

# ***Headquarters U.S. Air Force***

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*Integrity - Service - Excellence*

## **Alternative Covers for Air Force Landfills – AFCEE Resources**



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Mitretek Systems**

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# Scope

- Air Force landfills are different, but the Air Force uses conventional covers
  - Air Force needs covers that:
    - Fit Air Force landfill characteristics
    - Are more effective
    - Cost less
  - The AFCEE has an alternative:
    - It is accepted by regulators, meets requirements, and is a “green” cover
- It could save the Air Force > \$0.5 billion in construction cost**
- This presentation explains the AFCEE alternative



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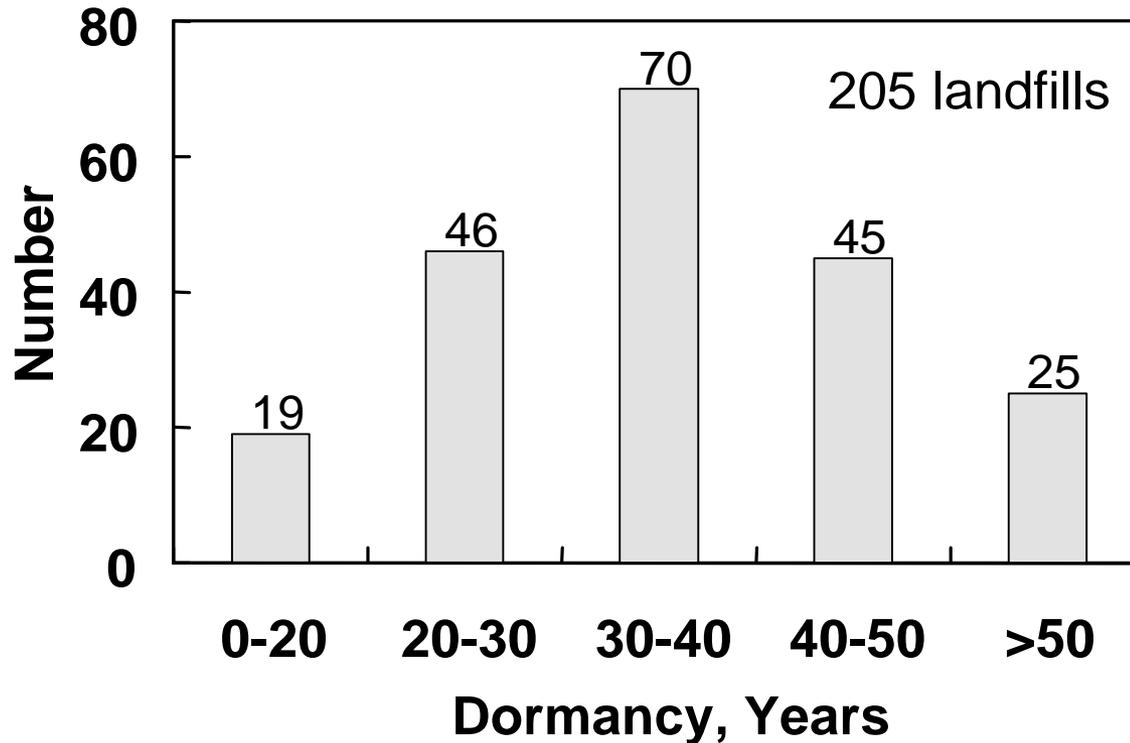
# *Topics*

- **Air Force landfill characteristics**
- **Currently used covers on Air Force landfills**
- **Remediation requirements**
- **Landfill cover alternatives and selection**
- **Evapotranspiration (ET) cover**
- **ET cover acceptance, design and application**
- **Air Force Center for Environmental Excellence (AFCEE) resources**



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# Air Force Landfill Characteristics – Dormancy\*



**90% > 20 Yr.**

**34% > 40 Yr.**

**\*Dormancy = not used, not remediated.** Based on sample size of 41% of Air Force landfills (1998 data) from AFCEE Report: *Survey of Air Force Landfills, Their Characteristics, and Remediation Strategies*. **Time periods brought up to date 2004**

