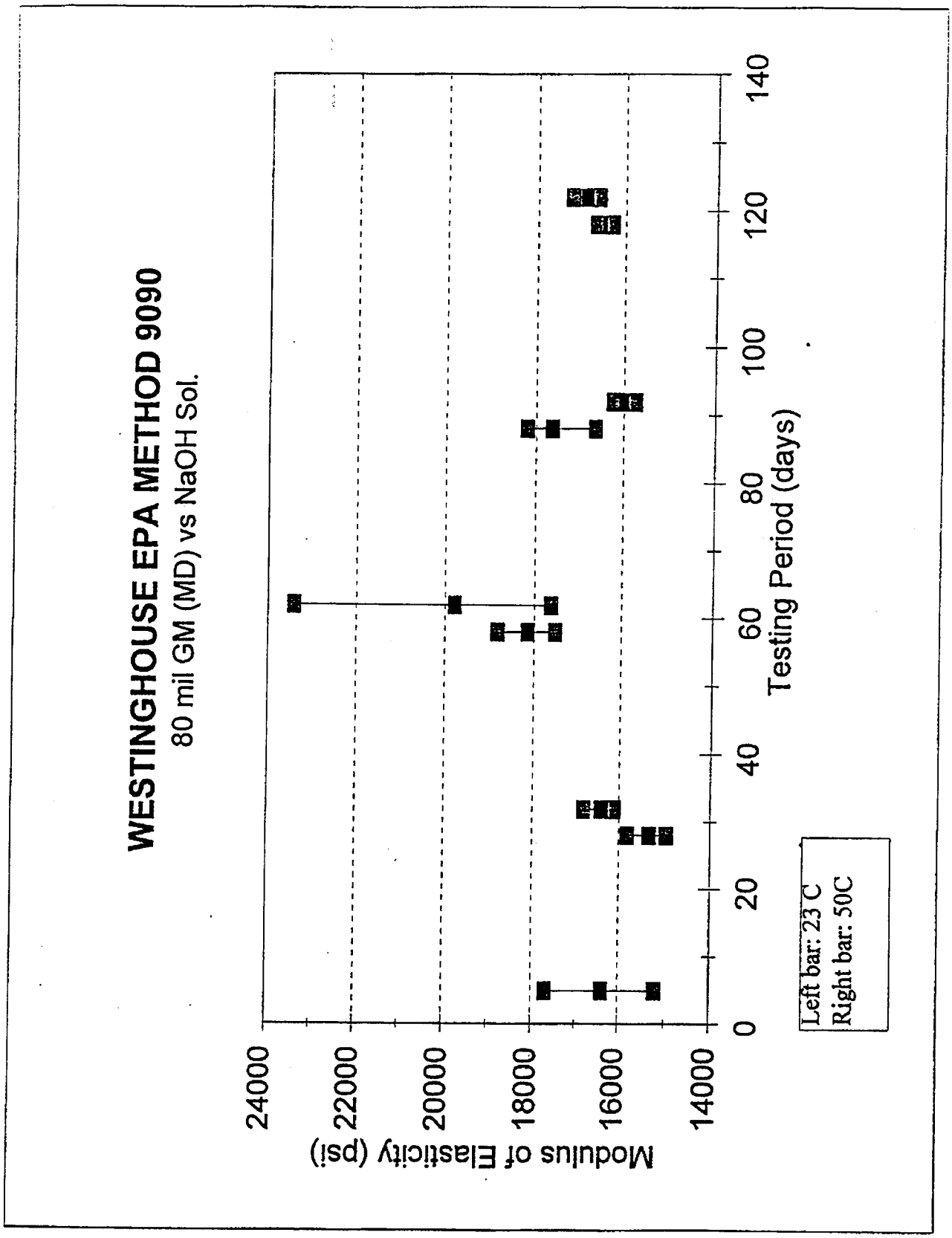

WESTINGHOUSE EPA METHOD 9090
80 mil GM vs Water / Nitrate Sol.
Seam Shear Strength (ppi)
170
160
150
140
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

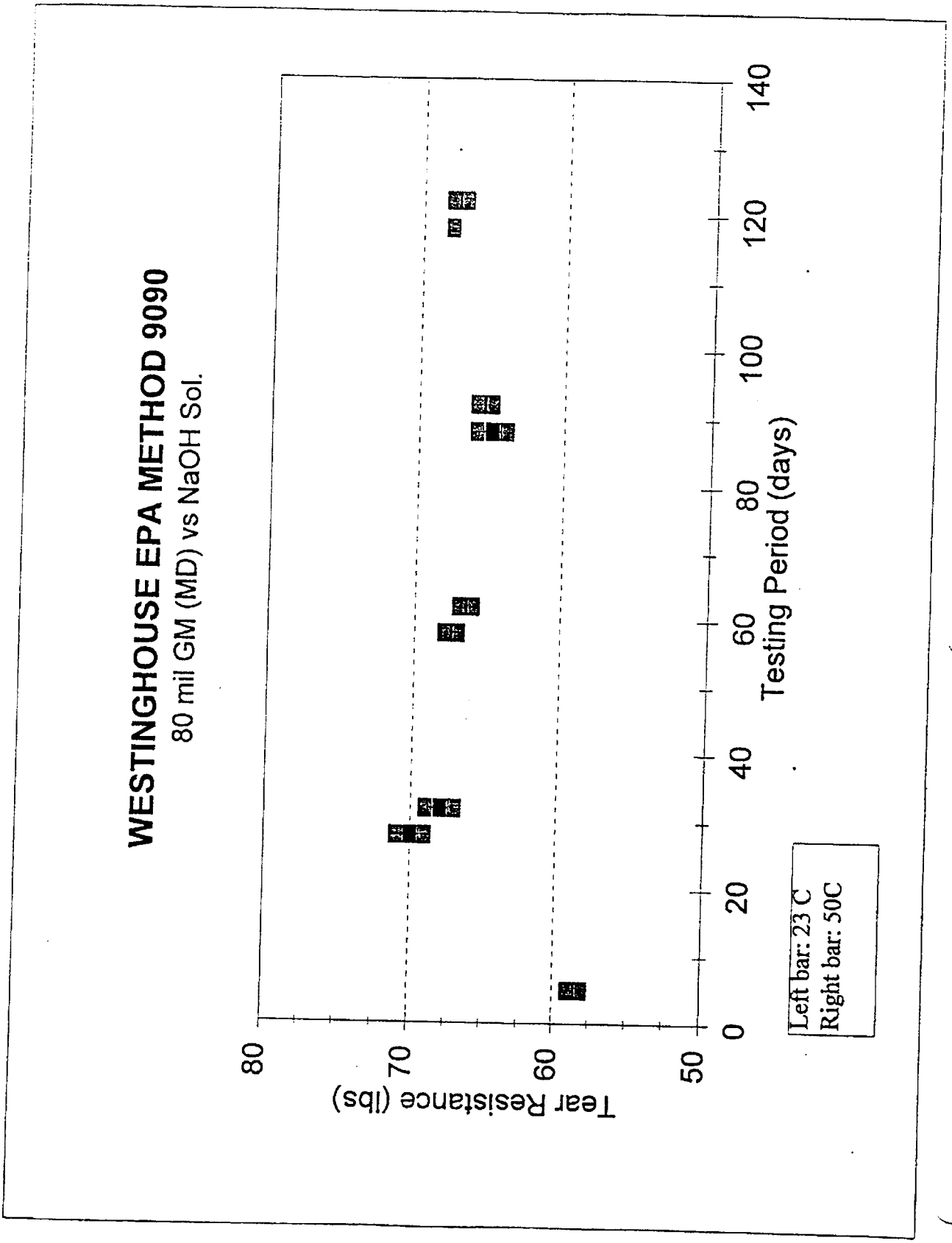

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs NaOH Sol.
Tensile stress @ yield (psi)
2550
2500
2450
2400
2350
2300
2250
2200
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

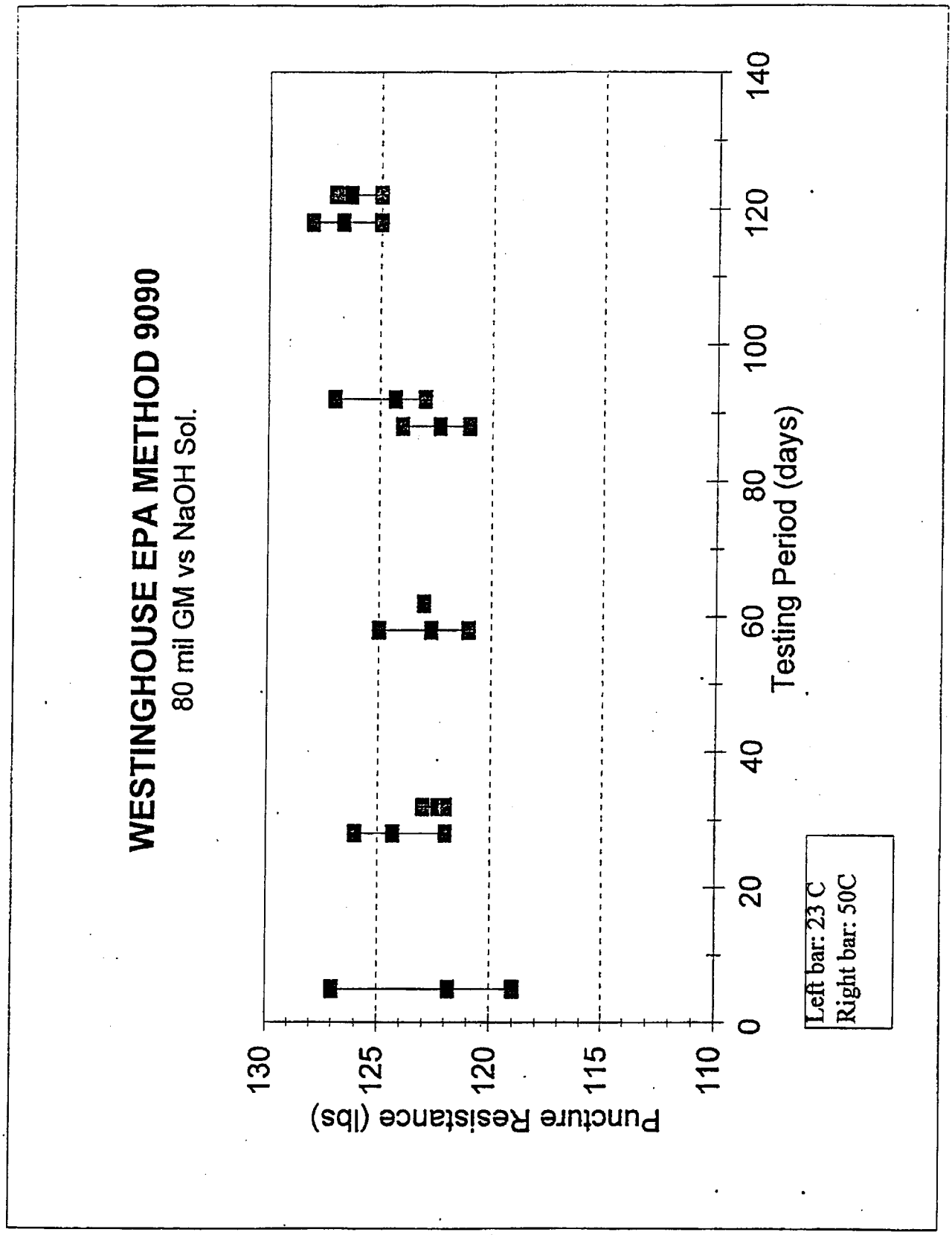

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs NaOH Sol.
Elongation @ yield (%)
28
24
20
16
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

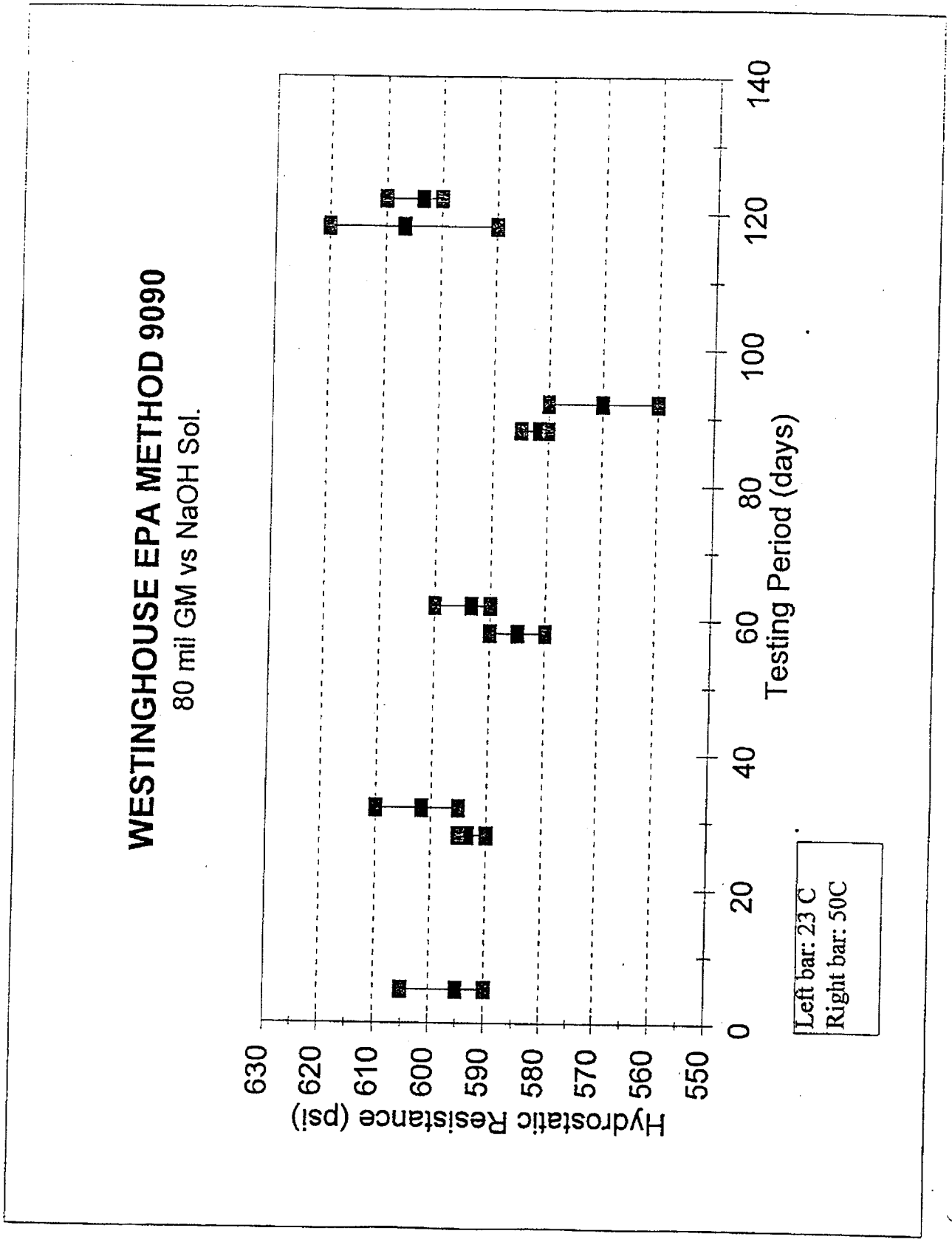

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs NaOH Sol.
Tensile stress @ break (psi)
6500
6000
5500
5000
4500
4000
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

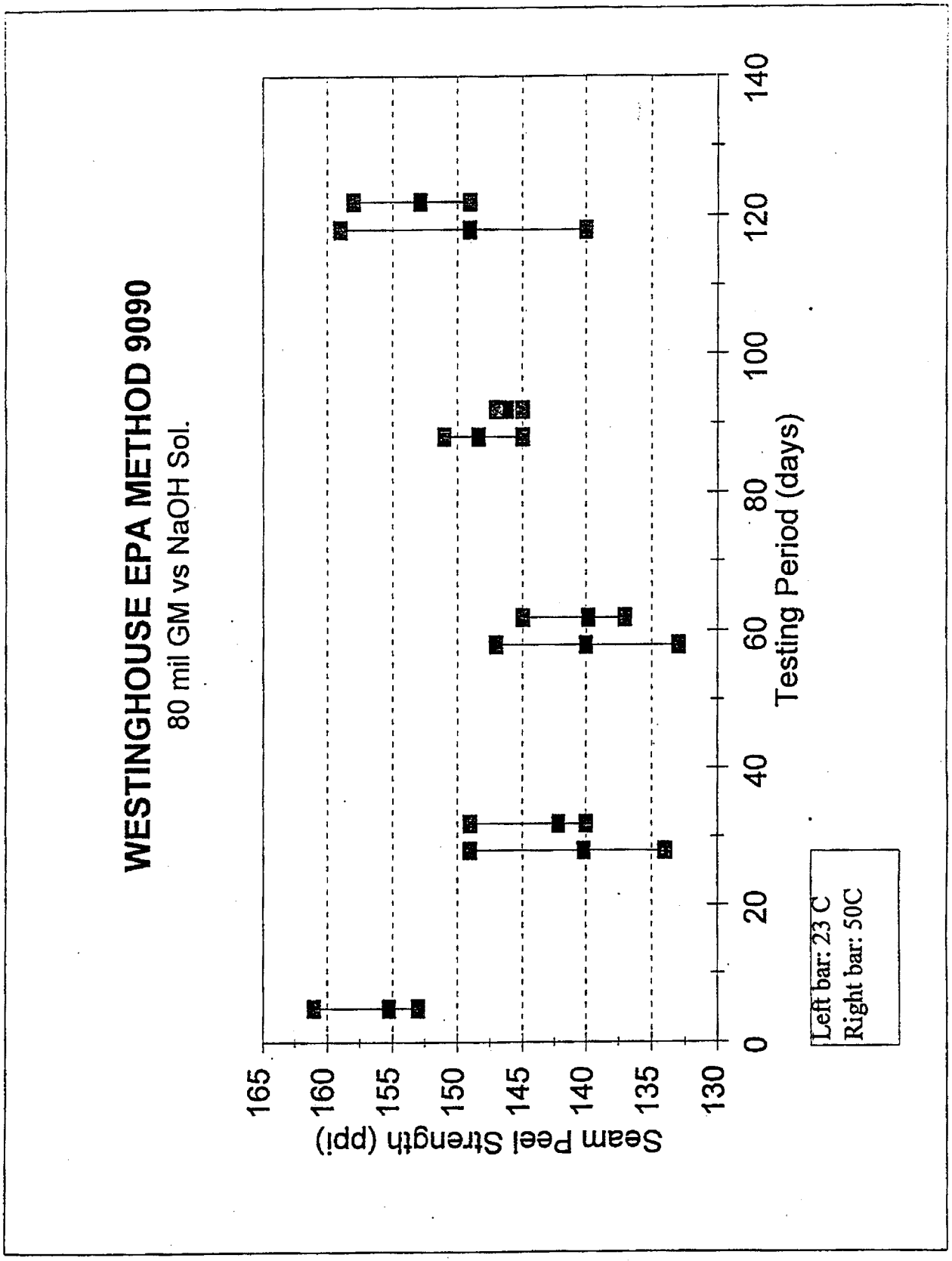

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs NaOH Sol.
Elongation @ break (%)
1050
950
850
750
650
550
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

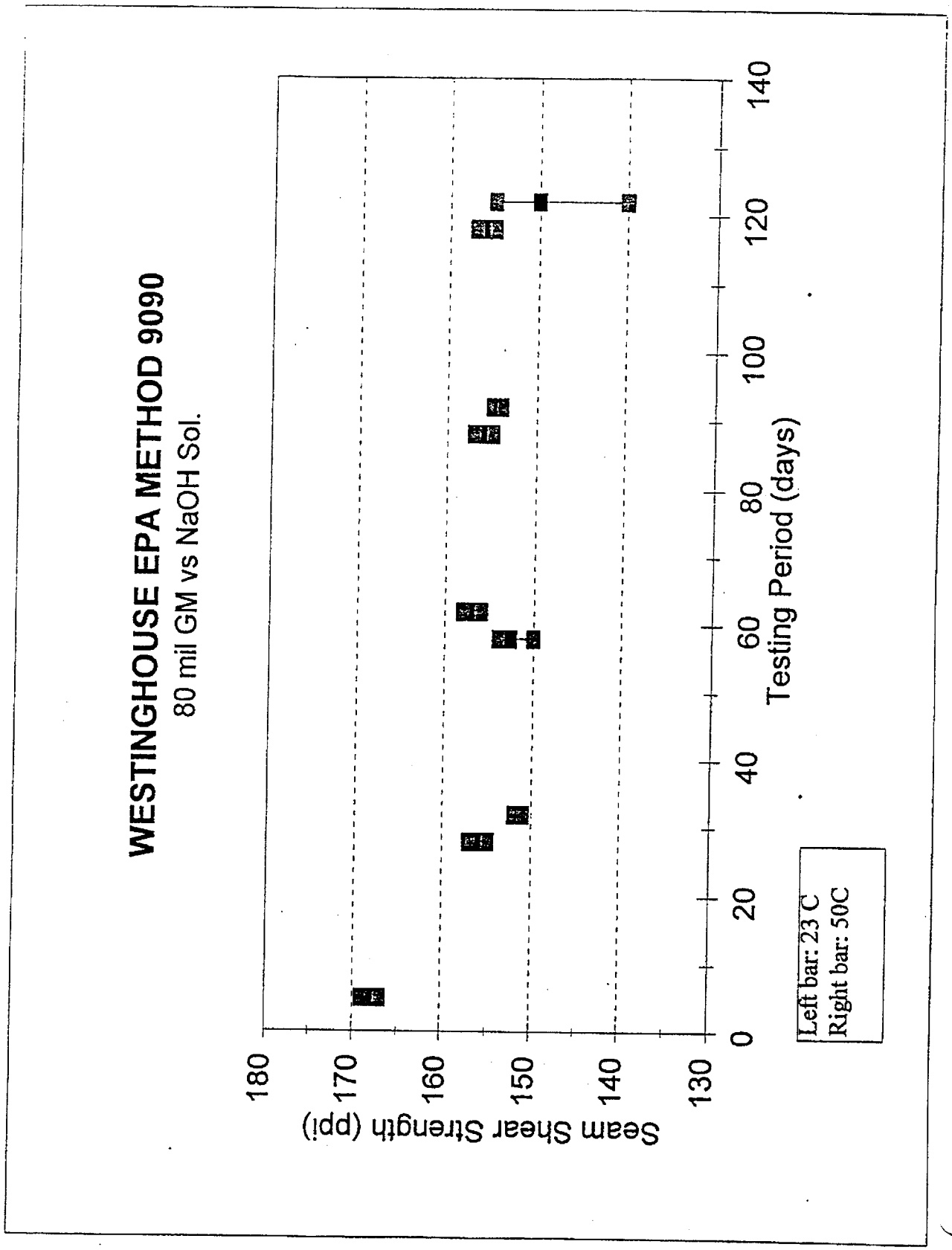

WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs NaOH Sol.
Modulus of Elasticity (psi)
24000
22000
20000
18000
16000
14000
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C


WESTINGHOUSE EPA METHOD 9090
80 mil GM (MD) vs NaOH Sol.
Tear Resistance (lbs)
80
70
60
50
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C


WESTINGHOUSE EPA METHOD 9090
80 mil GM vs NaOH Sol.
Puncture Resistance (lbs)
130
125
120
115
110
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C


WESTINGHOUSE EPA METHOD 9090
80 mil GM vs NaOH Sol.
Hydrostatic Resistance (psi)
630
620
610
600
590
580
570
560
550
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C


WESTINGHOUSE EPA METHOD 9090
80 mil GM vs NaOH Sol.
Seam Peel Strength (ppi)
165
160
155
150
145
140
135
130
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C


WESTINGHOUSE EPA METHOD 9090
80 mil GM vs NaOH Sol.
Seam Shear Strength (ppi)
180
170
160
150
140
130
0
20
40
60
80
100
120
140
Testing Period (days)
Left bar: 23 C
Right bar: 50C

D196010899

0042779

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

JAN 11 1996

96-SWT-020

Mr. Moses N. Jaraysi
200 Area Unit Supervisor
Nuclear Waste Program
State of Washington
Department of Ecology
1315 West Fourth Avenue
Kennewick, Washington 99336

Mr. Joseph J. Witczak
Unit Supervisor
Regulatory and Technical Support
State of Washington
P.O. Box 47600
Olympia, Washington 98504-7600

JAN 1996
RECEIVED
EDMC

Dear Messrs. Jaraysi and Witczak:

STRATEGY LETTER FOR THE DISPOSAL OF MIXED WASTE IN THE LOW-LEVEL BURIAL GROUNDS (LLBG)

A letter from Mr. N. T. Hepner, State of Washington Department of Ecology (Ecology), to Mr. C. E. Clark, U.S. Department of Energy, Richland Operations Office (RL), "Five Remaining LLBG Notices of Deficiency," dated June 1, 1995, requested that RL develop a disposal strategy for mixed waste disposal in unlined trenches of the LLBG. This disposal strategy supersedes a previous disposal strategy letter from Mr. R. D. Izatt, RL, and Mr. R. E. Lerch, Westinghouse Hanford Company (WHC), to Mr. R. S. Stanley, Ecology, and Mr. J. O'Hara, U.S. Environmental Protection Agency, "Hanford Solid Radioactive Mixed Waste Storage Facility Strategy," dated January 26, 1988. 41360 6532

The LLBG are identified as a landfill, divided into eight burial grounds. Six burial grounds are located in the 200 West Area and two burial grounds are located in the 200 East Area. In 1988, the Hanford Facility had extremely limited Resource Conservation and Recovery Act (RCRA) storage or minimum technical standard (MTS) facilities for mixed waste disposal. The January 26, 1988, letter provided the Hanford Facility with operating flexibility to safely handle mixed waste. Today, the LLBGs include RCRA compliant double-lined trenches with leachate collection and removal systems that meet or exceed the Title 40, Code of Federal Regulations (CFR), Part 264 MTS, and unlined trenches of various sizes and depths for radioactive only waste. All mixed waste

JAN 11 1996

destined for disposal in lined trenches will meet land disposal restriction requirements in Title 40, CFR, Part 268. In short, the operation of lined and unlined trenches will be in compliance with 40 CFR and the Washington Administrative Code 173-303 regulations.

Should you have any questions regarding the LLBG disposal strategy, please contact R. F. Guercia, RL, on (509) 376-5494 or C. E. Clark, RL, on (509) 376-9333.

Sincerely,

Thomas K. Teynor

Thomas K. Teynor, Director
Waste Programs Division

WPD:AKC

cc: R. Bowman, WHC
D. Duncan, EPA
W. Hamilton, Jr., WHC
N. Hepner, Ecology
M. Jaraysi, Ecology
D. Lundstrom, Ecology
R. Pierce, WHC
S. Price, WHC
Administrative Records, H6-08

4/3/96

Distribution:

L. D. Arnold	WHC	B2-35*
S. G. Arnold	WHC	T4-03*
B. M. Barnes	WHC	T3-04
R. C. Bowman	WHC	H6-24*
R. M. Carosino	RL	A4-52*
C. E. Clark	RL	A5-15
A. K. Crowell	RL	S7-55
N. P. Emerson	WHC	T4-03*
M. S. French	RL	S7-55*
R. J. Giroir	WHC	T4-05*
R. F. Guercia	RL	S7-55*
P. L. Hapke	WHC	T4-05*
G. D. Hendricks	GSSC	B1-42*
N. T. Hepner	Ecology	B5-18
S. Leja	Ecology	B5-18*
D. R. Lucas	WHC	G3-15*
K. M. McDonald	WHC	T4-03*
A. C. McKarns	RL	A5-15
R. D. Pierce	WHC	T3-04*
D. B. Powell	WHC	T4-03*
D. A. Pratt	WHC	T4-03*
S. M. Price	WHC	H6-23*
D. G. Saueressig	WHC	H6-24
L. T. St. Georges	WHC	H6-20*
H. T. Tilden	PNL	P7-79
G. C. Triner	WHC	T3-28*
B. D. Williamson	WHC	B3-15
RCRA/File	WHC	H6-24

*cc:Mail

ADMINISTRATIVE RECORD: Low-Level Burial Grounds, D-2-9
[Care of EDMC, WHC (H6-08)]

Washington State Department of Ecology Nuclear and Mixed Waste Library,
P.O. Box 47600, Olympia, Washington 98504-7600

Environmental Protection Agency Region 10, Seattle, Washington 98101,
Mail Stop HW-070, Records Center

Please send comments on distribution list to Gloria Cummins, WHC (H6-24),
(509) 372-2484

LOW-LEVEL BURIAL GROUNDS
Project Managers Meeting/Notice of Deficiency Resolution Meeting
2440 Stevens Center Place, Room 1200
Richland, Washington

April 3, 1996
7:30 a.m. - 11:00 a.m.

The undersigned indicate by their signatures that these meeting minutes reflect the actual occurrences of the above Project Managers Meeting/Notice of Deficiency Resolution Meeting.

Date: 10/23/96
Clifford E. Clark, Unit Manager, RL
(Represented by Anthony C. McKarns, DOE-RL)

Date: 10/22/96
Norman T. Hepner, Unit Manager, Washington State Department of Ecology

---

Low-Level Burial Grounds, WHC Concurrence

Brett M. Barnes Date: 8/14/96
Richard D. Pierce, Contractor Representative, WHC
(Represented by Brett M. Barnes, WHC)

Purpose: Discuss permitting process and Notice of Deficiency issues.

Meeting Minutes are attached. The minutes are comprised of the following:
Attachment 1 - Agenda
Attachment 2 - Summary of Discussion and Commitments/Agreements
Attachment 3 - Attendance List
Attachment 4 - Action Items

Attachment 1

LOW-LEVEL BURIAL GROUNDS
Project Managers Meeting/Notice of Deficiency Resolution Meeting
2440 Stevens Center Place, Room 1200
Richland, Washington

April 3, 1996
7:30 a.m. - 11:00 a.m.

AGENDA

1. **PREVIOUS MEETING MINUTES**

   - February 8, 1996 Meeting Minutes

2. **PROGRAM STATUS**

   - Pump and Treat Status (R. Mercer - WHC)

3. **PERMIT APPLICATION STATUS**

   - Part B NOD Workshop Schedule (G. Cummins - WHC)

4. **RCRA TOPICS**

   - NOD Five Remaining Issues Response Letter
   - NOI Status
   - Part A Rev. 8 Status
   - TSCA Application
   - LBL Issue

5. **WORKING DRAFT-1 WORKSHOP**

   - Chapter 2 Actions Follow-up
   - Chapter 4 Actions Follow-up
   - Chapter 5 Begin Discussion

6. **GENERAL TOPICS**

   - Past Action Items

     - 11-1-95:1 Schedule a technical meeting to discuss Response Action Plan engineering technology (RL/WHC) was scheduled for for December needs to be rescheduled

     - 11-1-95:2 Provide a letter approving Response Action Plan (Ecology). Was scheduled for December, needs to be rescheduled

- 11-1-95:3 Provide Hanford Facility Permit General Information Volume Presentation to Ecology (RL/WHC)

- 11-1-95:4 (old NOD 11-1-95:2) Arrange for discussion on lead shielding at the RIPI Council (RL/WHC)

- New Action Items

7. **SCHEDULE NEXT MEETING**

- Tentative Date

- Proposed Topics

Attachment 2

LOW-LEVEL BURIAL GROUNDS
Project Managers Meeting/Notice of Deficiency Resolution Meeting
2440 Stevens Center Place, Room 1200
Richland, Washington

April 3, 1996
7:30 a.m. - 11:00 a.m.

Summary of Discussion and Commitments/Agreements

1. **Previous Meeting Minutes**

The January 16, 1996, and February 8, 1996, meeting minutes were approved.

