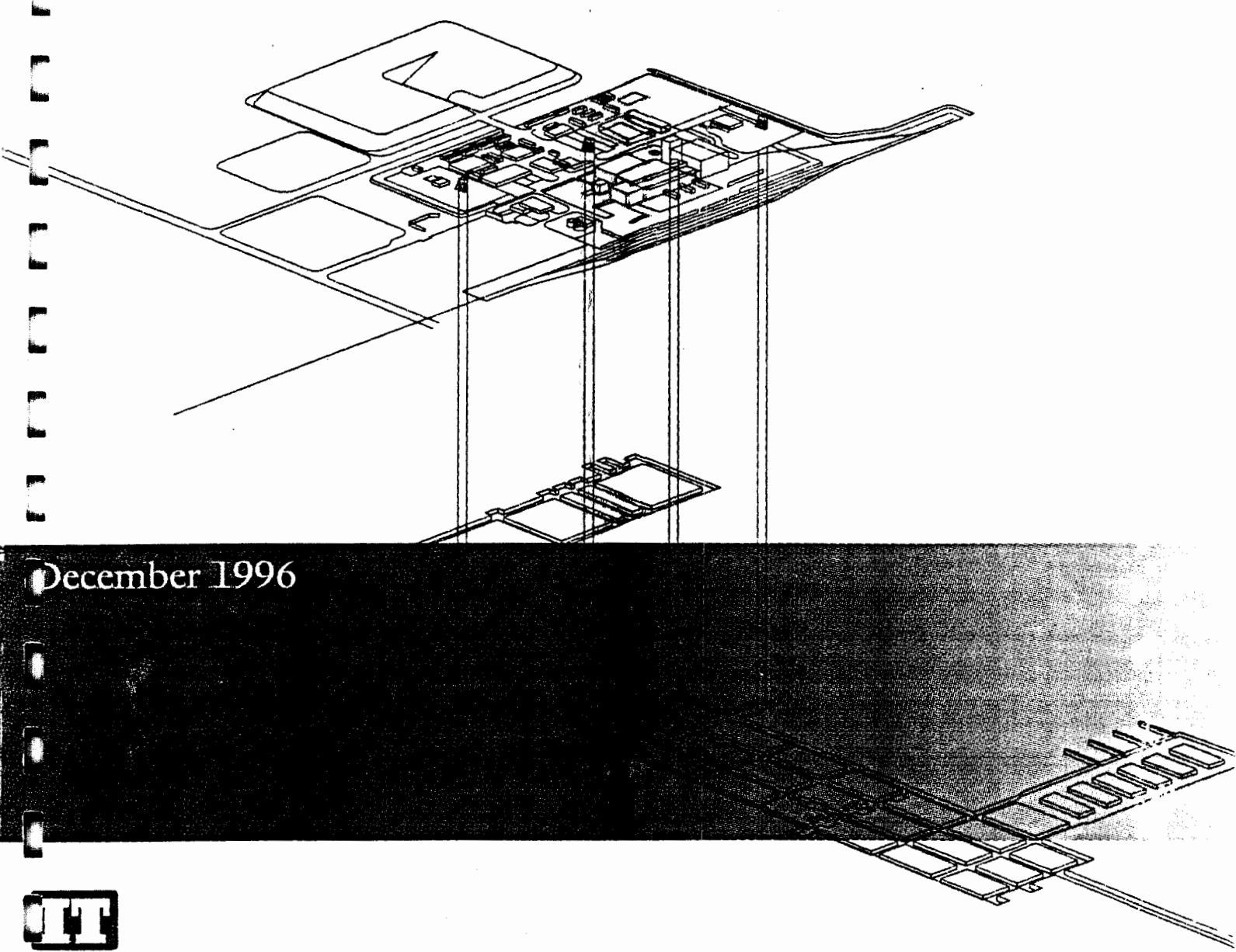


Analysis of Corrosion Testing Results for Galvanized Mesh Material Obtained from the Waste Isolation Pilot Plant, New Mexico

