

## **Correlation between Electrical Resistivity and Moisture Content of Municipal Solid Waste in Bioreactor Landfill**

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### **ABSTRACT**

The changes in electrical resistivity of municipal solid waste (MSW) measured with electrical resistivity tomography (ERT) have been used to assess the influence of leachate recirculation events at bioreactor landfills. An attempt is made in this study to develop a direct correlation between the electrical resistivity and the moisture content of MSW. This correlation is based on a field testing program at Orchard Hills landfill (Illinois, USA) that included (1) ERT at three different locations that have been subjected to leachate recirculation events, and (2) moisture content of waste samples obtained at different depths from boreholes at the same three locations of ERT. It is shown that Archie's law can reasonably correlate the electrical resistivity and the moisture content of the waste; however, the two parameters,  $a$  and  $m$ , needed for the correlation appear to depend on the specific waste conditions. For the studied waste, the best fitted parameter  $a$  is 0.75 and the parameter  $m$  ranges from 1.6 to 2.15. Using this correlation, the influence of leachate recirculation on the distribution of moisture content at three locations of the landfill is evaluated. This study shows that the ERT can be a useful noninvasive technique to monitor the moisture content of MSW and to assess the effectiveness of recirculation systems at bioreactor landfills.

**KEYWORDS:** Electrical resistivity tomography, electrical resistivity, moisture content, leachate recirculation, municipal solid waste, bioreactor landfill

### **INTRODUCTION**

Electrical resistivity tomography (ERT) has been used to monitor leachate recirculation in bioreactor landfills in France on the basis of decreasing resistivity values in the waste around the recirculation system during leachate recirculation events (Guerin 2004; Moreau 2003). However, direct correlation between the resistivity and the moisture content is not established because of the dependence of the resistivity on several other parameters such as temperature, ionic content, particle size, resistivity of the solid phase, permeability, porosity, tortuosity, pressure, and clay content (Guéguen and Palciauskas 1992). Based on a large-scale laboratory testing program, Grellier et al. (2005) developed relationships between electrical resistivity and temperature and between electrical resistivity and water content of

MSW assuming that the waste does not degrade within the short duration of the testing period. As of today, a direct correlation between the in-situ measured electrical resistivity and the moisture content of the waste has not been reported (Imhoff et al. 2006). Such a relationship will be valuable to evaluate the moisture content evolution with ERT during leachate recirculation events in landfills.

This paper presents the results of a field study aimed to: (1) correlate the electrical resistivity measured by ERT with the waste moisture content, and (2) study the influence of the leachate recirculation on the waste moisture content at different depths and different distances from the leachate recirculation lines based on characterization of waste samples and ERT results. Electrical resistivity tomography is performed at three locations of a bioreactor landfill to determine the electrical resistivity with depth at these locations. Immediately after the ERT measurements, boreholes are drilled at each location to collect the waste samples at different depths to determine moisture content in the laboratory. The one-to-one comparison of electrical resistivity and moisture content profiles at the locations allowed investigation of direct correlation between the electrical resistivity and the moisture content of waste. This correlation is then applied to estimate the spatial moisture content distribution using the measured electrical resistivity distributions at three locations of the landfill to investigate the influence of leachate recirculation system on the evolution of moisture content of waste.

## **PROJECT SITE AND FIELD TESTING**

All of the field testing is performed at Orchard Hills landfill located in Davis Junction, Illinois, USA, The Orchard Hills landfill is a large mounded MSW landfill with filling both above- and below-grade. Waste input is approximately 3200 tons/day with 70% MSW, 16% construction and demolition waste, 11% soils and the remainder special waste. The leachate recirculation started in July 2004. Leachate recirculation is performed through a series of 6-inch perforated HDPE pipes in gravel-filled trenches, called Leachate Recirculation Lines (LRLs). The leachate collected at the bottom of the cell is pumped out and then recirculated into the waste through the LRLs.

### **Electrical Resistivity Tomography**

The ERT consists of injecting an electrical current ( $I$ ) through two metallic electrodes and measuring the potential difference ( $\Delta V$ ) between two other electrodes (Dahlin 2001). The apparent resistivity ( $\rho_a$ ) is given by the following relationship:

$$\rho_a = K \frac{\Delta V}{I} \quad (\text{Equation 1})$$

with  $K$  a geometrical factor which only depends on electrode position. The  $\rho_a$  is the ratio of the potential obtained in situ with a specific array and a specific injected current by the potential which will be obtained with the same array and current for a homogeneous and isotropic medium of  $1 \Omega.m$  resistivity. The apparent resistivity measurements provide information about resistivity for a medium whose volume is proportional to the electrode spacing. The larger the electrode spacing, the higher is the investigated volume. Each measurement of apparent resistivity can be represented

on a pseudo-section with  $x$  in abscissa and pseudo- $z$  in ordinate. This representation is conventional and the pseudo- $z$  is not a real depth. Software such as Res2DInv (Loke and Barker 1996) is used to interpret these data, i.e. to propose a model of resistivity of the medium according to the real depth by inverting the measured apparent resistivity.