2. **Program Status**

- Pump and Treat Status (R. Mercer - WHC)

Mr. R. Mercer (WHC) reported that pump and treat wells are still being installed; however, completion of the last of these wells is nearly completed. There are a total of 10, to 12 pump and treat wells installed. Pump and treat is scheduled to being in June of 1996. A pump and treat demonstration currently is being conducted. The pump and treat wells are producing approximately 150 gallons per minute. Starting this month, reporting will commence on the effects of pump and treat to the groundwater flow. Mr. N. Hepner (Ecology) asked any changes in technique with regards to pump and treat have occurred. Mr. Mercer stated that some changes in drilling technique might occur as the water table is approached. Mr. Mercer also reported that some of the pump and treat well locations have shifted to the east.

3. **Permit Application Status**

- Part B NOD Workshop Schedule (G. Cummins - WHC)

Ms. G. Cummins (WHC) reported that there are still open issues that need to be resolved for Chapters 1.0 and 2.0. Today's meeting will focus on closing out as many issues as possible for Chapter 4.0 and if time permits, Chapter 5.0. Chapter 3.0 (Waste Analysis Plan) is scheduled for discussion during the May to June time frame with Chapter 11.0 to follow.

4. **RCRA Topics**

- NOD Five Remaining Issues NOD Response Letter

Ms. A. Crowell (RL) reported that a draft NOD response table was provided to Ecology in December 1995. Mr. Hepner stated that some changes will need to performed in order to finalize this NOD

response. Ms. Crowell took an action to finalize the NOD response letter and issue it to Ecology.

- NOI Status

  Mr. B. Barnes (WHC) reported that at the last quarterly M-20 meeting, Ecology was informed that there was a potential for doing an addendum to the LLBG NOI that was issued for public review in May of 1995. This addendum might address the addition of alternative dangerous waste processes for the LLBG and will follow the same public review approach that the T Plant addendum did. Basically, the addendum will be issued for a 60-day public review followed by the Part A revision. Mr. Barnes stated that he is hopeful that this addendum will be completed prior to the final permit for the LLBG being issued.

- TSCA Application

  Mr. Barnes said a TSCA application currently is being developed for the disposal of PCBs in Trenches 31 and 34.

- LBL Issue

  Ms. Crowell scheduled a separate meeting with Mr. Hepner to discuss this issue.

5. **Working Draft-1 Workshop**

- Chapter 2 Actions Follow-up

  Time did not permit discussion.

- Chapter 4 Actions Follow-up

  Mr. Barnes facilitated Chapter 4 text change proposals by projecting text on screen and soliciting comments from workshop participants. Accepted proposed text was incorporated into Chapter 4.

- Chapter 5 Begin Discussion

  Time did not permit discussion.

6. **General Topics**

- Past Action Items

  - 11-1-95:1 Schedule a technical meeting to discuss Response Action Plan engineering technology (RL/WHC) was scheduled for December needs to be rescheduled.

  (Scheduled for first week in May)?

  - 11-1-95:2 Provide a letter approving Response Action Plan (Ecology). Was scheduled for December, needs to be rescheduled.

  (Contingent on above action.)

  - 11-1-95:3 Provide Hanford Facility Permit General Information Volume Presentation to Ecology (RL/WHC)

    This action item is closed.

  - 11-1-95:4 (old NOD 11-1-95:2) Arrange for discussion on lead shielding at the RIPI Council (RL/WHC)

    This action item is closed.

- New Action Items

  4-3-96:1 Finalize the response letter.
  ACTION: Ms. Crowell

  4-3-96:2 Provide Mr. Hepner with a basis for design number.
  ACTION: Ms. Crowell

  4-3-96:3 Get a response by letter by April 17.
  ACTION: Mr. McKarns

7. **Schedule Next Meeting**

- Tentative Date

  The next meeting is tentatively scheduled for April 26.

- Proposed Topics

  Chapter 5

Attachment 3

LOW-LEVEL BURIAL GROUNDS
Project Managers Meeting/Notice of Deficiency Resolution Meeting
2440 Stevens Center Place, Room 1200
Richland, Washington

April 3, 1996
7:30 a.m. - 11:00 a.m.

Attendance List

NAME	ORGANIZATION	PHONE #
JoAnn McCoy	WHC-ES	372-3596
R. B. Mercer	WHC	376-8945
Gloria Cummins	WHC-ES	372-2484
Norm Hepner	Ecology	736-3048
Kent McDonald	WHC-SWM	373-4981
Laura J. Cusack	Ecology	736-3038
Dean Pratt	WHC-SWMFE	373-2464
J. R. Rosser	WHC-SWMFE	372-0699
Mark French	DOE/WPD	373-9863
Gerry Hendricks	GSSC	946-3687
Brett M. Barnes	WHC-SWD	376-3640
Tony McKarns	DOE-EAP	376-8981
Allison Crowell	DOE/WPD	372-2346

Attachment 4

LOW-LEVEL BURIAL GROUNDS
Project Managers Meeting/Notice of Deficiency Resolution Meeting
2440 Stevens Center Place, Room 1200
Richland, Washington

April 3, 1996
7:30 a.m. - 11:00 a.m.

Action Items

Action Item	Description
12-19-95:1	(Confirm with Reg. Analysis and EAP--Have Wayne Toebe call Tom Cusak). Add a percentage estimate of hazardous debris to be provided over a 30-yr period. ACTION: Wayne Toebe **OPEN**
4-3-96:1	Finalize the response letter. ACTION: Ms. Crowell **OPEN**
4-3-96:2	Provide Mr. Hepner with a basis for design number. ACTION: Ms. Crowell **OPEN**
4-3-96:3	Get a response by letter by April 17. ACTION: Mr. McKarns **OPEN**

102.5
LLBG
6/11/96

Distribution:

L. D. Arnold	WHC	B2-35*
S. G. Arnold	WHC	T3-04*
B. M. Barnes	WHC	T3-04
R. C. Bowman	WHC	H6-24*
R. M. Carosino	RL	A4-52*
C. E. Clark	RL	A5-15
A. K. Crowell	RL	S7-55
N. P. Emerson	WHC	T4-03*
M. S. French	RL	S7-55*
R. J. Giroir	WHC	T4-05*
R. F. Guercia	RL	S7-55*
P. L. Hapke	WHC	T4-05*
G. D. Hendricks	GSSC	B1-42*
N. T. Hepner	Ecology	B5-18
S. Leja	Ecology	B5-18*
D. R. Lucas	WHC	G3-15*
K. M. McDonald	WHC	T4-03*
A. C. McKarns	RL	A5-15
R. D. Pierce	WHC	T3-04*
D. B. Powell	WHC	T4-03*
D. A. Pratt	WHC	T4-03*
S. M. Price	WHC	H6-23*
D. G. Saueressig	WHC	H6-24
H. T. Tilden	PNL	P7-79
G. C. Triner	WHC	T3-28*
B. D. Williamson	WHC	B3-15
RCRA/File	WHC	H6-24

*cc:Mail

ADMINISTRATIVE RECORD: Low-Level Burial Grounds, D-2-9
[Care of EDMC, WHC (H6-08)]

Washington State Department of Ecology Nuclear and Mixed Waste Library,
P.O. Box 47600, Olympia, Washington 98504-7600

Environmental Protection Agency Region 10, Seattle, Washington 98101,
Mail Stop HW-070, Records Center

Please send comments on distribution list to Gloria Cummins, WHC (H6-24),
(509) 372-2484

LOW-LEVEL BURIAL GROUNDS
Project Managers Meeting/Part B Workshop
Federal Building, Room 554
Richland, Washington

June 11, 1996
7:30 a.m. - 12:00 p.m.

The undersigned indicate by their signatures that these meeting minutes reflect the actual occurrences of the above Project Managers Meeting/Notice of Deficiency Resolution Meeting.

Date: 10/23/96
Clifford E. Clark, Unit Manager, RL
(Represented by Anthony C. McKarns, DOE-RL)

Date: 10/22/96
Norman T. Hepner, Unit Manager, Washington State Department of Ecology

---

Low-Level Burial Grounds, WHC Concurrence

Brett M. Barnes Date: 8/14/96
Richard D. Pierce, Contractor Representative, WHC
(Represented by Brett M. Barnes, WHC)

Purpose: Discuss permitting process and Notice of Deficiency issues.

Meeting Minutes are attached. The minutes are comprised of the following:
Attachment 1 - Agenda
Attachment 2 - Summary of Discussion and Commitments/Agreements
Attachment 3 - Attendance List
Attachment 4 - Action Items

Attachment 1

LOW-LEVEL BURIAL GROUNDS
Project Managers Meeting/Part B Workshop
Federal Building, Room 554
Richland, Washington

June 11, 1996
7:30 a.m. - 12:00 p.m.

Agenda

1. **PREVIOUS MEETING MINUTES**

   - April 3, 1996 Meeting Minutes

2. **PROGRAM STATUS**

   - Pump and Treat Status (R. Mercer - WHC)

3. **PERMIT APPLICATION STATUS**

   - Part B NOD Workshop Schedule (D. Saueressig - WHC)

4. **RCRA TOPICS**

   - NOD Five Remaining Issues Response Letter
   - Part A Rev. 8 Status

5. **WORKING DRAFT-1 WORKSHOP**

   - Chapter 1 Actions Follow-up
   - Chapter 2 Actions Follow-up
   - Chapter 4 Actions Follow-up
   - Chapter 6 Begin Discussion

6. **GENERAL TOPICS**

   - Past Action Items

     - 11-1-95:1 Schedule a technical meeting to discuss Response Action Plan engineering technology (RL/WHC) was scheduled for December needs to be rescheduled

     - 11-1-95:2 Provide a letter approving Response Action Plan (Ecology). Was scheduled for December, needs to be rescheduled.

- 11-1-95:3 Provide Hanford Facility Permit General Information Volume Presentation to Ecology (RL/WHC)

CLOSED

- 11-1-95:4 (old NOD 11-1-95:2) Arrange for discussion on lead shielding at the RIPI Council

CLOSED

- New Action Items

7. **SCHEDULE NEXT MEETING**

- Tentative Date
- Proposed Topics

Attachment 2

LOW-LEVEL BURIAL GROUNDS
Project Managers Meeting/Part B Workshop
Federal Building, Room 554
Richland, Washington

June 11, 1996
7:30 a.m. - 12:00 p.m.

Summary of Discussion and Commitments/Agreements

1. **Previous Meeting Minutes**

   The meeting minutes for the April 3, 1996, Project Managers Meeting were not available. These minutes will be sent out for review, and approved at a future date.

2. **Program Status**

   - Pump and Treat Status (R. Mercer - WHC)

     Mr. R. Mercer (WHC) reported that BHI are concentrating on reducing the contaminants in the highest concentration areas. It was decided not to sample at area number 5. Phase III will start in August 1997. All six wells have been drilled, and run at between 150 - 500 gallons per minute. A modelling study has been prepared, a long term strategy document, and should be available by the end of the month.

3. **Permit Application Status**

   - Part B NOD Workshop Schedule (D. Saueressig - WHC)

     Mr. D. Saueressig (WHC) reported that delays in conducting workshops might jeopardize incorporating the LLBG Permit Application into Modification C of the Hanford Facility RCRA Permit. Mr. N. Hepner (Ecology) reiterated that there will be no delays, and that what ever is submitted on October 15, 1996, will be what he uses to write the permit for the LLBG.

4. **RCRA Topics**

   - NOD Five Remaining Issues Response Letter

Ms. A. Crowell (RL) stated that it was not issued, that the Navy portion was done. Mr. Hepner said that he can wait and that no letter was necessary, that is could be taken care of during the workshops.

- Part A Rev. 8 Status

  Ms. Crowell said that a design capacity for the LLBG has been reached. Ms. Crowell said that she would type up the design capacity and provide it to Mr. Hepner. Mr. B. Barnes (WHC) stated that another issue with the Part A was the Lawarence Berkeley National Laboratory (LBNL) issue, and Mr. Hepner said the there would be no repercussions from the LBNL issue. Ms. Crowell said that she might include portions of the trenches with LBNL waste in them. Mr. Hepner said that time is not a factor regarding the Part A, and not to hurry. Mr. Hepner also stated that he will reject a revised LLBG Part A that reflects a November 23, 1987, date.

5. **Working Draft-1 Workshop**

- Chapter 1 Actions Follow-up

  There are no more issues to discuss. The design capacity will be provided to Mr. Hepner by Ms. Crowell.

- Chapter 2 Actions Follow-up

  The issue of the November 23, 1987, date of regulation is the only outstanding issue.

- Chapter 4 Actions Follow-up

  Mr. Hepner had an action item with regards to Section 4.2.3.2 (Requirements for External Liner). This action item is gone because a cover is being used. Another action item, Air - hold until sampling done. The last issue was the Response Action Plan. A presentation/handout will be provided to Mr. Hepner at the next LLBG PMM/workshop.

- Chapter 6 Begin Discussion

  The entire chapter was reviewed and comments generated. Mr. Barnes will incorporate comments and reissue before the next LLBG workshop.

6. General Topics

- Past Action Items

  - 11-1-95:1 Schedule a technical meeting to discuss Response Action Plan engineering technology (RL/WHC) was scheduled for December needs to be rescheduled.

  (Scheduled for first week in May)?

  - 11-1-95:2 Provide a letter approving Response Action Plan (Ecology). Was scheduled for December, needs to be rescheduled.

  (Contingent on above action.)

  - 4-3-96:1 Finalize the response letter.
  ACTION: Ms. Crowell

  (Not discussed, remains open)

  - 4-3-96:2 Provide Mr. Hepner with a basis for design number.
  ACTION: Ms. Crowell

  (Not discussed, remains open)

  - 4-3-96:3 Get a response by letter by April 17.
  ACTION: Mr. McKarns

  (Not discussed, remains open)

- New Action Items

7. Schedule Next Meeting

- Tentative Date

  The next two workshops were scheduled for June 26, 1996, and July 1, 1996.

- Proposed Topics

  The June 26, 1996, meeting will discuss Chapter 6 follow-up, begin Chapter 3, and the Response Action Plan. The July 1, 1996, meeting will discuss four NOD issues, and begin Chapter 5.

Attachment 3

LOW-LEVEL BURIAL GROUNDS
Project Managers Meeting/Part B Workshop
Federal Building, Room 554
Richland, Washington

June 11, 1996
7:30 a.m. - 12:00 p.m.

Attendance List

NAME	ORGANIZATION	PHONE #
R. B. Mercer	WHC	376-8945
Norm Hepner	Ecology	736-3048
Dean Pratt	WHC-SWMFE	373-2464
J. R. Rosser	WHC-SWMFE	372-0699
Gerry Hendricks	GSSC	946-3687
Brett M. Barnes	WHC-SWD	376-3640
Tony McKarns	DOE-EAP	376-8981
Allison Crowell	DOE/WPD	372-2346
Dan Saueressig	WHC-HWMPS	376-9739

Attachment 4

LOW-LEVEL BURIAL GROUNDS
Project Managers Meeting/Part B Workshop
Federal Building, Room 554
Richland, Washington

June 11, 1996
7:30 a.m. - 12:00 p.m.

Action Items

Action Item	Description
12-19-95:1	(Confirm with Reg. Analysis and EAP--Have Wayne Toebe call Tom Cusak). Add a percentage estimate of hazardous debris to be provided over a 30-yr period. ACTION: Wayne Toebe **OPEN**
11-1-95:1	Schedule a technical meeting to discuss Response Action Plan engineering technology (RL/WHC) was scheduled for December needs to be rescheduled **OPEN**
11-1-95:2	Provide a letter approving Response Action Plan (Ecology). Was scheduled for December, needs to be rescheduled. **OPEN**
4-3-96:1	Finalize the response letter. ACTION: Ms. Crowell **OPEN**
4-3-96:2	Provide Mr. Hepner with a basis for design number. ACTION: Ms. Crowell **OPEN**
4-3-96:3	Get a response on letter by April 17. ACTION: Mr. McKarns **OPEN**

0048001

Meeting Minutes Transmittal

LOW-LEVEL BURIAL GROUNDS
Part B Workshop
2440 Stevens Center Place, Room 2519
Richland, Washington

February 19, 1997
12:30 p.m. to 4:00 p.m.

OCT 1997
RECEIVED
DMC

The undersigned indicate by their signatures that these meeting minutes reflect the actual occurrences of the above-dated Part B Workshop.

Kevin D. Bazzell, Project Manager, DOE-RL — Date: 6/24/97

Norman T. Hepner, Project Manager, Washington State Department of Ecology — Date: 7/15/97

Not Present
Fred A. Ruck III, Contractor Representative, FDH — Date:

Daniel G. Saueressig, Permitting Representative, RFSH — Date: 5/21/97

Low-Level Burial Grounds, RFSH Concurrence

Kent M. McDonald, Contractor Representative, RFSH (Represented by Brett M. Barnes, RFSH) — Date: May 16, 1997

Purpose: Prepare Low-Level Burial Grounds Part B Permit Application for inclusion in the Hanford Facility RCRA Permit.

Meeting Minutes are attached. The minutes are comprised of the following:
Attachment 1 - Summary of Discussion and Commitments/Agreements
Attachment 2 - Attendance List
Attachment 3 - Action Items

Attachment 1

LOW-LEVEL BURIAL GROUNDS
Part B Workshop
2440 Stevens Center Place, Room 2519
Richland, Washington

February 19, 1997
12:30 p.m. to 4:00 p.m.

Summary of Discussion and Commitments/Agreements

1. **CHAPTER 11.0**

Mr. N. Hepner (Ecology) raised several questions on the content of the revision that he was provided with. Mr. Hepner enquired if RL/PHMC received his mark-up of Chapter 11.0. Mr. Hepner was informed that no one had received his mark-up version of Chapter 11.0. Mr. Hepner stated he would send it out via cc:mail for review. Research will continue on revising Chapter 11.0.

2. **CHAPTER 3.0**

Although the Ecology/RL/PHMC workshops on finalizing waste analysis plans (WAP) for the Hanford Facility have not yet been completed, Mr. Hepner stated that we may need to discuss Chapter 3.0/WAP because the workgroup might not reach resolution. Mr. K. Bazzell (DOE-RL) stated that he has not been involved in the waste analysis plan workgroup, and that he needs an idea of where we are at and how we fit in. Mr. Hepner stated that he believed that the definitions and format have been agreed to, and the QA/QC has been partially agreed to. However, there are issues that are still not agreed to. Mr. Hepner will be kept informed via cc:mail of the continuing efforts on finalizing the WAPs.

3. **CHAPTER 4.0**

Mr. B. Barnes (RFSH) stated that he copied applicable parts of Chapter 4.0 from the Hanford Facility Dangerous Waste Permit Application for the 616 Nonradioactive Dangerous Waste Storage Facility and Central Waste Complex to include discussion on "greater-than-90-day container storage." Mr. Hepner stated that he only wants macro-encapsulated items put in trenches 31 and 34 for storage. Mr. Hepner requested that Mr. Bazzell provide him a list of the items that will be going into trenches 31 and 34 for storage. Mr. Hepner stated that only large containers should be moved into trenches 31 and 34 for storage. Smaller containers that meet land disposal restriction requirements currently at the Central Waste Complex could remain there because they are in a safe storage configuration.

Mr. Hepner requested that Section 4.1.1 (Description of Containers) be reworded to state that if void space in containers exceeds 10 percent, the containers must be crushed or repacked before storage. He wanted to delete the last part of the sentence that said "or burial" to make sure the void space would be taken care of before containers go in for storage. Mr. Hepner requested that the language in Section 4.1.2 (Container Management Practices)

be revised so only one trench could be used for storage. Mr. Hepner also suggested that all equipment to be used in the LLBG be discussed. Mr. Hepner also wants everyone to agree on how long items will be stored, and stated he might write a permit condition to this effect. Mr. Hepner asked how we plan on managing these containers before disposal. Mr. Bazzell stated that the intent is to place containers in the manner that they will be disposed. Mr. Hepner asked if there is a disposal plan document. Mr. Barnes stated that there is, but it changes frequently. Mr. Hepner asked if there was an item 5 on page 4-3, and Mr. Barnes stated that it was most likely a typo, and that he would check on it.

Mr. Hepner wanted Section 4.2.1 (Test For Free Liquids) to include information from the waste analysis plan in addition to just referencing the WAP. Mr. Hepner inquired about leachate management once the LLBG goes into the disposal mode. He stated that he wants assurance that 1 foot of head space will not be exceeded during normal operations. Mr. Barnes stated that during the last two years we have had above average precipitation, but Mr. Barnes does not see a problem with future leachate management.

Mr. Hepner requested that the language in Section 4.3.2.2 (Unlined Trenches) be reworded to reference the Hanford Facility Dangerous Waste Permit Application, General Information Portion (DOE/RL-91-28). Agreement was reached to reword this section. Mr. Hepner suggested adding more language in Section 4.3.3.3.2 (Stresses Resulting From Operating Equipment) discussing the base of the liner being able to handle vehicles and calculations on the ramp handling vehicles. Mr. T. McKarns (DOE-RL) stated that any restriction on the ramp needs to be discussed in Section 4.3.3.1.9 (Access Ramp).

Mr. Hepner requested that Section 4.3.6.1 (System Operation and Design) be revised to discuss operating the primary and secondary leachate collection systems automatically. Mr. Barnes stated that this could potentially cause the LLBG to operate 365 days a year. Agreement was reached to reword the paragraph that discusses the primary and secondary leachate collection systems.

Mr. Hepner requested that the third paragraph of Section 4.3.6.1.1 (Primary System) be clarified. Mr. Barnes agreed to reword the paragraph to clarify that secondary leachate also can be pumped to the leachate collection tank.

Mr. Hepner requested that Section 4.3.7.4 (Maintenance Procedures for Leachate collection and Removal Systems) be revised. Mr. Hepner requested "bullets" that identify monthly, weekly, etc., inspections. In addition, Mr. Hepner requested that the discussion on preventative maintenance from Chapter 6 be moved into this section. Mr. Barnes stated he would discuss the matter with Solid Waste Engineering and potentially modify the text accordingly. Mr. Hepner requested that a discussion be included on the loading pad for the leachate collection system.

Mr. Hepner requested that Section 4.3.10 (Liquids in Landfills) have the same information from Section 4.2.1 (Test For Free Liquids) and have the same information copied from the WAP. Mr. Hepner stated that the most important factor involved with closing the LLBG after trenches become full, from a safety stand point, is void space in containers, and suggested we find a cost effective way to determine the amount of void space in containers.

The next meeting was scheduled for the week of Wednesday, February 26, 1997.

Attachment 2

LOW-LEVEL BURIAL GROUNDS
Part B Workshop
2440 Stevens Center Place, Room 2519
Richland, Washington

February 19, 1997
12:30 p.m. to 4:00 p.m.

Attendance List

Name	Organization	Phone #
Norm Hepner	Ecology	736-3048
Brett Barnes	RFSH	376-3640
Dan Saueressig	RFSH	376-9739
Tony McKarns	DOE-EAP	376-8981
Seana Addleman	RFSH	373-4587
Kevin Bazzell	DOE-WPD	373-0464

Attachment 3

LOW-LEVEL BURIAL GROUNDS
Part B Workshop
2440 Stevens Center Place, Room 2519
Richland, Washington

February 19, 1997
12:30 p.m. to 4:00 p.m.

Action Items

Action Item #	Description
1-16-97:1	Ms. Addleman/Mr. Pratt (RFSH) will research the information contained in DOE Order 5820.2A and paraphrase what this order requires by Wednesday, January 22, 1997, while Mr. Hepner (Ecology) will research the information contained in WAC 173-303-610 and paraphrase what this regulations requires by Wednesday, January 22, 1997. ACTION: Ms. Addleman/Mr. Pratt (RFSH) and Mr. Hepner (Ecology) **CLOSED**
1-16-97:2	Mr. McKarns (RL) will look into the closure plan prepared by U.S. Ecology and determine if any information in that closure plan could be useful for the LLBG closure plan. ACTION: Mr. T. McKarns (RL) **CLOSED**
1-16-97:3	Mr. Ruck (FDH) will look into the Environmental Restoration (ER) Project Plan to make sure the LLBG closure plan doesn't contradict any planned activities contained in the ER Project Plan. ACTION: Mr. Ruck (FDH) **OPEN**
1-29-97:1	Mr. McKarns will look into U.S. Ecology's closure plan to see what is described regarding vadose zone monitoring as well as taking an action as to whether or not to include a paragraph on vadose zone monitoring. ACTION: Mr. McKarns (DOE-RL) **OPEN**

Distribution:

W. D. Adair	FDH	(H6-21)*
S. M. Addleman	RFSH	(T4-04)
L. D. Arnold	FDH	(B2-35)*
E. S. Aromi	RFSH	(T3-01)*
B. M. Barnes	RFSH	(T3-05)
K. D. Bazzell	RL	(S7-55)
R. C. Bowman	RFSH	(H6-24)*
B. J. Broomfield	RFSH	(T3-04)*
R. M. Carosino	RL	(A4-52)
M. Ciminera	GSSC	(A4-35)*
C. E. Clark	RL	(A5-15)*
R. R. Durfee	RFSH	(T4-04)*
R. H. Engelmann	RFSH	(H6-26)*
A. A. Garcia	RFSH	(T4-05)*
R. J. Giroir	RFSH	(T4-05)*
J. W. Golden	FDH	(N1-26)*
R. F. Guercia	RL	(S7-55)*
R. M. Irwin	RFSH	(T4-03)*
K. M. McDonald	RFSH	(T4-04)*
A. C. McKarns	RL	(A5-15)
D. A. Pratt	RFSH	(T4-03)*
S. M. Price	FDH	(H6-23)*
J. R. Rosser	RFSH	(T4-03)*
D. G. Saueressig	RFSH	(H6-24)
H. T. Tilden II	PNL	(P7-79)
B. D. Williamson	FDH	(B3-15)*
J. A. Winterhalder	RFSH	(H6-21)*
M. T. Yasdick	RFSH	(H6-10)*
RCRA Files	RFSH	(H6-23)

*cc:Mail

ADMINISTRATIVE RECORD: Low-Level Burial Grounds, D-2-9 [Care of EDMC, FDH (H6-08)]

Washington State Department of Ecology Nuclear and Mixed Waste Hanford Files, P.O. Box 47600, Olympia, Washington 98504-7600

Environmental Protection Agency Region 10, Seattle, Washington 98101, Mail Stop HW-070 (Records Center)

Please send comments on distribution list to D. Saueressig, RFSH (H6-24),(509) 376-9739

0047113

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

1315 W. 4th Avenue • Kennewick, Washington 99336-6018 • (509) 735-7581

March 6, 1997

Mr. James E. Rasmussen
U.S. Department of Energy
P.O. Box 550, MSIN: A5-15
Richland, WA 99352

Dear Mr. Rasmussen:

Re: Approval of Low-Level Burial Ground (LLBG) Part A, Revision 9

The Washington State Department of Ecology (Ecology) has received the LLBG Part A, Revision 9, dated March 4, 1997. It is Ecology's understanding that there is an urgent need for storage of bulky and long-length mixed waste awaiting disposal at Hanford. Trench 34 provides the necessary safeguards and the most affordable option to safely manage this waste form at Hanford.

Based on the above considerations, Ecology is approving the LLBG Part A, Revision 9. If you have any questions concerning this approval, please contact me at (509) 736-3048.

Sincerely,

for Norman T. Hepner, PE
Nuclear Waste Program

NH:sb
Enclosure

cc: Cliff Clark, USDOE
William Adair, FDH
Sue Price, FDH
Mary Lou Blazek, ODOE
Administrative Record: LLBG

MAR 1997
RECEIVED
EDMC

0060519

Meeting Minutes Transmittal

LLBG
Project Managers Meeting
825 Jadwin/340/700 Area
Hanford, Washington
August 28, 2003

The undersigned indicate by their signatures that these meeting minutes reflect the actual occurrences of the above dated Project Managers Meeting. Signatures denote concurrence with content only and are not intended to imply agreement to any commitments.

Project Manager, Ecology — Date: 10-02-03

Project Manager Representative, RL — Date: 10/2/03

Project Manager Representative, FH WMP — Date: 02 Oct 03

RECEIVED
OCT 13 2003
EDMC

LLBG Administrative Record	H6-08
MS. Collins	A6-38
F Jamison	B5-18
M Mills	B5-18
DG Saueressig	T4-04

LLBG PROJECT MEETING
825 Jadwin/Room 340/700 Area
Hanford, Washington
August 28, 2003

12:30 p.m. to 1:00 p.m.

Agenda

I. Approval of July 24, 2003 LLBG Project Meeting Minutes (Ecology/DOE-RL/FH)

II. Operational Status

III. Project Specific Issues
   A. Status of Part B Permit Application
   B. Status of Carbon Tetrachloride Issue
   C. Status of Rocky Flats/Kaiser Hill waste
   D. Status of M-91-12A

IV. General Discussions

V. Status of Actions

VI. New Action Items

VII. Next Project Managers Meeting

LLBG PROJECT MEETING MINUTES
Project Managers Meeting
825 Jadwin /340/700 Area
Hanford, Washington

August 28, 2003

I. Approval of the July 24, 2003 LLBG Project Meeting Minutes Ecology/DOE-RL/FH)

II. Operational Status (Darrin Faulk FH)

- Non-ATG Waste Accepted at Trench 34 in July

MLLW	128 cubic feet	17 drum eqs

- Waste Shipped from ATG to Trench 34 in July

Non-Thermal

MLLW	1,773 cubic feet	241 drum eqs

- No Defueled Reactor Compartment Received in July

III. Project Specific Issues

A. Part B Permit Application Status
   1. Matt Mills (Ecology) reported the workshops continue to make progress and are beginning to address WAP comments. RL formally transmitted the groundwater NOD comment responses to Ecology on August 26. They are currently under review at Ecology.

B. Carbon Tetrachloride Issue
   1. The Sampling and Analysis Plan required by the Administrative Order has been transmitted to Ecology for review. Soil vapor sampling is ongoing.

C. Rocky Flats/Kaiser Hill Waste
   1. No waste has been received.

D. M-91-12A Status
   1. Darrin Faulk reported that 15 cubic meters of waste will be applied to the milestone through the Permafix thermal desorption demonstration.

IV. General Discussions

A. Mike Collins was introduced as the new RL project manager for the low-level burial grounds.

V. Status of Actions (report attached)

A. 856 – Workshops are ongoing. Formal responses were submitted to Ecology on the groundwater chapter. Comments have been received from Ecology on the WAP. Ecology is evaluating DOE responses which will be addressed in the NOD resolution meeting.

VI. New Action Items

A. No new actions.

VII. Next Project Managers Meeting

A. The next Project Managers meeting is scheduled for October 2, 2003

Environmental Request Information System

Low-Level Burial Grounds

Task ID: 856 Task Lead: Saueressig, Dan Schedule workshops to address LLBG NOD comments received from Ecology.

Waste Management Project/Low-Level Burial Grounds POC: Prignano, Andrea

Category: PMM

Open Date: 10/17/2002

Due Date:

Closed

Description Schedule workshops to address LLBG NOD comments received from Ecology.

Date	Status
8/28/2003	Workshops are ongoing. Formal responses were submitted to Ecology on the groundwater chapter. Comments have been received from Ecology on the WAP.
7/24/2003	Workshops are ongoing. RL has received the letter extending the workshops to 1/18/04.
6/19/2003	Workshops are ongoing. Ecology is drafting a letter to extend the workshops to Jan/2004.
5/22/2003	Workshops are being scheduled weekly. Next workshop scheduled for 5/29.
4/1/2003	Workshops are scheduled weekly.
2/27/2003	Workshops are ongoing. Dan Saueressig will contact Tom Fogwell and bring him up to speed on current activities.
1/30/2003	Workshops are scheduled to begin the week of February 10, 2003.
11/21/2002	Workshops will be scheduled pending completion and submittal of Ecology comments.
10/17/2002	Action opened.

