Electrical Leak Location Surveys for Landfill Caps

Authors: Rusty Hansen and Abigail Beck, P.E.

Vector Engineering Inc., 143E Spring Hill Dr, Grass Valley, CA 95045, phone 530-272-2448, fax 530-272-8533, email rhansen@vectoreng.com and beck@vectoreng.com

Abstract

Electrical Leak Location (ELL) surveys are a proven technology for locating holes in installed geomembrane liners. Typically, leak detection surveys are specified for landfill expansion cells on the bottom lining system. Landfill capping systems often incorporate a geomembrane, designed to avoid infiltration into the waste and subsequent leakage through or overflowing of the bottom liner. Protective cover soil is placed over the geomembrane as part of closure construction. Placement of cover material on landfill caps is particularly difficult due to the orientation of the heavy equipment on steep slopes. Damage to the underlying geomembrane typically goes unnoticed since the damage is usually quickly covered after it has occurred. The Authors performed two leak locations surveys on two landfill geomembrane capping systems after the placement of the protective cover soil using the dipole method (ASTM D7007-03). One survey was specified as part of closure construction quality control while the other was specified forensically after poor closure construction. The survey methods for each survey are discussed, along with site preparations in order to maximize the sensitivity of the surveys. Results of the surveys are presented along with practical suggestions for future landfill cap surveys. Leak detection testing of landfill caps proved a viable tool to ensure the integrity of the geomembrane capping systems.

Introduction

Typically, regulations require landfill caps to maintain an overall permeability of less than or equal to the bottom liner system of the landfill. This usually means that a geomembrane is employed as a component of the landfill capping system for a modern landfill expansion, unless the landfill is located in an extremely arid environment. Protective and vegetative soil is then installed over the geomembrane to provide long term protection and to aid in the establishment of vegetation over the closed landfill. The placement of the soil cover over the geomembrane can occur on relatively steep slopes, whereas landfill expansion cells typically only install protective soil cover over the flat floor areas of the expansion cell. The slopes are covered during waste filling operations. The steeper the slope, the more difficult soil placement becomes, making equipment damage far more likely.

ELL survey technology has been developed and applied successfully over the past 25 years (Laine and Darilek, 1993) in order to pinpoint sources of leakage through installed geomembranes. The Dipole method (ASTM D7007-03) is used to locate holes in an installed geomembrane after it has been covered by water or soil material. In order to survey landfill caps, a dipole survey should be employed to locate the significant damage caused by the soil placement. Modern landfill regulations are increasingly specifying ELL surveys for the bottom lining system of landfill expansion cells, but landfill caps have not yet been subject to this requirement.

The authors performed ELL dipole surveys on two landfill capping systems. The first survey, herein referred to as Site 1, was specified after the construction of the cap was complete, while the second one, herein referred to as Site 2, was specified as part of closure Construction Quality Assurance (CQA). The following sections explain the technical requirements of a dipole survey and how each site was prepared to execute the ELL survey.

Dipole Method

The Dipole method (ASTM D 7007) is used to locate holes in the liner after it has been covered by water or earth material. In the case of soil or rock cover, the thickness of the cover layer can affect the sensitivity of the equipment. Holes as small as 5 mm in diameter can be located under 0.6 meters of cover, and successful surveys have been conducted on 1.5 meters of material, although detection sensitivity is subject to many site-specific variables, especially moisture content of the cover soil. To perform the survey, a positive electrode is placed in the overlying cover material and a high voltage is introduced. The underlying subgrade is grounded so that the electrical current will flow through possible holes in the geomembrane. The dipole equipment takes measurements of voltage potential in a grid pattern over the survey area. In the case of a hole, current flows through the hole and creates a voltage potential spike followed by a distinct drop before resuming the "background noise" values.

Site Conditions

The survey area must be electrically isolated in order to perform a successful dipole survey. The soil cover component of a landfill capping system is connected to the surrounding ground, which would preclude the performance of a survey in its final state of completion. Therefore, the site must perform preparations specific for an ELL survey in addition to the typical moisture requirements. The ELL equipment must also be grounded correctly to the waste mass within the landfill. If the landfill is assumed to be completely isolated by a geomembrane, a perforation must be made in the lining system in order to ground to the waste enclosed in the geomembrane.