The electrical resistivity (or its inverse, the electrical conductivity) depends on several parameters. Grellier (2005) estimated that during a short-time leachate recirculation event with outdoor leachate storage, the moisture content and the temperature are the most dominant parameters controlling the resistivity of a waste mass. In the case of bioreactor landfills in the USA, as the leachate collected from the landfill is directly recirculated and not stored outside the cell, the most dominant parameter controlling the resistivity of waste mass is the moisture content. The temperature of the leachate and the waste will be in equilibrium and the recirculation of the leachate will not induce significant change in the waste temperature. In comparison, in France, the leachate is collected by gravity and stored in a sump outside the landfill (and so influenced by the external temperature). Thus, without outdoor leachate storage, the changes in resistivity can be correlated to changes in moisture contents during leachate recirculation in bioreactor landfills if it is assumed that temperature variations inside the waste mass and the effects of others parameters on resistivity are negligible.

The electrical resistivity is expected to vary inversely with the moisture content. Waste with high moisture content will have low electrical resistivity and vice versa. The Archie's law (Archie, 1942) allows correlating electrical resistivity and saturation and porosity for rocks and soils. Grellier (2005) showed that for MSW Archie's law can be written:

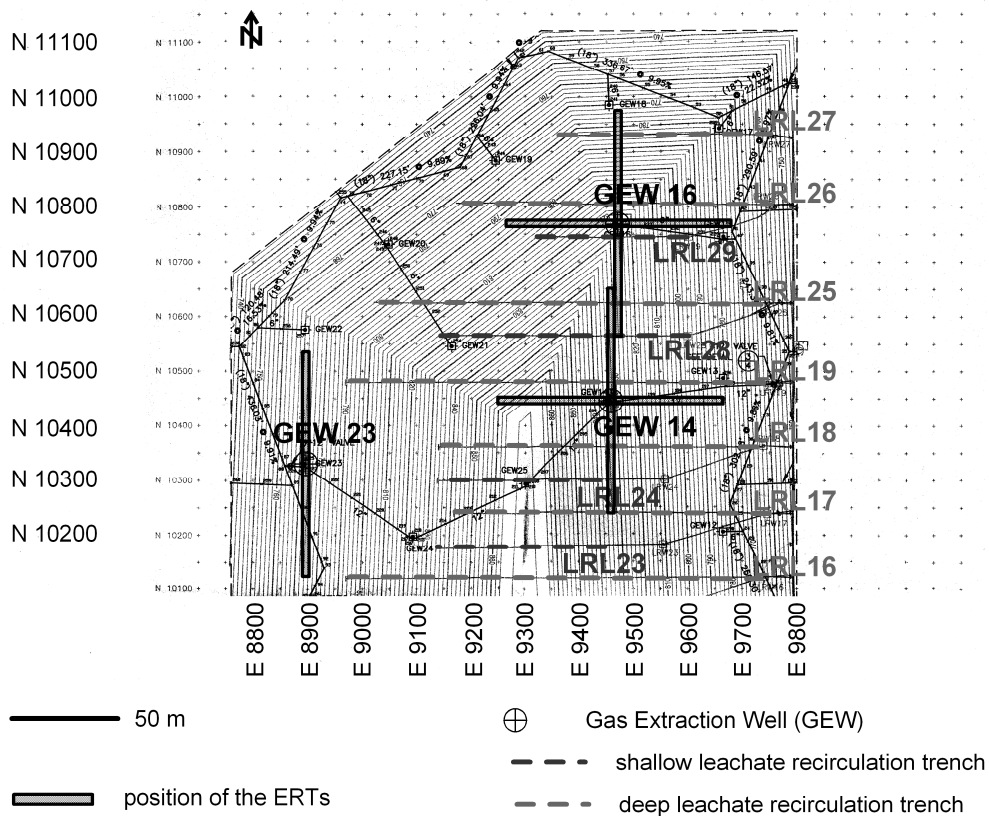
$$\rho = a\rho_1\theta^{-m} \quad (\text{Equation 2})$$

with  $\rho$  the interpreted electrical resistivity,  $\rho_1$  the electrical resistivity of the leachate,  $\theta$  the volumetric water content, and  $a$  and  $m$  empirical parameters. In the case of a French MSW,  $a=1$  and  $m=2.5$  fitted well the field data. In the general case, Archie proposed that  $a$  varies between 0.6 and 2, and  $m$  is around 2 ( $a<1$  for an intergranular porosity, case of the MSW, and  $a>1$  for a fracture porosity).

Three locations of the landfill are selected for ERTs in this study: around GEW 14, GEW 16 and GEW 23 as shown in Figure 1. The ERT details for each location are summarized in Table 1. Each ERT line consists of 48 electrodes at a spacing of 2.5 m. ERT lines are centered at the borehole locations to allow the maximum investigation depth. The investigation depth with the array and equipment used in this study is approximately 20 m. The results of the inversion of the apparent resistivity are extracted from each ERT at the location of the GEW. The average of the logarithm of the resistivities of the different ERTs is then used to define the resistivity for each depth.

**Table 1: Details of ERT conducted at borehole locations just before drilling and sampling**

Borehole	GEW14	GEW16	GEW23
Arrays	Wenner- $\alpha$	Wenner- $\alpha$ , Pole-Dipole	Wenner- $\alpha$
Direction of the ERT	W-E and N-S	W-E and N-S	N-S
Investigation depth	19.3 m	18.8 m	19.3 m



**Figure 1: Map of the studied landfill cell showing three borehole locations and position of ERTs**

### Waste Sampling and Testing

Immediately following the ERTs, boreholes are drilled at the three locations using bucket auguring method. The drilling is performed in conjunction with the installation of gas extraction wells at these locations. The depth of each borehole and the number of waste samples collected at each location are summarized in Table 2, and the distances between the borehole locations and the closest leachate recirculation lines are also shown in this table. Borehole locations GEW14 and GEW16 are selected within the leachate recirculation areas of the landfill cell to study the influence of leachate recirculation on moisture content of waste. Waste in borehole GEW14

should be affected by the leachate recirculation lines LRL18 and LRL19 (deep lines), and the waste in borehole GEW16 should be affected by LRL29 (shallow line) and LRL26 (deep line). Borehole GEW23 is situated farther away from the recirculation lines; therefore, it will serve as reference location where the waste is not influenced by the leachate recirculation (representing conventional landfill conditions).