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December 1996



**ANALYSIS OF CORROSION TESTING
RESULTS FOR GALVANIZED MESH MATERIAL
OBTAINED FROM THE WASTE ISOLATION
PILOT PLANT, NEW MEXICO**

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1.0 Introduction

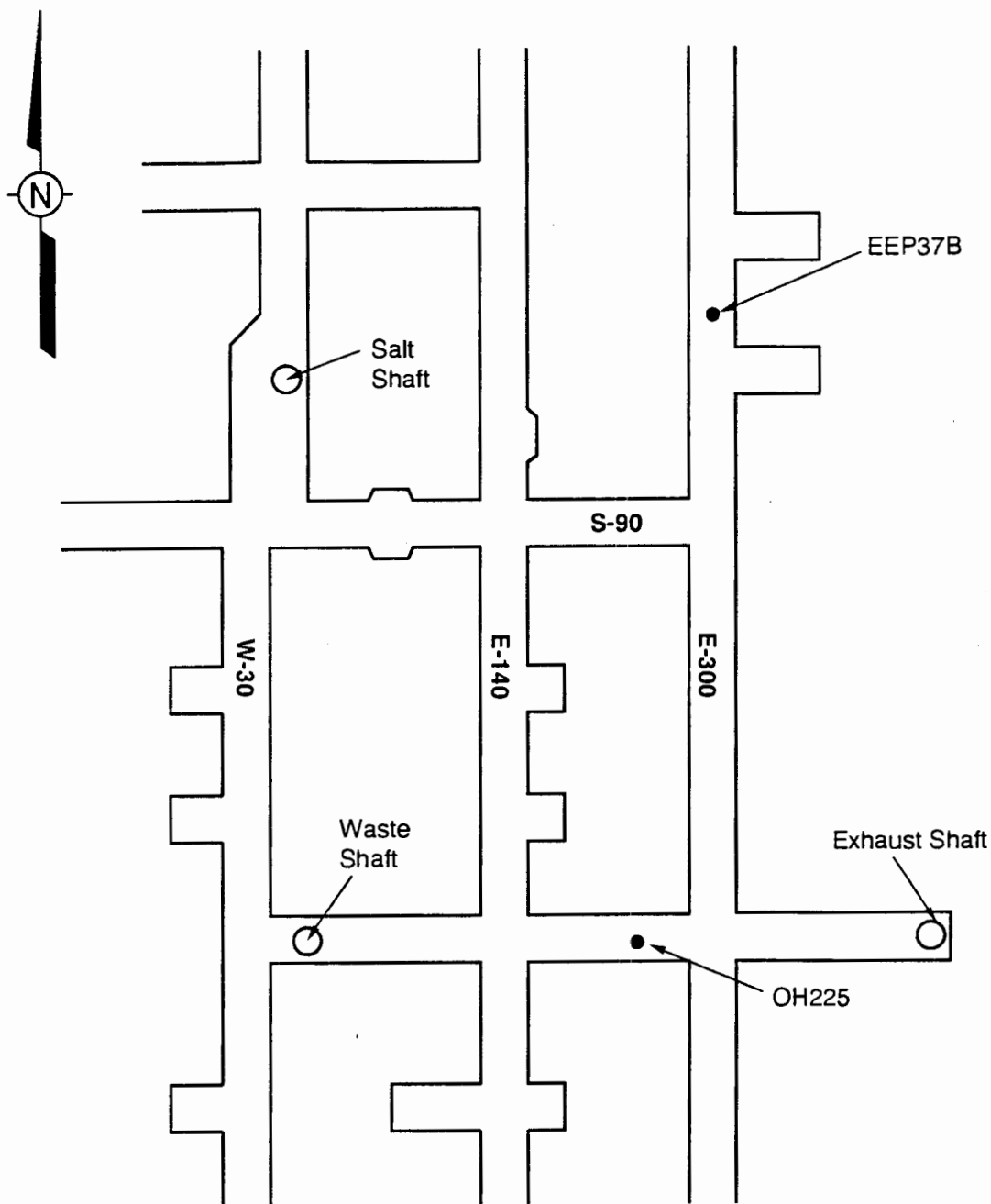
In the spring of 1995, lead (Pb) concentrations near the nonhazardous limit of 5 milligrams per liter (mg/L) were discovered in sodium-chloride (NaCl) brine recovered from the base of the Exhaust Shaft (ES). Similar hazardous levels of Pb were discovered in brine recovered from the Waste Handling Shaft (WHS) and boreholes between the ES and WHS in May of 1996 (Figure 1). The Pb concentrations were monitored quarterly until the spring of 1996, at which time the WIPP Exhaust Shaft Water and Lead Working Group (ESWLWG) was formed to investigate analytical uncertainty in the reported Pb results and the sources of the Pb in the brine. Since June of 1996, the ES has been sampled on a weekly basis, if brine is present, and other locations have been sampled weekly.