LLBG
Project Managers Meeting
825 Jadwin/340/700 Area
Hanford, Washington

August 28, 2003

Attendance List

Name	Organization	Phone Number	MSIN
Jeannette Hyatt	FH-ES-WDS	376-7923	T3-03
PAUL M. MARTIN	FH-EP	376-6620	T3-04
FRED JAMISON	EP&SE-1	736-3002	B5-18
Ellen Mattlin	DOE-RL-RCA	376-2385	A5-15
Michael Collins	DOE-RL-WMD	376 6536	
Darrin Faulk	FH EP	373-1611	T4-04
TONY MCKARNS	DOE	376-8981	A5-15
Matt Mills	Ecology	736-5721	B5-18
Alba D. Huckaby	Ecology	736-3034	B5-18
Darlene Hagel	FH / EP	373-0431	N1-26
Telecon:			
Dan Saueressig	FH / WMP		

ENCLOSURE II

Enclosure

SUBMITTED IN RESPONSE TO FOIA REQUEST NO. 2009-0054, ITEM #5

Closure Plan for Active Low-Level Burial Grounds

0051178

DOE/RL-2000-70
Revision 0

Closure Plan for Active Low-Level Burial Grounds

RECEIVED
DEC 07 2000
EDMC

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

United States Department of Energy
P.O. Box 550
Richland, Washington 99352

Approved for public release; further dissemination unlimited

DOE/RL-2000-70
Revision 0
EDT 622852

Closure Plan for Active Low-Level Burial Grounds

D. A. Pratt
Fluor Daniel Hanford Company

W. A. Skelly
COGEMA Engineering Corporation

Date Published
October 2000

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

United States Department of Energy
P.O. Box 550
Richland, Washington 99352

Janis Aardal 11-16-2000
Release Approval Date

Approved for public release; further dissemination unlimited

LEGAL DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

This report has been reproduced from the best available copy.

Printed in the United States of America

EXECUTIVE SUMMARY

This plan has been prepared in response to direction from the U.S. Department of Energy. The purpose of the plan is to define approaches that will be implemented to ensure protection of the public and the environment when active Low-Level Burial Grounds (LLBGs) at the Hanford Site are closed.

Performance assessments for active burial grounds in the 200 East and West 200 Areas provide current estimates of potential environmental contamination and doses to the "maximum exposed individual" from burial ground operation and closure and compare dose estimates to performance objective dose limits for the facilities. This is an Operational Closure Plan. The intent of the guidance in DOE Order 435.1 is that this plan will be a living document, like the facility performance assessments, and will be revised periodically through the operational life of the LLBGs to reflect updated information on waste inventory, management practices, facility transition planning, schedule dates, assessments of post-closure performance, and environmental consequences. Out year dates identified in this plan are tentative. A Final Closure Plan will be prepared in the future when the timing and extent of closure-related activities for LLBGs can be established with greater certainty.

After current operations at the LLBGs are concluded, this plan proposes transitioning of these facilities to the Environmental Restoration Program. This action will enable the Environmental Restoration Program to design and implement consistent and coordinated final remedial actions for active and inactive LLBGs. Active and inactive burial grounds in the 200 West and 200 East Areas are commingled.

This plan describes approaches that will be implemented during Interim Closure, Final Closure, and Institutional Control Periods to prepare LLBGs for surface barriers, and the construction of barriers, as well as the scope of inspection, monitoring and maintenance practices that will be performed during and after closure. Environmental monitoring is briefly discussed in this plan. However, a more comprehensive discussion of monitoring issues is provided in a separate performance assessment monitoring plan for LLBGs. Supporting information is provided regarding the geography, climate, hydrogeology, geochemistry and land-use practices of adjacent land areas.

During the Final Closure period, engineered surface barriers will be constructed over the LLBGs. A conceptual cover design, which is a development of the Hanford Site Environmental Restoration Program, is discussed as the current planning basis for capping LLBGs. This barrier meets all applicable federal and state requirements for covers over sites with Category 3 low-level waste (LLW) and/or hazardous/dangerous waste constituents. Attributes of this design are discussed in the context of ensuring the integrity of the closed facility and the cover system, preventing long-term degradation of the cover, ensuring structural stability, limiting infiltration, minimizing maintenance, limiting consequences of human intrusion, and achieving compliance with facility performance objectives.

CONTENTS

EXECUTIVE SUMMARY iii

ACRONYMS/ABBREVIATIONS vii

1.0 INTRODUCTION 1-1
1.1 GENERAL FACILITY DESCRIPTION 1-1
1.2 GENERAL APPROACH TO CLOSURE 1-1
1.3 CLOSURE SCHEDULE 1-3
1.4 RELATED ACTIVITIES 1-3
1.4.1 Final Remediation of Inactive LLBGs 1-3
1.4.2 Canyon Disposition Initiative Project 1-3
1.4.3 Environmental Impact Evaluation of Alternatives for Future Solid Waste Management at the Hanford Site 1-4
1.4.4 TRU Retrieval from Active LLBGs 1-4
1.4.5 Dangerous Waste Facility Permit 1-4
1.4.6 Proposed Dedicated Trench for Immobilized Low Activity Waste (ILAW) Facility Waste 1-4
1.4.7 Monitoring Plan for LLBGs 1-5
1.5 KEY ASSUMPTIONS 1-5
1.5.1 Key Assumptions from Facility PAs 1-5
1.5.2 Key Assumptions Relating to Future Waste Inventory 1-5
1.5.3 Key Assumptions Relating to Interim Closure and Final Closure 1-6
1.5.4 Key Schedule Assumptions 1-6

2.0 DISPOSAL FACILITY CHARACTERISITCS 2-1
2.1 SITE CHARACTERISTICS 2-1
2.1.1 Site Geography and Demography 2-1
2.1.2 Site Climatology and Meteorology 2-1
2.1.3 Site Ecology 2-1
2.1.4 Hydrogeology 2-2
2.1.5 Geochemistry 2-6
2.1.6 Natural Resources 2-6
2.2 FACILITY CHARACTERISTICS 2-7
2.2.1 Facility Description 2-7
2.2.2 Features of the Cover System that will Minimize Water Infiltration 2-10
2.2.3 Features that will Assure Integrity of the Cover System 2-10
2.2.4 Features that will Ensure Structural Stability of Closed LLBG Facilities 2-11
2.2.5 Inadvertent Intruder Barrier 2-11
2.3 WASTE CHARACTERISTICS 2-12
2.3.1 Current Waste Inventory 2-12
2.3.2 Future Additions To Waste Inventory 2-12
2.3.3 Radiological Inventory 2-13

3.0 TECHNICAL APPROACH TO CLOSURE 3-1
3.1 FACILITY TRANSITION 3-1
3.2 OPERATIONAL/INTERIM CLOSURE 3-1
3.2.1 Background/Introduction 3-1
3.2.2 Sub-grade Modification 3-2
3.2.3 Supporting Geophysical Monitoring/Investigation Methods 3-3

CONTENTS (cont)

3.2.4 Implementation of Sub-Grade Modification Methods to LLBG Trench Fills 3-3
3.2.5 Inspection, Monitoring and Maintenance during Interim Closure 3-4
3.3 FINAL CLOSURE 3-5
3.3.1 Background for Final Cover Design 3-5
3.3.2 Description of Final Cover Design 3-6
3.3.3 Sources of Cover Materials 3-8
3.3.4 Cover Performance 3-8
3.3.5 Inspection, Monitoring and Maintenance during Final Closure 3-9
3.4 INSTITUTIONAL CONTROL 3-9
3.4.1 Inspection Plan 3-9
3.4.2 Monitoring Plan 3-11
3.4.3 Maintenance Plan 3-11
3.4.4 Contingency Corrective Action Plans 3-13
3.5 UNRESTRICTED RELEASE OF SITE 3-13
3.6 COMPLIANCE WITH PERFORMANCE OBJECTIVES AND OTHER REQUIREMENTS 3-14
3.6.1 All-Pathways Dose 3-15
3.6.2 Air Pathway Dose 3-15
3.6.3 Radon Flux 3-16
3.6.4 Other Requirements 3-16

4.0 Closure Schedule 4-1

5.0 REFERENCES 5-1

FIGURES

Figure 2.1. Map Showing Locations of the Hanford Site and the 200 Areas. F2-1
Figure 2.2. Topography of the Hanford Site. F2-2
Figure 2.3. Historical Seismicity of the Columbia Plateau and Surrounding Areas. F2-3
Figure 2.4. Hydrologic Basins Designated for the Washington State Portion of the Columbia Plateau F2-4
Figure 2.5. Centralized Stratigraphy of Suprabasalt Sediments on the Hanford Site F2-5
Figure 2.6. Geomorphic Features in the West-Central Portion of the Hanford Site F2-6
Figure 2.7. Water Table Map for the 200 Areas, December 1987. ..... F2-7
Figure 2.8. Hanford Site Water Table Map, January 1944 ..... F2-8
Figure 3.1. Profile View Through Modified RCRA Subtitle C Barrier. F3-1

TABLES

Table 2.1. Waste Inventory and Forecast Volumes for Active LLBGs for the Baseline Alternative Described in the SW-EIS (DOE 2000)(a) T2-1
Table 2.2. Waste Inventory and Forecast Volumes for Active LLBGs for the Regional Alternative Described in the SW-EIS (DOE 2000)(a) T2-1
Table 2.3. Current Inventories of Radionuclides In LLBG (in Ci) T2-2
Table 2.4. Projected LLW and MLLW Inventory to be Disposed in LLBG from 1998 to Closure T2-6
Table 3.1. Performance Objectives for 200 East and West Area LLBGs. 3-14
Table 4.1. Current Trench Filling Sequence and Estimated Fill Dates T4-1
Table 4.2. TRU Retrieval Schedule. T4-2
Table 4.3. Closure Schedule Estimates. T4-4
Table 4.4. Documentation Schedule. T4-5
Table 4.5. Closure Schedule. T4-5

ACRONYMS/ABBREVIATIONS

ARAR	Applicable or Relevant & Appropriate Requirement (EPA)
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act of 1980
CH	Contact-Handle
DOE	Department of Energy
DOE-RL	Department of Energy - Richland Operations Office
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
FFS	Focused Feasibility Study
GTCC	Greater Than Class C (LLW)
HDW-EIS	Hanford Defense Waste Environmental Impact Statement
HELP	Hydrologic Evaluation of Landfill Performance
HFSUWG	Hanford Future Site Uses Working Group
HIC	High-Integrity Container
HMS	Hanford Meteorological Station
ILAW	Immobilized Low Activity Waste
LDR	Land-Disposal Restricted
LLBG	Low-Level Burial Ground
LLW	Low-Level Waste
MLLW	Low-Level Mixed Waste
NRC	Nuclear Regulatory Commission
PA	Performance Assessment
RCRA	Resource Conservation & Recovery Act of 1976
RH	Remote-Handle
SAR	Safety Analysis Report
SW-EIS	Hanford Site Solid Waste Program Environmental Impact Statement
SWITS	Solid Waste Inventory Tracking System
TRU	Transuranic (Waste)
WAC	Washington Administrative Code
WHC	Westinghouse Hanford Company
WIPP	Waste Isolation Pilot Plant
WNP-2	Washington Nuclear Plant 2 (Supply System)
WRAP	Waste Receiving & Packaging

1.0 INTRODUCTION

Future tense (e.g., "will") is used in discussions of Interim Closure, Final Closure and Institutional Control activities in this plan. The intent of this usage is to simplify discussion and to convey the sense that current visions and assessments of activities under discussion are futuristic. It is not intended to imply that the Solid Waste Storage and Disposal Program has made specific decisions and/or commitments regarding details of activities that are 30 to 40 years in the future.

1.1 GENERAL FACILITY DESCRIPTION

Active LLBGs in the 200 West and 200 East Areas cover a combined (but non-contiguous) area of 560 hectares (1,400 acres). Active LLBGs began accepting waste in the early 1960s from processing operations on the Hanford Site and are anticipated to continue to receive waste from on-site and off-site generators until approximately 2045. Other, older LLBGs, which were inactive in 1994 when the Hanford Site Environmental Restoration (ER) Contract was implemented, were assigned to the ER Contractor for surveillance and maintenance and final remediation at that time. As of January 1, 1999, approximately 274,000 m^3 (358,000 yd^3) of LLW and 9,200 m^3 (12,000 yd^3) of low-level mixed waste (MLLW) had been disposed in active LLBGs in various containers including drums and boxes made of steel, wood, and cardboard. Bulk contaminated equipment and soils have also been disposed in LLBG trenches. Containerized waste is typically stacked in the bottom of each trench using either cranes or forklifts. Bulk soils and debris are typically dumped from the trench lip down a working face for disposal. A minimum of 2.4 m (8 ft) of backfill is currently placed over disposed waste. Early operations placed as little as 0.6 m (2 ft) of soil over filled waste trenches but found through experience that 2.4 m (8ft) was required to minimize biointrusion concerns. Category 3 waste and waste containing certain mobile radionuclides are currently stabilized by placement in concrete vaults/high-integrity containers (HIC) or encasement in concrete. Mixed waste is disposed in Resource Conservation and Recovery Act of 1976 (RCRA) compliant lined trenches.

After all trenches in a burial ground have been filled with waste, the facility will be turned over to the ER Program for final remediation in a manner that will be integrated with adjacent sites. During Interim and Final Closure, measures will be taken to improve the bearing capacity of trench fills to support the weight of a final cover and a cover will be constructed over the site. Cover construction will be coordinated with remediation of adjacent facilities, including inactive LLBGs. The cover will limit water infiltration and inadvertent intrusion to meet performance objectives as described in the facility performance assessments (PAs). Land use adjacent to the burial grounds is currently limited to Hanford operations. In the region surrounding the Hanford Site, land use is typically agricultural.

1.2 GENERAL APPROACH TO CLOSURE

In Section 3.0 of this closure plan, a two-phase approach to closure of active LLBGs is presented. The two key elements of the approach are as follows:

- Increase the bearing capacity of trench fills (consisting of disposed waste and cover soil) to support the weight of a closure cover without excessive long-term settlement or subsidence

- Construct engineered covers as final remedial actions over active LLBGs. Covers will be designed specifically to minimize moisture infiltration, resist natural degradation processes, minimize maintenance, and control releases of radionuclides for a period of at least 500 years after closure.

Measures will be implemented to improve the bearing capacity of trench fills during the Interim Closure period. Trench fills will be stabilized by applying a number of sub-grade modification methods to compact trench fill materials, eliminate large voids (either by compaction or by void-fill grouting), and/or bond larger volumes of trench contents together by cement grouting. Sub-grade modification may be performed once or several times as necessary to achieve an adequate bearing capacity value within trench fills to support the distributed weight of cover materials over the closed facility.

During the Final Closure period, engineered surface barriers will be constructed over LLBGs. A generic conceptual cover design, which is a development of the ER Program at the Hanford Site, is described in this plan as the current planning basis for capping LLBGs. The Modified RCRA Subtitle C Barrier conforms to all applicable state and Federal regulatory requirements for landfill closure of sites containing Category 3 LLW and hazardous/dangerous waste. This design also is assumed as the final cover treatment over LLBGs for evaluation of future waste management alternatives in the Hanford Site Solid (Radioactive and Hazardous) Waste Environmental Impact Statement (SW-EIS) (DOE 2000). The planning basis may change in the future to reflect barrier design developments and remediation strategies for inactive LLBGs within the ER Program.

The Modified RCRA Subtitle C barrier design will be effective in controlling releases of radionuclides from the facilities after closure. The barrier will control releases of radionuclides by (1) minimizing infiltration of precipitation into and through disposed waste, (2) preventing biointrusion into buried waste, and (3) minimizing adverse consequences of inadvertent human intrusion in the future if there is a loss of active institutional control. The proposed cover system is designed to eliminate virtually all moisture infiltration by evapotranspiration. Biointrusion will be prevented by incorporation of a low-permeability layer that cannot be penetrated by plant roots or burrowing animals. Buried waste will be covered with at least 5 m (16.7 ft) of layered soil, rock and asphaltic materials. The overall thickness of material and the low-permeability layer will effectively isolate buried waste from inadvertent intrusion.

The cover design incorporates two independent strategies for elimination of soil moisture. The design includes a two-layer topsoil treatment. Compaction of the lower topsoil layer and a capillary barrier at the interface between the topsoil and underlying materials will retard moisture migration through the topsoil, increasing the time available for removal of moisture by evapotranspiration. The thickness of the two topsoil layers is designed to support a healthy stand of perennial vegetation. Moisture that infiltrates through the topsoil system will be eliminated by lateral drainage.

The Modified RCRA Subtitle C barrier system will be constructed of durable materials and includes design features that will minimize susceptibility to erosion of the topsoil surface. The upper topsoil layer includes a pea gravel admix treatment that will limit erosion by forming a surface armoring layer during any extended periods of wind erosion. The cover surface will be sloped at 2 percent, which is sufficient to induce runoff during severe storm events, but low enough to limit susceptibility to erosion by wind. Established cover vegetation, consisting of a mix of perennial grass species, should limit topsoil losses to an acceptably low value. In combination, these strategies should enable the cover to remain functional with minimum active maintenance for a performance period of at least 500 years.

The design is tailored to the Hanford Site's semiarid climate conditions and the local availability of suitable materials of construction. The capillary barrier feature, the compacted topsoil layer, and the selection of perennial grasses as cover vegetation are all treatments designed to maintain successful vegetative cover at a semiarid site. The pea gravel admix treatment, low surface slope, and cultivation of vegetative cover are designed to minimize soil losses from wind erosion.

1.3 CLOSURE SCHEDULE

The final closure schedule for each of the burial grounds is dependant upon several related activities. Current policy based on the Record of Decision for the Hanford Defense Waste Environmental Impact Statement (HDW-EIS) is that all stored transuranic (TRU) waste will be retrieved from LLBGs before they are closed. Trenches that are currently used for storage of TRU may be reused for LLW disposal, or they may be refilled with native soil in advance of closure. In the current Hanford Site Solid Waste Program Environmental Impact Statement (SW-EIS) a sub-alternative is being studied that would involve leaving TRU in place (i.e., changing the policy established by the HDW-EIS). After TRU retrieval (assuming no change to the current policy), the trench contents must be compacted to provide a stable base for the final closure cover, before the final closure cover can be constructed. The closure schedule in Section 4.0 of this plan assumes that all TRU waste must will be retrieved before 2030. A trench filling sequence has been developed in the "Low Level Burial Grounds Disposal Plan" (Pratt 2000) by allocating all LLW in the forecast to future trenches in the burial grounds. The filling sequence shows trenches receiving waste up until 2030. Once all TRU waste has been retrieved and the trenches have been filled with LLW, the burial ground will transition into an Interim Closure period where the bearing capacity of trench fills will be increased to support the final closure cover. This is planned to take from 1 to 6 years per burial ground. To cycle through all of the burial grounds and construct final covers will take until 2056. Construction of the final cover will require transporting massive quantities of construction materials and will take from 1 to 5 years per burial ground. If the final covers are constructed directly after the end of the Interim Closure period for each active LLBG, the last one will be complete in 2057. The schedules assume an Institutional Control period of at least 100 years beyond Final Closure.

1.4 RELATED ACTIVITIES

1.4.1 Final Remediation of Inactive LLBGs

Inactive LLBGs at the Hanford Site were assigned to the ER Contractor in 1994 when the Site's ER Contract was implemented. Inactive LLBGs will undergo final remediation following the Comprehensive Environmental Response, Compensation & Liability Act of 1980 (CERCLA) process. This plan proposes transitioning active LLBGs to the ER Program after conclusion of operations, so that final remediation of inactive and active LLBGs can be accomplished in an integrated manner under a single site contractor.

1.4.2 Canyon Disposition Initiative Project

The Canyon Disposition Initiative is a collaborative effort to evaluate the feasibility of using the five chemical processing facilities (canyon buildings) in the 200 Areas for waste disposal in conjunction with final remediation. A Canyon Task Team, consisting of personnel from DOE-RL, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology, is evaluating a number of technical alternatives for dispositioning these facilities. Some alternatives under consideration would involve constructing engineered surface barriers over these facilities as final remedial actions. Covers over canyon buildings could be large enough (in terms of areal extent) to impact designs of covers over nearby LLBGs.

1.4.3 Environmental Impact Evaluation of Alternatives for Future Solid Waste Management at the Hanford Site

The SW-EIS (DOE 2000) is being prepared to evaluate the environmental consequences of three alternatives for managing solid waste streams at the Hanford Site in the future. The evaluation involves newly generated TRU, MLLW, LLW, and contaminated equipment, retrievably stored TRU in LLBGs, new and existing facilities for characterization, treatment and storage of solid waste streams, and disposal options for various streams. Selection of the No-Action Alternative would eliminate plans for construction of some new treatment facilities, TRU retrieval from LLBGs and off-site disposal of TRU waste. The Baseline Alternative is generally consistent with the Hanford Site's current planning baseline. Most wastes that are currently in storage would be processed and prepared for disposal over the next 10 years, and the need for significant storage facilities gradually would be reduced over that time. Wastes would be treated in Waste Receiving & Packaging (WRAP) facility, T Plant, the M-91 Treatment Facility, and/or commercial facilities. Suitable treatment options would be made available for all solid waste streams. TRU waste would be shipped to the Waste Isolation Pilot Plant (WIPP) repository. A sub-alternative of the Baseline Alternative would involve leaving some TRU in place (i.e., potentially altering the policy on TRU retrieval and disposal established by the HDW-EIS). The Regional Alternative would create the same new treatment facilities and implement the same management processes and activities as the Baseline Alternative. It would also involve receipt, processing and on-site disposal at Hanford of additional volumes of LLW and MLLW from other DOE sites. The Regional Alternative would increase the inventories of LLW and MLLW disposed in LLBGs.

1.4.4 TRU Retrieval from Active LLBGs

Based on the Record of Decision for the HDW-EIS, all stored TRU waste will be retrieved from LLBGs before they are closed. Most active LLBGs include trenches containing retrievably stored TRU waste. Several active LLBGs (e.g., 218-W-3A, 218-W-4B and 218-E-10) could be closed when TRU retrieval is completed unless the trench space freed up by TRU retrieval is reallocated for LLW disposal. Schedule information for TRU retrieval is included in Section 4.0 of this plan. As noted above, a sub-alternative under consideration in the SW-EIS would involve leaving TRU waste in place.

1.4.5 Dangerous Waste Facility Permit

Several active LLBGs contain LLW with dangerous waste constituents (i.e., MLLW) that was disposed on or after August 19, 1987, which is the date that Hanford-generated waste streams became subject to regulation under WAC 173-303 by the State of Washington. A single site-wide Treatment, Storage and Disposal Facility Permit has been issued to the Hanford Site by the Washington State Department of Ecology. Negotiations are ongoing between DOE-RL and the Department of Ecology regarding inclusion of specific permit conditions for active LLBGs in the site-wide permit. MLLW currently is being disposed in a RCRA-compliant trench (Trench 34) in 218-W-5 Burial Ground. The Navy Reactor Compartment Trench (Trench 94) in 218-E-12B also is subject to dangerous waste regulations, although that trench is not lined. Near-future MLLW disposal is planned for Trench 31 in 218-W-5 Burial Ground. A third (larger) MLLW trench is planned for 218-E-12B at a later date (Pratt 2000).

1.4.6 Proposed Dedicated Trench for Immobilized Low Activity Waste (ILAW) Facility Waste

Solid Waste Storage and Disposal Operations has proposed to construct and operate a new, special-purpose trench in the northwest corner of 218-E-12B Burial Ground for disposal of contaminated equipment (e.g., failed melters) from the ILAW Facility. The proposed trench could also receive small

volumes of LLW and MLLW from the ILAW process operation. This trench would be designed and operated as a RCRA-compliant facility (i.e., with a double liner and a leachate collection system) and subject to the State of Washington's dangerous waste regulations (WAC 173-303). Design requirements and waste acceptance criteria for this trench have not been fully determined. If DOE elects to proceed with this plan, closure requirements and schedule data for the 218-E-12B Burial Ground would be impacted.

1.4.7 Monitoring Plan for LLBGs

A separate plan for monitoring of environmental media at active LLBGs was prepared recently by Chou et al. (DOE/RL-2000-72). The purpose of ongoing environmental monitoring is to acquire the necessary data to evaluate conformance of LLBGs to assumptions and performance predictions identified in the facility PAs and the Composite Analysis for the 200 Areas (Kincaid et al. 1998). Insofar as groundwater is regarded to be the most significant long-term exposure pathway in all of these assessments, it is the principal focus of the plan. The intent of DOE Order 435.1 is that any significant findings from environmental monitoring will be addressed in revisions to the facility closure plan and PAs.

1.5 KEY ASSUMPTIONS

1.5.1 Key Assumptions from Facility PAs

The current PAs for 200 East and West Area LLBGs rely on the following key assumptions:

- No major changes will occur in current land uses of areas adjacent to active LLBGs.
- There will be no significant changes in site conditions (i.e., climate, hydrogeology) through the period of interest for PAs.
- There will be no easing of the current waste acceptance criteria for LLBG operations between the present time and the time that LLBGs are closed (i.e., assumptions applied in the PAs regarding concentration limits, isolation of wastes containing mobile radionuclides, and waste stabilization, which are based on current waste acceptance criteria, will remain valid).

Any changes that impact these assumptions will be addressed in revisions to the PAs. Potential impacts to the current closure strategy for LLBG facilities will be addressed in future revisions of this plan.

1.5.2 Key Assumptions Relating to Future Waste Inventory

Three alternatives for management of solid waste streams (including LLBGs) at the Hanford Site are currently being evaluated in the SW-EIS (DOE 2000). These alternatives affect future waste inventory projections for LLBGs as described in Section 2.3 of this closure plan and as evaluated in the facility PAs (Wood et al. 1995, Wood et al. 1996). Uncertainties relating to future inventory additions will be reduced when a Record of Decision is published identifying the selected alternative. Current waste inventories of active LLBGs and future inventory projections will be updated in revisions to this document and the PAs.

1.5.3 Key Assumptions Relating to Interim Closure and Final Closure

Some proof-of-principle testing has been conducted of proposed sub-grade modification methods as discussed in Section 3.2.2. However, a pilot program will be needed to determine specifically how the proposed methods can best be utilized to achieve sub-grade stabilization objectives for Interim Closure.

A key assumption for this closure plan is that the proposed cover design will perform in a manner consistent with numerical simulation results. The ER Contractor plans to construct a prototype of the Modified RCRA Subtitle C Barrier in the 200 Areas within the next few years. After construction, the barrier will undergo a multi-year period of performance monitoring and evaluation. From the prototype, it is expected that an adequate performance information basis will be available to proceed with closure of LLBGs by the time operations are concluded.

1.5.4 Key Schedule Assumptions

Schedule information presented in Section 4.0 of this closure plan relies on the following assumptions:

- Availability of contractors and equipment for sub-grade modification is currently limited, because of the specialty nature of the work and limited demand for these services. It is envisioned that this constraint will continue into the future. Therefore, it is assumed that only one LLBG will undergo sub-grade modification at any given time.

- Aside from the constraint on sub-grade modification, there will be no other constraints on labor, equipment or materials. For scheduling purposes, it has been assumed that individual LLBGs will proceed directly from TRU retrieval into Interim Closure, Final Closure, and Institutional Control without schedule gaps. Schedule delays could occur in conjunction with facility transition.

2.0 DISPOSAL FACILITY CHARACTERISITCS

2.1 SITE CHARACTERISTICS

In this section, the environmental conditions that characterize the 200 East and West Area LLBGs are summarized. A detailed discussion will not be provided because these topics have been discussed at length in other publications [e.g., the HDW-EIS (DOE 1987) and SW-EIS (DOE 2000)] and numerous Safety Analysis Reports (SAR)). Environmental characteristics discussed include regional geography and demography, regional and site-specific geology, regional and site-specific hydrology, climatology, meteorology, and ecology.

2.1.1 Site Geography and Demography

The 200 Area LLBGs are located on the Hanford Site in the southeast corner of Washington State (Figure 2-1). The Hanford Site is located in a structural and topographic depression of the Columbia Plateau called the Pasco Basin. The northern and eastern boundaries of the site generally follow the Columbia River. The western margin of the site is generally bounded by the Rattlesnake Hills. The southern boundary of the site is approximated by the ridgeline of Rattlesnake Mountain and the Yakima River. The Hanford Site covers an area of about 1,500 km^2 (580 mi^2). With the exception of a few natural basalt hills (e.g., Gable Butte and Gable Mountain), the central area of the site is relatively flat (Figure 2-2), with a topographic low at the Columbia River [about 100 to 120 m (300 to 390 ft) above sea level] and a gradual increase in elevation toward the north-central part of the site. The 200 Area LLBGs are located in this region, commonly referred to as the 200 Area Plateau. The elevation of the burial grounds is about 225 m (738 ft).

The nearest population center consists of three small cities (Richland, Kennewick, and Pasco) that are situated to the southeast of the site on the Columbia River. The population living within 80 km (50 mi) of the burial grounds is about 375,000 (Kincaid, et al 1993).

2.1.2 Site Climatology and Meteorology

Meteorological data has been collected at the Hanford Meteorology Station (HMS) since the year 1945. The HMS is located between the 200 East Area and the 200 West Area. Temperature and precipitation data have been recorded in the region since 1912. Generally, the Hanford Site climate is classified as semiarid with an average rainfall of about 16 cm/yr (6.3 in/yr), nearly half of which occurs in the winter months of November through January.

The prevailing winds of the area are from the northwest and secondarily from the southeast. Average wind speeds are about 10 to 15 km/h (6 to 9 mi/hr). The area is subjected to occasional high winds (e.g., a peak gust of wind of 130 km/h (80 mi/h) was recorded at the HMS in 1972).

2.1.3 Site Ecology

Site ecology is thoroughly summarized in the HDW-EIS (DOE 1987) and SW-EIS (DOE 2000). Dominant vegetation at the Hanford Site includes sagebrush, rabbit brush, and a variety of grasses, including cheat grass and, bunchgrass. Common mammals on the site include mule deer, elk, jack and cottontail rabbits, coyotes, badgers, raccoons, and a variety of rodents. Common birds on site include

grouse, doves, falcons, hawks, owls geese, and ducks. A wide variety of fish inhabit the Columbia River including salmon, trout, shad, bass, whitefish, sturgeon, and catfish.

Endangered, threatened, or candidate species have been identified onsite. However, a review based on information from the Fish and Wildlife Service for the Department of Interior suggests that these species are not directly at risk from waste management activities in the 200 Areas (DOE 1987).

2.1.3.1 Regional and Site-Specific Land Use

In the region surrounding the Hanford Site, commercial land use is typically agricultural which relies on irrigation to grow crops. The sources of irrigation are generally the Columbia and Yakima Rivers and confined aquifers (sediment layers between upper basalt flaws). Several nuclear facilities are in operation on or adjacent to the Hanford Site including the Columbia Generating Station formerly known as Washington Nuclear Plant No. 2 (WNP-2), a commercial nuclear reactor operated by Energy Northwest, and the Siemens Nuclear Power Corporation Fuel Fabrication Plant. In addition, a commercial LLW disposal facility operated by U.S. Ecology is located adjacent to the 200 East Area on the central plateau of the Hanford Site.

On the Hanford Site, a large number of facilities including reactors and processing plants have been operated to produce nuclear materials. None of these facilities (except T Plant, which has been converted to support waste management operations) are currently operational and permanent shutdown is planned. The Solid Waste Storage and Disposal Complex is operating for management of LLW. The complex consists of a number of active and inactive burial sites (shallow land trenches), storage buildings (primarily for mixed waste), and administrative buildings.