**Table 2: Details of drilling and sampling at three borehole locations**

Borehole	GEW14	GEW16	GEW23
Depth	31 m	28.8 m	11.2 m
Number of samples	11	12	5
Distance from the closest LRL	26.5 m from the LRL18 9.8 m from the LRL19	7.5 m from the LRL29 11.9 m from the LRL26	68 m from the LRL16 88 m from the LRL17 75 m from the LRL18 51 m from the LRL19 87 m from the LRL23 75 m from the LRL24

During the drilling, waste samples, each weighing approximately 30 kg, are collected at every 3 m depth up to the termination of the boreholes. Temperature of the waste samples is measured immediately upon the retrieval to the ground surface. The waste samples are weighed in the field and then sealed in plastic bags. The samples are then transported to the laboratory for moisture content testing. The moisture content of waste samples is determined by drying in ovens at 60°C for several days (until there is no change in total mass). Based on the results, the wet gravimetric moisture content ( $w_w$ ) is calculated by:

$$w_w = \frac{M_l}{M_{tw}} \quad (\text{Equation 3})$$

with  $M_l$  the mass of liquid in the sample, and  $M_{tw}$  the mass of the total wet sample. Usually, the electrical resistivity is related to volumetric moisture content ( $\theta$ ) which is defined by:

$$\theta = \frac{V_l}{V_{tw}} \quad (\text{Equation 4})$$

with  $V_l$  the volume of liquid and  $V_{tw}$  the volume of the total wet sample. The gravimetric moisture content and volumetric water content are related by the following relationship:

$$w_w = \theta \frac{D_l}{D_{tw}} \quad (\text{Equation 5})$$

with  $D_l$  the density of the liquid which approximately equals to 1,000 kg/m<sup>3</sup> and  $D_{tw}$  the bulk (total) density of the wet sample.

## RESULTS AND ANALYSIS

The resistivity values of the waste samples from the boreholes are corrected for temperature based on the waste temperature data recorded every 1.5 m during the drilling using the relationship determined by Grellier et al. (2006). This relationship

indicates that the electrical resistivity decreases by about 2% for temperature increase of 1°C. Waste temperatures range from 20 to 38°C, from 3 m depth to the bottom of the boreholes. At 1.5 m from the surface, lower temperatures are measured (from 5 to 14°C). Equation 5 is used to convert the measured gravimetric moisture contents into volumetric moisture content or vice-versa. For this conversion, the density of the waste must be known. Based on the total mass of waste disposed in the landfill cell divided by the total volume of the cell, the average wet density of waste is determined to be 890 kg/m<sup>3</sup>. In addition, the wet density of waste at different depths is measured during drilling a borehole numbered GEW10 within the landfill cell by measuring the volume of borehole depth zone and the waste mass recovered from it. Based on this, the average density of waste is determined to be 1,500 kg/m<sup>3</sup>, with values ranging from 1,220 to 2,000 kg/m<sup>3</sup>. This range of density values and the global average value are used for the conversion of the moisture content of the waste.