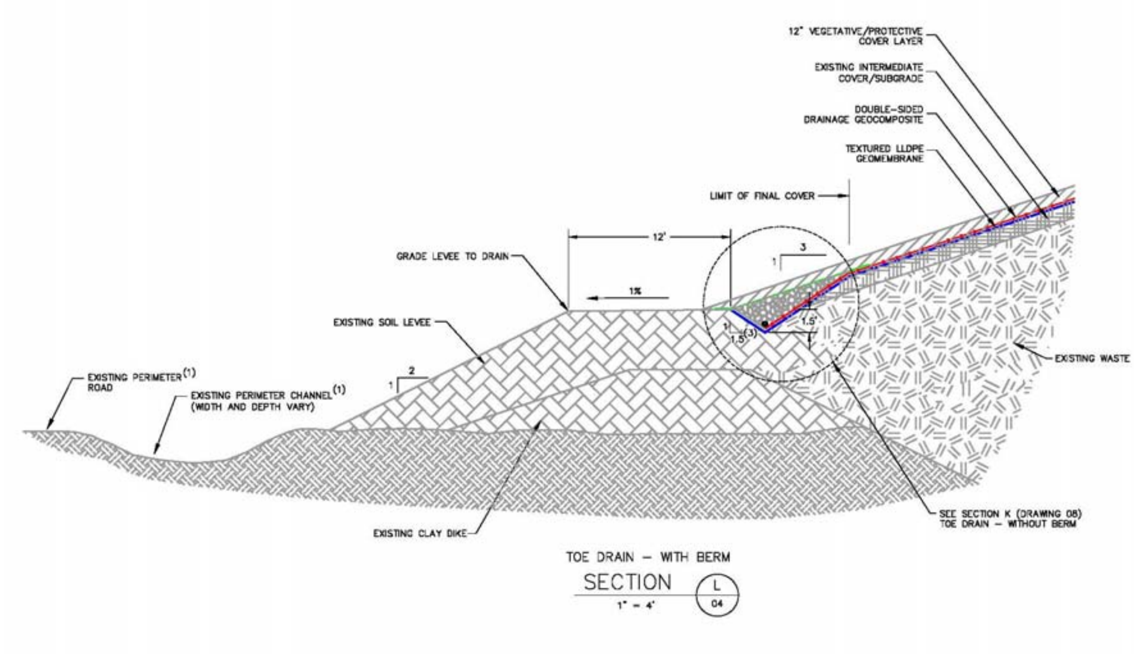
For Site 1, the ELL survey was specified after the landfill was in its final closure configuration. Therefore, a trench was dug around the entire perimeter of the landfill, as shown in Figure 1. A geocomposite drainage net was installed as part of the closure cap and recent rains had saturated this material. Therefore, geocomposite was also separated and allowed to dry out in order to prevent electrical conductivity through the trench, as shown in Figure 2.

Figure 1. Perimeter Trench

Figure 2. Perimeter trench with geocomposite separation.

For Site 2, the ELL survey was specified as part of closure construction so that a novel perimeter isolation detail was created early in the design process. This detail allowed the liner to be extended from the anchor trench to create an isolation strip around the perimeter of the cap.

Figure 3. Design Detail of perimeter isolation



A photo of the isolation strip at the time of the ELL survey is provided as Figure 4.

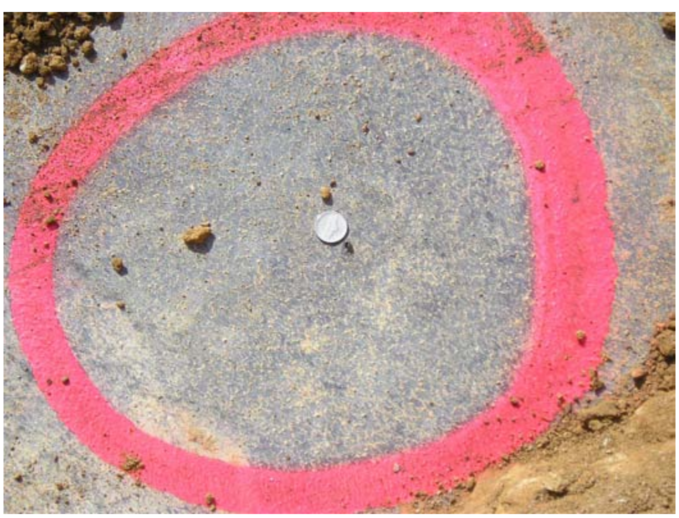
The Isolation of the site is critical since any soil, water, or other conductive material bridging the survey area and the grounded area can potentially ground out the survey and mask the presence of leaks through the geomembrane. The exposed liner trenches shown in the previous photos were covered after the survey was completed.