Analytical results and detailed interpretations of the geochemistry of brine samples collected from the underground locations will be discussed in a final report issued by the WIPP ESWLWG, while this report summarizes the corrosion tests conducted to investigate the source of Pb in the underground brine samples. The principal conclusion of this report is that the Pb and Zn concentrations observed in the brine samples collected from the ES basin, WHS sump, and borehole OH225 are derived from corrosion of the galvanized mesh present in the ES and WHS.

2.0 Potential Sources for Lead

Two potential sources for the Pb observed in the brine samples were identified in construction materials used in the ES and WHS. Lead wool was used to seal joins and borings in the cement liners, and galvanized chain-link mesh lines the shafts where the cement liners are absent. However, as the volume of Pb wool is small relative to that of the galvanized mesh, and the wool is not readily exposed whereas the mesh is, the initial conclusion was that galvanized mesh is the most likely source of the Pb. Observations also revealed that the mesh within the shafts is corroded and caked with salt.

The process of galvanizing steel involves the plating of Zinc (Zn) onto the steel, with the Zn serving to protect against oxidation of the steel. In natural minerals (e.g., sphalerite, ZnS) and in the electro-plating industry, trace quantities of Pb are always associated with Zn. Therefore, if the galvanized material is the source for Pb in the brines, much greater concentrations of Zn should be observed. This is true for all the analytical results received to



LEGEND

- Boreholes

Figure 1

Brine sampling locations in the WIPP underground. Elevated lead and zinc concentrations are observed only between the Exhaust Shaft and Waste Handling Shaft. Brine recovered from borehole EEP37B is indigenous Salado Formation brine (i.e., background).

date where Pb is an issue of regulatory concern. Therefore, observations of materials in the shafts and analytical results are consistent with the galvanized mesh being the source for the observed Zn and Pb concentrations in brine samples.

3.0 Sampling and Analysis Program

To verify that the galvanized mesh is the source for Zn and Pb in the brine samples, samples of unused mesh and corroded mesh in the ES and WHS were collected and subjected to acid digestion and a corrosion test with a saturated NaCl solution. Analysis of the fluids derived from these tests for iron (Fe), Zn, and Pb indicate that the range of Pb/Zn ratios in these test fluids are identical to the range of Pb/Zn ratios in the affected brine samples (Section 4.0, Analytical Results).

Table 1 summarizes the sample numbers and locations of the mesh samples. Galvanized mesh samples were obtained from unused mesh stored in the CONNEX area at the WIPP site (2 samples), from mesh installed in the ES (1 sample), and from mesh installed in the WHS (12 samples). Access restrictions prohibited the collection of more than a single sample from the ES. Six of the 15 samples were selected for the corrosion study, and these samples are identified in Table 1. Samples consisted of approximately 6-inch squares that were obtained using a hand-held wire cutter. The IT Technology Development Laboratory (TDL) in Knoxville, Tennessee performed the acid digestion and corrosion tests. Appendix A contains the report on the results of the corrosion testing as submitted by the IT TDL.