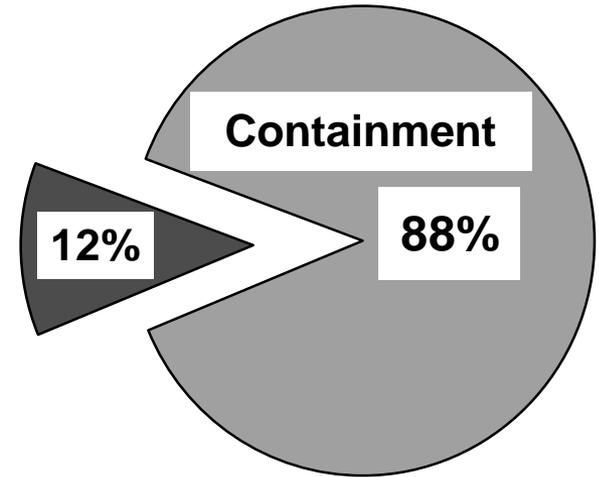


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# Air Force Landfill Characteristics\* (continued)

Inactive	> 99%
Bottom liners	< 1%
Remediation complete	23%

➔ No further action



\*Based on sample size of 41% of Air Force landfills (1998 data) from AFCEE Report: *Survey of Air Force Landfills, Their Characteristics, and Remediation Strategies*.



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# *Air Force Landfill Characteristics (concluded)*

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## Landfill characteristic differences

<b>Air Force</b>	<b>Conventional</b>
<b>Decayed waste</b>	<b>Fresh waste</b>
<b>Little gas</b>	<b>Much gas</b>
<b>No liner</b>	<b>Lined</b>

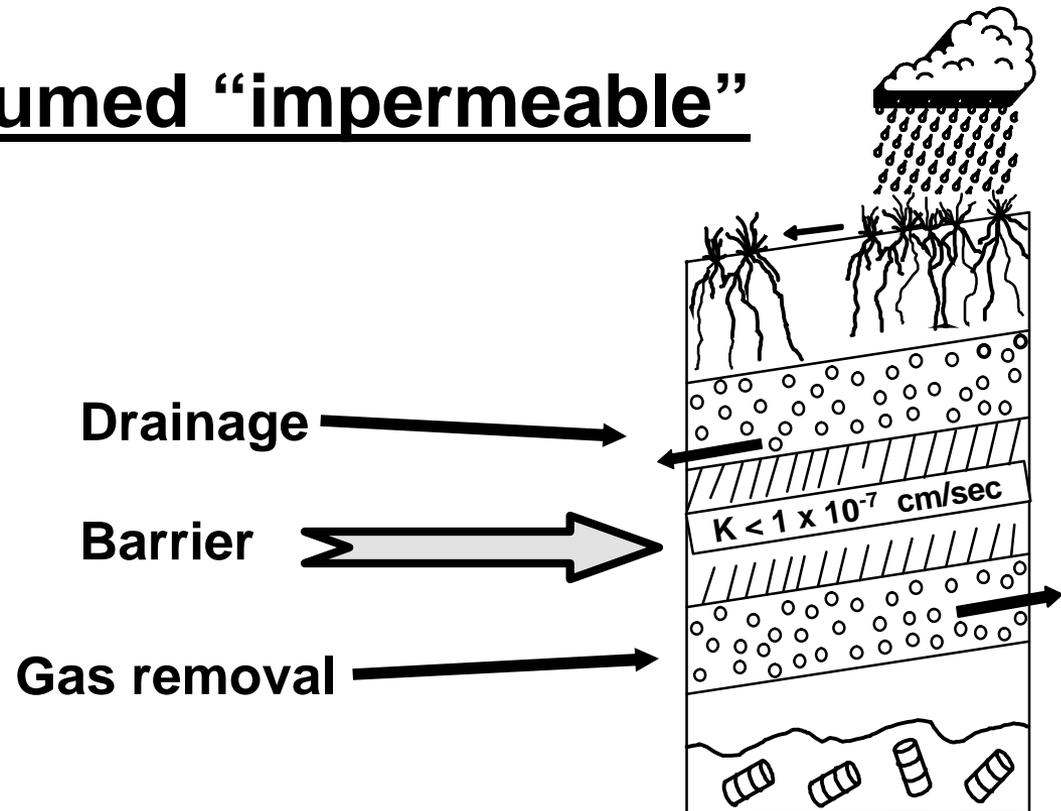
*Air Force landfills are different*



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# Landfill Covers Used by Air Force

- Barrier-type covers – primary current cover
- Barrier assumed “impermeable”





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# ***Landfill Covers Used by Air Force (continued)***