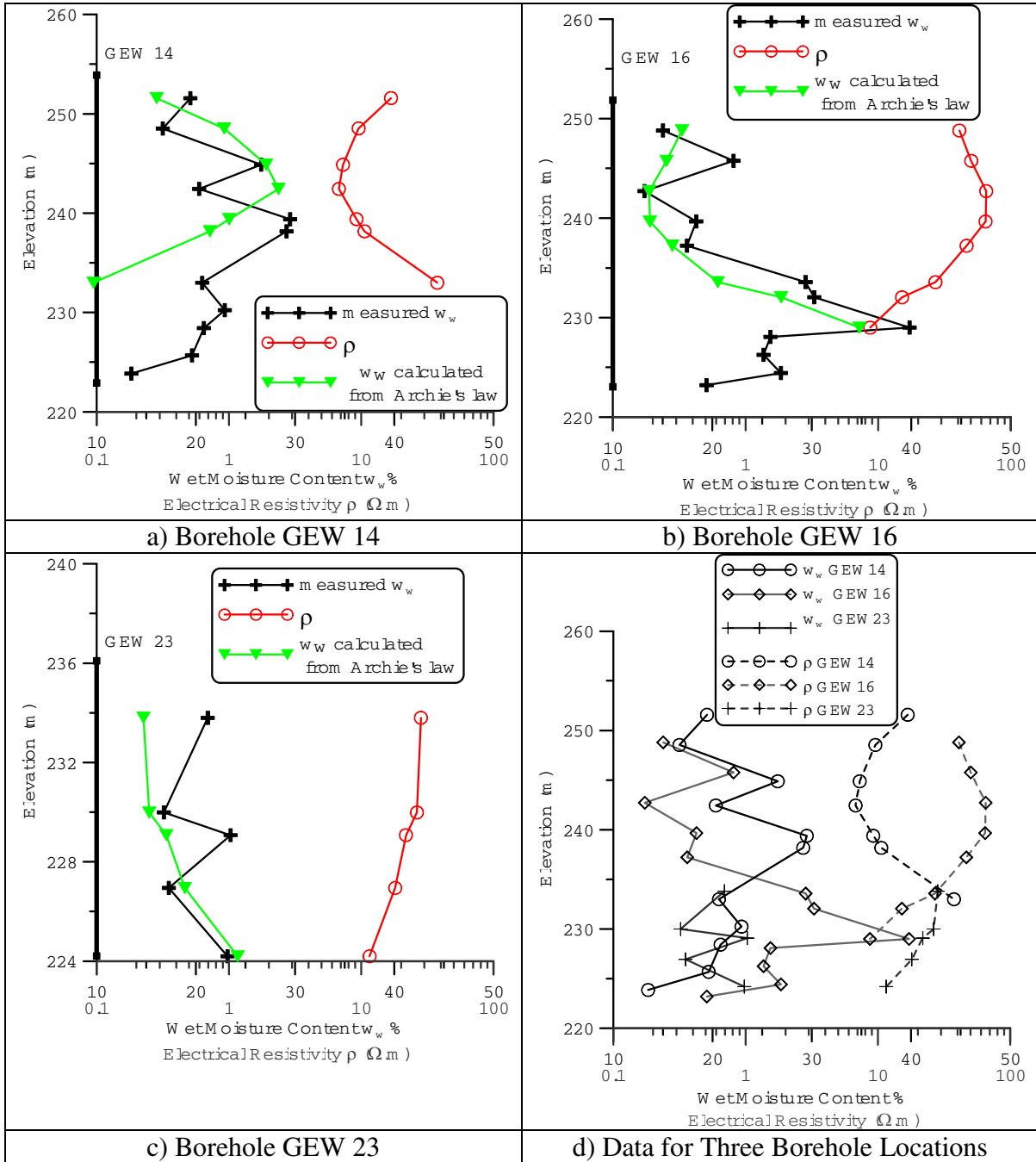
### **Correlation between Resistivity and Wet Gravimetric Moisture Content**

Figure 2 presents the measured electrical resistivity ( $\rho$ ) and wet gravimetric moisture content ( $w_w$ ) versus depth at each borehole location (GEW). At location GEW14 (Figure 2a), the moisture content increases within the elevation interval of 253 m and 238 m, and then it decreases. In the same elevation range, the resistivity starts to decrease and then it increases. The inverse relationship between electrical resistivity and moisture is evident from these results. At location GEW16 (Figure 2b), moisture content is low close to the surface, then it increases to an elevation of 230 m, and finally shows decreasing trend at the bottom of the borehole. The decrease in resistivity with increase in moisture is also observed at this location. The trend for the moisture content of the waste samples at location GEW23 is less obvious as there are only few data points (Figure 2c). A general trend of slightly increase of the moisture with the depth is observed. This is correlated with the slight decrease of resistivity with depth. The fluctuating moisture content values observed at all three locations are mainly as a result of heterogeneous nature of the waste and the use of a small representative waste sample for laboratory moisture content testing. Therefore, instead of point-to-point correlation, a general correlation between moisture content and resistivity is observed at the three borehole locations as seen in Figure 2(d).

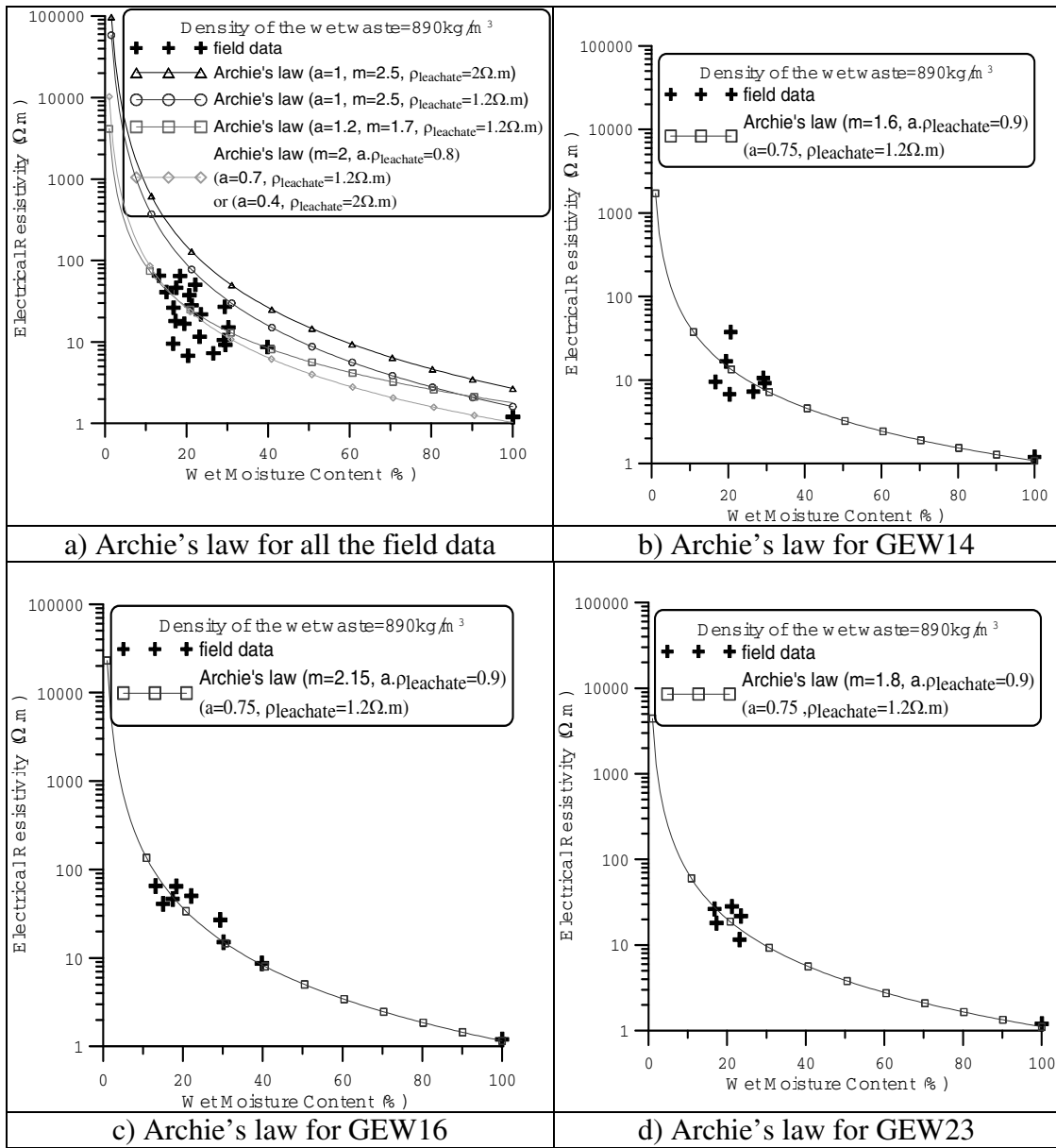
To correlate electrical resistivity with wet gravimetric moisture content, the volumetric water content in the Archie's law is converted into wet gravimetric water content using density of waste according to Equation 3. The correlations have been evaluated for different wet densities of waste ranging from 890 kg/m<sup>3</sup> to 1,500 kg/m<sup>3</sup>. Figure 3 represents the electrical resistivity of the waste versus the moisture content of the drilled samples for the three studied borehole locations (GEW) using the average wet waste density of 890 kg/m<sup>3</sup>.