A saturated NaCl brine was prepared for use as the contact solution in the corrosion tests. Mined salt from the Panel 1 area was obtained with a polyethylene scoop and placed in a clean 5-gallon plastic bucket. The salt was taken to the surface and mixed with deionized (DI) water to produce the contact solution. Excess salt was placed in two clean, plastic 5-gallon buckets and approximately 8 liters (L) of DI water was added to each bucket and stirred with a wooden dowel. The salt and brine solutions were stirred daily, covered, and stored in a CONNEX trailer at ambient temperature for a week. The brine solutions were then filtered and transferred to a single container for homogenization. Eight L of the homogenized brine solution were sent to IT's TDL for the corrosion tests, and 1 L was sent to Wastren Analytical Laboratory (Wastren) in Grand Junction, Colorado to determine the concentrations of Fe, Zn, and Pb in the initial brine contact solution.

Table 1
Sample Locations and Analytical Results

Location	Sample ID	Solution	Iron (mg/l)	Zinc (mg/l)	Lead (mg/l)
Connex, unused mesh	WST96273	Acid digestion	897,000	86,300	590
		DI bath	0.508	14.0	0.00995
		NaCl brine	0.0302	58.5	0.0251
Exhaust Shaft, at intersection with drift roof	WST96282	Acid digestion	961,000	23,900	140
		DI bath	0.480	206	0.0060
		NaCl brine	0.501	360	0.0111
Waste Handling Shaft, 908 ft depth, E side	WST96312	Acid digestion	939,000	32,400	360
		DI bath	1.50	4.02	0.0149
		NaCl brine	13.3	24.4	0.0896
Waste Handling Shaft, 1145 ft depth, SE side	WST96314	Acid digestion	810,000	5,160	180
		DI bath	0.280	21.4	0.0845
		NaCl brine	1.03	214	1.74
Waste Handling Shaft, 1625 ft depth, W side	WST96319	Acid digestion	905,000	85,100	950
		DI bath	0.211	14.5	0.0811
		NaCl brine	8.40	766	2.47
Waste Handling Shaft, 2105 ft depth, NW side	WST96323	Acid digestion	970,000	35,500	550
		DI bath	0.284	14.2	0.0479
		NaCl brine	1.41	218	0.663

Prior to conducting the acid digestion and corrosion test, the galvanized mesh samples were weighed to the nearest 0.1 milligram (mg) and the weights recorded. If loose salt was found in the sample bag, it was weighed with the sample and included with the total recorded weight. All samples received from the ES and WHS were encrusted with salt, and these samples were placed in a DI water bath to remove the salt prior to testing. Washed samples were then split for the acid digestion and corrosion tests. Appendix A provides additional details on the laboratory preparation procedures.

One split underwent microwave digestion in aqua-regia to determine the Fe, Zn, and Pb content of the mesh. The other split was subjected to the corrosion test at 40°C, per ASTM procedure G31-72. Prior to conducting the corrosion test, the saturated NaCl solution provided to IT TDL was analyzed by IT TDL for Fe, Zn, and Pb in triplicate. Details on the laboratory tests and results of the triplicate analyses are provided in Appendix A.

At the IT TDL, solutions obtained from the acid digestion were analyzed for Fe, Zn, and Pb by inductive-coupled plasma (ICP) analysis, and methods and results are provided in Appendix A. The DI bath solutions and corrosion-test solutions were sent to Wastren for Fe and Zn analysis by ICP and Pb analysis by ICP-mass spectrometry (MS). These solutions were sent to Wastren because the IT TDL could not meet QA/QC requirements for Pb analysis by graphite furnace atomic absorption (AA), due to high chloride concentrations in the bath and corrosion solutions. Additional details are provided in Appendix A.

4.0 Results

A summary of the mass data for DI baths and corrosion tests is provided in Tables 1 and 2 of Appendix A. IT TDL analytical results for the initial contact solution and solutions obtained from acid digestion of the mesh samples are provided in Table 3 of Appendix A. Wastren results for the initial contact solution and solutions obtained from the DI bath and corrosion tests are provided in Appendix B. A summary of the analytical results for Fe, Zn, and Pb is also provided in Table 1.