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- **Barrier-type covers – primary current cover**
    - **Construction costs for typical 20-acre landfill (cost data from 8 Air Force sites\*)**
      - Range - \$6.4 to \$11.4 million (1999 data)
      - Average - \$9.0 million
    - **Prone to failure and leaks**
      - DOE research (leaked in dry climate)<sup>1</sup>
      - German study (clay barrier leakage rate >150 mm/year)<sup>2</sup>
      - Composite barrier (> 4 mm/year)<sup>2</sup>
      - Failure-prone<sup>3</sup>

\* 1999. *Survey of Air Force Landfills, Their Characteristics, and Remediation Strategies*, AFCEE

<http://www.afcee.brooks.af.mil/products/techtrans/landfillcovers/LandfillProtocols.asp>

1. Dwyer, 2001. *Civil Engineering*: 58-62

2. Melchoir, 1997. *Proc. International Containment Conference*: 365-373

3. Suter et al., 1993. *Jour. Environmental Quality*: 217-226



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# ***Landfill Covers Used by Air Force (concluded)***

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- **Current, barrier-type covers:**
  - **The regulators readily accept them, but they:**
    - **Do not match requirements for Air Force landfills**
    - **Have high construction and maintenance cost**
    - **Are prone to failure**
  - **The Air Force needs improved landfill covers**

- ★ **AFCEE has an alternative – ready to use, but**
- ★ **AFCEE's alternative is not used by the Air Force**

- **How to implement an alternative?**
  - **Establish the remediation goal and requirements**
  - **Know the alternatives**
  - **Select an alternative for a site**



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# ***Requirements for Landfill Remediation at Air Force Sites***

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- **Goal: Protect human health and the environment**
- **Primary functions of landfill covers**
  - **Control infiltration through the waste**
  - **Isolate waste**
  - **Control landfill gasses, if needed**
- **The Air Force needs alternative covers that:**
  - **Meet Air Force remediation goals**
  - **Match requirements for Air Force landfill remediation**
  - **Have longer life**
  - **Are less costly**



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# *Landfill Cover Alternatives*

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## ■ Alternatives to conventional covers ( \$\$\$\$ )

■ No further action

\$

■ ET cover

\$\$

■ Waste removal

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*Increasing  
cost*



■ Other alternatives are components for barrier-type covers - experimental



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# *Cover Selection – First Step*

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- **Determine site-specific performance requirements\***
- **Then – use any alternative that meets the requirements**

\*1999. *Landfill Covers for Use At Air Force Installations*

\*1999. *Decision Tool for Landfill Remediation*

\*1999. *Landfill Remediation Project Managers Handbook*

<http://www.afcee.brooks.af.mil/products/techtrans/landfillcovers/LandfillProtocols.asp>



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# *Choose a Remediation Alternative - How?*

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- **Best to use the AFCEE “Decision Tool”<sup>1</sup>**
  - **Contains applicable rules**
  - **Provides detailed assistance, if needed**
  - **Seldom requires use of more than two charts**

1. Boyer, I. et al., 1999. *Decision Tool for Landfill Remediation*, on the AFCEE web at:  
<http://www.afcee.brooks.af.mil/products/techtrans/landfillcovers/LandfillProtocols.asp>



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# ***ET Landfill Cover***

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**Focus on the ET cover**



**Soil + Plants = New Cover**

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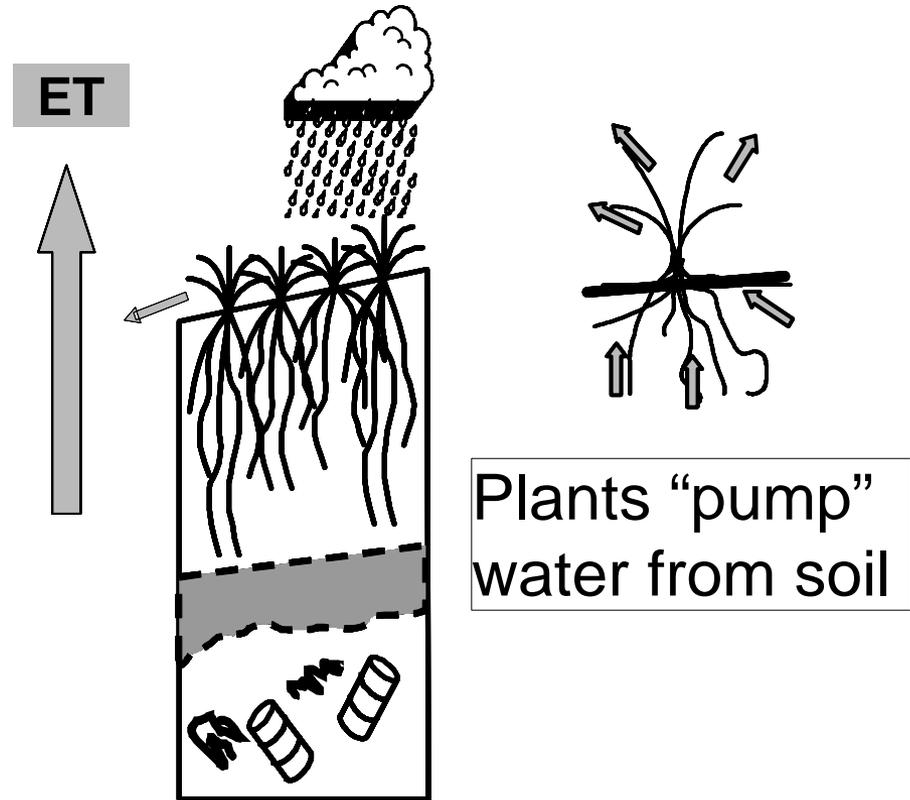