The electrical resistivity and wet gravimetric moisture content data in Figure 3 is fitted with Archie's law as given in Equation 2. In this equation,  $\rho_1$  is the leachate conductivity. At Orchard Hills landfill, the electrical conductivity of leachate is measured quarterly in four leachate collection points. The average leachate conductivity is around 5,000 mS/cm (or electrical resistivity of 2  $\Omega$ .m), between

February 2004 and November 2005, but increased to 8,000 mS/cm (or electrical resistivity of 1.2  $\Omega$ .m) in February 2006. These two values are selected for the evaluation of correlation between electrical resistivity and moisture content using Archie's law. The electrical resistivity range of the waste is about 5 to 100  $\Omega$ .m. These values are comparable to typical values of clay or wet sand. The maximum resistivities for dry soils and rocks can be in the order of few thousand  $\Omega$ .m.



**Figure 2: Wet gravimetric moisture content  $w_w$  (%) and electrical resistivity  $\rho$  ( $\Omega$ .m) versus elevation (depth) at three borehole (GEW) locations**



**Figure 3: Electrical resistivity versus wet moisture content for the GEW**

Figure 3(a) shows that the Archie's law with  $a=1$  and  $m=2.5$  does not fit the experimental data very well. The Archie's law with different values of  $a$  and  $m$  and leachate resistivities ( $1.2$  or  $2 \Omega \cdot m$ ) are shown in Figure 3(a). The measured wet moisture content of waste ranges from 13% to 40% and follows the trend of the Archie's law, even though some values deviate from the best-fit curves. Nevertheless the range of the moisture content is too narrow to have a good definition of the empiric parameters,  $a$  and  $m$ , of this law. In order to represent a wider range of moisture content and improve the definition of empiric parameters, an additional data point has been added to the field data. It corresponds to the leachate alone ( $w_w=100\%$ ), assuming that the resistivity of the leachate is closer to  $1.2$  than to

2  $\Omega$ .m. Table 3 summarizes the best fitted parameter values for different wet density conditions. The range of values given by Archie can be achieved if either (1) the resistivity of the liquid inside the studied waste sample is around 1.2  $\Omega$ .m and the density of the waste is around 890  $\text{kg/m}^3$  or (2) the resistivity of the liquid inside the studied waste sample is around 2  $\Omega$ .m and the density of the waste is around 1,200  $\text{kg/m}^3$ .

**Table 3: Best-fit  $a$  and  $m$  parameters from the Archie’s law based on the field data**

Field Data Points and Wet Waste Density (D)	$\rho_{\text{leachate}}=1.2 \Omega\cdot\text{m}$	$\rho_{\text{leachate}}=2 \Omega\cdot\text{m}$
All data, D=890 $\text{kg/m}^3$	<b><math>a=0.7, m=2</math></b>	$a=0.4, m=2$
All data, D=1200 $\text{kg/m}^3$	$a=1.5, m=2$	<b><math>a=0.75, m=2</math></b>
All data, D=1500 $\text{kg/m}^3$	$a=2.3, m=2$	$a=1.15, m=2$
GEW14, D=890 $\text{kg/m}^3$	<b><math>a=0.75, m=1.6</math></b>	
GEW16, D=890 $\text{kg/m}^3$	<b><math>a=0.75, m=2.15</math></b>	
GEW23, D=890 $\text{kg/m}^3$	<b><math>a=0.75, m=1.8</math></b>	

The value of  $a$  controls the later portions of the fitted curve (around  $w_w=100\%$ ). By assuming the leachate resistivity value is the same as that used in Figures 3(b), 3(c) and 3(d), the value of  $a$  is fixed at 0.75. The best fitted parameter  $m$  for the studied waste varies according the location of GEW, from 1.6 to 2.15. The parameter  $m$  depends on the pore shape and the compaction, generally increasing with the compaction.