Figure 2 summarizes the mass of the initial samples selected for testing and the percent mass of each fraction after the DI bath. The fractions are defined as percent mesh, percent salt, and percent residual solids. Residual solids are soil and metal particles that did not dissolve in the DI bath. The metal particles were derived from mesh samples that were partially corroded when received at the laboratory. Therefore, samples with the highest percent

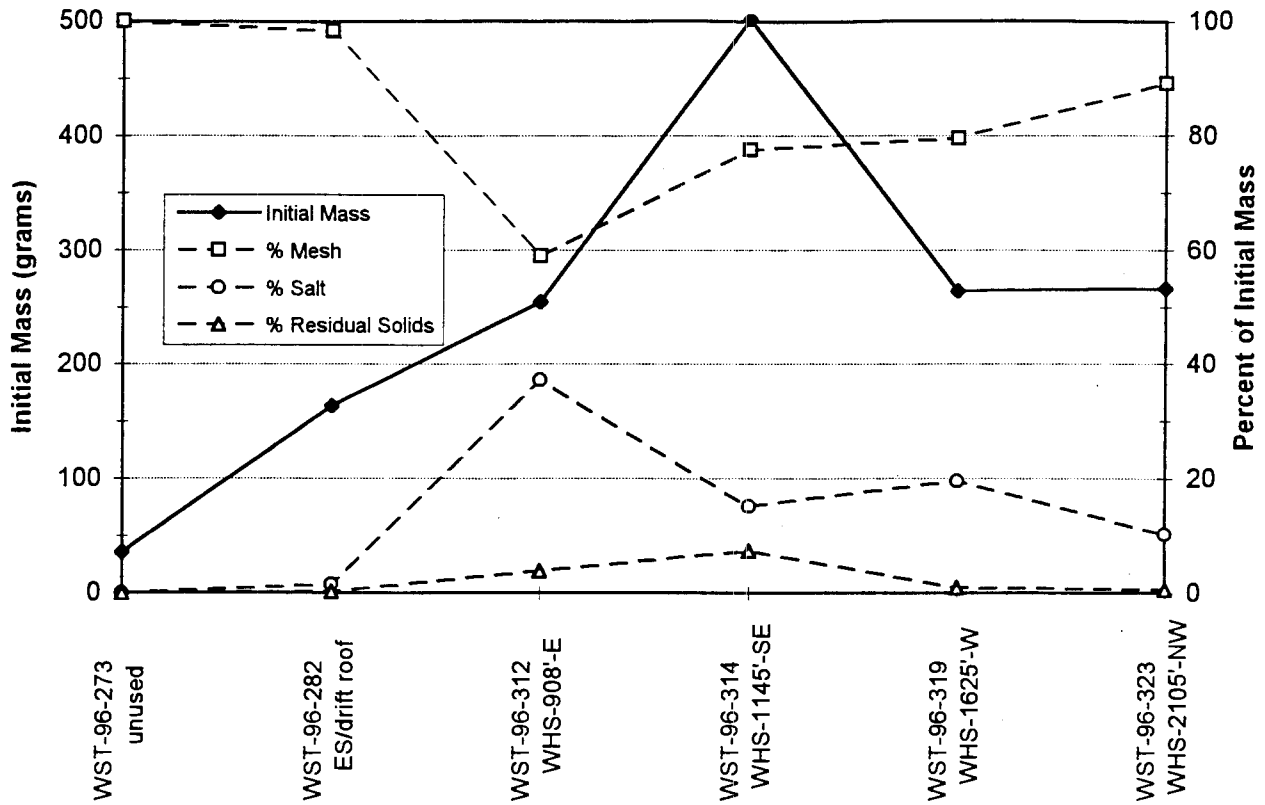


Figure 2

Summary of mass balance for received galvanized mesh samples. Total mass of received sample is given on left y-axis, and percent of components comprising the total mass of the sample is given on the right y-axis. Text below sample refers to location of samples (ES = exhaust shaft or WHS = waste handling shaft), depth below surface of collection point (e.g., 908' = 908 feet), and azimuth of sample (e.g., E = east, SE = southeast, etc.).