2.1.3.2 Seismology

The Hanford Site is in an area of low seismicity (Figure 2-3). Earthquakes typically occur at shallow depths [focal depth less than 6 km (Caggiano and Duncan 1983)] as multiple events or swarms at magnitudes of less than 3.5. Two moderate-size earthquakes have been recorded near the site, one in 1936 in the Milton-Freewater area (Modified Mercallie intensity VII) about 40 mi southeast of the Hanford Site and another in Corfu in 1918 (Modified Mercallie intensity IV to VI) about 118 mi north of the site. The Corfu earthquake is estimated to have produced peak ground accelerations of 0.01 to 0.03 g onsite. The epicenters of recorded earthquakes occur somewhat randomly and are not strongly associated with any geologic structural features.

2.1.4 Hydrogeology

The Hanford Site is located on a geologic province referred to as the Columbia Plateau. The Columbia Plateau covers much of eastern Washington, eastern Oregon, and parts of Idaho. It was formed by a massive upwelling of basalt magma. The Hanford Site is located in the Pasco Basin, which is a structural depression within the Columbia Basin Plateau. About 3,000 m (10,000 ft) of flow basalts underlie sedimentary units of variable thickness within the Pasco Basin. The major supra-basalt sediments are the Ringold Formation and the Hanford formation. The Ringold Formation overlies the uppermost basalt flow and was deposited by various erosional processes. The Hanford formation overlies the Ringold Formation and was deposited in a series of catastrophic floods associated with glacial melting.

The hydrology of the Pasco Basin is characterized by a number of surface sources and aquifers. Groundwater occurs both within the upper unconfined aquifer system and within a system of deeper confined to semi-confined aquifers in the basalt flow tops, flow bottom zones, and sedimentary interbeds (DOE 1988b, vol. 2, p. 3.6-1). The confined aquifers are intercalated with aquitards, consisting of basalt

flow interiors (colonnades and entablatures). The uppermost aquifer system occurs within the suprabasalt sediments. This aquifer is regionally unconfined.

Surface water enters the Pasco Basin from several adjacent basins (Figure 2-4), including the Yakima River Basin, Horse Heaven Basin, Walla Walla River Basin, Palouse/Snake Basin, and Big Bend Basin. Within the Pasco Basin, major tributaries including the Yakima, Snake, and Walla Walla rivers join the Columbia River. Two intermittent streams, Cold Creek and Dry Creek, cut through the Hanford Site. These drainages contain flowing water during the wetter winter and spring months.

Total annual precipitation over the Pasco Basin averages less than 16 cm (6.3 in. per year). Mean annual runoff is estimated to be less than 2.5×10^4 acre-ft per year, or approximately 3 percent of the total precipitation. The remaining precipitation is assumed to be lost through evapotranspiration, with a small component (perhaps less than 1 percent) contributing to recharging of the groundwater system (DOE 1988b, vol. 2, p. 3.1-6).

The general direction of groundwater flow is from the natural recharge areas along the west edge of the Hanford Site to discharge areas along the Columbia River. Recharge of the confined basalt aquifers occurs through infiltration on the anticlinal ridges bounding the Pasco Basin and from westward flow in basalt aquifers beneath the Columbia Plateau. Sources of natural recharge to the uppermost (unconfined) aquifer system are infiltration and runoff of precipitation and runoff on the reaches of the Yakima and Columbia Rivers. Cold Creek and Dry Creek, which are located between the Rattlesnake Hills and Umtanum Ridge, drain the western slopes of the Pasco Basin, losing water to the subsurface as they spread across the lower valley plains.

The 200 Areas are 90 m (300 ft) or more above the normal surface level of the Columbia River, which is well beyond the area that would be affected by the 500-year flood or the probable maximum flood event. The most likely source of flooding in the vicinity of the 200 Areas is Cold Creek, which is an ephemeral stream. The projected maximum flood on Cold Creed would reach the southwest corner of 200 West Area, but would not come within 0.8 km (0.5 mi) of any active LLBG.

Infiltration of precipitation through the vadose zone has been studied at several locations on the Hanford Site (Gee 1987; Routson and Johnson 1990; Rockhold et al. 1990; Fayer et al. 1991). The general conclusion is that very little, if any, infiltration occurs in areas where the surface soils are relatively fine-grained and deep-rooted vegetation is present. In other areas where soils are coarse and vegetation is shallow rooted or not present, infiltration may exceed 50 percent of annual precipitation.

Artificial recharge to the unconfined aquifer occurs at the Hanford Site from wastewater disposal operations, mainly in the 200 Areas. Recharge from the 200 Areas wastewater disposal facilities was estimated to be approximately 10 times the natural recharge rate at the Hanford Site by Graham et al. (1981). More recently, Fayer and Walters (1995) have estimated that the total volume of natural recharge over the Hanford Site in 1992 was about 8.47×10^6 m^3/yr, (2.24×10^9 gal/yr). This value is of the same order of magnitude as the artificial recharge to 200 Areas wastewater disposal facilities during 1992 and is about half the volume that was being discharged in 1979. Liquid wastewater disposal is now regulated, it is decreasing significantly from year to year, and will eventually cease, leading to falling groundwater levels.

2.1.4.1 Hydrogeology of the 200 West LLBG

The sources of data described in this section are (1) a detailed summary of the hydrogeology of the 200 West Area by Connelly et al. (1992) and (2) a detailed characterization of Burial Ground 218-W-5 by Bjornstad (1990). These reports represent the most recent synthesis of available data that have been used to characterize the primary features of the vadose zone and unconfined aquifer that influence groundwater

movement. Typical soil characterization data taken from the soil samples include particle size distribution, ambient moisture content, calcium carbonate content and gross gamma radiation counts as a function of depth below the surface. The database shows that Hanford Site soils are predominantly sandy with ambient moisture content in the range of 3 to 15 volume percent. Calcium carbonate is generally present in sufficient quantity to control the pH of the groundwater solution.

Isopach maps (Connelly et al. 1992) of the major soil column units underlying the 200 West Area are shown in Wood et al. 1995. A generalized cross-section of the stratigraphic units is shown in Figure 2-5. Also, several cross sections (Bjornstad 1990) across Burial Ground 218-W-5 are included in Appendix A of Wood et al. 1995. These drawings illustrate the spatial distribution of the major vadose zone units in a three-dimensional fashion. The bulk of the thickness of the vadose zone consists of Hanford formation and underlying Ringold Formation. The Ringold Formation consists of fluvial and lacustrine sediments while the Hanford formation consists of catastrophic flood deposits. The total thickness of the vadose zone and the relative thicknesses of the two main formations vary depending on the location of interest on the Hanford Site.

Beneath the 200 West Area LLBG, four distinct subunits of the Ringold Formation have been described (Bjornstad 1990). The water table occurs within the middle Ringold subunit. Between the Ringold and Hanford formations is a thin erosional layer (the Plio-Pleistocene layer), which appears to be mostly continuous across the burial grounds. The Plio-Pleistocene layer is a fine-grained sandy mud that has been reworked by plant and animal activity and is variably cemented with calcite. The early Palouse soil, which is an unconsolidated, muddy sand layer that may have been deposited by wind erosion and then reworked by animal burrowing and root growth, is developed in the upper part of the Plio-Pleistocene unit. The Hanford formation consists of a variety of facies ranging from coarse gravels in areas of high-energy deposition to fine-grained silts in low-energy environments. Numerous cycles of flooding apparently occurred, leading to a chaotic distribution of subfacies units. As indicated by Figure 2-6, a secondary channel is indicated along the east side of the burial grounds by high-energy deposits of coarse gravelly sand in Burial Grounds 218-W-3A and 218-W-3AE. In contrast, the burial grounds to the south and west (218-W-5 and 218-W-4C) are considered to be moderate energy depositional environments as indicated by a larger component of finer sands and less gravel. The formation thickens from northeast (about 18m/60 ft) to southwest (about 43m/140 ft) . The characterization of soil samples from wells in the vicinity indicated that small lenses of fine-grained material are interspersed in the Hanford formation that appear to be no more than 3 to 6 m (10 to 20 ft) thick, with a lateral extent of hundreds of meters or less.

Hydrologic flow patterns across the 200 West Area burial grounds were also estimated based on hydraulic conductivity data from site-wide soil samples and hydraulic head data from wells in the vicinity of the burial ground. As with the geologic interpretation, the hydrologic flow patterns were estimated in the context of the current understanding of the Hanford Site hydrologic regime.

The present direction of groundwater flow in the vicinity of the 200 West Area is highly influenced by a groundwater mound associated with past artificial recharge at 216-U-10 Pond (U Pond) and with current recharge to the 126-U-14 Ditch, which lies just east of U Pond (Bjornstad 1990). The influence of the U Pond mound on groundwater flow beneath 200 West Area Burial Grounds is demonstrated on a regional water table map that also indicates generalized groundwater flow direction (Figure 2-7). Artificial recharge at U Pond raised the level of the unconfined aquifer 17 m (55 ft) between 1944, before the construction of U Pond, and 1987. Based on water-level measurements collected at well 299-W15-2, it appears that the water table has fluctuated as much as 5 m (15 ft) over a 36-yr time period (Bjornstad 1990). The fluctuations are probably the result of varied volumes of process water being delivered to U Pond.

Even though U Pond was decommissioned in 1985, the groundwater mound is expected to continue to gradually decline for a number of years. Since about the time U Pond was decommissioned, water levels have in general declined, having fallen a total of about 2 m (7 ft) in the last 6 yr at Monitoring Well 299-W15-2. Hydrographs from the other wells located within 1,000 ft of 218-W-5 corroborate a general drop in water levels relative to those measured since the water levels have been measured at the site (Bjornstad 1990). As the groundwater mound dissipates, the direction of groundwater flow beneath 218-W-5 and the contiguous burial grounds will likely swing to the east, perhaps returning to the due-east regional groundwater flow direction recorded in 1944 (Figure 2-8).

The gradient across the burial ground is very slight (Figure 2-7). The general direction of flow is currently to the north-northeast. Saturated hydraulic conductivity data reported in the document show a reduction in hydraulic conductivity in the soils as a function of depth from 10^{-3} to 10^{-4} cm/s in the Ringold Formation. This trend is presumably the result of compaction by the soil column.

2.1.4.2 Hydrogeology of the 200 East Area LLBG

The sources of the data described in this section are a detailed summary of the hydrogeology of the 200 East Area by Connelly et al. (1992) and a detailed characterization of the 200 East Area Burial Grounds by Lindsey et al. (1994). These reports represent the most recent synthesis of available data that have been used to characterize the primary features of the vadose zone and unconfined aquifer.

The principal source of geologic and hydrologic information in the 200 East Area is borehole data. A generalized view of the suprabasalt sediment facies of 200 East Area is provided in Figure 2-5. The 200 East Area lies on the Cold Creek bar, a geomorphic remnant of the cataclysmic floods of the Pleistocene (Figure 2-6). As floodwater raced across the lowlands of the Pasco Basin and Hanford Site, energy was dissipated and deposits of gravels were left behind. The entire 200 Area Plateau is one of the most prominent of these deposits. In the northern half of the 200 East Area the water table is situated within gravel- to sand-dominated facies of the Hanford formation. To the south and east, it more commonly is found within gravels of Ringold units A and E and silts of the lower mud unit. Transmissivity and hydraulic conductivity data are summarized in Connelly et al. 1992. The vadose zone beneath the 200 East Area LLBG consists primarily of Hanford formation sediments.

2.1.4.2.1 Description of the Soil Column Underlying the 218-E-12B Burial Ground

Suprabasalt sediments beneath this burial ground consist entirely of Hanford formation sediments (refer to Appendix A, Figures A-1, A-2, A-3, and A-4 of Wood et al. 1996). The uppermost unit, Unit 1, is variable in thickness and distribution. It ranges from 11 to 37 m (35 to 120 ft) thick, and is predominantly a gravel facies. The unit is thinnest in the southwestern part of the burial ground and thickens to the north and east. The contact between Unit 1 and underlying strata generally is very irregular. The sands that make up Unit 2 are thickest [up to 55 m (180 ft)] in the southwestern part of the burial ground and pinch out toward the east and north. Silty beds and horizons within this unit have the potential to form perched water conditions. Unit 2a represents a transitional unit between Units 2 and 3, and exhibits increased gravel content. Unit 2a is locally well developed, especially to the east where Unit 2 pinches out and interfingers with Units 1 and 3. Unit 3, which is characterized by predominant gravel content, thickens to the north and northeast, from 12 to 45 m (40 to 150 ft) thick. Interbeds of sand and silt are present throughout Unit 3. Due to these interbeds, perched water conditions may also occur within Unit 3.

2.1.4.2.2 Description of the Soil Column Underlying the 218-E-10 Burial Ground

Hanford formation Units 1, 2, 2a, and 3 are all present beneath the 218-E-10 Burial Ground. Boreholes adjacent to the BX-BY Tank Farms encountered a thin sequence of Ringold-like sediments suggestive of the lower mud unit. However, Ringold Formation deposits are not present beneath the218-E-10 Burial

Ground. Unit 1 ranges from 12 to 33.5 m (40 to 110 ft) thick. It consists predominantly of gravel with interbedded sands. The unit is thickest to the northwest and thins to the east and south. Sands of Unit 2 range from 27 to 40 m (90 to 130 ft) thick, generally thickening to the south and west over the burial ground area. Several gravel intervals 3 to 5 m (10 to 15 ft) thick occur in the middle part of Unit 2. The lower part of Unit 2 (referred to as Unit 2a) also exhibits increased gravel content and is up to 15 m (50 ft) thick. As much as 34 m (110 ft) of gravelly strata assigned to Unit 3 occur beneath the 218-E-10 Burial Ground. Data from boreholes that reached the top of basalt indicate the strata dip to the west and south beneath the burial ground. This is consistent with regional data.

2.1.4.3 Characteristics of the Uppermost Aquifer System Underlying the 200 East and 200 West LLBGs

A water table contour map of the uppermost aquifer for the Hanford Site, based on 1993 data, is shown in Figure 2-7. The position of the water table in the western portion of the Hanford Site generally occurs within Ringold Unit E gravels. The water table in the eastern portion of the Hanford Site generally occurs within Hanford formation sediments. The gradient across the burial grounds is very slight (Figure 2-7). The general direction of flow is currently east to west under the 200 East Area LLBG. The primary driving force is the groundwater mound underneath B Pond, situated to the east of the LLBG.

Recharge to the uppermost aquifer occurs primarily from wastewater disposal practices at surface ponds, ditches, and various cribs in the 200 East and 200 West Areas. Three large recharge mounds have developed at the Hanford Site: U Pond in the 200 West Area, B Pond east of the 200 East Area, and Gable Mountain Pond north of the 200 East Area. Under U Pond, which was decommissioned in 1985, the water table had risen more than 17 m (55 ft) since the start of wastewater disposal operations there. The mound under B Pond has risen more than 9 m (30 ft) (Graham et al. 1981). Underneath the 200 East Area LLBG, the depth to the water table is about 66 m (215 ft). The projected post-Hanford depth is about 69 m (225 ft). As these groundwater mounds dissipate, the direction of groundwater flow beneath the 200 East and West Area burial grounds is likely to return to the easterly regional groundwater flow direction estimated to exist before Hanford Site operations began (Figure 2-8).

2.1.5 Geochemistry

The general geochemical characteristics of the soil column are very consistent in the suprabasalt sediments across the Hanford Site. The soil phases are predominantly feldspar and quartz with minor quantities of smectite clay, hydrous oxides, and calcium carbonate that are consistently present. Measured quantities of soil phases from 218-W-5 Burial Ground (Serne et al. 1993) were about 31 percent feldspar, about 43 percent quartz, about 3 percent smectite clay, about 1 percent hydrous oxides, and about 2 percent calcium carbonate. Many analyses of the unconfined aquifer groundwater have been completed at the Hanford Site. Again, the data are very consistent. The groundwater is characterized as moderately alkaline (pH about 7.8 to 8.4), and oxidizing (Eh about 280 to 380 mv) with moderate concentrations of aqueous species (about 5 meq/L). Analyses of moisture from vadose zone sediments (Serne et al. 1993) show essentially the same chemical characteristics.

2.1.6 Natural Resources

The Central Plateau of the Hanford Site has no important natural resources other than industrial minerals (i.e., sand and gravel). No major mining operations exist in the vicinity of the Hanford Site. Oil and gas exploration has occurred in the region; however, no economically viable accumulations of either have been found. Some local gravel processing is performed in the area.

2.2 FACILITY CHARACTERISTICS

2.2.1 Facility Description

Active LLBGs are classified as a landfill facility and cover a noncontiguous combined area of about 570 hectares (1,400 acres) (DOE 1990, p. 2-5). The facility is located in the 200 East and 200 West Areas of the Hanford Site. It is divided into eight active burial grounds with various size trenches, currently including 167 unlined trenches for the disposal of low level waste, two RCRA compliant lined trenches for the disposal of MLLW and one large unlined trench for disposal of U.S. Navy reactor compartments.

2.2.1.1 Low-Level Waste Disposal Trenches

LLW generally is received packaged in 208-L (55-gal) steel drums and wood or steel boxes, although concrete burial vaults, other accepted burial containers, and inherently stable waste packages and bulk waste may also be disposed. Concrete drag-off boxes formerly were used for disposing of wastes that exceeded 200 mrem/h surface radiation dose rate. The boxes, which are approximately 61.5 m^3 (2,170 ft^3) in volume, were transported to a trench by a flatbed railroad car or truck. Drag-off boxes are no longer used in LLBG operations. LLW with hazardous/dangerous waste constituents was disposed in unlined trenches prior to August 19, 1987. Dangerous waste regulations were applied to LLW on that date.

Flat-bottom trenches nominally range from 5.2 m (17 ft) to 20 m (65 ft) deep. An engineering analysis is performed for trenches over 6.1 m (20 ft) deep to ensure stable slopes during the operational life. Bottom dimensions range from 4.9 m (16 ft) to over 30 m (100 ft) wide. Trench slopes are normally 1.5H:1V to avoid sloughing of the trench walls. Modifications are made to these trench designs as needed to accommodate a variety of waste packages. Trench bottoms are stabilized to the extent necessary to ensure sound bearing for waste handling equipment. The flat-bottom trenches are routinely backfilled with approximately 2.4 m (8 ft) of soil.

DOE has directed that waste disposal operations should maximize the use of the remaining LLBG area, by widening existing trenches and by constructing new deeper trenches in areas currently occupied by shallow unused trenches. The Disposal Plan (Pratt 2000) assumes that future trenches for contact-handled (CH) Category 1 LLW in drums and boxes and CH Category 3 LLW will be deep trenches. Trench depth will vary depending on location and the proposed stacking arrangement. Special-purpose trenches will be constructed for disposal of CH Category 1 LLW in drums and boxes in multiple tiers. These trenches may be as deep as 21 m (70 ft). Drums will be treated with dynamic compaction every fourth tier. Boxes will be stacked to a height of 5 m (16 ft) and covered with 1.2 m (4 ft) of soil; each layer of boxes will be treated with dynamic compaction before placement of the next layer. The final tier will be covered with 2.4 m (8 ft) of soil to bring the trench back to grade.

Currently, remote-handled (RH) LLW (i.e., LLW with dose rates greater than 200 mrem/h measured at the waste container surface) is disposed in single layers in V-trenches. Small quantities of RH LLW also have been disposed in covered caissons. All caissons in the LLBG are located in trench 14 of the 218-W-4B burial ground. Caissons for disposal of RH LLW are referred to as beta-gamma caissons.

2.2.1.2 Mixed Waste Disposal Trenches

The current MLLW disposal trenches receive waste that meets the applicable land disposal restrictions/requirements. MLLW trenches can also be permitted for greater-than-90-day storage prior to going to the disposal mode. Waste forms are containerized, inherently stable, and/or bulk waste. If approved by the LLBG operating contractor, nonstandard waste packages and miscellaneous equipment

waste may also be placed in a MLLW disposal trench. Less than 5 percent of MLLW is expected to be RH material. RH MLLW will be shielded or backfilled to minimize worker exposure. Lined MLLW trenches will be filled in balanced layers to ensure the liner is not differentially loaded to the point it is damaged.

The following is a general description of a lined MLLW trench. Future trenches are likely to vary in size, shape, and other design details. However, from a safety standpoint, they will be identical in that they will be in compliance with the applicable regulations. Geomembranes incorporated in the design primarily function in this application as a protective barrier to prevent leachate from reaching the environment. Water infiltration is anticipated to be very low, as discussed in this section under water infiltration. Lined MLLW disposal trenches have a liner system that consists of bentonite-enriched soil, geosynthetic liner materials, and the leachate drainage system. This liner system will prevent the release of leachate to the environment and prevent migration of any hazardous constituents through the liner during the operational life of the landfill and the post-closure period. The leachate collection system is capable of collecting and removing leachate such that a nominal hydraulic head on the liner is not exceeded. A low-capacity pump will handle the normal, average leachate flow. When adverse precipitation conditions require a higher capacity, such as for the assumed worst-case precipitation event, a high-capacity pump is available. The pumps and associated piping are resistant to leachate corrosion.

2.2.1.3 Navy Reactor Compartment (RC) Disposal Trench

The RC is the section of a submarine or surface vessel containing the sealed and defueled reactor compartment, associated components, bulkheads, and hull sections. Once placed, RCs are managed in the same manner as any other LLW. Because of its structural characteristics, the RC waste package is impervious to wind, rain, dust, fire, etc. RCs are placed on structural supports that have been designed in accordance with applicable earthquake standards for the Hanford Site.

The Navy RC disposal trench is designated Trench 94 in the 218-E-12B Burial Ground. This trench is located in the northeast corner of the 200 East Area. Trench 94 is managed as a MLLW disposal unit by agreement with the Washington State Department of Ecology.

RCs are classified as state-only regulated hazardous waste due to the presence of shielding lead. The waste package is classified as a bulk waste with the characteristics of a U.S. Department of Transportation Type B container carrying highway route controlled quantities of radioactive material (49 CFR 173.403). The Department of the Navy has obtained a certificate of compliance (NRC 1989) with the Type B packaging criteria. This compliance provides a high level of confidence that the RC waste will not represent a hazard to personnel or the environment.

2.2.1.4 LLBG Overview

The facility is comprised of eight burial grounds as described below. Most trenches that received waste prior to 1987 contain some waste with constituents that are currently regulated by the State of Washington as dangerous wastes.

218-W-3A – This facility extends over an area of approximately 20 hectares (50 acres) and contains a total of 57 trenches. The oldest trench (trench 11) was opened in 1970 and filled in 1971. The last trench to receive waste (trench 49) was filled in 1998. A number of different trench designs (depth, width, and cross-section area) were constructed (see H-2-34880). A few of the oldest trenches (opened in 1972 and earlier) probably contain only 1.2 m (4 ft) of operational soil cover. In 1972, LLBG operating practices were modified to increase the thickness of operational cover to 8 ft to eliminate biointrusion problems. This burial ground received both Category 1 and Category 3 wastes. The two LLW categories were not

segregated. Two trenches contain post-August 19, 1987 RCRA and state-only designated mixed waste. Twelve trenches contain retrievable TRU.

218-W-3AE – This facility extends over an area of approximately 20 hectares (49 acres) and currently contains a total of eight trenches. Three additional trenches are planned (Pratt 2000). This burial ground first received waste in 1981. A number of different trench designs (cross-sections) have been constructed. All filled trenches are believed to contain at least 2.4 m (8 ft) of operational soil cover. The facility contains both Category 1 and Category 3 wastes (unsegregated). Two trenches (trenches 5 and 10) contain post-August 19, 1987 RCRA and state-only designated MLLW. Waste disposed in this burial ground does not include any waste classified as retrievable TRU. A stabilized liquid effluent disposal site (216-T-4 Pond) is situated inside the facility boundary.

218-W-4B – This facility extends over an area of approximately 3.5 hectares (8.6 acres) and contains a total of 13 trenches. The two oldest trenches (1 and 5) were filled in 1967. Trench 7 was the last trench to be filled (in 1983). Twelve below-grade caissons at the south end of the facility contain RH LLW and retrievable TRU. Waste disposal in caissons occurred between 1969 and 1990. Two trenches (7 and 11) contain retrievable TRU. Waste disposed in trenches other than trenches 7 and 11 was not segregated, and includes Category 1 and Category 3 LLW. Most trenches in this facility (other than trenches 7 and 11) were opened and filled prior to 1972 and likely have only 1.2 m (4 ft) of operational cover. No post-August 19, 1987 RCRA and state-only designated MLLW was disposed at this facility.

218-W-4C – This burial ground is approximately 20 hectares (49 acres) in size and currently contains a total of 15 trenches. Five additional trenches are planned (Pratt 2000). The facility first received waste in 1978. Therefore, all filled trenches should have at least 2.4 m (8 ft) of operational soil cover. A number of different trench designs (cross-sections) have been constructed in this burial ground. The facility contains both Category 1 and Category 3 wastes (unsegregated). Trench NC, Trench 14, and Trench 58 contain post-August 19, 1987 RCRA and state-regulated mixed waste. Seven trenches contain TRU that will be retrieved. An adjoining 8.8-acre area at the southeast corner of this burial ground is included in the facility description. However, the adjoining area currently is unused, and no future utilization for LLW disposal is envisioned (Pratt 2000).

218-W-5 – This burial ground is approximately 37.2 hectares (91.9 acres) in size and currently contains a total of thirteen trenches. Five additional trenches are planned (Pratt 2000). The first waste receipts were in 1986. Several different trench designs (cross-sections) have been constructed in this burial ground. Trenches 31 and 34 at the south end of the facility are RCRA-compliant trenches with liner and leachate collection systems for disposal of MLLW. The facility has received both Category 1 and Category 3 wastes (unsegregated). Trenches 22 and 24 contain post-August 19, 1987 RCRA and state-regulated MLLW. There is no retrievable TRU in this burial ground.

218-W-6 – This burial ground is approximately 16 hectares (40 acres) in size. No trenches have been opened and no waste has been received. The site is reserved for future LLW and/or MLLW disposal. However, the current disposal plan (Pratt 2000) indicates that it will remain unused.

218-E-10 – This facility extends over an area of approximately 36.1 hectares (89.2 acres), which is divided into two areas (labeled as northern portion and a southern portion). The northern portion is unused. The southern portion currently contains a total of 14 trenches with a north-south orientation and two other stub trenches at the southeast corner with an east-west orientation. This burial ground first received waste in 1960. Waste was unsegregated and included both Category 1 and Category 3 LLW. This burial ground does not contain any retrievable TRU. Trench 9 contains post-August 19, 1987 RCRA and state-regulated MLLW. No additional trenches are planned. The northern portion could be used for future MLLW disposal trenches. However, the current disposal plan (Pratt, 2000) envisions that it will remain unused.

218-E-12B – This facility extends over an area of approximately 68 hectares (168 acres) and began receiving waste in 1967. This facility currently contains a total of 40 trenches. One additional trench is planned, which will be a large RCRA-compliant landfill trench with liner and leachate collection system for MLLW disposal (Pratt 2000). This burial ground includes another large, special-purpose trench (Trench 94) for disposal of RCs from decommissioned U.S. Navy submarines and surface vessels. Trench 94 is a relatively wide and deep excavation. When RC disposal activities are concluded in Trench 94, a separate engineering design will be necessary to ensure that fill is placed and compacted in an adequate manner to prepare this trench for closure. Disposed RCs are regulated as mixed waste. The majority of the waste volume in the 218-E-12B burial ground was disposed prior to 1987 (except for disposal activities in Trench 94). Trenches contain unsegregated Category 1 and Category 3 LLW. Retrievable TRU resides in portions of three trenches. There is a limited amount of unused disposal capacity in existing trenches.

2.2.2 Features of the Cover System that will Minimize Water Infiltration

The current planning basis cover system for closure of active LLBGs (described in Section 3.3.2) incorporates two independent water management strategies to minimize infiltration. The primary strategy makes use of the high evapotranspiration potential at the Hanford Site, which reflects the Site's semiarid climate. The cover design includes two topsoil layers. The upper layer consists of silt loam soil placed in a relatively loose (non-compacted) condition. The lower topsoil layer will be placed in a relatively dense (compacted) condition. A capillary barrier will be present at the base of the compacted topsoil layer, which will tend to prevent drainage of soil moisture out of the topsoil layers. The capillary barrier and the compacted condition of the lower topsoil layer will tend to retard vertical moisture migration and increase retention time, increasing the amount of time available for moisture to be eliminated from the system by evaporation and transpiration processes.

The second strategy is to provide a lateral drainage path so that any moisture that does drain below the topsoil layers can be eliminated. At a lower level within the cover, moisture will be intercepted by a thick layer of low-permeability asphalt (i.e., a double-tar asphaltic material with in-field permeability values of between 10^{-7} and 10^{-9} cm/s). The asphalt layer will be constructed with a 2 percent slope toward the perimeter of the covered area. The material placed directly above the asphalt will be clean, screened aggregate material with a hydraulic conductivity of at least 1 cm/s. These properties ensure that the material will be free draining and that hydraulic head (standing water) cannot accumulate within the drainage media.

PAs for LLBGs indicate that long-term performance goals will be achieved if engineered surface barriers limit deep infiltration into/through the waste layer to 0.5 cm/yr or less. Numerical simulations of cover performance indicate that the proposed final cover treatment will eliminate more than 99 percent of annual precipitation by evapotranspiration and will limit deep infiltration to about 0.1 cm/yr (0.2 in/yr). The need for external drainage controls (e.g., surface run-on and runoff controls, perimeter drainage collection and routing) will be evaluated as aspects of definitive design.

2.2.3 Features that will Assure Integrity of the Cover System

The current planning basis cover system for closure of active LLBGs will be constructed of materials that are highly resistant to natural degradation processes. With the exception of the asphalt layer, the cover system is designed entirely of natural soil and rock materials that will provide appropriate long-term resistance to chemical and physical weathering. The ER Program is evaluating long-term durability of

asphalt materials. Preliminary indications are that asphalt materials in cover systems will have adequate durability to maintain function for post-closure periods of 500 to 1,000 years (Waugh et al. 1994).

The cover system is designed to require minimal maintenance during its design life. The silt loam topsoil in the surface layer will contain a 15 weight percent pea gravel admixture. As silt particles are removed from the topsoil surface by wind erosion, the pea gravel will concentrate into a lag deposit that will tend to protect the surface from further erosion. The surface slope of the cover has been specified at 2 percent to limit susceptibility to wind erosion. Perennial vegetation will be cultivated on the cover surface to minimize soil losses to wind and water erosion. Straw mulch will be crimped into the soil when seeding is performed to limit wind erosion during the first year, while vegetation is becoming established. The intent of these design strategies is to maximize the physical integrity of the cover and to minimize the need for ongoing maintenance. Sample calculations (which do not consider the beneficial effect of the pea gravel admixture) indicate that topsoil losses from the proposed cover system should be less than two tons per acre per year. Two tons per acre per year is the Environmental Protection Agency's (EPA) recommended performance guideline (EPA 1989).

2.2.4 Features that will Ensure Structural Stability of Closed LLBG Facilities

During the Interim Closure period, extensive sub-grade modification measures will be applied to densify and stabilize trench fills and to eliminate void volumes in containers in preparation for construction of final covers over LLBGs. Bearing capacity and tolerable settlement criteria for trench fill materials will be developed as an aspect of definitive design of the cover system. Sub-grade modification methods are described in Section 3.2, together with geophysical survey methods that may be used to evaluate the adequacy of sub-grade stabilization efforts.

The PAs do not require waste form stabilization for disposal of Category 1 LLW. Stabilization of Category 1 LLW will be accomplished solely by sub-grade modification. However, for Category 3 LLW, stabilization is required. Currently, Category 3 LLW is being stabilized by placement in concrete vaults or by encasement in concrete monoliths in trenches at the time of disposal.

As noted above, the cover system will be constructed of materials that are highly resistant to natural degradation processes (i.e., chemical and physical weathering).