With the best-fit values of  $a$  and  $m$  presented in Table 3, the wet gravimetric moisture content  $w_w$  has been calculated from the electrical resistivity measurements using Archie’s correlation and are compared with the measured moisture content data as shown in Figure 2. For GEW14 (Figure 2a), the trends of the two moisture content curves are similar but the values are different. Only one point out of 7 fits well between the measured and calculated  $w_w$ . For GEW16 (Figure 2b), the trends of the two curves fit very well and almost all the points are in the same range (5 points out of 7 fit well). For GEW23 (Figure 2c), the trend of the calculated curve is more visible than for the measured one (3 points out of 5 fit well). Considering all the points, 9 points of calculated  $w_w$  out 19 (i.e. 47%) fit well the measured  $w_w$  (variations less than 13% between the two values).

The relationships between the resistivity and the particle size, resistivity of the solid phase, permeability, porosity, tortuosity, pressure and clay content have not been established for any type of MSW. As a result, it can be difficult to correlate perfectly the electrical resistivity with the moisture content. Nevertheless the trends shown in Figures 2 and 3 have a physical meaning and suggest a strong correlation between the wet moisture content and the electrical resistivity. A larger range of  $w_w$  for the field data will allow more accurate definition of the empirical parameters in Archie’s law.

The field data shows that the empirical parameters  $a$  and  $m$  of the Archie's law may include the dependency of the various parameters cited above. This implies that it does not seem possible to establish a unique relationship (Archie's law) with only one set of empirical parameters to represent relationship between moisture content and electrical resistivity. However, the results of this study and those for a French waste (Grellier et al, 2005) shows that the relationship between electrical resistivity and moisture content can be represented by the Archie's law with the definition of the empirical parameters specific to the type of MSW, and which may depend on the landfilling conditions. Overall, this study results shows that the ERT is a useful noninvasive technique to evaluate the moisture content. Similar to all the other invasive and noninvasive non-direct methods, a calibration between the measured properties and the moisture content is needed. For the bioreactor landfills, such a calibration may be required at different degradation states of the waste (due to changes in particle size, porosity, etc.).

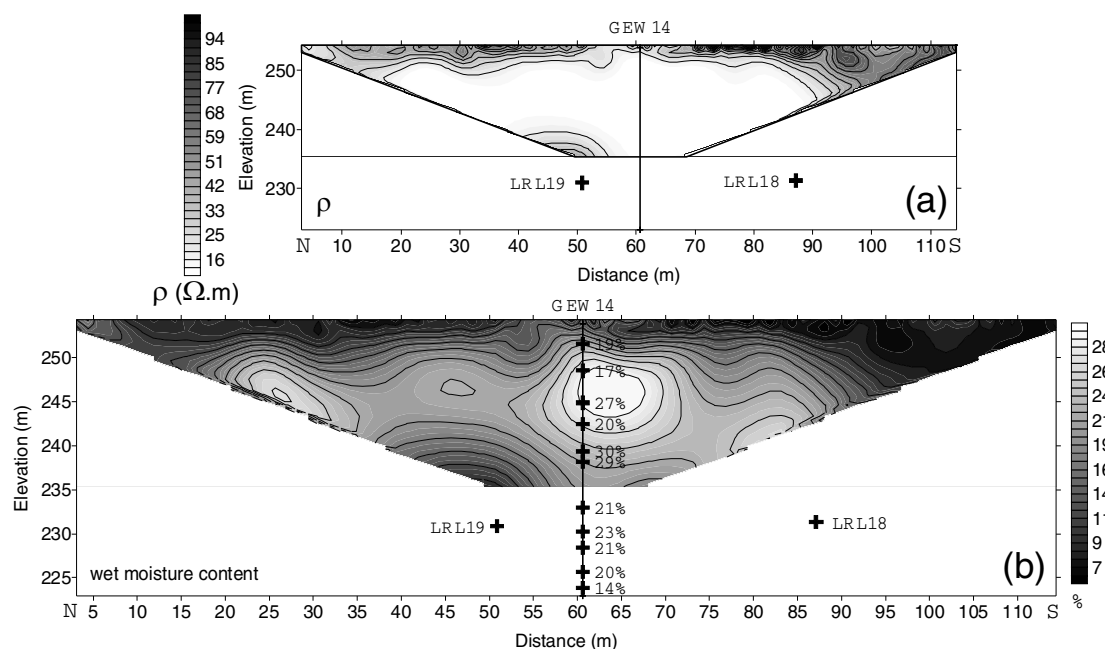
### **Influence of Leachate Recirculation on Evolution of Wet Moisture Content**

The spatial variation of in-situ measured electrical resistivity and the wet moisture content calculated with the Archie's law from the electrical resistivity around each borehole location (GEW). The calculation of the wet moisture content with the Archie's law assumes that the empirical parameters  $a$  and  $m$  and density of waste are the same along the ERT lines and that the temperature changes are too small to influence the electrical resistivity. The measured (actual) wet moisture contents of the waste samples collected from different depths in boreholes (GEW) are plotted on the moisture content distribution map for comparison purposes, as well as the locations of the closest LRLs. Contrary to the direct wet moisture content measurement, ERT is a global measurement method that does not yield sudden changes in electrical resistivity (hence the moisture content determined using the Archie's law) within a short distance.

