US EPA ARCHIVE DOCUMENT
Measurement of Moisture

• Water balance

• Collect waste samples and measure gravimetrically

• *In situ* methods
Water Balance

• Track moisture into and out of landfill
Collection of Waste Samples

- Great data
- Expensive
- Infrequent
In Situ Devices

• Adapted from devices used for soil irrigation purposes

• Examples:
  – Neutron probes
  – Time domain reflectometry (TDR)
  – Resistance devices
Neutron Probes

• Neutrons emitted by the probe travel through adjacent medium; neutrons get thermalized by other atoms, especially hydrogen (H₂O).
• Can measure thermalized neutrons using a device like a Geiger counter.
• Relate this measurement to moisture content.
• Probe lowered into pipes in landfill.
TDR Devices

- An electromagnetic pulse is emitted.
- The propagation time of the pulse is a function of the dielectric constant of the surrounding medium.
- The dielectric constant is also a function of the moisture content.
Resistivity Devices

- Measures the electrical resistance of between two electrodes inserted into a medium.
- The greater the moisture content, the lower the resistance.
- A function of liquid specific conductance.
- Example: Gypsum block
Challenges

• How to install: TDR and resistivity are permanent; Neutron probe requires borehole

• Direct contact with the waste: Desired for TDR and resistivity.

• Calibration (what is actual moisture content?)

• Neutron probe required radioactive source
TDR Device Used in Florida
Resistivity Probe Used in Florida
Results of Field Trial

![Graph showing the resistance (kOhm) over time for two sensors, Sensor 1 and Sensor 2. The graph plots Resistance (kOhm) on the y-axis and Time on the x-axis from 9-Apr to 15-Apr. Sensor 1 is represented by blue diamonds, and Sensor 2 is represented by magenta squares. The data points show a decrease in resistance over time.]
Resistivity distribution inside NRRL Bioreactor, 12/18/02

High Resistivity (Low Moisture)

Low Resistivity (High Moisture)

Surface of Bioreactor
20 feet deep
40 feet deep
60 feet deep
Remaining Questions

- How long will they work?
- Once wetted, do they stay wet?
- Does installation create preferential flow paths?
- Can true moisture content be measured, or only relative moisture content?
- Are they economical?
- Can wireless measurement be implemented?