2.2.5 Inadvertent Intruder Barrier

Human habitation of surfaces over closed LLBG facilities is the most potentially adverse inadvertent intrusion scenario considered in PAs (Wood et al. 1995, Wood et al. 1996). For closure of facilities with Class C LLW (comparable DOE Category 3 LLW), Nuclear Regulatory Commission (NRC) requires (10 CFR 61.52(a)(2)) that either the top of the waste must be a minimum of 5 m (16.4 ft) below final grade, or the waste must be covered with a surface barrier designed to protect against inadvertent human intrusion for at least 500 years. Criteria applied to the conceptual design of the proposed cover system were to:

1. Design a cover with a functional life of 500 years

2. Ensure that the top of the waste is at least 5 m (16.4 ft) below final grade or include appropriate design provisions to limit inadvertent human intrusion.

PAs for LLBGs with Category 3 LLW indicate that dose consequences to inadvertent intruders who take up residence 100 to 500 years after closure will not exceed the performance objective for intruder

protection (continuous exposure limit of 100 mrem/year) if the cover system conforms to the provisions in 10 CFR 61.52(a)(2).

The Modified RCRA Subtitle C cover is designed to withstand soil losses from wind and water erosion for a functional performance period of 500 years. The cover system (Layers 1 through 7) is 1.7 m (5.7 ft) thick. Filled trenches generally have been covered with 2.4 m (8 ft) of operational cover soil. The 5-m cover requirement will be met by placing a minimum 0.9 m (3 ft) of grading fill over each facility as an aspect of establishing grading slopes for the engineered cover layers. Grading plans will be developed during definitive design of the cover system.

The 15-cm (6 in.) thick low-permeability asphalt layer (Layer 6) of the proposed cover system represents a substantial barrier to inadvertent human intrusion. This layer will be impenetrable by hand excavation, and can only be breached with mechanized equipment. Absent other overt indications, this layer should serve to communicate to an intruder that the asphalt layer is part of an engineered structure. Any additional requirements that may be imposed on the design for intrusion prevention (e.g., surface warning markers) will be evaluated during definitive design.

2.3 WASTE CHARACTERISTICS

2.3.1 Current Waste Inventory

According to the draft SW-EIS, as of January 1, 1999, the Hanford Site Solid Waste Storage and Disposal Program inventory included a total volume of approximately 298,000 m^3 (390,000 yd^3) of LLW, TRU waste, MLLW, and minor volumes of elemental metals. Of this total, approximately 296,000 m^3 had been disposed in active LLBGs, and the remainder was undergoing treatment or storage in preparation for disposal.

2.3.2 Future Additions To Waste Inventory

The SW-EIS considers three separate management alternatives for solid waste streams at the Hanford Site:

- A No-Action Alternative: Under this alternative, LLW and LDR-compliant MLLW would continue to be disposed in LLBGs. Additional shallow LLBG trenches would be constructed as necessary to support ongoing operations. TRU in burial grounds would not be retrieved; Hanford generated TRU wastes would not be shipped to WIPP for disposal off site. Existing waste treatment operations at WRAP (certification and repackaging) and T Plant (decontamination) would continue. However, no new treatment facilities would be constructed on site. Wastes would continue to be accepted from off-site generators who currently ship waste to the Hanford Site.

- A Proposed Baseline Alternative: With this alternative, new facilities will be constructed at the Hanford Site for storage, inspection, treatment and final disposal or shipment off-site for all waste streams currently managed by the Solid Waste Storage and Disposal Program. It assumes the same sources, waste streams and volumes as the No Action Alternative. Most wastes currently in storage would be removed, treated as required, and disposed over the next 10 years. TRU waste in LLBGs would be retrieved, treated as necessary, packaged, and shipped to WIPP for final disposal. Wastes would continue to be accepted from off-site generators who currently ship waste to the Hanford Site. Capping and final closure of active LLBGs, including MLLW trenches, are considered under this alternative.

A sub-alternative considered under this alternative is to leave TRU waste in LLBGs in place as part of the site inventory at final closure.

- A Proposed Regional Alternative: This alternative is similar to the Baseline Alternative in terms of waste management activities and processes and plans for new waste handling facilities. It differs from the Baseline Alternative in that additional volumes of LLW and MLLW would be shipped to the Hanford Site from other DOE sites. This alternative results in greater volumes of LLW and MLLW being managed and disposed at the Hanford Site, as well as inspecting and preparing additional TRU for shipment to the WIPP repository. Capping and final closure of active LLBGs, including MLLW trenches, are considered under this alternative.

Table 2.1, which is a summary of information presented in Table B.1 of the draft SW-EIS, provides a listing of the waste inventory in LLBGs, as well as a forecast of future inventory volumes for the No-Action and Proposed Baseline Alternatives. Table 2.2, which is a summary from Table B.2 of the EIS, gives current and future inventory data for the Proposed Regional Alternative. The values in these tables are from the current draft of the EIS and may change after this Closure Plan is issued and before the EIS becomes final.

2.3.3 Radiological Inventory

Table 2.3 provides a listing of current radiological inventories in active LLBGs based on records in Solid Waste Inventory Tracking System (SWITS). PAs for active LLBGs consider only the inventories of waste disposed since September 26, 1988 with emphasis on the projected and final inventories of radionuclides in LLBGs that are regarded to be mobile in groundwater or contribute towards potential inadvertent intruder dose. Projected inventory additions to be disposed in LLBG are summarized in Table 2.4 (from Wood, 1999).

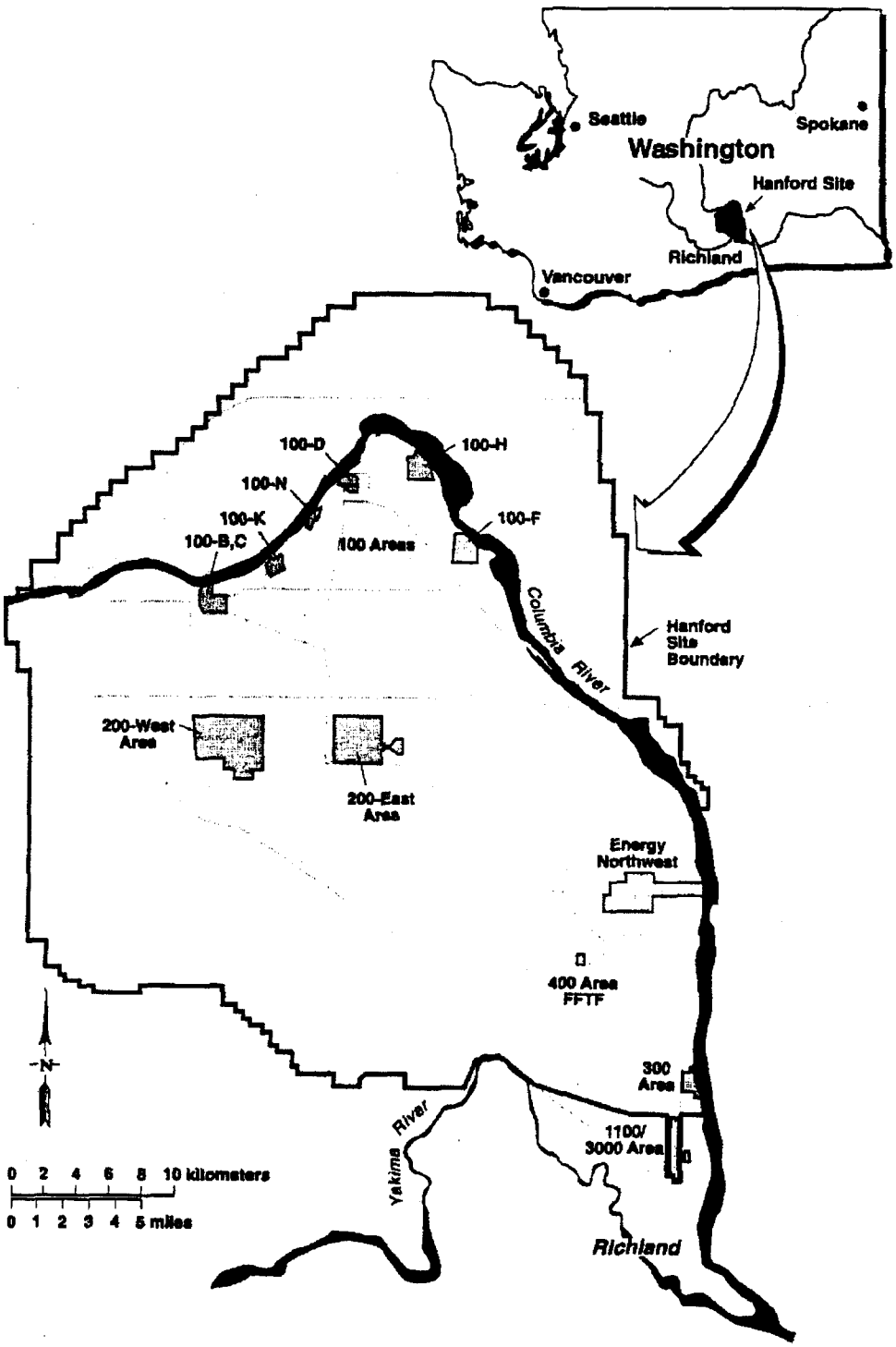


Figure 2.1. Map Showing Locations of the Hanford Site and the 200 Areas.

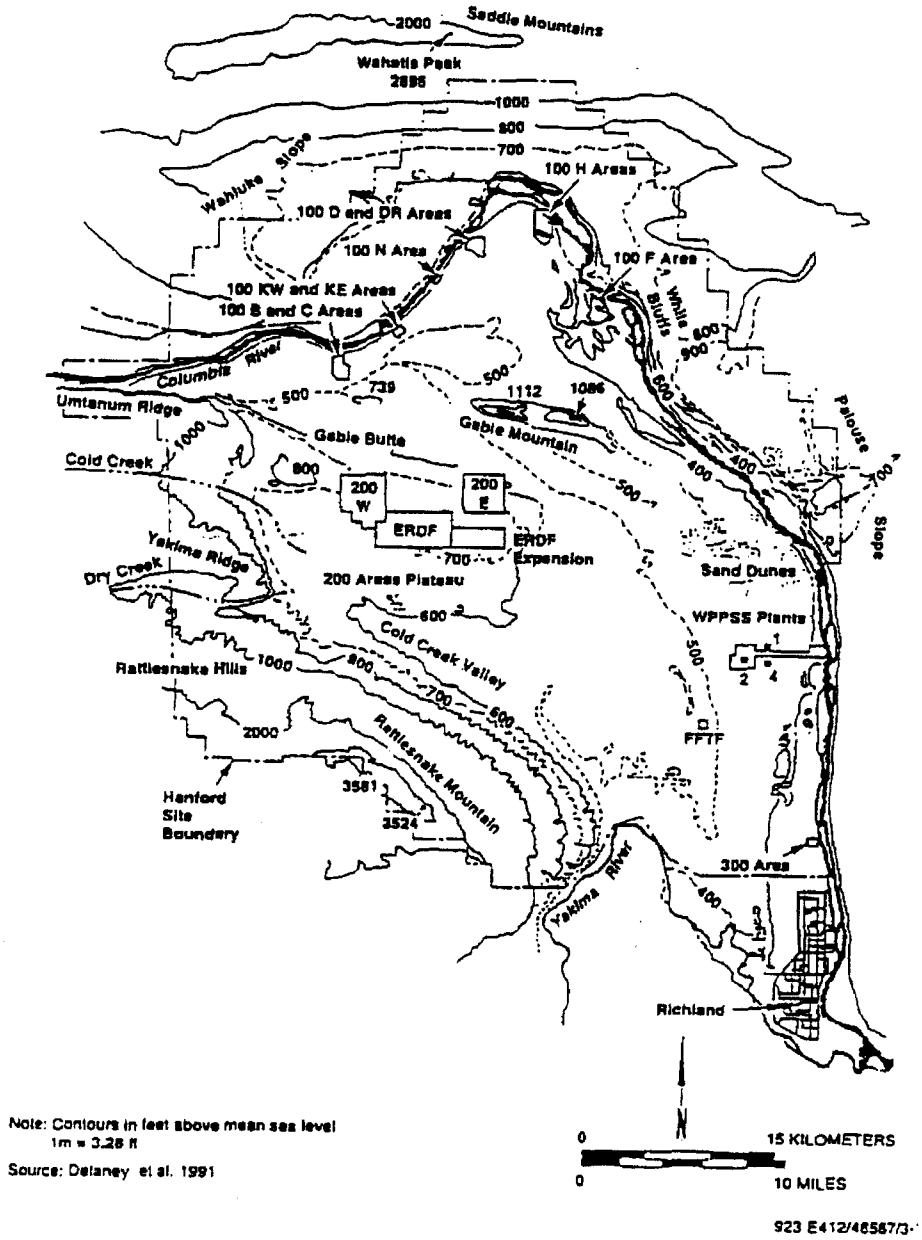


Figure 2.2. Topography of the Hanford Site.

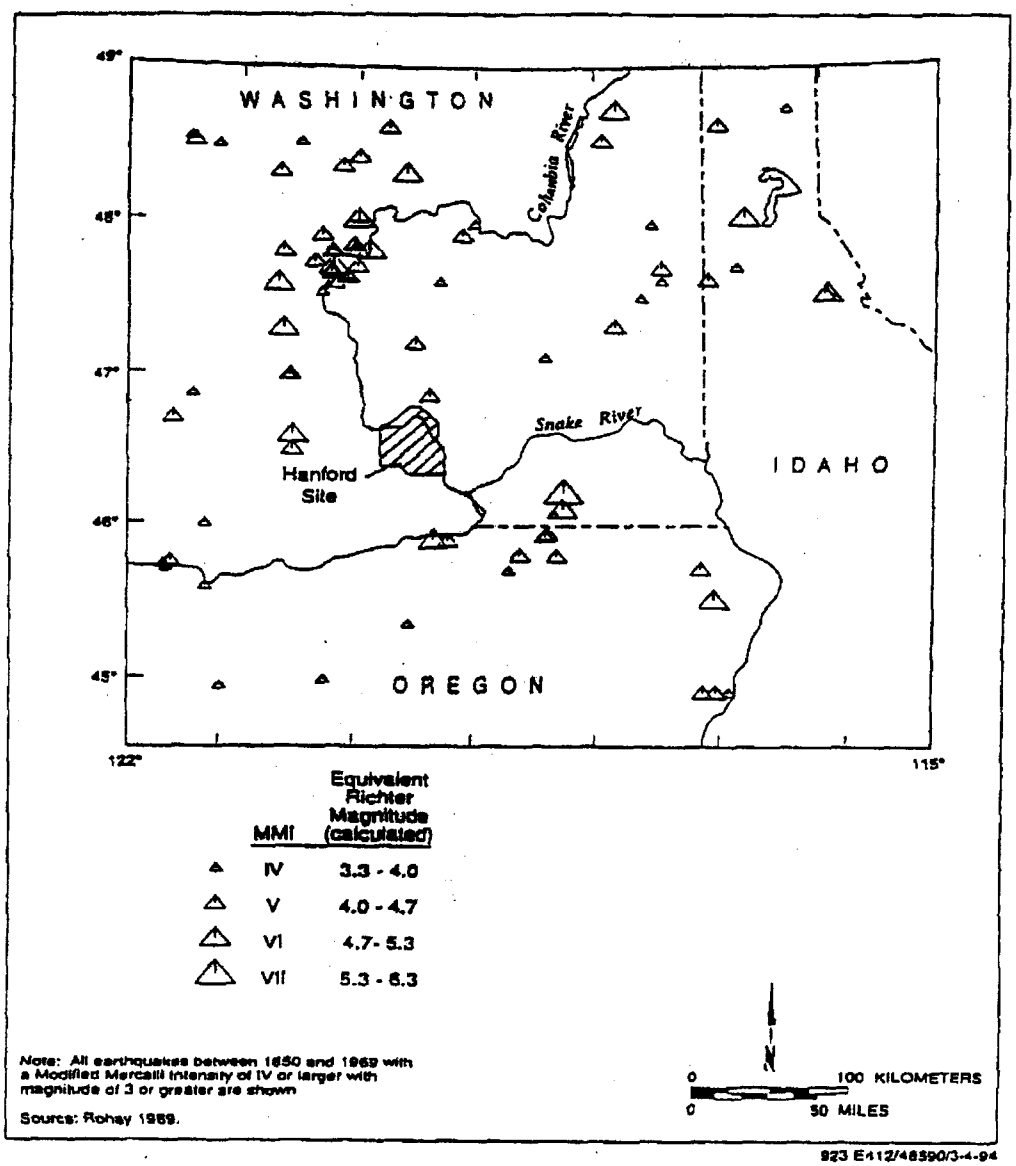


Figure 2.3. Historical Seismicity of the Columbia Plateau and Surrounding Areas.

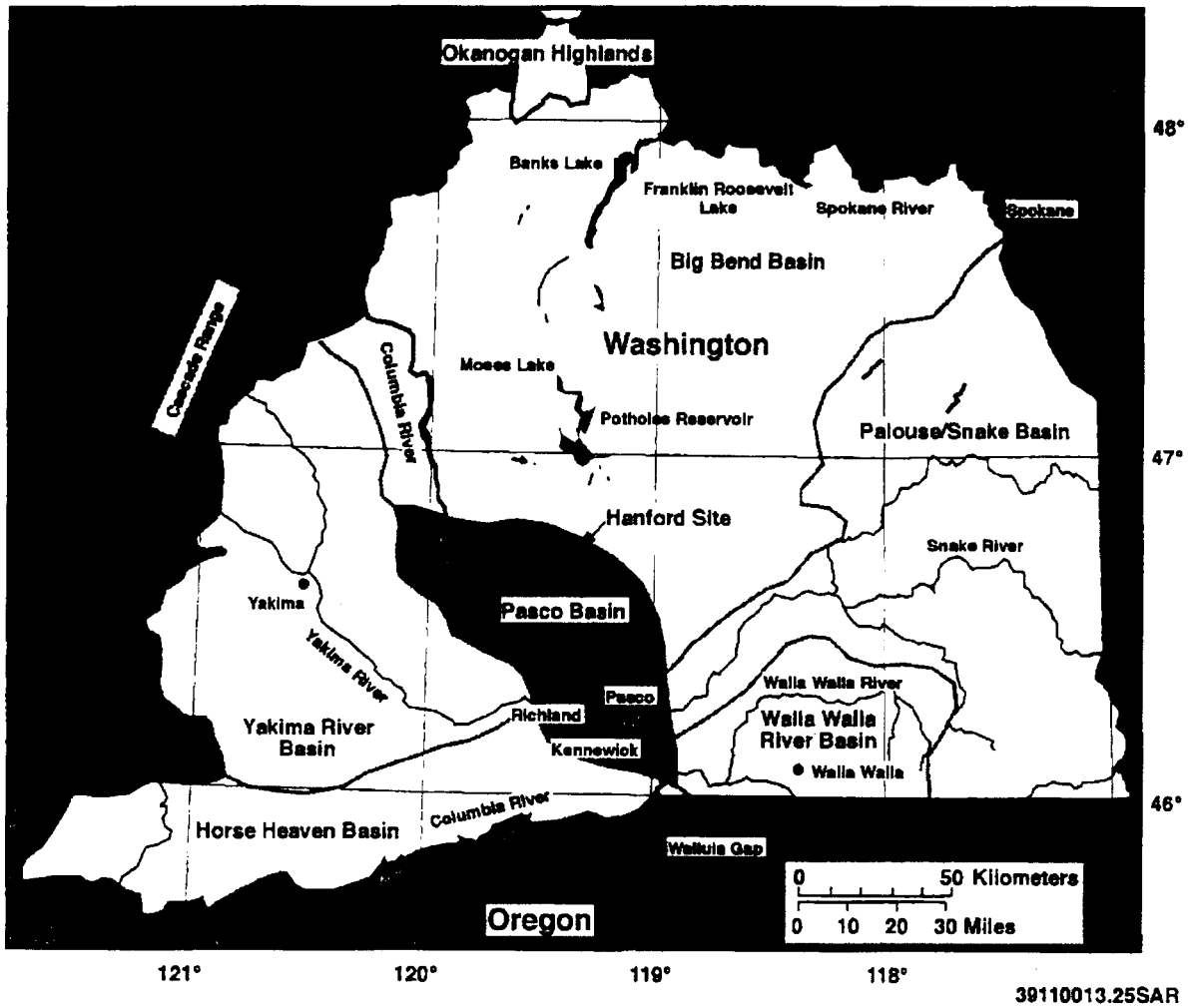


Figure 2.4. Hydrologic Basins Designated for the Washington State Portion of the Columbia Plateau.

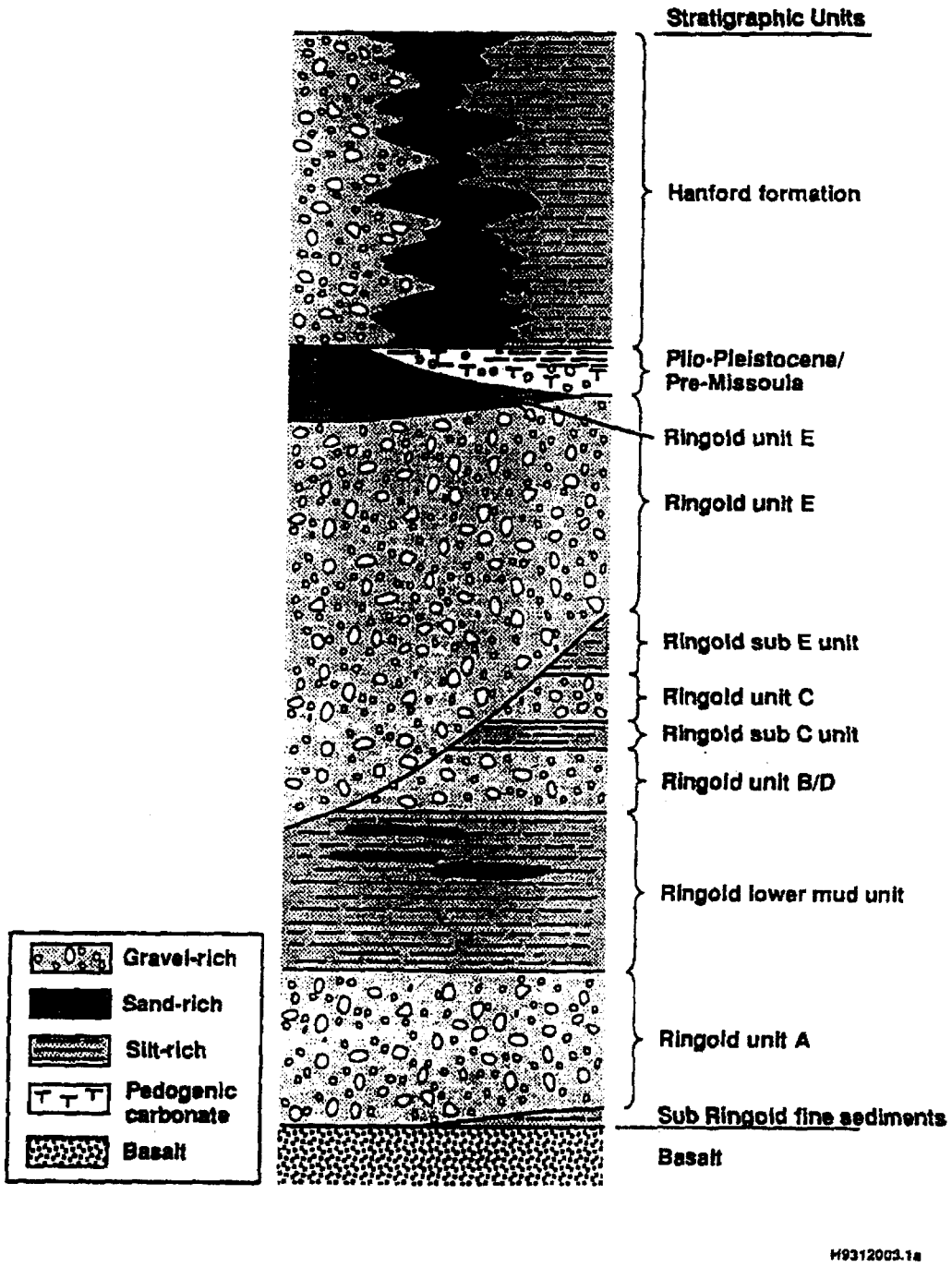


Figure 2.5. Centralized Stratigraphy of Suprabasalt Sediments on the Hanford Site.

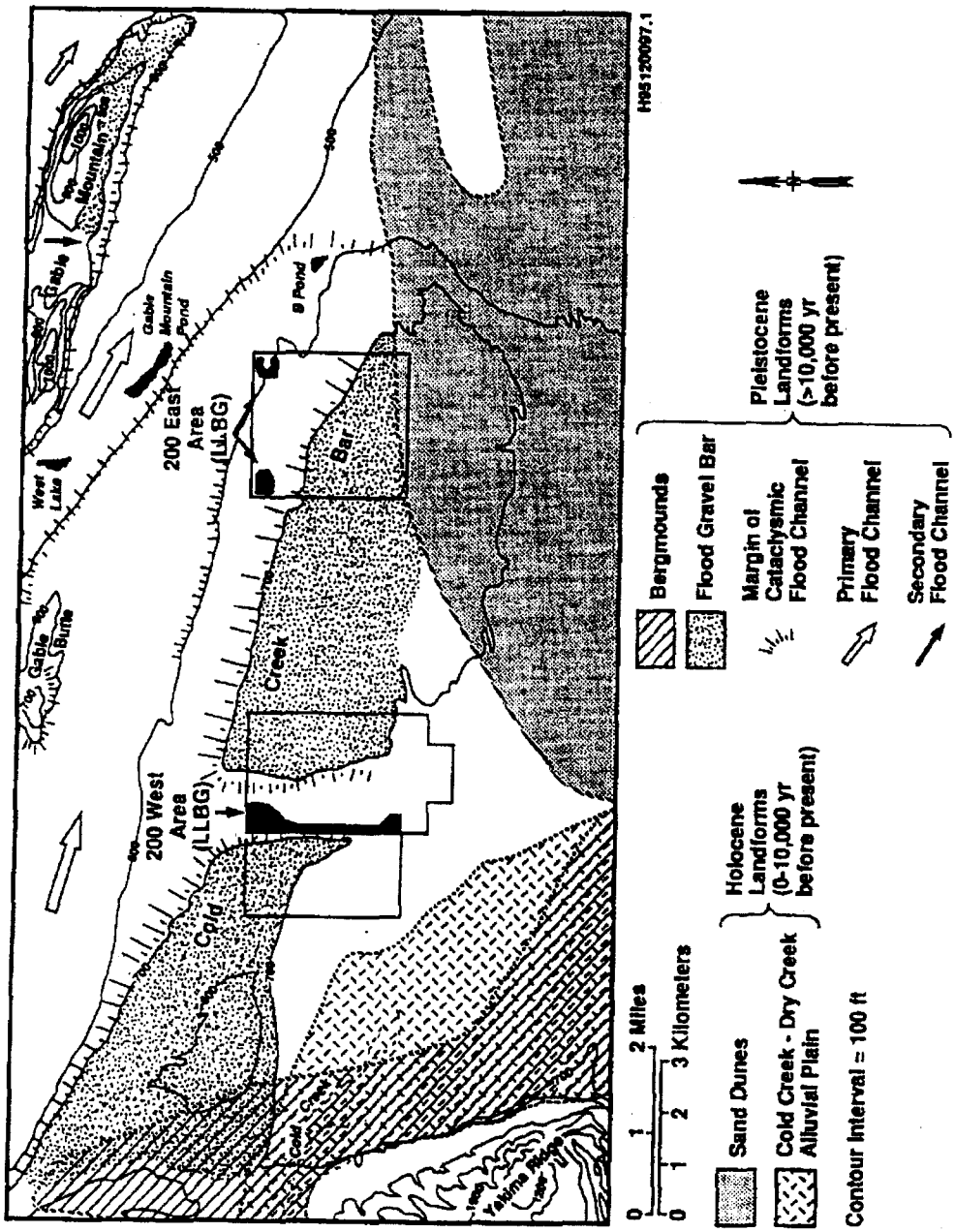


Figure 2.6. Geomorphic Features in the West-Central Portion of the Hanford Site.

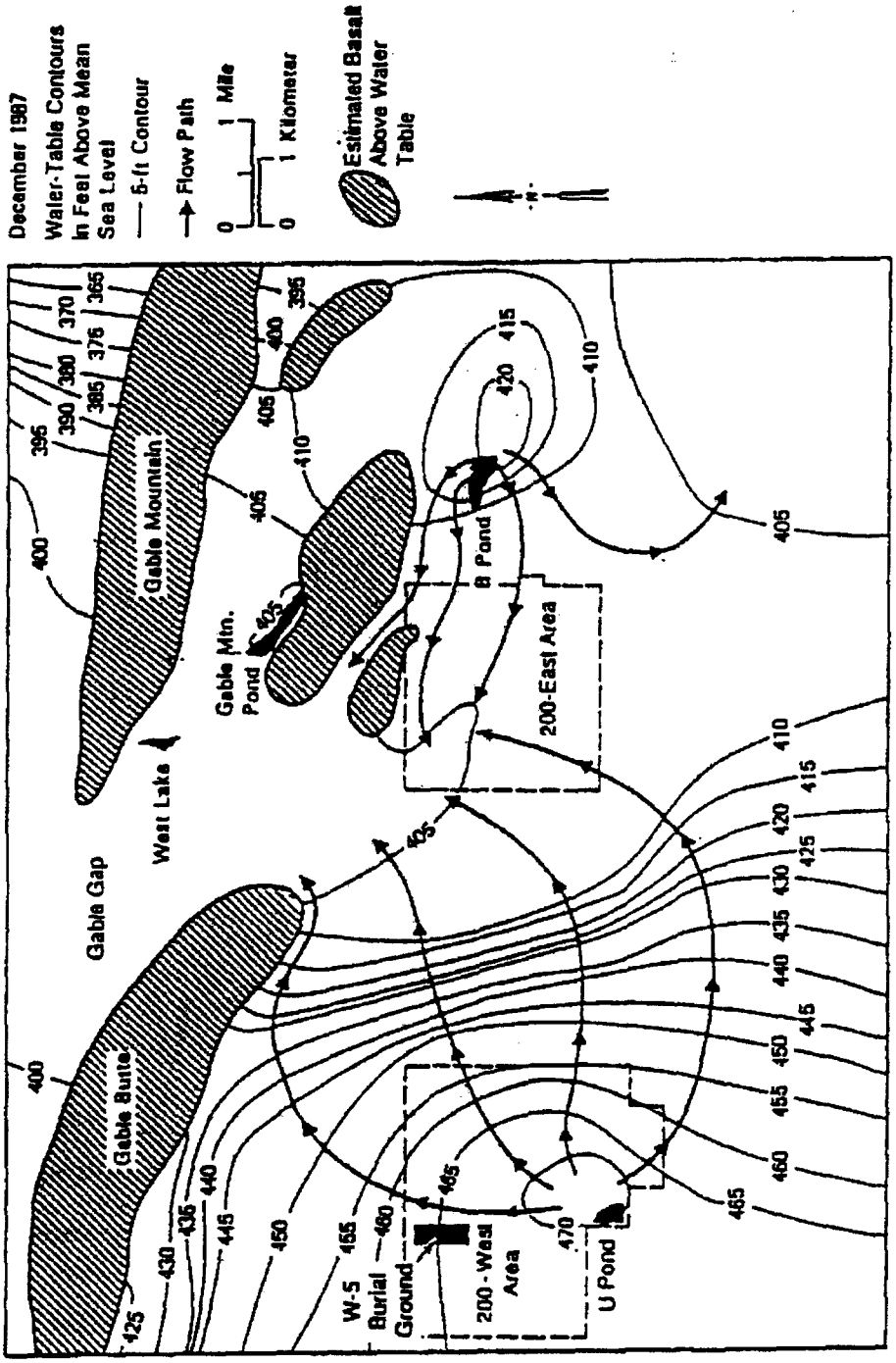


Figure 2.7. Water Table Map for the 200 Areas, December 1987.