Figure 4(a) shows that the measured electrical resistivity at and around borehole location GEW14 generally decreases with depth and then somewhat remains uniform and low up to the depth of investigation (about 20 m). The resistivity is converted into wet moisture content using the Archie's law as summarized in Figure 4(b), and these results show the inverse relationship between moisture content and resistivity. The moisture content increases with depth and a somewhat higher moisture zone exists between the elevations 250 m and 240 m with moisture content ranging from 20% to 30%. This is consistent with the measured moisture content values for the waste samples (from 20 to 27%). For the top half of the borehole, the actual moisture content values  $w_w$  is increasing (from 17-19% to 30%). Then in the bottom half of the borehole,  $w_w$  is decreasing (from 30 to 20%). The average wet moisture content for all the collected samples of GEW14 is 21.7%.

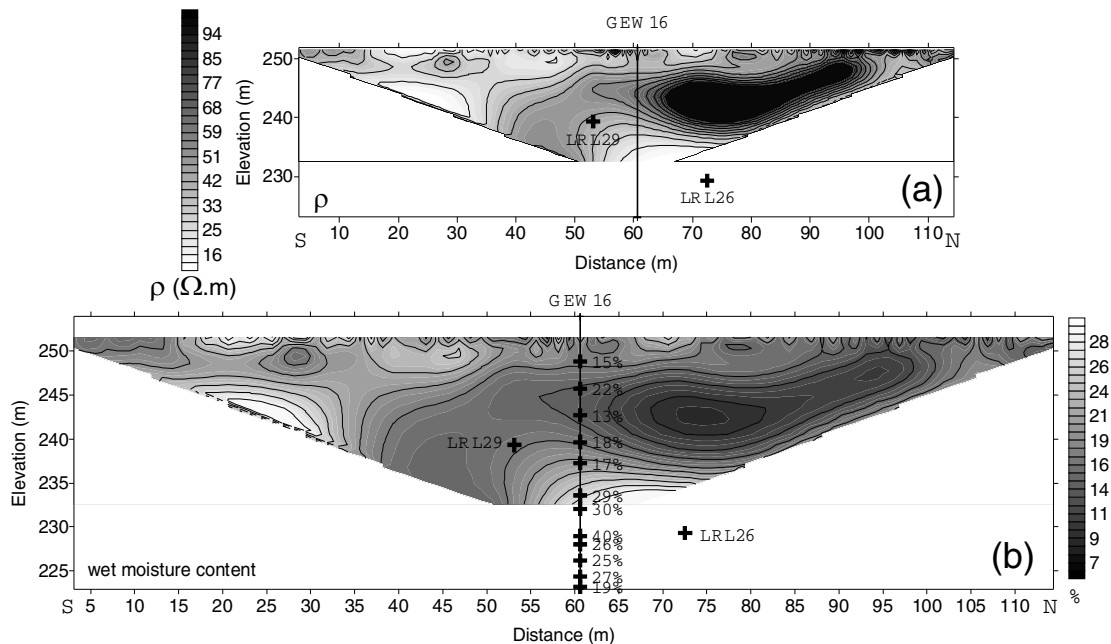
The two closest LRLs to GEW14 are deep lines oriented in east-west direction as shown in Figure 4. The presence of the LRL 19 (located at 9.8 m from the GEW14) does not seem to affect the moisture distribution. The LRL18 seems too far (26.5 m) from the borehole location to influence the moisture content of the waste. The

observed moisture content variations at shallow depths are attributed to the surface application of leachate during filling operations and potential infiltration of precipitation (this location was not capped during the time of this field investigation). Between the beginning of the recirculation and the drilling of boreholes, 218 and 232 m<sup>3</sup> of leachate are recirculated through LRL18 and 19, respectively. This leads to a recirculation rate of 1.1 L and 0.8 L of leachate per ton of waste, respectively, assuming that the average density of the waste of 890 kg/m<sup>3</sup>, radius of influence of 10 m, and a homogeneous distribution of the leachate all along the lengths of the line. Thus, the leachate injected into LRL19 or 18 may be low and/or the zone of influence of these LRLs is less than 10 m.



**Figure 4: Electrical resistivity  $\rho$  (figure (a)) and wet moisture content (figure (b)) calculated with the Archie's law from the electrical resistivity around borehole GEW14. The wet moisture contents of the collected waste samples are indicated.**