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# ET Landfill Cover (continued)

How does the ET cover control percolation into waste?

- Soil is a natural water reservoir
  - Natural process (ET) empties the reservoir
- (ET = soil evaporation + plant transpiration)





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# ***ET Landfill Cover (concluded)***

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## **■ Advantages**

- Natural system
- Self renewing
- Less prone to fail
- Long life
- More protective
- Easily repaired
- Low cost (about 50% of conventional)

## **■ Disadvantages**

- Requires adequate soil resource nearby
- Reuse restricted



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# *ET Landfill Cover – Construction Cost*

- **Air Force cost estimates for F. E. Warren AFB, landfill 6 (41 acres)\***

Cover type	Cost	Savings
Conventional barrier	\$16.2 million	----
ET cover	\$6.0 million	\$10.2 million

- **Typical, conservative construction cost for ET cover – half that of conventional covers\*\***

•1999. *Survey of Air Force Landfills, Their Characteristics, and Remediation Strategies*, AFCEE  
<http://www.afcee.brooks.af.mil/products/techtrans/landfillcovers/LandfillProtocols.asp>

\*\* Hauser, Weand, and Gill. 2001. *Natural Covers for Landfills and Buried Waste*. Am. Soc. Civil Engineers, J. Environmental Engineering, vol. 127, no. 9, 768-775.



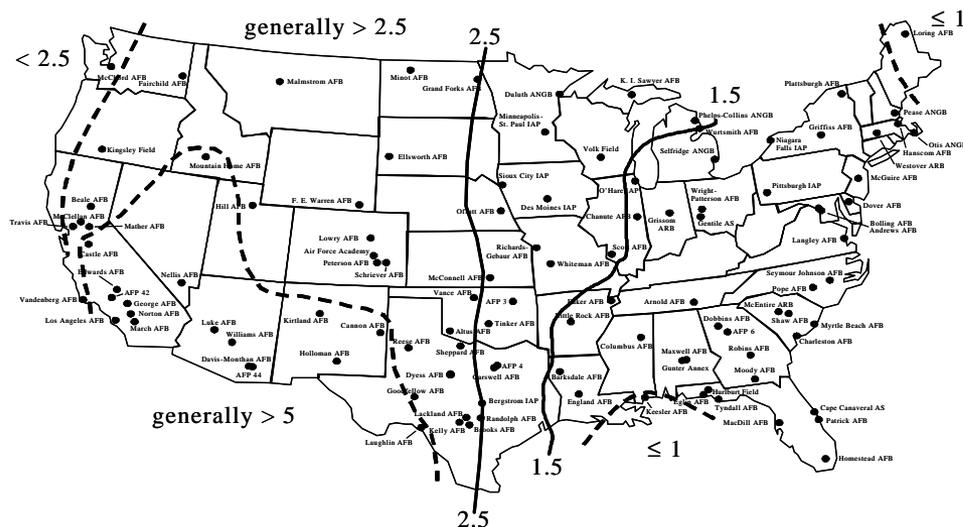
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# ET Landfill Cover – Potential Application

## PET/Precipitation Ratio

At Air Force bases,  
potential for use is:

**Favorable = 93%**



From the AFCEE site evaluation tool:

Hauser, V. L. and D. M. Gimon, 2001. *Vegetated Landfill Covers and Phytostabilization—The Potential for Evapotranspiration-based Remediation at Air Force Bases*. AFCEE.