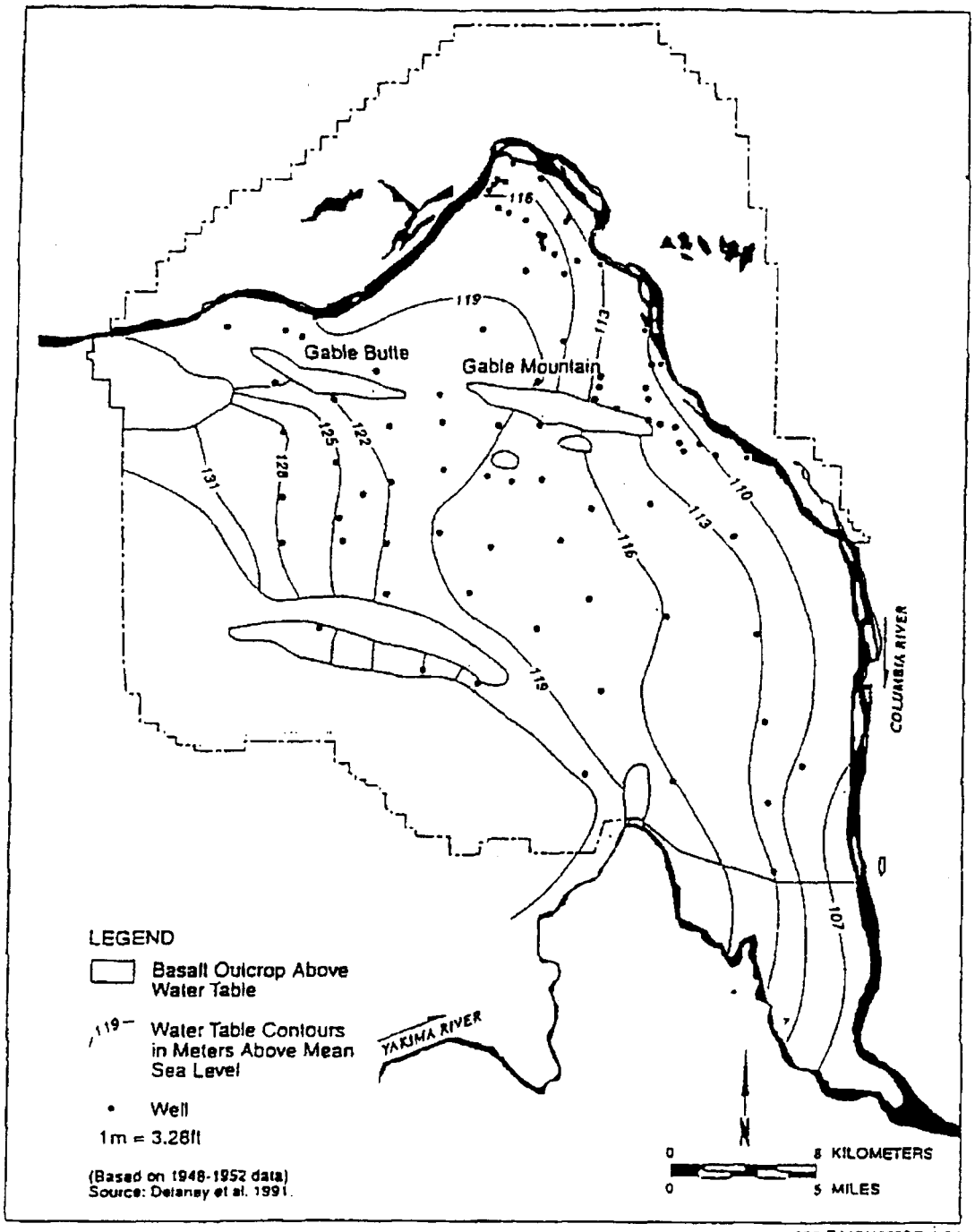


Figure 2.8. Hanford Site Water Table Map, January 1944.

Table 2.1. Waste Inventory and Forecast Volumes for Active LLBGs for the Baseline Alternative Described in the SW-EIS (DOE 2000)(a)

Waste Categories (i)	Inventory in LLBGs as of January 1, 1999 (in m^3)	Future Additions to Inventory (in m^3)	Cumulative Future Inventory (in m^3)
CAT 1 LLW	274,029 (b)	98,784 (c)	412,765
CAT 3 LLW		39,952 (d)	
TRU in Trenches and Caissons	14,825 (e)	57,189 (f)	72,014
MLLW	9,169 (g)	59,681 (h)	68,850

(a) Based on information presented in Table B.1 of the SW-EIS
(b) Sum of Streams 6, 19 and 20 in Table B.1
(c) Stream 1
(d) Stream 2
(e) Sum of Streams 4 and 5
(f) Sum of Streams 8, 9, 10, 16 and 17
(g) Sum of current inventories in Streams 11, 12, 13, 14 and 15
(h) Sum of future inventory additions in Streams 11, 12, 13, 14 and 15
(i) Waste Volumes in Streams 3 and 18 of Table B.1 are not included.

Table 2.2. Waste Inventory and Forecast Volumes for Active LLBGs for the Regional Alternative Described in the SW-EIS (DOE 2000)(a)

Waste Categories (i)	Inventory in LLBGs as of January 1, 1999 (in m^3)	Future Additions to Inventory (in m^3)	Cumulative Future Inventory (in m^3)
CAT 1 LLW	274,029 (b)	278,031 (c)	611,611
CAT 3 LLW		59,551 (d)	
TRU in Trenches and Caissons	14,825 (e)	63,492 (f)	78,317
MLLW	9,169 (g)	200,018 (h)	209,187

(a) Based on information presented in Table B.2 of the SW-EIS
(b) Sum of Streams 6, 19 and 20 in Table B.2
(c) Stream 1
(d) Stream 2
(e) Sum of Streams 4 and 5
(f) Sum of Streams 8, 9, 10, 16 and 17
(g) Sum of current inventories in Streams 11, 12, 13, 14 and 15
(h) Sum of future inventory additions in Streams 11, 12, 13, 14 and 15
(i) Waste Volumes in Streams 3 and 18 of Table B.2 are not included.

Table 2.3. Current Inventories of Radionuclides In LLBG (in Ci)

ISOTOPE	218-W-3A	218-W-3AE	218-W-4B	218-W-4C	218-W-5	218-E10	218-E-12B
^{277}Ac		8.00E-04		1.01E-06	6.15E-04		
^{228}Ac		3.58E-03		5.15E-04	1.51E-04		
^{108}Ag	9.10E-06	2.70E-05			2.84E-03		
^{110M}Ag-- ^{110}Ag	3.07E+00	1.17E-05		2.84E-05	3.14E-04		
^{28}Al					3.40E-05		
^{241}Am	7.93E+01	5.94E+01	4.16E+00	5.63E+02	3.33E+00	1.46E-03	1.67E+00
^{242M}Am	6.20E-03	1.86E-01		3.15E-04	4.35E-03		2.05E-06
^{243}Am	2.44E-02	8.01E-02		1.06E+01	1.69E-02		4.32E-06
^{39}Ar					2.30E-03		
^{195}Au		9.25E-05			4.78E-05		
^{133}Ba	1.59E-04	1.36E-02		6.95E-03	6.76E-02		
^{134}Ba					1.33E-07		
^{140}Ba				1.00E-03	1.38E-04		
^{10}Be	6.92E-10	4.60E-11		5.66E-05	1.06E-05		1.28E-06
^{7}Be	1.75E-01	3.98E-02		6.04E-03	1.38E+00		1.30E-09
^{207}Bi	2.70E-03	1.12E-03		1.20E-02	1.22E-02		
^{212}Bi		9.17E-02		4.35E-04	7.04E-03		
^{214}Bi	3.48E-05	6.75E-05		3.40E-04	7.21E-04		
^{14}Bi	1.74E+00	1.39E+01		2.63E+00	5.28E+00		1.31E+02
^{14}C ACTIV. METAL		2.01E+01		7.60E+01	3.51E-04		1.42E+02
^{45}Ca	1.00E-04	3.01E+00		1.99E+00	1.79E-02		
^{109}Cd	5.10E-04	2.38E-04		2.26E-03	2.03E-02		
^{113M}Cd	3.61E-05	1.46E-03		1.57E-05	3.64E-04		
^{141}Ce	1.75E+02	2.85E+00		1.19E-04	1.21E-03		4.01E-01
^{144}Ce --^{144}Pr	5.75E+04	1.16E+00	8.42E+01	1.67E+03	6.93E+00	9.67E-07	3.48E+01
^{249}Cf					1.67E-03		
^{250}Cf					2.38E-03		
^{251}Cf		1.05E-02			2.96E-06		
^{252}Cf	2.01E-05	1.38E-04		1.08E+03	1.29E+01		
^{36}Cl	2.00E-04	1.35E-03		1.61E-05	2.04E-03		5.56E-03
^{242}Cm	1.04E-02	6.34E-02		3.70E-03	1.61E+01		2.94E-03
^{243}Cm	3.92E-04	2.62E-01		2.43E-05	3.69E-03		5.11E-07
^{244}Cm	4.81E-01	1.66E+01		4.23E+01	4.81E-01		3.12E-04
^{245}Cm		2.04E-04		1.41E+00	3.95E-05		
^{246}Cm		1.99E-04			3.10E-05		
^{247}Cm		4.18E-07					
^{248}Cm		8.54E-06		7.00E-07	5.25E-05		
^{250}Cm					3.83E-21		
^{56}Co	2.78E-05	2.87E+00		1.57E-04	5.28E-01		
^{57}Co	2.83E-03	1.01E+01		2.57E-04	6.19E-01	3.78E-04	1.28E-03
^{58}Co	2.53E+01	3.93E+02		1.96E+03	1.45E+00		2.08E+04
^{59}Co					4.00E-06		
^{60}Co	4.98E+04	1.14E+05	2.09E+04	1.02E+06	7.17E+03	3.80E+03	1.08E+06
^{60}Co ACTIV. METAL		9.80E+00			3.36E-01	1.12E-02	7.60E+04
^{51}Cr	9.96E-03	3.53E-01	1.00E-01	8.95E+02	4.48E+00		3.61E+02

Table 2.3. Current Inventories of Radionuclides In LLBG (in Ci)

ISOTOPE	218-W-3A	218-W-3AE	218-W-4B	218-W-4C	218-W-5	218-E10	218-E-12B
^{133M}Cs					2.80E-03		
^{134}Cs	1.73E+04	1.94E+02	3.00E-01	1.79E+03	1.90E+00	1.61E-06	1.06E-01
^{135}Cs	1.10E-06	3.80E-07		4.80E-07	1.31E-07		
^{137}Cs-- ^{137M}Ba	3.14E+05	6.16E+04	3.55E+02	5.75E+04	3.06E+03	1.02E+06	2.69E+04
^{65M}Cu					7.02E-03		
^{254}Es		6.30E-09			1.15E-04		
^{152}Eu	2.29E+00	1.32E+03		2.10E+01	1.73E+00	2.01E-06	2.45E-05
^{153M}Eu		1.00E-09		6.37E+02			
^{154}Eu	1.73E+00	2.10E+03	2.20E-01	4.75E+02	1.28E+02	4.43E-07	1.96E-06
^{155}Eu	3.84E+01	5.29E+02		2.52E+04	1.27E+01	2.27E-06	
^{55}Fe	1.71E+00	2.46E+04		1.11E+04	1.04E+03	1.12E+00	9.27E+05
^{59}Fe	3.33E-01	1.49E+02	2.05E+00		3.70E+00		7.14E+01
^{68}Ga				2.20E-08	6.21E-02		
^{152}Gd	3.39E-03				8.47E-02		
^{153}Gd				1.00E-05	6.48E-04		
^{154}Gd	2.31E-03	1.25E-05			4.42E-02		
^{68}Ge	2.40E-02	1.12E-03		1.70E-05	6.19E-01		
^{3}H	4.44E+05	6.58E+04	2.31E+05	3.29E+04	5.32E+04	8.00E-08	1.12E+03
^{175}Hf		1.00E-03			1.00E-06		
^{181}Hf		1.07E-02			3.36E-06		2.32E+00
^{203}Hg		1.20E-06		6.00E-07	2.17E-04		
^{123}I					5.61E-04		
^{125}I	1.51E-02	4.11E-02		1.21E-01	1.57E-01		
^{129}I	1.44E-02	4.01E-04	5.00E-01	1.46E-03	3.44E-02		2.94E-03
^{131}I	1.37E-03	2.12E-04		1.00E-05	1.28E-02		
^{40}K	2.02E-04	6.05E-02		2.00E-04	1.53E-02	3.96E-04	9.27E-03
^{85}Kr	3.73E+03	1.31E+01		2.48E+01	8.80E+00		
^{140}La				1.20E-06			
^{54}Mn	4.36E+00	8.71E+03	3.62E+00	4.10E+02	9.66E+00	8.32E-04	1.12E+04
^{93}Mo		5.60E-02		2.29E+00	1.33E+00		6.90E-02
^{22}Na	6.64E+00	6.65E+00		5.73E-02	1.42E+01		
^{91}Nn		5.78E-02			4.41E-01		
^{93M}Nb	7.43E-05	1.64E-02		9.08E-05	2.61E-02		5.61E-01
^{94}Nb	2.14E-04	1.08E+00		1.38E+01	2.77E-01		1.50E+01
^{94Nb} ACTIV. METAL							1.45E+01
^{95}		2.09E+03		7.35E-05	1.04E-01		1.35E+03
^{147}Nd					2.41E-06		
^{59}Ni	8.78E-04	5.24E+02		9.77E+01	8.54E+01		5.12E+03
^{60}Ni	2.98E-01	1.80E+03		2.25E-01	3.23E+00		
^{63}Ni	3.89E+00	6.28E+04		1.27E+04	9.93E+03		9.56E+05
^{63}Ni ACTIV. METAL		1.21E+01					4.32E+05
^{237}Np	2.21E-02	6.69E-02	1.51E-01	1.02E-01	2.81E-02	1.05E-03	1.56E-08
^{32}P	4.71E-02	3.22E+00		1.90E-01	1.45E+00		
^{33}P		4.81E-01					
^{231}Pa		6.36E-03		2.32E-06	7.74E-01		
^{208M}Pb					9.20E-08		

Table 2.3. Current Inventories of Radionuclides In LLBG (in Ci)

ISOTOPE	218-W-3A	218-W-3AE	218-W-4B	218-W-4C	218-W-5	218-E10	218-E-12B
^{210}Pb		5.96E-04		3.60E-04	3.16E-02		
^{212}Pb		2.24E-03		5.76E-03	3.34E-03		
^{214}Pb	4.25E-05	7.03E-05		3.41E-04	2.59E-04		
^{107}Pd					1.62E-08		
Pe-Ci	3.00E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
^{147}Pm	4.02E+04	2.22E+00	9.59E+03	3.88E+03	3.71E+00		3.00E+00
^{210}Po		1.18E-02	7.00E+00	1.14E-04	4.79E-03		
^{195M}Pt					9.00E-10		
Pu	1.91E+04	7.98E+01	4.33E+04	2.40E+05	1.09E+02	3.23E+03	1.01E+03
^{236}Pu		1.99E-09					
^{238}Pu	9.19E+00	8.86E+00	2.45E+01	8.98E+04	5.88E+00	1.51E-04	1.89E+00
^{239}Pu	4.41E-01	1.53E+01		2.22E+02	7.67E+00	2.57E-03	1.59E-01
^{240}Pu	2.95E-01	7.67E+00		1.23E+02	1.37E+02	1.37E-03	1.15E-01
^{241}Pu	2.95E+01	3.21E+02		2.15E+04	1.13E+02	3.36E-02	4.52E+01
^{242}Pu	1.32E-04	5.05E-03		8.13E-02	6.85E-04		4.05E-07
^{244}Pu		1.10E-05		1.83E-12	2.99E-06		
^{239}Pu FSL GR EQUIV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
^{224}Ra		9.19E+02		2.27E+02	5.61E+02		
^{226}Ra	2.57E+00	2.35E-02		3.52E-02	2.89E+00		
^{228}Ra		7.80E-04		4.54E-04	1.31E-03		
^{85M}Rd					3.00E-06		
^{86}Rb	5.02E-03	1.00E-04			6.61E-03		
^{187}Re	2.00E-04	1.21E-09		5.07E-09	3.00E-06		
^{103}Ru--^{103M}Rh		1.00E-06	1.24E+00	2.00E-06	1.43E-01	1.21E-07	
^{106}Ru --^{106}Rh	6.80E+03	5.18E+02		3.23E+03	4.21E+00	1.15E-06	1.07E+00
^{35}S	4.24E-02	2.35E-02		2.18E-02	1.82E-01		
^{122}Sb	3.00E-07				6.62E-06		
^{124}Sb		4.30E-04		9.58E-07	1.85E-04		
^{125}Sb	1.49E+03	9.05E+03	2.00E-02	5.14E+02	2.53E-01	4.08E-07	1.21E+04
^{126}Sb	3.99E+00	7.20E-08		9.00E-08	2.50E-04		
^{46}Sc	2.87E-04	1.27E+00		2.23E-02	5.21E-02		
^{75}Se	8.60E-05	1.13E-02		5.00E-08	3.54E-03		
^{79}Se	1.12E-04	9.77E-03		2.71E-05	5.00E-03		2.31E-05
^{31}Si	1.50E-05				1.00E-04		
^{147}Sm	2.00E-04				7.86E-13		
^{151}Sm	9.98E-04	8.17E-03		3.07E+02	8.26E-01		4.44E-01
^{113}Sn		1.01E-05		4.30E-06	5.92E-01	1.42E-07	
^{119M}Sn		1.28E+04			4.64E-19		7.28E+03
^{121M}Sn	2.87E-07	1.60E+01		1.25E-07	3.30E-07		4.98E+01
^{123M}Sn		1.08E+02			2.00E-05		
^{126}Sn -- ^{126M}Sb	1.05E-03	3.78E-02			1.03E-03		
^{82}Sr				2.00E-06	4.33E-04		
^{85}Sr	2.88E-03	1.07E-02		2.02E-03	8.68E-02		
^{89}Sr		1.28E-04		1.91E-05	2.46E+00		
^{90}Sr -- ^{90}Y	9.11E+04	5.32E+04	2.88E+02	7.33E+03	2.08E+03	8.53E+05	2.69E+04
^{182}Ta	1.27E-03	1.24E+02		2.56E-01	2.52E-01		1.00E-03

Table 2.3. Current Inventories of Radionuclides In LLBG (in Ci)

ISOTOPE	218-W-3A	218-W-3AE	218-W-4B	218-W-4C	218-W-5	218-E10	218-E-12B
^{183}Ta		9.00E-01					
^{99}Tc	2.88E-01	9.80E+00		1.64E+01	3.95E-01	5.07E-03	8.08E-01
^{99}Tc ACTIV. METAL		1.00E-07					
^{121}Te					1.00E-04		
^{125M}Te	3.39E+02	1.92E+03		5.21E-04	4.15E-04		1.40E+03
^{127M}Te					5.02E-34		
^{129M}Te					1.00E-07		
^{228}Th	1.24E-04	6.32E+05		3.95E-01	1.53E+02	1.90E-05	
^{229}Th		1.84E-04		1.13E-04	3.26E-04		
^{230}Th	1.18E-03	5.04E-03		9.73E-04	1.90E+00		
^{232}Th	1.23E-01	7.61E-02	7.35E-02	1.38E-02	2.52E-01	9.73E-06	2.20E-11
^{234}Th	1.20E-02	1.95E+04		2.96E+00	1.34E+03	1.04E-02	4.18E-03
^{204}Th	5.00E-10	4.02E-01		1.00E-05	8.65E-04		
^{208}Th		6.76E-04		4.32E-01	2.12E-03		
^{170}Th	2.00E-04	2.00E-06			6.90E-07		
TOTAL BETA/GAMMA	1.69E+06	5.78E+05	5.07E+05	1.84E+06	1.86E+07	4.70E+06	1.10E+07
TOTAL-ALPHA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
^{232}U	3.32E-09	5.29E+01		1.86E-02	5.71E+00		
^{233}U	1.96E+00	1.07E-01	7.33E+01	8.08E+00	4.75E-02		
^{234}U	6.49E-03	8.53E+00		2.17E+01	1.49E-01	9.54E-02	1.02E-02
^{235}U	2.17E-03	8.41E-01		7.50E-01	2.88E-02	2.78E-03	3.97E-04
^{236}U	1.69E-04	2.60E+00		1.22E+00	1.47E-03	6.09E-13	
^{237}U				5.31E+07			
^{238}U	1.11E-01	6.22E+01		4.01E+01	6.66E-01	1.14E-02	4.68E-03
URANIUM-DEPLETED	2.48E+01	8.83E+00	1.63E+00	2.09E+00	6.61E+00		8.45E-02
URANIUM-ENRICHED	9.86E-01	1.17E+00	8.66E-01	6.11E-01	1.40E+00		3.86E-04
URANIUM-NATURAL	3.08E-01	2.57E-01	2.87E-01	1.10E+00	2.41E+00	2.80E-01	2.67E-03
^{49}V	4.00E-08	3.83E-09		1.70E-01	1.65E+00		
^{131M}Xe		2.75E-05			4.35E-07		
^{183M}W					5.77E-06		
^{185}W				6.10E-09	2.12E-05		
^{87}W				2.40E-03			
^{87}W					3.53E-03		
^{88}Y	1.40E+00	1.10E-02		2.80E-01	9.47E-05		
^{65}Zn	3.98E+01	2.12E+00		7.62E-02	2.08E+00	2.26E-07	3.32E-01
^{93}Zr	1.83E-05	2.00E+00		5.70E-04	1.01E-03		5.61E-01
^{95}Zr—^{95M}Nb	3.84E-06	9.77E+02	3.00E+01	4.51E-05	1.14E-02		3.94E+00

Table 2.4. Projected LLW and MLLW Inventory to be Disposed in LLBG from 1998 to Closure (Wood, 1999)

Radionuclide	Predicted Inventory (Ci)	Current Inventory (Ci)	Predicted Total Inventory at Closure (Ci)
H-3	3.80 E+05	8.20 E+05	1.20 E+06
C-14	6.14 E+01	2.66 E+02	3.27 E+02
Cl-36	4.99 E-05	7.15 E-03	7.20 E-03
Co-60	4.23 E+05	2.26 E+06	2.68 E+06
Se-79	5.44 E-04	5.21 E-03	5.75 E-03
Sr-90	3.86 E+07	1.02 E+06	3.96 E+07
Tc-99	1.57 E+01	1.82 E+01	3.39 E+01
I-129	2.64 E+00	5.54 E-01	3.19 E+00
Cs-137	3.85 E+07	1.47 E+06	4.00 E+07
Np-237	1.51 E+00	3.28 E-01	1.84 E+00
Pu-241	1.10 E+03	2.19 E+04	2.30 E+04
Pu	2.69 E+03	4.19 E+05	4.22 E+05
Am	260 E+03	6.75 E+02	3.28 E+03
U-233	1.84 E+00	8.35 E+01	8.53 E+01
U-234	3.18 E-01	3.00 E+01	3.03 E+01
U-235	1.43 E+00	1.60 E+00	3.03 E+00
U-238	1.03 E+00	1.01 E+02	1.02 E+02
U Total	4.61 E+00	2.16 E+02	2.21 E+02
Other	1.04 E+02	1.54 E+07	1.54 E+07
Total	7.79 E+07	2.14 E+07	9.93 E+07

*Tritium activities are those identified at the time of disposal and do not account for radioactive decay.
**53.48 Ci are present in activated metal and 7.92 Ci are associated with unconsolidated waste.

3.0 TECHNICAL APPROACH TO CLOSURE

After operations are concluded at individual LLBGs, they will enter into a process of closure consistent with requirements identified in DOE Order 435.1 or subsequent orders or regulations. During an initial period (termed Interim Closure), below ground modification methods will be applied to concentrate and stabilize waste and operational cover soil within individual trenches. These measures will be necessary to prepare each trench for construction of an engineered surface barrier, which is the anticipated final remedial action. It is envisioned that administrative control of individual LLBGs will be transferred from the Waste Management contractor to the ER contractor at some point during the Interim Closure period. Construction of surface barriers will occur during the Final Closure period. Information is presented in this section regarding the anticipated scope and extent of activities to be performed during Interim Closure, Final Closure and the Institutional Control Period following closure.

3.1 FACILITY TRANSITION

Currently, the Hanford Site Waste Management contractor has the prime responsibility for operation of active LLBGs. The site ER contractor has responsibility for remediation of radioactive waste burial grounds in the 200 Areas that were "inactive" when the ER contract was implemented at the Hanford Site in 1994. Active and inactive burial grounds are-located in the 200 East and West Areas. In the ER contractor's remedial action planning documents for the 200 areas (e.g., DOE/RL-98-28), active and inactive burial grounds are identified together in a single process-based waste site operable unit (200-SW-2, "Radioactive Landfills and Dumps Group").

Prior to terminating operations at active LLBGs, a Facility Transition Plan will be developed for transfer of the active LLBGs for final remediation. End-point turnover criteria will be prepared for use as acceptance criteria for facility transition. These criteria will be documented in the transition plan. The transition plan will delineate respective roles and responsibilities during the transition period and will identify a specific point in time or set of conditions when turnover and transition from active to inactive status will occur.

3.2 OPERATIONAL/INTERIM CLOSURE

3.2.1 Background/Introduction

This plan specifically addresses closure of the eight active LLBGs at the Hanford Site. However, the intent of transitioning active LLBGs to the ER program for final remedial action (i.e., Final Closure) is to facilitate remediation of active and inactive LLBGs in a manner that will be integrated to the maximum practical extent. Therefore, it is anticipated that the following discussion of proposed approaches for closure of active LLBGs would be applicable to inactive LLBGs as well. The oldest active facility (218-E-10) first received LLW in 1960. Over the past 40 years, waste disposal practices at LLBGs have evolved in response to lessons learned, administrative changes, changes in DOE policy regarding classification and management of radioactive waste, and the imposition of new state and federal regulations.

Trench designs (i.e., trench lengths, depths, widths and cross-sections) vary within individual burial grounds, in response to factors such as packaging, external dose rates, unloading methods, and environmental considerations. All active burial grounds have accepted some quantity of bulk waste (e.g., contaminated vegetation and contaminated equipment) as well as packaged waste. Packaging has

included steel drums and boxes, wood pallets, plywood and cardboard boxes, and reinforced concrete high-integrity containers (HICs) for stabilization of Category 3 waste. Drummed and boxed wastes were intermingled in many trenches. In some cases, trenches have been used exclusively to dispose of CH or RH wastes. However, historical operating practices have not included a procedural requirement to segregate Category 1 and Category 3 LLW. Consequently, all active LLBGs contain significant quantities of Category 3 LLW. Operations at all active LLBGs (excluding 218-W-6, which is unused) predate implementation of the State of Washington's dangerous waste regulations (WAC-173-303) at the Hanford Site.

Disposed waste in trenches is covered with soil to minimize or prevent worker exposures, environmental releases of contaminants, and biointrusion. Prior to 1972, the prevailing operating practice was to construct trenches so that by covering the waste with 1.2 m (4 ft) of soil, the surface would be restored to the surrounding grade. An assessment in 1972 concluded that 1.2 m (4 ft) of cover was not always sufficient to prevent biointrusion, and procedures were modified at that time increasing the thickness of operational cover to 2.4 m (8 ft).

No systematic or specific efforts have been made during burial grounds operations to compact trench fills. Deterioration of packaging in covered trenches is the source of an ongoing problem with localized subsidence, requiring weekly inspection and maintenance. Low bulk density and the ongoing decomposition of waste packaging in trench fills present significant long-term stability issues that must be resolved before final site remediation (i.e., final closure) can be implemented.

3.2.2 Sub-grade Modification

The principal objectives of sub-grade modification activities performed during the Interim Closure Period will be to:

1. Densify and stabilize trench fill materials to minimize or eliminate sources of long-term settlement and subsidence.

2. Develop sufficient bearing capacity to support the weight of an engineered surface barrier over the site (i.e., the anticipated final remedial action).

Potential sub-grade modification methods are listed and briefly described below. Implementation of these methods is 30 years in the future and new ground-modification technologies may become available within this time frame. However, the necessary objectives could be met using methods and equipment that are available now.

- Deep Dynamic Compaction: The technique involves dropping heavy (e.g., 4.5 to 18.1 metric ton, 5 to 20-ton) steel or concrete blocks onto the ground surface 6 to 30 m (20 to 100 ft). A grid pattern is marked off over the surface area to be treated. Each grid point receives several (two to ten) blows in one or several passes. The drop block typically is raised and dropped by a crane with appropriate capacity and rigging for the activity. Limited performance tests at the Hanford Site (Phillips and Gilbert 1985) have shown that multiple blows with impact energies of 4.0×10^5 J/m^2 (or about 27,000 lb ft/ft^2) give adequate compaction of waste fills to a depth of 3.0 m (10 ft).

- Vibroflotation: Vibroflotation is a technique that has been in use since the 1930s for compacting granular soils to considerable depths [6 m (20 ft) or more]. A tool string is vibrated into the ground, with or without assistance of a water spray jet. Soil is compacted in a radial direction outward from the centerline of the tool string. Effective compaction of soil is achieved to a radial distance of about 1.5 m (5 ft).

- Compaction Grouting: This technique is included as an alternative to mechanical methods and involves injecting a very stiff mortar-like grout into the soil mass. The grout is designed to stay together in a homogeneous mass that displaces and compacts the surrounding soil (Bandimere 1993). Displacement of the soil increases its in-place density and bearing capacity. Specially designed equipment is required for mixing and pumping the stiff and abrasive grout mix used in this method.

- Permeation Grouting: A highly flowable grout material is injected into the soil mass under low pressure, displacing air and filling the void volume in the soil. Chemical grouts or micro-fine cement grouts with moderate to high water to cement ratios typically are used (Bandimere 1993). When the cement hardens, the soil mass is bonded together into a monolith with improved bearing capacity. This technique is envisioned to be advantageous for limited situations such as improving bearing capacity of backfill soil around HICs.

- Void-Fill Grouting: For certain types of waste containers (such as large heavy-gauge steel boxes) that may retain structural integrity in trench fills for many years, and may be difficult to compact effectively by dynamic methods, a useful alternative is to drill into the container and displace the air volume with a flowable, self-leveling grout formulation. This technique already is used, to a limited extent, in LLBG operations.

3.2.3 Supporting Geophysical Monitoring/Investigation Methods

It is envisioned that sub-grade modification operations will be monitored and evaluated principally by geophysical survey methods. The primary objectives of geophysical surveys over solid waste landfill trenches will be to:

1. Accurately delineate the lateral boundaries of individual trenches, the locations of various disposed materials and void spaces within the trenches, and the thickness of overburden (i.e., operational soil cover),

2. Evaluate the density of trench fill materials.

Geophysical surveys will be used to plan and administer trench fill densification work and to provide confirmation of the effectiveness of densification efforts. Electromagnetic induction, ground-penetrating radar, and micro-gravity surveys are proposed investigative methods for making these assessments. Shallow reflection seismic surveys could also be performed as an alternative to micro-gravity surveys or as a supplemental method for obtaining in-place density data. These methods are all noninvasive techniques.

3.2.4 Implementation of Sub-Grade Modification Methods to LLBG Trench Fills

The goal of sub-grade modification is to densify and/or stabilize trench fill materials so that adequate bearing capacity can be developed to support the weight of an engineered surface barrier over the site. The actual bearing capacity requirement is traceable to specific attributes of the surface barrier design. The key determinants from the design are: (1) the combined weight per unit area of materials in the various barrier layers and (2) the amount of differential settlement that can be tolerated by the barrier without compromising any essential performance functions or design attributes.