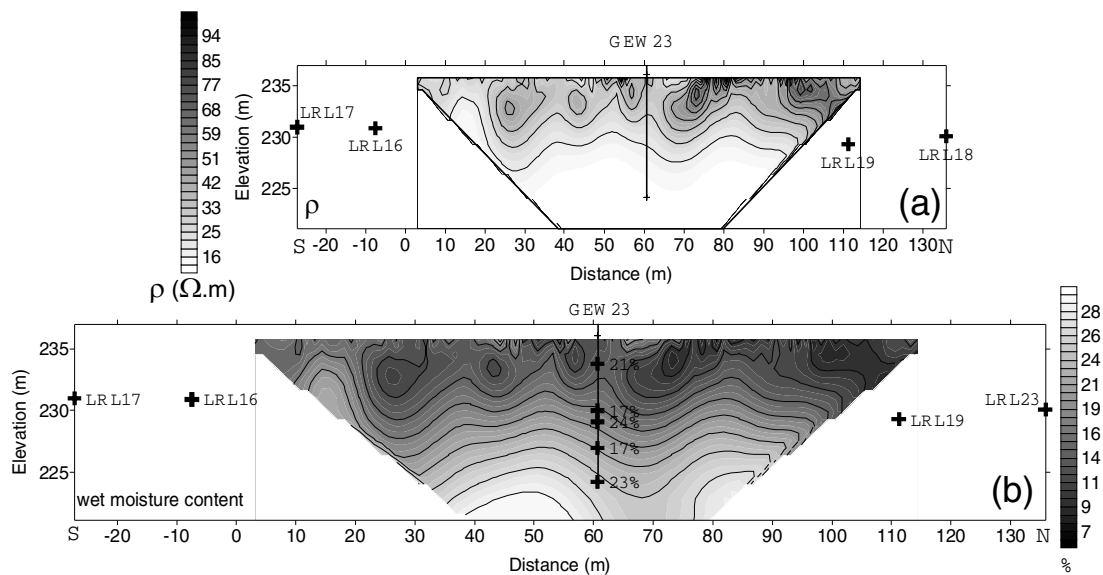
Figure 5 shows the variation of the electrical resistivity and interpreted wet moisture content around the borehole location GEW16. The interpreted moisture contents at different depths at the borehole location fit well with the actual measured water content values of the samples collected in the borehole. The average wet moisture content for all the collected samples of GEW16 is 23.6%. The two closest LRLs to the borehole location are LRL29 and LRL26 as shown in Figure 5. At the depth of the LRL 29 (located at 7.5 m from the GEW16), the wet moisture content is higher (18 and 17.5%) than just above the LRL29 (13%). With increasing depth, the wet moisture content increases (from about 18% at the depth of the LRL29 until 40% 10 m below the LRL29). Therefore, it can be concluded that the leachate recirculation on LRL29 has increased the moisture content of the waste below the LRL by 208% (from 13% to 40%). The wet moisture content of the samples is decreased from 40% to 20% at deeper depths to the bottom of the GEW. It seems that LRL26 may not have significantly affected the moisture content of the waste.



**Figure 5: Electrical resistivity  $\rho$  (figure (a)) and wet moisture content (figure (b)) calculated with the Archie's law from the electrical resistivity around borehole GEW16. The wet moisture contents of the collected waste samples are indicated.**

The interpreted moisture content distribution is not uniform around the borehole location (Figure 5b). With the shallow LRL29 located on the south side of GEW16, it can be clearly seen that higher wet moisture contents exist in this area than the north side where only the deep LRL26 is present. The last leachate recirculation occurred on LRL29 about 12 days before the drilling of the borehole. The leachate should have had time to drain through the waste. This can explain the higher moisture content at the bottom of the GEW rather than around the LRL29. Overall, these results show that the radius of influence of recirculation is greater than 8 m, but less than 12 m. Between the beginning of the recirculation and the drillings, 531 and 609 m<sup>3</sup> of leachate are recirculated through LRL26 and 29, respectively. This leads to a recirculation rate of 79.2 L of leachate per ton of waste respectively with the average density of the waste of 890 kg/m<sup>3</sup>, radius of influence of 10 m, and a homogeneous distribution of the leachate all along the lengths of the line.

Figure 6 shows measured resistivity and interpreted wet moisture content distribution at and around the borehole location GEW23. The LRLs in the vicinity of the borehole are oriented in the east-west direction. Compared to GEW14 and 16, all the LRL are farther than 50 m from the borehole. The actual moisture contents of the waste samples collected at different depths in the borehole are plotted. The average wet moisture content for all the collected samples of GEW23 is 20.4%. The inverse correlation between the electrical resistivity and moisture content is clearly seen for the results. The wet moisture content distribution shows a global increase of moisture content with depth.



**Figure 6: Electrical resistivity  $\rho$  (figure (a)) and wet moisture content (figure (b)) calculated with the Archie's law from the electrical resistivity around borehole GEW23. The wet moisture contents of the collected waste samples are indicated.**

The results from the three borehole locations show that the moisture content distribution plots obtained by applying the Archie's law to the measured electrical resistivity using ERT can provide an understanding of the moisture distribution and zone of influence and will help towards optimization of the leachate recirculation operations at bioreactor landfills.

## CONCLUSIONS

Three boreholes are drilled through the waste in Orchard Hills landfill that allowed correlating the electrical resistivity measured before the drilling and the wet gravimetric moisture content measured using waste samples obtained during the drilling. This study shows that the Archie's law describes well the relationship between electrical resistivity and the wet moisture content. The two empirical parameters of this law have been defined for each borehole and allowed calculating the wet moisture content from the electrical resistivity. The calculated moisture content data fitted reasonably well with the measured data. Therefore, the ERT method seems very promising to assess moisture distribution in waste. The difficulty to apply it routinely is the necessity to calibrate the empirical parameters for each new MSW or each stage of the biodegradation, considering that even in the same landfill cell the parameters can vary.

The study of the wet moisture content from collected samples regarding the location of the samples from the LRL shows that the zone of influence of the recirculation system is greater than 8 m but less than 10 m as the two LRLs at 10 and 12 m from the samples do not seem to have an influence on the moisture content of the waste. The average wet moisture content of the GEW16, which is the closest borehole to the LRLs, is 9% and 15% higher than for GEW14 and GEW23, respectively.

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