residual solids are taken to represent insitu conditions that are the most corrosive. Sample WST96273 is the unused mesh sample and 100 percent of the initial sample mass is mesh. The sample obtained from the drift roof at the intersection with the ES (WST96282) had very little encrusted salt (about 2 %), while the remaining samples had 10 to 38 percent of their total mass as encrusted salt. Samples WST96312 and WST96314 had the highest percentage of residual solids.

For the initial NaCl contact solution, IT TDL results indicate respective Fe, Zn, and Pb concentrations of <0.1 mg/L, 1.1 mg/L, and <0.04 mg/L. Analytical results from Wastren (Appendix B) report respective Fe, Zn, and Pb concentrations of 0.0142 mg/L, 1.31 mg/L, and 0.0311 mg/L in the initial contact solution. Although the higher detection limits for the IT TDL results preclude direct comparison of Fe and Pb results between the laboratories, the detection limit values are above the Wastren reported Fe and Pb concentrations, as expected. Results for Zn agree within approximately 20 percent.

Analytical results for Fe, Zn, and Pb are reported in Table 1 and displayed graphically for Pb and Zn on Figure 3. As expected, the mesh samples digested in aqua-regia yielded the highest Pb and Zn concentrations, followed by the NaCl corrosion solution and DI water bath (Figure 3). Lead and Zn results for the digested mesh appear fairly uniform, with the exception of Zn results for sample WST96314. Similar Pb results for samples WST96282 and WST96314 suggests that Zn results for these two samples would be similar, yet Zn results for WST96314 are approximately one-half the value of sample WST96282. There is no indication in the laboratory report of difficulty with the Zn analysis.

For the DI bath and NaCl solutions (Table 1 and Figure 3), the highest Pb concentrations were found in samples from the WHS (WST96312, WST96314, WST96319, and WST96323), with lower concentrations in samples from the ES (WST96282) and the unused mesh (WST96273). The lowest Pb concentrations for the NaCl corrosion solution are less than the Pb concentration in the initial NaCl contact solution (0.0311 mg/L). This indicates that some Pb may have been precipitated by evaporation of the sample during the 40°C corrosion test, analogous to lower Pb concentrations in samples from brines that have undergone evaporation in the ES basin (discussed in Section 5.0). For Zn, the highest concentrations were observed in three of the WHS samples (WST96312, WST96314, WST96319) and the single sample from the ES (WST96282), with lower values in the unused mesh (WST96273) and one of the WHS samples (WST96312).