For each burial ground undergoing closure, trench-specific remedial designs will be developed that take into consideration the original waste inventory information, the results from geophysical investigations,

and the final cover design. Remedial designs will provide specifications for the types of sub-grade modification methods to be implemented for trench fills and remedial action goals (corresponding to acceptable bearing capacity and settlement values).

Among currently available methods, deep dynamic compaction is envisioned to be the method of choice for densifying trench fills containing bulk waste, drummed waste, and small boxes. Deep dynamic compaction probably will not be suitable for trenches or portions of trenches containing HICs. However, since the number of trenches in LLBGs containing HICs is relatively small, this limitation is not viewed as severe. Deep dynamic compaction may also be unsuitable for compacting boxes with large air voids or large boxes with reinforced concrete or heavy steel construction. Alternative methods (e.g., vibroflotation, permeation grouting, or compaction grouting) can be used to densify soil in the vicinity of HICs. Large boxes could be filled with grout.

Trench fills will be periodically resurveyed by geophysical methods during and after sub-grade modification to assess progress toward site improvement goals and to identify areas that require additional remedial attention. The geophysical survey reports generated during the work will provide an effective means of documenting the extent of remedial activities at the conclusion of the work.

An implementation-testing program will be required to develop and evaluate performance attributes of various candidate sub-grade modification methods. This testing is needed to:

- Evaluate performance attributes (e.g., hole spacings, number of passes, drop weights and heights, grout formulations),
- Develop correlations between geophysical measurements and target bearing capacity values (e.g., correlations between seismic velocity data and/or micro-gravity readings and in-place bulk density and bearing capacity),
- Evaluate the overall suitability and effectiveness of various proposed methods,
- Acquire cost and schedule data for devising appropriate procurement strategies for contracting of geotechnical services and equipment.

All of these types of information are needed to prepare effective trench-specific remedial action plans and designs.

3.2.5 Inspection, Monitoring and Maintenance during Interim Closure

It is anticipated that current inspection, monitoring, and maintenance activities performed in support of facility operations will continue into and through the Interim Closure period. Inspections of burial grounds surfaces for newly-formed subsidence features will continue to be performed on a regular schedule. Leachate collection systems for lined mixed-waste trenches will be inspected, monitored and maintained until leachate generation is eliminated. Site access controls also will be inspected at regular intervals. Maintenance activities will be scheduled as needed to address deficiencies noted on inspection logs.

The regimen of inspection, monitoring, and maintenance practices carried over from LLBG Operations into the Interim Closure period will be revised (downgraded) as specific inspection and monitoring requirements can be eliminated. As sub-grade modification of individual trench fills is completed, there will be no further need to include these areas in periodic inspections. Groundwater monitoring will continue through the Interim Closure period, consistent with requirements and commitments described in

Environmental Monitoring Plan (DOE 1991), *Revised Groundwater Monitoring Plan for the 200 Areas Burial Grounds* (WHC 1989) and/or successor documents. Currently, groundwater monitoring of LLBGs involves semiannual sampling and analysis of a total of 57 wells. Groundwater sampling procedures, laboratory analytical procedures, statistical evaluation procedures, data quality objectives and quality assurance requirements for the current near-facility groundwater monitoring program are provided in WHC (1989). Changes to the groundwater monitoring program for LLBGs will be documented as revisions to that document or successor documents.

Monitoring wells are inspected at each scheduled sampling event. An inspection log is prepared to document any maintenance issues (e.g., repairs to casing, screen, pump or locking cap) identified.

3.3 FINAL CLOSURE

3.3.1 Background for Final Cover Design

Performance assessments for LLBGs in the 200 East and West Areas of the Hanford Site provide separate assessments of Category 1 and Category 3 LLW facilities. The PAs included the following assumptions regarding final cover treatments:

- Category 1 LLW facility: The Category 1 facility would be covered by a minimum thickness about 3 m (10 ft) of sand-gravel cover with no vegetation or sparse shallow-rooted vegetation such as cheat grass, permitting a maximum amount of moisture infiltration (assumed to be 5 cm/yr, 2 in/yr) into the buried waste layer. The thickness of cover material would not be sufficient to prevent an inadvertent intruder who digs a basement or drills a well from coming into direct contact with buried waste. Stabilization of buried waste to support a final cover was not assumed. Immobilization of radionuclides in waste disposed in a Category 1 facility is not required.

- Category 3 LLW facility: The Category 3 facility would be covered with suitable soil to support natural vegetation, including a mix of shallow- and deep-rooted plant species. The cover treatment would limit infiltration into the waste layer to 0.5 cm/yr (0.2 in/yr). A minimum of 5 m (16.1 ft) of cover materials would be placed over a Category 3 facility, so that the inadvertent intruder would not expose buried waste in a typical basement excavation, but would penetrate the waste layer in the process of drilling a well. The assumption was made that buried waste in a Category 3 facility would have to be stabilized to achieve acceptable cover performance. Immobilization of radionuclides may be required for some wastes disposed in a Category 3 facility, depending on the concentrations of long-lived radionuclides that are mobile in the soil column.

The PAs do not provide specific recommendations regarding the design of either cover treatment. However, it will be necessary to demonstrate during the design process that the proposed final cover design will meet or exceed the performance allocated to (assumed for) covers in the PAs.

Historically, Category 1 and Category 3 wastes have not been segregated. All active burial grounds have received Category 1 and Category 3 LLW, and the two waste classes are commingled in many individual trenches. In addition, all active burial grounds have received some quantities of waste containing constituents that are currently regulated by the State of Washington as dangerous waste under provisions of WAC 173-303. Several burial grounds also inadvertently received small quantities of waste that, based on the current waste designation method, are classified as TRU and/or Greater Than Class C (GTCC) LLW. Because these wastes were designated Category 3 at the time they were received, they were not disposed in a manner that would facilitate retrieval at a later date. There are no current plans to attempt to remove these wastes prior to final closure.

Consequently, closure requirements pertaining to Category 3 facilities in the PAs likely will apply to all active LLBGs. Closure requirements for State regulated dangerous waste also will apply as "Applicable or Relevant and Appropriate Requirements" (ARARs) during final remedy selection under CERCLA. The current PAs for LLBGs have determined that small quantities of waste in LLBGs currently designated as TRU or GTCC LLW are not significant relative to overall facility performance (i.e., additional closure requirements that pertain specifically to these waste types will not apply).

In 1996, the ER contractor prepared a Focused Feasibility Study (FFS) of engineered surface barrier treatments as a class of remedial action strategies for diverse waste sites in the 200 Areas (DOE 1996). The study included a comprehensive review of federal and state regulations and DOE Directives pertaining to various categories of regulated waste as sources of requirements and criteria for cover designs. It drew upon the collective experience with cover designs for Hanford Site applications, including research and development activities as well as site-specific designs for individual waste sites. A graded approach based on a limited number of conceptual cover designs was proposed for a broad range of waste site applications. These designs provide a range of cover options for minimizing health and environmental risks associated with specific waste categories and performance periods ranging from 30 to 1,000 years.

The cover designs in the FFS are generic conceptual designs rather than definitive designs for specific sites. Each conceptual design provides a description of the layer sequence in section view through the cover. The conceptual designs do not address construction details, such as the method of terminating individual layers at the edge of the covered area or the method for collecting surface runoff and/or lateral drainage at the perimeter. A definitive design must be generated to adapt one of these generic designs to a specific site or group of sites. Considerations to be addressed in definitive design include the contaminant inventory at the site, remedial action objectives, the local geology, topography, and proximity and surface grading of adjoining facilities and/or waste sites. In the FFS, it is envisioned that a site-specific definitive design might result in modifications to a generic design or development of an alternate design that is optimal for unique site conditions.

3.3.2 Description of Final Cover Design

Based on the decision logic and selection rationale elaborated in the FFS, the Modified RCRA Subtitle C Barrier design has been designated as the current planning basis for final closure of active LLBGs. The logic and rationale supporting this design are consistent with the current out-year planning and long-range implementation planning of the Department of Energy. This barrier treatment also is assumed in the SW-EIS (DOE 2000) as an element of the Baseline Alternative and the Regional Alternative for purposes of evaluating closure of LLBGs. The planning basis may change in the future to reflect developments and/or modifications to barrier technology for Hanford Site applications. Any changes to the planning basis will be documented in revisions to this document.

Design descriptions of the individual layers in the Modified RCRA Subtitle C Barrier and their respective functions are provided in the following subsections, which are excerpted from DOE (1996). Figure 3.1 shows a profile view through the barrier.

3.3.2.1 Layer 1 (Topsoil with Pea Gravel Admixture) and Layer 2 (Compacted Topsoil without Pea Gravel)

Layer 1 consists of 50 cm (20 in.) of sandy silt-to-silt loam soil containing 15 percent (by weight) pea gravel. Layer 1 will be placed in a relatively loose condition, with a bulk density value of about 1.46 g/cc

(91 to 92 lb/ft^3). Layer 2 consists of 50 cm (20 in.) of the same silt loam soil, without pea gravel, placed in a relatively densified state, approximately 1.76 g/cc (110 lb/ft^3).

The topsoil component (i.e., Layers 1 and 2) is designed to perform as a storage medium for soil moisture, and to support cover vegetation. The purpose of the pea gravel in Layer 1 is to improve the soil's resistance to wind erosion (Ligotke and Klopfer 1990). The surface slope will be limited to 2 percent (after allowances for settlement and subsidence). This value is steep enough to provide for coherent drainage of runoff from the covered area, yet shallow enough to limit exposure of the surface to wind erosion.

Compaction of Layer 2 during construction will decrease its saturated hydraulic conductivity by three to four orders of magnitude (i.e., from values in the range of 10^{-3} to 10^{-4} cm/s down to values between 10^{-6} to 10^{-7} cm/s). The indicated reduction in conductivity is readily achievable by compacting the silt loam soil to densities in the range of 1.68 to 1.84 g/cc (105 to 115 lb/ft^3). Laboratory testing indicates that these results can be accomplished with moderate compactive effort (Skelly et al. 1994). Compaction will retard moisture migration through Layer 2. A capillary barrier at the base of Layer 2 will enhance moisture retention and evapotranspiration within Layers 1 and 2. Numerical performance simulations using the Hydrologic Evaluation of Landfill Performance (HELP) Model predict that essentially 100 percent of average annual precipitation will be removed from the barrier by evapotranspiration (DOE 1996, Appendix C).

Cover vegetation will consist of a mixture of perennial grass species. Specifications for the seed mix, and the methods of seed application, fertilizing, and mulching will be developed during definitive design. Planting of cover vegetation will meet or exceed recommendations in EPA's technical guidance for final covers (EPA 1989).

3.3.2.2 Layer 3 (Sand Filter) and Layer 4 (Gravel Filter)

These layers are components of a two-layer graded filter designed to prevent topsoil particles from moving downward and accumulating in the lateral drainage layer (Layer 5). Both layers are 15 cm (6 in.) thick. These materials will be clean, screened aggregate materials obtained from a local borrow site. The design of the graded filter conforms to the criteria published in Cedergren (1989) and Ecology (1987).

3.3.2.3 Layer 5 (Lateral Drainage Layer)

This layer will facilitate the removal of any moisture that moves completely through the topsoil component of the barrier (Layers 1 and 2). This layer represents a contingency scheme to remove soil moisture in response to extreme climatic events, such as the design storm. Layer 5 will be sloped at 2 percent to move water to the edge of the cover where it will be collected and/or diverted in an appropriate manner. Layer 5 will be 15 cm (6 in.) thick and will be constructed of clean, screened aggregate material with a hydraulic conductivity of at least 1 cm/s. An effective particle size (D_{10}) of 1 mm or greater is needed for the drainage media to achieve the desired permeability value. Layer 5 will be situated approximately 1.3 m (4.3 ft) below final grade, which satisfies the design criterion for frost protection. Performance simulations with the HELP Model indicate that little (if any) lateral drainage will occur (DOE 1996, Appendix C).

3.3.2.4 Layer 6 (Asphalt Layer)

This layer will function as a low-permeability barrier layer and as a biointrusion barrier. Layer 6 will be constructed of a durable asphaltic concrete mixture consisting of double-tar asphalt (i.e., twice the tar content of normal highway asphalt) with added sand as binder material. Laboratory permeability tests on asphaltic concrete cores from the Hanford Barrier prototype yielded values on the order of 10^{-10} cm/s.

In-field values, measured by falling-head permeameter testing, ranged between 10^{-7} and 10^{-9} cm/s (DOE-RL 1994). Hydraulic conductivity testing will be performed on the asphalt layer in situ to determine the actual in-field value at the time of construction. The asphalt layer will be constructed with a slope of 2 percent (after allowances for settlement and subsidence).

The low-permeability asphalt layer is expected to be a highly effective deterrent to intrusion by plant roots and burrowing animals. As necessary, it will also function as a human intrusion barrier. The strength of the asphaltic concrete material, the thickness of Layer 6, and its deliberate construction should serve to advise inadvertent intruders that this layer is an intentional barrier. Layer 6 can be breached with mechanical excavation equipment, but intrusion scenarios involving the use of heavy equipment probably would be considered advertent rather than inadvertent.

3.3.2.5 Layer 7 (Asphalt Base Course)

This layer will provide a stable base for placement of the overlying asphalt layer. The base course will consist of screened, crushed-surfacing material, with 100 percent passing the 32 mm (1.25 in.) sieve.

3.3.2.6 Layer 8 (Grading Fill)

Grading fill will be placed, as necessary, to establish a smooth, planar base surface for construction of the overlying layers. The preexisting site surface will be contoured and graded to create uniform surfaces sloped at 2 percent, as needed for internal lateral drainage and surface runoff control. Grading the site before construction will facilitate accurate and controlled placement of soil lifts and layers. Grading fill will consist of a well-graded granular soil mixture, which may include as much as 20 percent by volume of cobbles measuring no more than 75 mm (3 in.) in the greatest dimension.

3.3.3 Sources of Cover Materials

Specifications and performance predictions for topsoil in Layers 1 and 2 of the Modified RCRA Subtitle C design in DOE (1996) are based on field and laboratory characterization tests of soil samples obtained from the McGee Ranch site, located north and west of the Yakima Barricade on the Hanford Site. That site is within the portion of the Hanford Site land area that acquired National Monument status earlier in 2000. The draft SW-EIS proposes to obtain silt loam soil for construction of engineered surface barriers over LLBGs from two areas north of State Route 240 and southwest of the 200 West Area. The EIS indicates that approximately 727,000 m^3 (950,000 yd^3) of silt loam soil will be required for construction of covers over the eight active burial grounds.

Sand and gravel will be obtained from Pit 30 (an existing borrow pit) on the Hanford Site. This pit is located midway between the 200 East and 200 West Areas. The EIS indicates that approximately 1.5 million m^3 (2.0 million yd^3) of screened and unscreened sand and gravel materials will be required for cover construction.

Additionally, the EIS estimates that cover construction will require 377,000 m^3 (493,000 yd^3) of asphalt from commercial off-site sources.

3.3.4 Cover Performance

Performance Assessments for active LLBGs indicate that long-term performance goals will be achieved if engineered surface barriers over burial grounds limit deep infiltration into/through the waste layer to 0.5 cm/yr (0.2 in./yr) or less. Hydrologic performance of the Modified RCRA Subtitle C Barrier has been

modeled in numerical simulations using the HELP code. Results of simulations for steady-state ambient climate conditions are included in Appendix C of DOE (1996). The results indicate that the proposed final cover treatment will eliminate more than 99 percent of annual precipitation received at the Hanford Site by evapotranspiration and will limit deep infiltration to 0.1 cm/yr (0.04 in./yr) or less.

Sample calculations of potential wind and water erosion of the topsoil surface of the Modified RCRA Subtitle C Barrier are provided in Appendix D of DOE 1996. The calculations indicate that soil losses should be tolerable (i.e., less than two tons per acre per year). Erosion susceptibility is largely attributable to wind erosion. The Modified RCRA Subtitle C Barrier has a design life of 500 years. Over this period of time, topsoil losses should be limited to 15 cm (6 in.) or less. Losses of this magnitude should not have any appreciable effect on the cover's ability to control infiltration of precipitation.

3.3.5 Inspection, Monitoring and Maintenance during Final Closure

It is envisioned that inspection, monitoring, and maintenance practices in place at the time of transition from Interim Closure to Final Closure will be continued. Regularly scheduled inspections of surfaces over filled trenches for evidence of subsidence will have been phased out as a result of sub-grade modification measures implemented during Interim Closure. As lined mixed-waste trenches are covered and cease to generate leachate, inspection, monitoring and maintenance of leachate collection systems can be eliminated.

Groundwater monitoring is planned to continue through the Final Closure period, consistent with requirements and commitments described in *Environmental Monitoring Plan* (DOE 1991), *Revised Groundwater Monitoring Plan for the 200 Areas Burial Grounds* (WHC 1989) and/or successor documents. Changes to the groundwater monitoring program for active LLBGs will be documented as revisions to WHC (1989) or successor documents.

3.4 INSTITUTIONAL CONTROL

An extended period of active institutional control is envisioned following closure of individual LLBG facilities. Activities to be performed during this period include site access control, inspection, monitoring and maintenance of closed LLBG facilities, and maintenance of facility records. Plans and procedures will be prepared for management and administration of these activities during this period. Contingency plans will be developed for foreseeable types of corrective actions that might be needed during the Institutional Control Period. Additional discussion of these activities is provided in the following subsections.

3.4.1 Inspection Plan

Inspections will be conducted on prescribed schedules to ensure continued integrity of the closed facilities and the cover systems during the Institutional Control Period. Inspections will be conducted in accordance with controlled procedures, and permanent logs of inspection results will be maintained. An Inspection Plan and procedures will be prepared which will address the following issues and concerns.

3.4.1.1 Site Access Control

The LLBGs are located within controlled access areas of the Hanford Site, which cannot be accessed by the general public. Physical access controls will be inspected at regular intervals. Any deficiencies will be noted in inspection logs.

3.4.1.2 Erosion Damage

Damage to closure cover surfaces may occur either from wind or water erosion. Visual inspections will be performed at regular intervals (e.g., quarterly) to identify localized areas where significant soil losses have occurred. Inspectors will check for conditions such as sheet or rill erosion (gully formation), sand deposition, uniformity of vegetative cover, and the integrity of run-off and run-on control measures. Observations will be recorded in an inspection logbook.

If soil losses occur over larger areas of the cover, they will be detected by surveys of monuments laid out on a regular grid spacing. Cover surfaces will be most susceptible to wind erosion during the first year after construction, before a mature vegetative cover has been established, or periods following reduction of vegetation by range fires.

3.4.1.3 Cover Settlement, Subsidence, and Displacement

Localized subsidence features will be identified in periodic visual inspections of cover surfaces. Settlement over larger areas will be detected by surveys of surface monuments (also used to detect soil losses from wind erosion). Covers will be reinspected for settlement/subsidence damage following seismic events producing surface accelerations above a predetermined threshold. Accelerometers in the 200 Areas will record the amplitude and frequency of surface accelerations during seismic events. The threshold for significant acceleration will be determined based on a seismic evaluation of the final cover design. Inspectors will check for ground fractures and surface displacements of cover materials.

3.4.1.4 Vegetative Cover Condition

Frequent (e.g., monthly) visual inspections of cover vegetation will be performed beginning with seeding of the cover surface and continuing until vegetation becomes well established. Inspectors will record quantitative measures of the condition and density of the vegetative cover, and note colonization of covers by deep-rooted plants and/or other invasive species. More frequent inspections would be implemented (as necessary) to monitor recovery of vegetation after range fires.

3.4.1.5 Burrowing Animal Activity

During visual inspections, any evidence of destructive activity by burrowing animals will be noted. Observations will be recorded in an inspection logbook.

3.4.1.6 Cover Drainage System

Accessible drainage components of the cover system will be inspected at regular intervals for evidence of sedimentation or blockage.

3.4.1.7 Leachate Collection/Detection System

If some cover systems over regulated mixed waste trenches will need to include leachate collection/detection and removal systems, then visual inspections of these systems will be performed. The tubing, pumps, and holding tanks will be inspected for leaks, damage, corrosion, or blockage. Observations will be recorded in an inspection logbook.

3.4.1.8 Monitoring Well Condition

Monitoring wells will be examined on each occasion that groundwater samples are withdrawn. Locking caps, vehicle guard posts and pump connectors will be inspected semiannually for damage. Any damage or other problems will be noted in an inspection logbook.

3.4.1.9 Benchmark Integrity

Benchmarks and survey monuments will be inspected as an aspect of erosion and settlement surveys. Any indication that a benchmark has been damaged or misaligned will be noted in an inspection logbook.

3.4.2 Monitoring Plan

Monitoring plan contents are discussed in the following subsections.

3.4.2.1 Groundwater Monitoring

It is anticipated that groundwater monitoring will continue during the Institutional Control Period, consistent with requirements and commitments described in *Environmental Monitoring Plan* (DOE 1991), *Revised Groundwater Monitoring Plan for the 200 Areas Burial Grounds* (WHC 1989) and/or successor documents. Active LLBGs are undergoing detection-level monitoring at the present time. It is also anticipated that detection-level monitoring will continue into the institutional control period unless dangerous waste constituents from a LLBG facility are detected at a designated point of compliance at some time in the future. In that event, more stringent sampling and analysis requirements may be imposed (e.g., assessment- or compliance-level monitoring requirements), or it may be necessary to implement a corrective action program.

Currently, groundwater monitoring of LLBGs involves semiannual sampling and analysis of a total of 57 wells. Several active monitoring wells are situated inside areas that will be covered during Final Closure. Consequently, some wells will have to be modified or capped and abandoned and replaced in order to maintain current monitoring capabilities during the Institutional Control Period.

Groundwater sampling procedures, laboratory analytical procedures, statistical evaluation procedures, data quality objectives and quality assurance requirements for the current near-facility groundwater monitoring program are provided in WHC 1989. Program changes will be documented as revisions to that document or to successor documents.

3.4.2.2 Leachate Collection/Detection and Removal

For facilities with leachate collection systems, operation of the leachate collection/detection and removal system will be continued (if necessary) into the Institutional Control Period to monitor leachate generation after closure. Leachate production should attenuate over time during or after cover construction, enabling monitoring and maintenance requirements for this system to be incrementally reduced and eventually eliminated.

3.4.3 Maintenance Plan

The cover, groundwater monitoring, and leachate collection systems will be regularly maintained to ensure their continued integrity during the Institutional Control Period. Maintenance activities generally will be triggered by inspection reports generated as discussed in Section 3.4.1. Maintenance reports will

be prepared to document all maintenance activities. Maintenance reports will reference the initiating inspection report and the follow-up maintenance record to provide comprehensive documentation of all maintenance activities. Maintenance reports and records will be maintained available for inspection at a designated location.

3.4.3.1 Security Controls

Security controls, consisting of perimeter fences, locked gates, and warning signs, will be inspected at regular intervals and maintained as necessary to prevent unauthorized access to closed facilities.

3.4.3.2 Erosion Damage

Depending on the areal extent of the damage and the specific cause (e.g., wind or water erosion), maintenance may simply take the form of replacing lost topsoil to restore the surface to the original grade, or it might also involve revegetation efforts (e.g., mulching and reseeding). Maintenance might also involve removal of soil (silt loam topsoil or windblown sand) from areas of accumulation. Criteria for initiating maintenance (repair) of the cover surface will be developed during definitive design of the cover system.

3.4.3.3 Cover Settlement and Subsidence

Minor settlement or subsidence may be difficult to distinguish from localized topsoil losses due to wind erosion in visual inspections of cover surfaces. Settlement and subsidence affect all cover layers, whereas wind erosion affects the condition of the topsoil layer only. In cases where settlement and/or subsidence are suspected, more detailed inspections must be performed which would involve probing downward through the upper layers of the cover to determine the elevation of the low-permeability asphalt layer. Criteria for initiating maintenance (repair) of the cover surface will be developed during definitive design of the cover system.

Minor settlement over a broad area may not significantly effect long-term performance of the cover system and may be corrected by adding topsoil to restore the surface to design grade. Localized settlement or subsidence is a relatively more serious problem which could produce closed depressions (i.e., ponding conditions) on top of the asphalt layer. Extreme localized subsidence or differential settlement could lead to rupture of the asphalt layer, depending on the severity of the event. Contingency corrective action plans will be developed to address the range of appropriate remedial responses that can be anticipated.

3.4.3.4 Vegetative Cover Condition

Active maintenance of cover vegetation will be performed in cases where vegetation fails to become sufficiently well established within six months to a year after planting to limit erosion damage. As experience is acquired over time, more suitable mixes of shallow-rooted perennial species may be identified and substituted. Revegetation of entire cover areas may be necessary following range fires.

3.4.3.5 Animal Activity

Large burrows identified within covered areas will be filled in and the animals involved in the activity will be trapped and removed from the site.

3.4.3.6 Cover Drainage Components

Components of the cover design that are provided to control or collect drainage will be maintained so that they remain functional for the duration of active Institutional Control. Blockages will be eliminated using methods that minimize disturbance to the cover system.

3.4.3.7 Leachate Collection/Detection and Removal System

Maintenance activities will be performed (as needed) on tubing, pumps, and holding tanks of any leachate collection/detection and removal systems included in covered areas as long as these systems are required to remain functional.

3.4.3.8 Groundwater Monitoring Wells.

Maintenance will be performed as needed on groundwater monitoring wells, including locking caps, down-hole casing, screens, and pumps. Damaged equipment will be repaired or replaced as necessary.

3.4.3.9 Benchmark Integrity.

A benchmark that is found to be damaged or out of alignment will be replaced as necessary and its location will be resurveyed.

3.4.4 Contingency Corrective Action Plans

Contingency plans and procedures will be developed describing detailed responses for foreseeable types of major problems with the cover system and/or facility monitoring systems during the Institutional Control Period. Corrective action plans will be developed in conjunction with the inspection, monitoring, and maintenance plans described above. Specific threshold values and conditions will be identified to enable inspectors to distinguish situations requiring maintenance from situations requiring corrective action. Any of the following types of problems may require a corrective action response:

- Excessive settlement or subsidence of portions of the cover system
- Excessive infiltration through the cover, resulting in detectable contaminant migration
- Damage to the cover as the result of natural phenomena (e.g., earthquakes or severe storm events)
- Failure of monitoring systems/equipment
- Loss of cover vegetation (e.g., by range fires) or replacement by undesirable plant species
- Excessive erosion (e.g., formation of deep gullies through the topsoil layers of the cover)
- Uncontrolled site access.

3.5 UNRESTRICTED RELEASE OF SITE

Institutional Control will continue until such time as the facility can qualify for unrestricted release consistent with requirements in DOE Order 5400.5, *Radiation Protection of the Public and the Environment* and/or successor directives or documents. Section 4 of DOE Order 5400.5 addresses guidelines and authorized limits for residual radioactive material (e.g., residual radionuclides in soil and surface contamination limits) at sites where radioactive waste management activities have been performed. Site-specific release criteria (dose and residual concentration limits) can be developed by procedures given in DOE/CH-8901, *A Manual for Implementing Residual Radioactive Material Guidelines* (DOE 1989). As a prerequisite for unconditional release, DOE would have to authorize discontinuation of post-closure monitoring activities.

The Hanford Future Site Uses Working Group (HFSUWG) was established by DOE in 1992 and was tasked with developing a consensus vision regarding future uses of various parts of the Hanford Site. The HFSUWG includes local, state and federal officials, representatives of tribal nations in the region, individuals representing agricultural and labor interests, and members of environmental and special interest groups. The following position statement is from the Working Group's 1992 summary report (HFSUWG 1992):

> "In general, the Working Group desires that the overall cleanup criteria for the Central Plateau should enable general usage of the land and groundwater for other than waste management activities in the horizon of 100 years from the decommissioning of waste management facilities and closure of disposal areas."

DOE recently issued the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999). This plan proposes that, for the foreseeable future, the 200 Area Plateau will be used exclusively for management of Hanford Site waste.

3.6 COMPLIANCE WITH PERFORMANCE OBJECTIVES AND OTHER REQUIREMENTS

The PAs for 200 East and West Area LLBGs identify performance objectives for LLBGs and provide the current technical basis for demonstrating that there is a reasonable expectation that all objectives will be met. These objectives are summarized in Table 3.1. The purpose of this section is to show that the conceptual design for closure of LLBGs supports and conforms to the models (exposure/release scenarios) forming the basis for the assessments.

Table 3.1. Performance Objectives for 200 East and West Area LLBGs*.

Exposure Pathway	General public protection	
	Time Period (yr)	Performance objective
All Pathways	≤10,000	25 mrem/yr
Air Emissions (excluding Rn)	≤10,000	10 mrem/yr
Air Emissions (Rn)	≤10,000	20 pCi/m^{2}s
	Intruder Protection	
Continuous Exposure	100 to 500	100 mrem/yr
Single Acute Exposure	100 to 500	500 mrem/yr
	Groundwater Resource Protection	
Drinking Water	≤10,000	4 mrem/yr

*Limits apply to the maximum exposed individual.

In the PAs, the performance objectives listed in the table were interpreted to distinguish two basic types of release scenarios: (1) exposure mechanism due to inadvertent intrusion by humans at some time after cessation of active institutional control and (2) release of radionuclides from the facility by natural causes, with the primary mechanism being leaching of radionuclides through the soil column to groundwater.

3.6.1 All-Pathways Dose

The all-pathways exposure scenario was evaluated in the PAs as a series of events in which radionuclides are first leached from the disposal facility by infiltration of precipitation into and through the disposed waste. Contaminated water then moves downward through the vadose zone to the unconfined aquifer. Subsequently, man drills a well into the aquifer and draws contaminated water for drinking, crop irrigation, and livestock consumption. Dose is received by direct exposure to gamma-producing radionuclides in the soil, inhalation of contaminated dust, and ingestion of contaminated crops, water, beef, and milk. The performance objective for the all-pathways dose is 25 mrem/yr. All-pathway dose estimates developed in the PAs do not exceed 1.65 mrem/yr (Wood, 1999).

The limiting dose estimate is derived from evaluation of a Category 3 LLBG with a soil cover system supporting natural vegetation, including a mix of shallow- and deep-rooted species. It is assumed that the cover treatment limits infiltration into the waste layer to 0.5 cm/yr (0.2 in/yr). A minimum of 5 m (16.4 ft) of cover materials (including operational soil cover within trenches and engineered cover materials over trenches) is assumed to be placed over the disposed waste, so that an inadvertent intruder would not expose buried waste in a basement excavation, but would penetrate the waste layer in the process of drilling a well.

The Modified RCRA Subtitle C cover (the current planning basis) will meet or exceed all performance criteria assigned to the cover in the PAs. Disposed waste will be covered with a minimum of 5 m (16.4 ft) of operational soil and engineered cover materials as required for inadvertent intruder protection for a Category 3 facility. The design of the cover includes two topsoil layers. Layer 1 consists of 50 cm (20 in.) of silt loam soil with pea gravel admix for enhanced resistance to wind erosion. Layer 2 consists of 50 cm (20 in.) of the same silt loam soil, without pea gravel, which will be placed in a relatively densified state to impede vertical moisture movement. The topsoil system is designed to perform as a storage medium for soil moisture and to support cover vegetation. The combined thickness of Layers 1 and 2 is sufficient to support continued storage and removal of moisture by evapotranspiration even if significant topsoil losses should occur. Cover vegetation will consist of a mixture of perennial grass species. A capillary barrier at the base of Layer 2 will enhance moisture retention and evapotranspiration within Layers 1 and 2. Numerical performance predictions of the Modified RCRA Subtitle C cover design indicate that essentially 100 percent of average annual precipitation will be removed from the barrier by evapotranspiration (refer to Appendix C of DOE 1996). The assumed value of 0.5 cm/yr (0.2 in/yr) for deep infiltration in PAs corresponds to about 3 percent of average annual precipitation at the Hanford Site.