[<http://www.afcee.brooks.af.mil/products/techtrans/landfillcovers/LandfillProtocols.asp>]



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# ***Is the ET Cover Technology Complete and Accepted?***

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## **Completeness:**

- **AFCEE - complete library of technology and design guidance**
- **Mitretek - proof of concept\***
- **ET cover technology is ready to use**

## **Acceptance:**

- **DOE research confirms the concept**
- **EPA has 11 ET cover test sites**
- **2003 The Interstate Technology Regulatory Council (ITRC) a state-led group published:**
  - **ET cover case histories**
  - **Technical and regulatory guidance for the ET cover.**

\* Hauser, Weand, and Gill. 2001. *Natural Covers for Landfills and Buried Waste*. Am. Soc. Civil Engineers, J. Environmental Engineering, vol. 127, no. 9, 768-775.



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# *Is the ET Cover Technology Complete and Accepted?*

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- EPA web site lists 33 full-scale “*Alternative Landfill Cover Projects*” installed or proposed
- 2003 U.S. EPA “*Fact Sheet*” on ET covers
- 2004 The U.S. EPA – new “*final rule*” allows variance from existing regulatory requirements for landfill covers. Allows use of ET covers.

Is the ET cover technology complete and accepted? **Yes!**



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# *ET Cover Application – Required Steps*

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- 1. Establish requirements for landfill remediation\***
  - 2. Verify applicability of ET cover**
  - 3. Use a verified model for design**

\* 1999. *Landfill Covers for Use At Air Force Installations*

\* 1999. *Decision Tool for Landfill Remediation*

\* 1999. *Landfill Remediation Project Managers Handbook*

\* 2001. *Vegetated Landfill Covers and Phytostabilization– The Potential for Evapotranspiration-based Remediation at Air Force Bases*

[<http://www.afcee.brooks.af.mil/products/techtrans/landfillcovers/LandfillProtocols.asp>]



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# ***ET Cover Design – Model Evaluation***

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- **Recent AFCEE evaluation:**
  - **Hauser and Gimon, 2004. “*Evaluating Evapotranspiration (ET) Landfill Cover Performance Using Hydrologic Models.*” Available on AFCEE landfill web page\***
- **Results:**
  - **Tested two engineering design models (EPIC and HELP)**
  - **Accuracy consistent with high-quality field measurements**
  - **The EPIC model is more accurate**
- **EPIC is a public domain model and is available**

\* <http://www.afcee.brooks.af.mil/products/techtrans/landfillcovers/LandfillProtocols.asp>



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# ***Why the Air Force Needs the ET Cover***

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- **Meets remediation requirements**
- **Natural, dependable, self-renewing cover**
- **Has a long life**
- **Less costly**

**(Potential construction cost savings for  
Air Force: >\$ 0.5 billion\*)**

\* 1999. *Survey of Air Force Landfills, Their Characteristics, and Remediation Strategies*  
(includes database)

<http://www.afcee.brooks.af.mil/products/techtrans/landfillcovers/LandfillProtocols.asp>



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# ***Summary***

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- **The ET cover:**
  - **Meets the requirements for Air Force landfill remediation**
  - **Low-cost, effective alternative cover**
  - **Ready for use by the Air Force**
- **AFCEE has the tools to implement the ET cover**
- **Regulators accept ET landfill covers**

● **The AFCEE has the resources required to significantly increase use of the ET landfill cover**



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# ***AFCEE Resources - ET Landfill Cover***

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## **AFCEE's Complete Library of ET Cover Technology**

### **AFCEE Landfill Web Page\***

- 1. 1999. Landfill Covers for Use at Air Force Installations**
- 2. 1999. Survey of Air Force Landfills, Their Characteristics, and Remediation Strategies (includes database)**
- 3. 1999. Decision Tool for Landfill Remediation**
- 4. 1999. Landfill Remediation Project Managers Handbook**
- 5. 2000. Golf Courses on Air Force Landfills**
- 6. 2001. Vegetated Landfill Covers and Phytostabilization– The Potential for Evapotranspiration-based Remediation at Air Force Bases**
- 7. 2001. Alternative Landfill Covers (for ITRC landfill summit)**
- 8. 2004. Evaluating Evapotranspiration (ET) Landfill Cover Performance Using Hydrologic Models**

\* <http://www.afcee.brooks.af.mil/products/techtrans/landfillcovers/LandfillProtocols.asp>