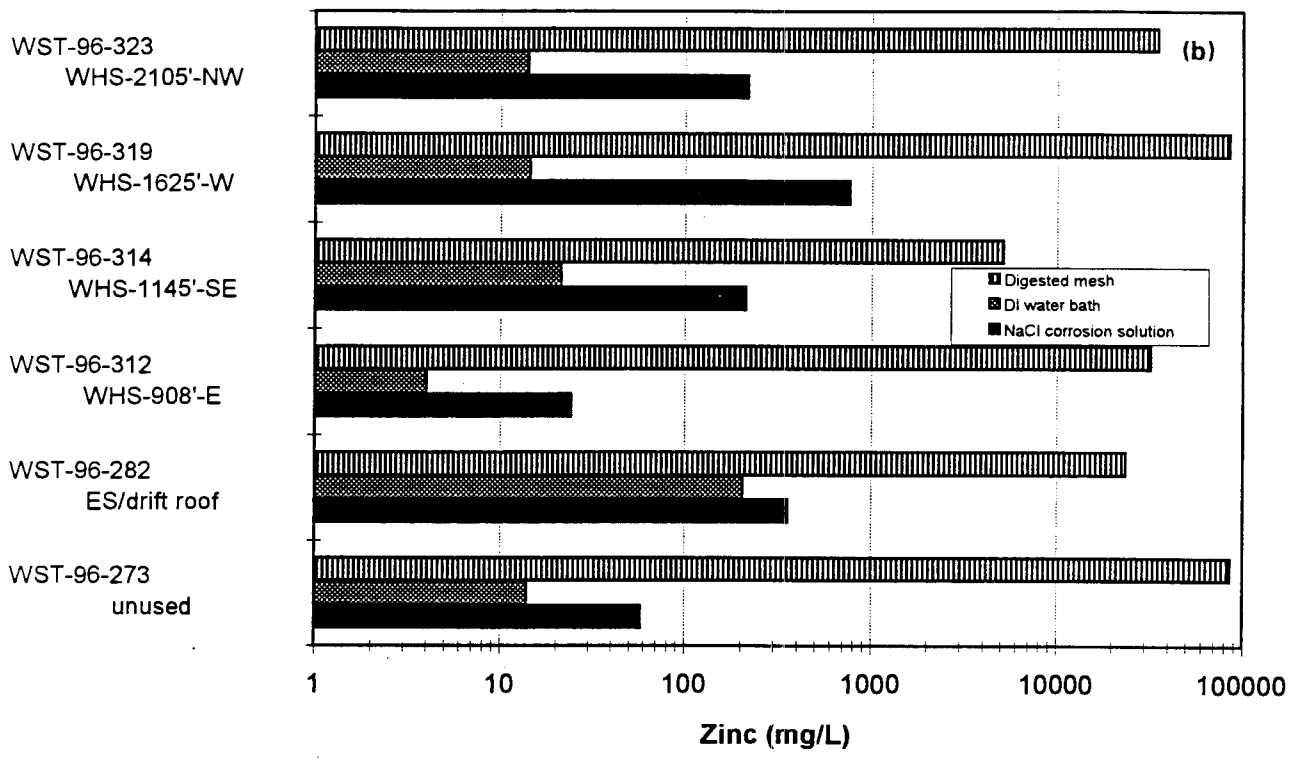
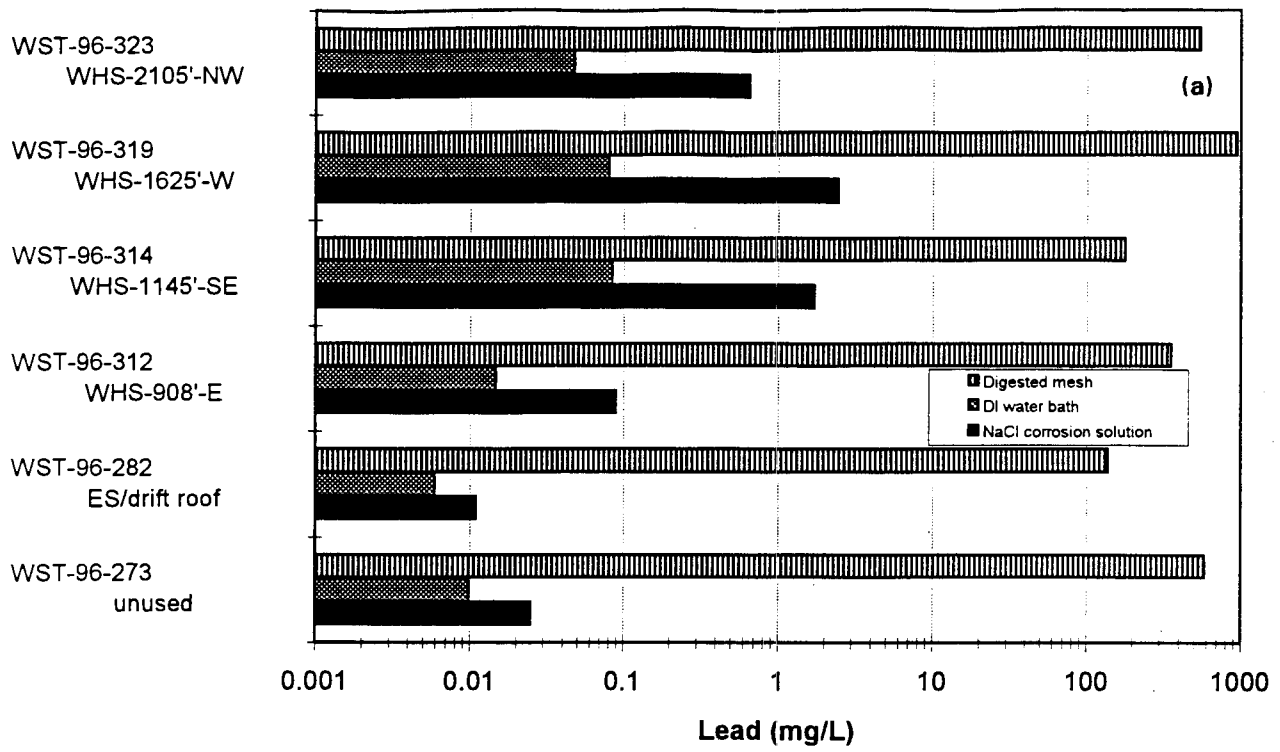