The Modified RCRA Subtitle C design incorporates a contingency strategy for removing any moisture that infiltrates through (below) the topsoil system. The lateral drainage layer (Layer 5) and low-permeability asphalt layer (Layer 6) provide the capability to intercept and divert the excess moisture to the perimeter of the covered area. However, due to the predicted efficiency of the topsoil system, numerical performance predictions indicate that the volume of lateral drainage will be negligibly small (Appendix C, DOE 1996).

3.6.2 Air Pathway Dose

The PAs address vapor release as a potential exposure mechanism. Only three radionuclides, ^{14}C, ^{3}H, and ^{222}Rn, have the potential to migrate upward from disposed LLW and escape into the atmosphere in gaseous form. Two on-site exposure scenarios were considered for ^{14}C and ^{3}H. In one case, human intrusion occurs 100 years after closure of the site, waste is exhumed during basement excavation and mixed with uncontaminated soil in a garden plot, and the intruder resides in a home constructed on top of the contaminated soil. In the second case (also assumed to occur 100 years after closure), buried waste is

not disturbed but the intruder builds and resides in a home situated directly above the waste. A steady-state diffusion model was used to calculate release rates and to estimate dose for ^{14}C and ^{3}H. For the air release assessments, a 3-m (10-ft) thickness of cover soil materials with a diffusion coefficient of 0.01 cm^2/s was assumed. The performance objective for the air pathway dose is 10 mrem/yr. A maximum on-site annual exposure of 0.012 mrem/yr was calculated (Wood et al. 1995). This dose is more than an order of magnitude higher than the largest calculated off-site dose. Therefore it has been concluded that the air pathway performance objective will be easily satisfied, and minimal reliance will be imposed on the final cover treatment to limit releases of radionuclides in gaseous form.

Any RCRA-compliant surface barrier treatment (which must include some type of a low-permeability layer) will limit vapor diffusion well below the level of performance assumed in the air pathway dose evaluation. The Modified RCRA Subtitle C barrier includes a 15-cm (6-in.)-thick low-permeability layer (Layer 6) that will be constructed of a durable asphaltic concrete formulation containing twice the tar content of normal highway asphalt. Laboratory permeability tests on cores of this material have produced values on the order of 10^{-10} cm/s. In-field values of between 10^{-7} and 10^{-9} cm/s have been measured (DOE-RL 1994).

3.6.3 Radon Flux

The PAs include evaluations of potential ^{222}Rn flux (emissions) in relation to the performance objective of 20 $pCi/m^2/s$. This radon isotope is a decay daughter of ^{234}U, ^{238}U and ^{236}Ra. Radon release rate is dependent on the decay characteristics of the parent and their concentrations. Concentrations of the parents in the LLBG wastes were estimated from waste inventory data. Flux from ^{236}Ra decay decreases over time, while flux from decay of the two uranium isotopes increases over time. Of the two uranium isotopes, the flux contribution from ^{234}U greatly exceeds that from ^{238}U. The maximum anticipated ^{222}Rn flux is 0.033$pCi/m^2/s$ (Wood 1999), which is approximately 0.2 percent of the performance objective. The PAs indicate that radon emissions from LLBGs will remain well within the permissible limit without imposing any specific performance criteria on the design of the final cover. Low-permeability asphalt layers, like the asphaltic concrete layer (Layer 6) in the Modified RCRA Subtitle C Barrier, have been demonstrated to be highly effective in inhibiting the diffusion of radioactive gases with low partial pressures and short half-lives, such as radon. This conclusion is supported by documentation from the *Uranium Mill Tailings Reclamation Act* program (Wing 1994).

3.6.4 Other Requirements

For the design of the Modified RCRA Subtitle C Barrier, a comprehensive review was conducted of state and Federal regulations and other technical guidance sources (DOE 1996). Specific design and/or performance requirements for engineered surface barriers over sites with radiological and/or dangerous waste constituents were applied as design criteria. Applicable requirements and sources (other than DOE Order 435.1) are summarized below, with the design criteria derived from each source.

3.6.4.1 Applicable or Relevant and Appropriate Requirements (ARARs) for Facilities with Low-Level Radioactive Waste Constituents

The intent of the design process summarized in DOE 1996 was to provide a single barrier design that satisfies the requirements for Category 3 LLW facilities as well as sites with hazardous/dangerous waste constituents.

10 CFR 61.41, WAC 173-480-040, WAC 173-480-050, and WAC 246-247-040.

These regulations are functionally equivalent. They limit radionuclide releases from radiological waste disposal sites to levels that provide reasonable expectation that the annual equivalent dose to the public will not exceed 25 mrem to the whole body or 75 mrem to any critical organ. To some degree, the natural system contributes to limiting release rates of contaminants to the accessible environment. However, a conservative approach is to require the cover system to satisfy all performance goals for isolating waste from the accessible environment. Therefore, the cover is designed to prevent plants and animals from intruding into the waste zone and redistributing contaminants into the accessible environment. These criteria will generally pertain to the definitive design stage, when the significance of specific release limits can be evaluated in the context of individual waste-site conditions. Criteria applied to the conceptual design are as follows:

1. Minimize moisture infiltration through the cover.

2. Prevent plants from accessing and mobilizing contamination.

3. Prevent burrowing animals from accessing and mobilizing contamination.

10 CFR 61.42.

This ARAR pertains to conceptual and definitive designs of surface barriers for radioactive waste sites. The cover must be designed to protect humans from inadvertent contact with waste above acceptable levels at any time after the loss of active institutional controls. The criterion applied to the conceptual design was to:

1. Include appropriate design provisions to limit inadvertent human intrusion.

10 CFR 61.44.

This ARAR requires that the cover be designed to achieve long-term stability and to eliminate (to the degree practicable) the need for ongoing maintenance. This requirement can be met with an engineered cover system and supplemented, as necessary, by stabilizing the site sub-grade to minimize settlement. This requirement pertains to conceptual and definitive designs. The criteria applied to the conceptual design were as follows:

1. Design a multi-layer cover of materials that are resistant to natural degradation processes.

2. Design a durable cover that needs minimal maintenance during its design life.

10 CFR 61.51.

This ARAR directs that the cover be designed to (1) minimize water infiltration, control runoff and run-on of surface water, and otherwise minimize contact between water and waste after disposal and (2) resist degradation by surface geologic processes (i.e., surface erosion) and biotic activity. These criteria pertain to conceptual and definitive designs.

The following criteria were imposed on the design:

1. Minimize moisture infiltration through the cover.

2. Design a multi-layer cover of materials that are resistant to natural degradation processes.

3. Design a durable cover that will require minimal maintenance during its design life.

4. Prevent plants from accessing and mobilizing contamination.

5. Prevent burrowing animals from accessing and mobilizing contamination.

6. Facilitate drainage and minimize surface erosion by wind and water.

10 CFR 61.52(a)(2).

As an ARAR, this regulation requires that Class C LLW (comparable to DOE Category 3 LLW) must be disposed so that either the top of the waste is a minimum of 5 m (16.4 ft) below final grade, or the waste is covered with a surface barrier designed to protect against inadvertent human intrusion for at least 500 years. This requirement pertains to both conceptual and definitive designs.

The criteria applied to the conceptual design are as follows:

Design a cover with a functional life of 500 years.

Ensure that the top of the waste is at least 5 m (16.4 ft) below final grade or include appropriate design provisions to limit inadvertent human intrusion.

3.6.4.2 ARARs for Facilities with Hazardous/Dangerous Waste Constituents

40 CFR 264.111, 40 CFR 265.111, and WAC 173-303-610

These ARARs require a disposal facility for dangerous waste be closed in a manner that (1) minimizes the need for further maintenance; (2) controls, minimizes, or eliminates releases of dangerous constituents to the environment; and (3) returns land to the appearance and use of surrounding land to the degree possible, given the nature of previous waste-handling activities. These requirements can best be met by developing a low-maintenance cover constructed of durable materials that will support perennial vegetative cover similar to vegetation on surrounding land, and be highly effective in limiting moisture infiltration.

Criteria applied to the conceptual design are as follows:

1. Minimize moisture infiltration through the cover.

2. Design a multi-layer cover of materials that are resistant to natural degradation processes.

3. Design a durable cover that will need minimal maintenance during its design life.

4. Prevent plants from accessing and mobilizing contamination.

5. Prevent burrowing animals from accessing and mobilizing contamination.

6. Facilitate drainage and minimize surface erosion by wind and water.

40 CFR 264.228, 40 CFR 265.228, 40 CFR 264.310, and 40 CFR 265.310; and WAC 173-303-650 and WAC 173-303-665.

These six ARARs are functionally identical and require that the cover meet the following requirements: (1) minimize moisture infiltration, (2) function with minimum maintenance, (3) promote drainage and

minimize erosion, (4) accommodate settlement, and (5) have a permeability less than or equal to any natural subsoils present. The ARARs pertain to conceptual and definitive design. The ARARs can best be met by designing an engineered cover system supplemented, as necessary, by site sub-grade improvement to minimize settlement. Determination of specific sub-grade improvement methods is an issue to be addressed during definitive design.

Criteria applied to the conceptual design based on these ARARs are as follows:

1. Facilitate drainage and minimize surface erosion by wind and water.

2. Design the low-permeability layer of the cover to have a permeability less than or equal to any natural subsoils present.

3.6.4.3 Technical Guidance for Facilities with Hazardous/Dangerous Waste Constituents

EPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments. This document provides design criteria for specification of granular soil materials used in construction of graded filter media. The intent of the criteria is to prevent failure of the drainage layer by clogging with fines. The criterion imposed on the conceptual design is to:

1. Design the cover to prevent the migration and accumulation of topsoil material within the lateral drainage layer.

Hanford Plant Standards. The standards require the bottom of foundations for permanent buildings at the Hanford Site to be placed at least 0.76 m (2 ft, 6 in.) below final grade for frost protection purposes. This criterion was applied to the lateral drainage layer and the low-permeability component.

1. Ensure that the lateral drainage layer and the low-permeability asphalt component of the barrier are situated at least 0.76 m (2 ft, 6 in.) below final grade for frost protection.

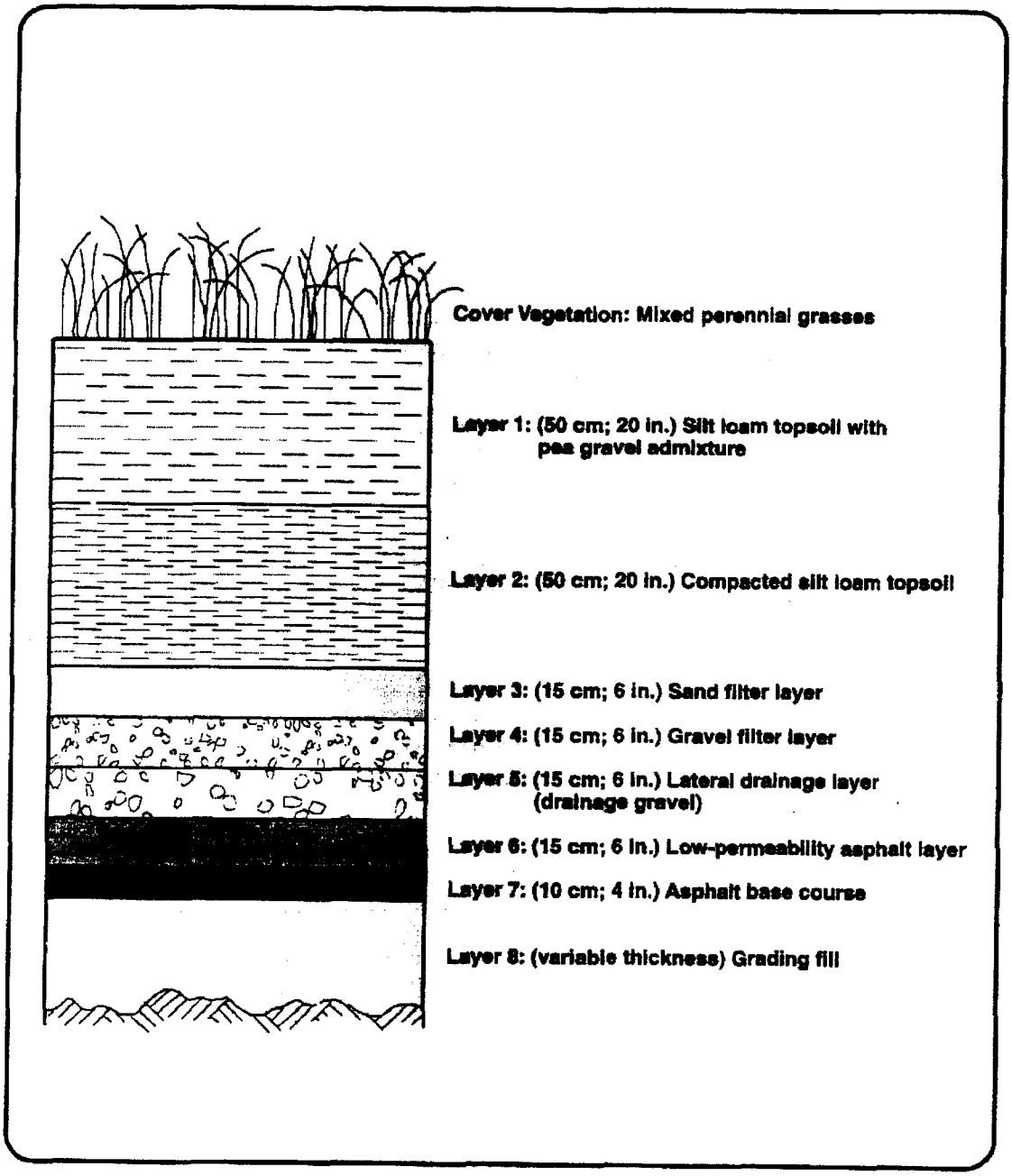


Figure 3.1. Profile View Through Modified RCRA Subtitle C Barrier.

4.0 CLOSURE SCHEDULE

Closure of each of the burial grounds covered in this plan will require completion of several related activities. First trenches must be filled with waste. All stored TRU waste must be retrieved from the burial ground and replaced with low-level waste where possible. Trench fill must be stabilized by sub-grade modification (Interim Closure). The burial ground will then be turned over to ERC and the final closure cover will be designed and installed. Finally, the final closure cover is designed and installed and the burial ground will be remediated as required.

Estimated fill dates for trenches in each of the burial grounds are calculated based on the waste forecast information, trench geometry, and current fill rates. This information is calculated annually in the "The Low-Level Burial Grounds Disposal Plan" (Pratt 2000). Estimated trench fill sequence and fill dates are shown in Table 4.1. Detailed information about trench size and geometry can be obtained from the Disposal Plan.

TRU waste that is stored for retrieval in each burial ground and an estimated retrieval date is shown in Table 4.2. TRU retrieval activities are described in Johnson (1994). Waste trenches, quantities, and dates for retrieval have been set for the 10,000 drums which will be included in an initial retrieval effort. The remaining TRU waste to be retrieved is outlined in Johnson (1994). A firm schedule for TRU retrieval has not been developed. As a result, dates in Table 4.2 are lacking. For the purpose of developing a closure schedule, it has been assumed that all TRU waste will be retrieved by 2030. Time has not been included in the closure schedule for refilling these trenches with LLW.

Interim Closure includes sub-grade modification to stabilize the disposed waste areas to support the soil cover overburden. Waste density (i.e., the density of waste containers and backfill soil) was not controlled at the time of waste disposal. As a result, when waste containers collapse, a local subsidence event will be created. Sub-grade modification will collapse containers and compact both the waste and the backfill material around the container in a controlled manner to create a stable base on which to build a closure cover. Estimated times required for sub-grade modification and closure cover construction are listed in Table 4.3.

The final closure cover will require the placement of massive amounts of material. Each cover will be constructed in layers. Estimated minimum times to construct each final closure cover are shown in Table 4.3. The closure cover design is described in Section 3.3.2.

A documentation schedule is shown in Table 4.4. Major documents required for LLBGs include safety analysis reports, RCRA permits, environmental impact statement, performance assessment and composite analysis documents.

The final closure schedule is as shown in Table 4.5. The schedule assumes that interim closure will commence directly after TRU retrieval from each burial ground is complete and that final closure covers will be constructed immediately after interim closure activities are complete.

The closure plan is a living document that will be continuously updated throughout the operational life of the facility. Changes in facility design and operations, additional information developed from monitoring data, or improved understanding of LLW disposal facility performance can lead to changes in the analyses and documentation for the facility, which could lead to changes in the closure plan. Updates of the closure plan are necessary to ensure that the radioactive waste management basis is current and protective of workers, the public, and the environment. This closure plan will be reviewed annually and updated as required at least every five years.

Table 4.1. Current Trench Filling Sequence and Estimated Fill Dates (Pratt, 2000).

Waste Type	Trench I.D.*	Date Filled**
Cat I LLW Drums	218-W-4C(33) 218-W5 (Drums #2)	May 2004 49 percent filled
Cat I LLW Drums	218-W-5 (33) 218-W-5 (Boxes #2)	Jun 2007 53 percent filled
Cat I LLW Misc.	218-W-5 (29) 218-E (MISC #2)	Nov. 2000 53 percent filled
Cat I LLW V Trench	218-E-12B (42) 218-E12B (36) 218-E-12 B (32) 218-W-5 (V-Trench #4) 218-W-5 (V-Trench #5) 218-W-4C (V-Trench #6) 218-W-5 (V-Trench #7) 218-W-4C (V-Trench #80 218-W-3AE (V-Trench #9) 218-W-3AE (V-Trench #10) 218-W-5 (V-Trench #11) 218-W-4C (V-Trench #12) 218-W-4C (V-Trench #13) 218-W-4c (V-Trench #14)	Feb 2000 Mar 2002 Feb 2003 May 2004 Dec 2005 Sep 2007 Oct 2010 Jun 2012 May 2016 Feb 2020 Sep 2023 Nov 2025 Jan 2028 80 percent filled
Cat 3 LLW	218-W-4C (14) 218-W-3AE (8)	July 2000 85 percent filled
Remote handle LLW	218-W-3AE (13) 218-E-10 (9) W-3AE (16)	June 2002 May 2003 77 percent filled
Mixed Waste	218-W-5 (31) 218-W-5 (34) 218-E-12B (MMLW #3)	Sep 2005 Aug 2009 23 percent filled

* Trench I.D. values are listed by Burial Ground and (Trench). New trenches are listed by waste type to be disposed (i.e. drums, boxes, misc., v-trench, etc.) and new trench number.
** Trenches that will not be filled with waste in the current forecast are listed as percent filled at the end of FY 2029.

Table 4.2. TRU Retrieval Schedule (Johnson, 1994).

Burial Ground	Trench	Stored for Retrieval
218W-3A	Trench S6	5 EBR II Casks
218W-3A		One BATCO Cask
218W-3A	Trench S9	70 Grams
218W-3A	Trench 01	4 Drums
218W-3A	Trench 04	143 Drums
218W-3A	Trench 05	360 Drums
218W-3A	Trench 06	2182 Drums 7 Boxes
218W-3A	Trench 08	460 Drums 53 Boxes (& Other) 22 Concrete Casks
218W-3A	Trench 10	3 Drums
218W-3A	Trench 15	7 Drums
218W-3A	Trench 17	112 Boxes
218W-3A	Trench 23	6 Drums 8 Boxes
218W-3A	Trench 30	29 Drums 5 Boxes (&Other)
218W-3A	Trench 32	2 Boxes
218W-3A	Trench 34	5 Boxes
218W-4B	Trench V7	1320 Drums
218W-4B	Trench 07	8080 Drums 67 Boxes
218W-4B	Trench 11	3140 Drums
218W-4B		106 Boxes
218W-4C	Trench 01	5080 Drums 124 Boxes 46 Casks
218W-4C	Trench 07	67 Drums

Burial Ground	Trench	Stored for Retrieval
		73 Boxes 13 Casks (Grouted Drums)
218W-4C	Trench 19	One Drum
218W-4C	Trench 20	613 Drums 29 boxes
218W-4C	Trench 29	2544 Drums 10 Boxes
218E-12B	Trench 17	2660 Drums 60 Boxes
218E-12B	Trench 27	240 Drums

Table 4.3. Closure Schedule Estimates.

LLBG	Area	Length	Interim Cl. @ 50 lf/day + 200 days/12 mos	Final C. @ 2ac/mo
218-W-3A	50 acres	43 trenches @ 1100' = 47,300 lf 14 trenches @ 600' = 8,400 lf	1114 days = 67 mos	25 mos
218-W-3AE	49 acres	8 trenches @ 1500' = 12,000 lf	240 days = 15 mos	25 mos
218-W-4B	9 acres	14 trenches @ 700' = 9,800 lf	192 days = 12 mos	5 mos
218-W-4C	49 acres	20 trenches @ 700' = 14,000 lf	280 days = 17 mos	18 mos*
218-W-5	92 acres	17 trenches @ 900' = 15,300 lf	306 days = 19 mos	46 mos
218-E-10	89.2 acres	13 trenches @ 1200' = 15,600 lf	312 days = 19 mos	32 mos*
218-E-12B	168 acres	41 trenches @ 700' = 28,700 lf + Navy RC Trench	576 days + 1 year for RCT = 47 mos	58 mos*

* Assumes 70 percent of facility area is covered.

Table 4.4. Documentation Schedule.

RCRA Permit Interim Status	1988 (completed)
Interim Safety Basis	1994 (completed)
Initial Performance Assessment for the 200 West Area	1995 (completed)
Initial Performance Assessment for the 200 East Area	1996 (completed)
Initial Composite Analysis	1999 (completed)
Annual PA Review	Annually
Operational Closure Plan	2000
Operational Monitoring Plan	2000
Master Safety Analysis Report	2002
RCRA Permit Final Status	2002
Solid Waste Environmental Impact Statement	2002
Operational Closure Plan Update	2005
Operational Monitoring Plan Update	2005
Final Performance Assessment for the 200 West Area	2030
Final Performance Assessment for the 200 East Area	2030
Final Composite Analysis	2030
Final Closure Plan	2030
Final Monitoring Plan	2030
Final Performance Assessment for the 200 West Area	2030
Final Performance Assessment for the 200 East Area	2030
Final Composite Analysis	2030
Final Closure Plan	2030
Final Monitoring Plan	2030

Table 4.5. Closure Schedule.

Burial Ground	Interim Closure	Final Closure	Institutional Control
218-W-3A	2035-2041	2042-2044	100 yr min
218-W-3AE	2039-2035	2036-2038	100 yr min
218-W-4B	2050-2052	2053-2054	100 yr min
218-W-4C	2053-2055	2056-2057	100 yr min
218-W-5	2042-2044	2045-2048	100 yr min
218-W-6	2033-2035	2036-2038	100 yr min
218-E-10	2033-2035	2036-2038	100 yr min
218-E-12B	2045-2049	2050-2054	100 yr min

5.0 REFERENCES

Bandimere, S.W., 1993, *Grouting; Engineers and Contractors Working Together*, in course notes: Fundamentals of Grouting, Vol. 2, University of Florida, Division of Continuing Education.

Bjornstad, B., 1990, *Geohydrology of the 218-W-5 Burial Ground, 200 West Area, Hanford Site*, PNL-7336, Pacific Northwest Laboratory, Richland, Washington.

Caggiano, J.A. and, D.W. Duncan, 1983, *Preliminary Interpretation of the Tectonic Stability of the Reference Repository Location, Cold Creek Syncline, Hanford Site*, RHO-BW-ST-19P, Rockwell Hanford Operations, Richland, Washington.

Cedergren, H. R., 1989, *Seepage, Drainage, and Flow Nets*, Third Edition, John Wiley and Sons, Inc., New York, New York.

Chou, C.J., V.G. Johnson, and R.B. Mercer, 2000, *Performance Assessment Monitoring Plan for the Hanford Site Low-Level Waste Burial Grounds*, DOE/RL-2000-72, Rev. 0, U.S. Department of Energy, Richland, Washington.

Connelly, M.P., B.H. Ford, and J.V. Borghese, 1992, *Hydrologic Model for the 200 West Groundwater Aggregate Area*, WHC-SD-EN-TI-014, Westinghouse Hanford Company, Richland, Washington.

DOE, 1987, *Final Environmental Impact Statement: Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes*, DOE/EIS-0113, Vol. 1-5, U.S. Department of Energy, Washington, D.C.

DOE, 1989, *A Manual for Implementing Residual Radioactive Material Guidelines: A Supplement to U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites*, DOE/CH-8901, U.S. Department of Energy, Washington, D.C.

DOE, 1991, *Environmental Monitoring Plan*, DOE/RL-91-50, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1994, *Constructibility Report for the 200-BP-1 Prototype Surface Barrier*, DOE/RL-94-76, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE 1996, *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas*, DOE/RL-93-33, Rev. 1, Bechtel Hanford Inc. for U.S. Department of Energy, Richland, Washington.

DOE, 1999, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program*, DOE/RL-98-28, U.S. Department of Energy, Richland, Washington.

DOE, 1999, *Final Hanford Comprehensive Land-Use Environmental Impact Statement*, DOE/EIS-0222F, U.S. Department of Energy, Washington, D.C.

DOE, 2000, *Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement (Internal Working Draft)*, DOE/EIS-0286D, U.S. Department of Energy, Office of Environmental Management, Richland Operations Office, Richland, Washington.

Ecology, 1987, *Solid Waste Landfill Design Manual*, by Parametrix, Inc., Bellevue, Washington, No. 87-13, for Washington State Department of Ecology, Olympia, Washington.

EPA, 1989, *EPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments*, EPA/530-SW-89-047, U.S. Environmental Protection Agency, Washington, D.C.

Fayer, M.J., M.L. Rockhold, and G.W. Gee, 1991, *Recharge Potential of a Sandy Soil. EOS Transactions (Transactions of the American Geophysical Union)*, Vol. 72, p. 1074.

Fayer, M.J., and T.B. Walters, 1995, *Estimated Recharge Rates at the Hanford Site*, PNL-10285, Pacific Northwest Laboratory, Richland, Washington.

Gee, G.W., 1987, *Recharge at the Hanford Site, Status Report*, PNL-6403, Pacific Northwest Laboratory, Richland, Washington.

Graham, M.J., M.D. Hall, S.R. Strait, and W.R. Brown, 1981, *Hydrology of the Separations Area*, RHO-ST-42, Rockwell Hanford Operations, Richland, Washington.

HFSUWG, 1992, *The Future for Hanford: Uses and Cleanup, the Final Report of the Hanford Future Site Uses Working Group*, Document No. 0026619, Hanford Future Site Uses Working Group, Richland, Washington.

Johnson, D.M., 1994, *Phase 2 Solid Waste Retrieval Trench Characterizations*, WHC-SD-W221-DP-01, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Kincaid, C.T., J.W. Shade, G.A. Whyatt, M.G. Piepho, K. Rhoades, J.A. Voogd, J.H. Westsik, Jr., M.D. Freshley, K.A. Blanchard, B.G. Lauzon, 1993, *Performance Assessment of Grouted Double-Shell Tank Waste Disposal at Hanford*, WHC-SD-WM-EE-004, Westinghouse Hanford Company, Richland, Washington.

Kincaid, C.T., M.P. Bergeron, C.R. Cole, M.D. Freshley, N.L. Hassig, V.G. Johnson, D.I. Kaplan, R.J. Serne, G.P. Streile, D.L. Strenge, P.D. Thorne, L.W. Vail, G.A. Whyatt, and S.K. Wurstner, 1998, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, PNNL-11800, Pacific Northwest National Laboratory, Richland, Washington.

Ligotke, M. W. and D. C. Klopfer, 1990, *Soil Erosion Rates from Mixed Soil and Gravel Surfaces in a Wind Tunnel*, PNL-7435, Pacific Northwest Laboratory, Richland, Washington

Lindsey, K.A., J.L. Slate, G.K. Jaeger, K.J. Swett, and R.B. Mercer, 1994, Geologic Setting of the Low-Level Burial Grounds, WHC-EN-TI-290, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

NRC, 1989, *Directory of Certificates of Compliance for Radioactive Material Packages*, NUREG-0383, U.S. Nuclear Regulatory Commission, Washington, D.C.

Phillips, S.J., and T.W. Gilbert, 1985, *Near-Field Evaluation of Subsidence and Geotechnical Remedial Actions at Hazardous and Radioactive Materials Disposal Sites*, RHO-RE-EV-82P, Rockwell Hanford Operations, Richland, Washington.

Pratt, D.A., 2000, *Low-Level Burial Grounds Disposal Plan*, HNF-SD-WM-ES-355, Rev. 3, Waste Management Federal Services of Hanford, Inc., Richland, Washington.

Rockhold, M.L., M.J. Fayer, G.W. Gee, and M.J. Kanyid, 1990, *Natural Groundwater Recharge and Water Balance at the Hanford Site*, PNL-7215, Pacific Northwest Laboratory, Richland, Washington.

Routson, R.C., and V.G. Johnson, 1990, *Recharge Estimates for the Hanford Site 200 Areas Plateau*, Northwest Science, Vol. 64, No. 3, pp. 150-158.

Serne, R.J., J.L. Conca, V.L. LeGore, K.J. Cantrell, C.W. Lindenmeier, J.A. Campbell, J.E. Amonette, and M.I. Wood, 1993, Solid-Waste Leach Characteristics and Contaminant-Sediment Interactions Volume I: Batch Leach and Adsorption Tests and Sediment Characterization, PNL-8889, Vol. 1, Pacific Northwest Laboratory, Richland, Washington.

Skelly, W. A., C. J. Chou, J. W. Lindberg, and D. J. Hoff, 1994, *Material Properties Data and Volume Estimate of Silt Loam at the NRDWL Reserve, McGee Ranch*, WHC-SD-EN-TI-218, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Waugh, W.J., J.C. Chatters, G.V. Last, B.N. Bjornstad, S.O. Link, and C.R. Hunter, 1994, *Barrier Analogs: Long-Term Performance Issues, Preliminary Studies, and Recommendations*, PNL-9004, Pacific Northwest Laboratory, Richland, Washington.

WHC, 1989, *Revised Groundwater Monitoring Plan for the 200 Areas Burial Grounds*, WHC-SD-EN-AP-015, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Wing, N. R., 1994, *Permanent Isolation Surface Barrier Development Plan*, WHC-EP-0673, Westinghouse Hanford Company, Richland, Washington.

Wood, M.I., R. Khaleel, P.D. Rittman, A.H. Lu, S.H. Finfrock, R.J. Serne, K.J. Cantrell, T.H. DeLorenzo, 1995, *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*, WHC-EP-0645, Westinghouse Hanford Company, Richland, Washington.

Wood, M.I., R. Khaleel, P.D. Rittman, S.H. Finfrock, T.H. DeLorenzo, D.Y. Garbrick, 1996, *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*, WHC-SD-WM-TI-730, Westinghouse Hanford Company, Richland, Washington.

Wood, 1999, *1996-1998 Biennial Review of the 200 West and 200 East Area Performances Assessments, HNF-4750, Rev. 0*, Waste Management Federal Services of Hanford, Inc., Richland, Washington.

DISTRIBUTION

	MSIN
U.S. Department of Energy, Richland Operations Office	
B. E. Bilson	H0-12
R. F. Guercia	H0-12
G. H. Sanders	H0-12
T. A. Shrader	H0-12
G. L. Sinton	H0-12
Fluor Hanford	
M. D. Aichele	T4-04
E. S. Aromi	H6-10
J. F. Beckstrom	T4-04
T. T. Blackford	T3-05
D. R. Ellingson	T3-06
C. K. Girres	T3-01
K. B. Lewis	T4-04
D. A. Pratt	T4-03
D. R. Pyzel	T4-04
L. W. Roberts	T4-56
J. R. Rosser	T4-03
D. G. Saueressig	T4-04
B. L. Slettene	T4-04
Pacific Northwest National Laboratory	
Hanford Technical Library	K1-11
Lockheed Martin Services, Inc.	
Central Files	B1-07
EDMC (2)	H6-08
DPC	H6-08