Survey Results

The Site 1 survey located 7 holes in the geomembrane that varied in size from 5mm to approximately 1 meter. In excavating the electrical anomalies it was found that the geocomposite and underlying geomembrane had been ripped.

Figure 5. Equipment damage on side slope of Site 1

Figure 6. Small puncture found under approximately 1.0 m of soil at Site 1



During the first hour of surveying of site 2 a 1m hole was located wear a dozer blade had torn through the geocomposite and the liner. After the hole was uncovered and isolated the current supplied to the site also dropped indicating that the site conditions are improving. As the survey continued a small cut in the liner probably caused by a utility knife being used to cut something on the liner, like the geo-composite, was located. A second tear in the liner was also located wear a dozer blade tore the liner and was covered up. In addition several areas were found were the protective cover was to thin and a dozer had torn up the liner with its tracks. The survey was also able to detect several uninstalled pipe clamps were booted pipe for a gas collection system had not been correctly sealed. The survey of site two was able to locate 8 holes in all.

Figure 7. Equipment damage located at Site 2 on side slope

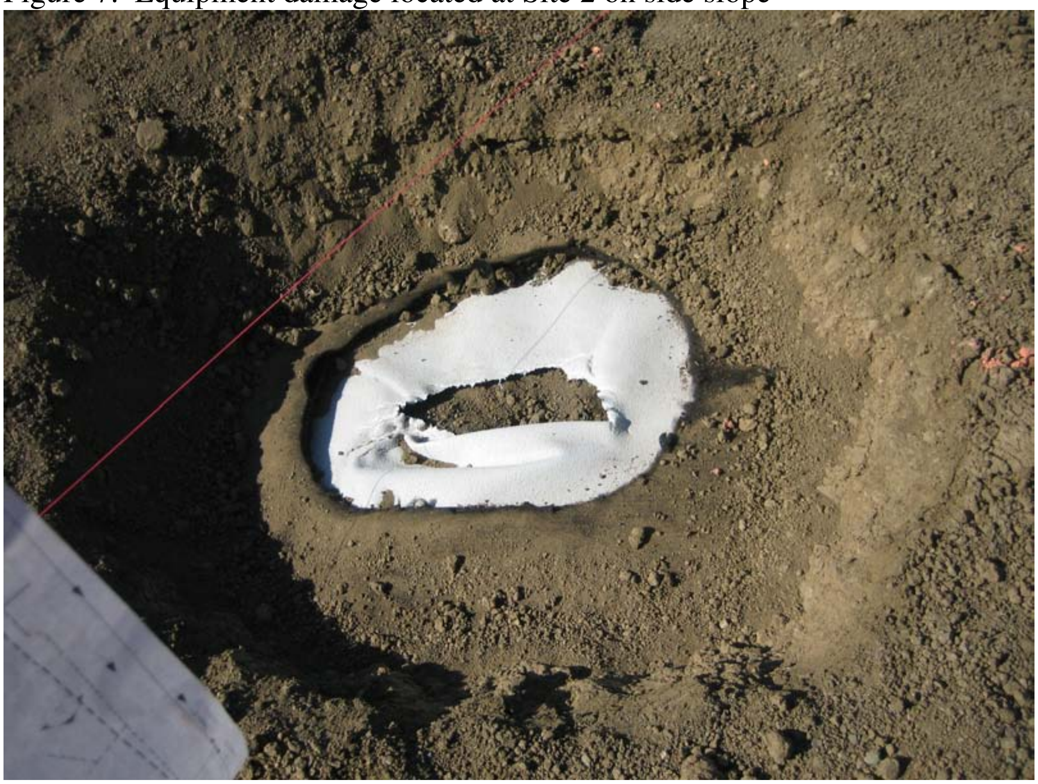


Figure 8. Equipment damage on top deck of Site 2

Conclusions

Both surveys were very successful, being able to locate holes in the geomembrane after the cover soil had been placed. It is important to recognize that the soil is the electrical conduit in which the current will pass through. In order to successfully survey an area the site must be properly prepared to allow the current to flow through possible holes in the geomembrane and not an area of poor isolation. The use Electrical Leak Location Survey is a valuable tool in aiding in the construction quality assurance of a Landfill Cap.

References

ASTM D 7007, Standard Practices for "Electrical Methods for Locating Leaks in Geomembranes covered with Water or Earth Materials.

Laine, D.L. and Darilek, G.T. (1993). "Locating Leaks in Geomembrane Liners of Landfills Covered With a Protective Soil," Geosynthetics '93 Conference Proceedings, Vancouver, British Colombia, Canada, IFAI, pp. 1403-1412.