Figure 3

(a) Lead and (b) zinc concentrations in solutions obtained from acid digestion of mesh, deionized water bath, and NaCl brine used in corrosion tests.

Figure 4 is a plot of the Pb/Zn ratios for the digested mesh, DI water bath, and NaCl corrosion solutions. The Pb/Zn ratios linked to the digested mesh samples all cluster near a Pb/Zn value of 0.01, similar to brine samples recovered from the ES basin and borehole OH225 (see Section 5.0). All results for the DI bath and NaCl corrosion samples fall below the Pb/Zn ratios of the digested mesh samples. Results from the DI bath and NaCl corrosion samples from the WHS (WST96312, WST96314, WST96319, WST96323) are fairly uniform and lie near a Pb/Zn value of 0.004, while the Pb/Zn ratios for the ES sample (WST96282) and unused mesh sample (WST96273) are approximately two orders and one order of magnitude lower, respectively. As the Pb/Zn ratios in all digested mesh samples are within an order of magnitude, the relatively lower Pb/Zn values and range of Pb/Zn ratios in the DI bath and NaCl corrosion solutions suggests Pb loss from these samples during the evaporation of solutions derived from the DI bath and corrosion tests (see Appendix A). However, it is unclear as to why the Pb/Zn ratios in the DI bath and NaCl corrosion samples for WST96282 and WST96273 are significantly lower than other samples.

5.0 Discussion

Figure 5 shows the Pb/Zn ratio and boron (B) concentration of brine samples recovered from the ES basin, borehole OH 225, WHS sump, and borehole EEP 37B and the ranges for Pb/Zn values obtained from digested mesh, DI bath, and NaCl corrosion solutions. Borehole EEP37B samples indigenous Salado Formation brine, which is representative of background brine compositions in the repository. Note that indigenous Salado Formation brine is readily distinguished from introduced brines by its high B concentration. Additionally, note that the general trend for ES basin samples is an increase in B concentration as Pb/Zn ratios decrease.

Boron concentrations increase in the brine held in the ES basin during evaporation, which occurs as large volumes of air are passed over the basin and expelled from the underground via the ES. The relatively constant B concentrations for brine samples from OH 225 and the WHS sump indicate little to no evaporation is occurring at these locations. Lead and zinc analytical results collected on the underground brine samples indicate the observed decrease in Pb/Zn values as B increases is due to Pb removal during evaporation. Limited analytical data for total inorganic carbon (TIC), which represents bicarbonate and carbonate ions in the brine, also show TIC concentrations increase as the brine in the ES basin is evaporated. The current hypothesis is that the Pb loss observed in brine subjected to evaporation is due to the precipitation of $PbCO_3$.

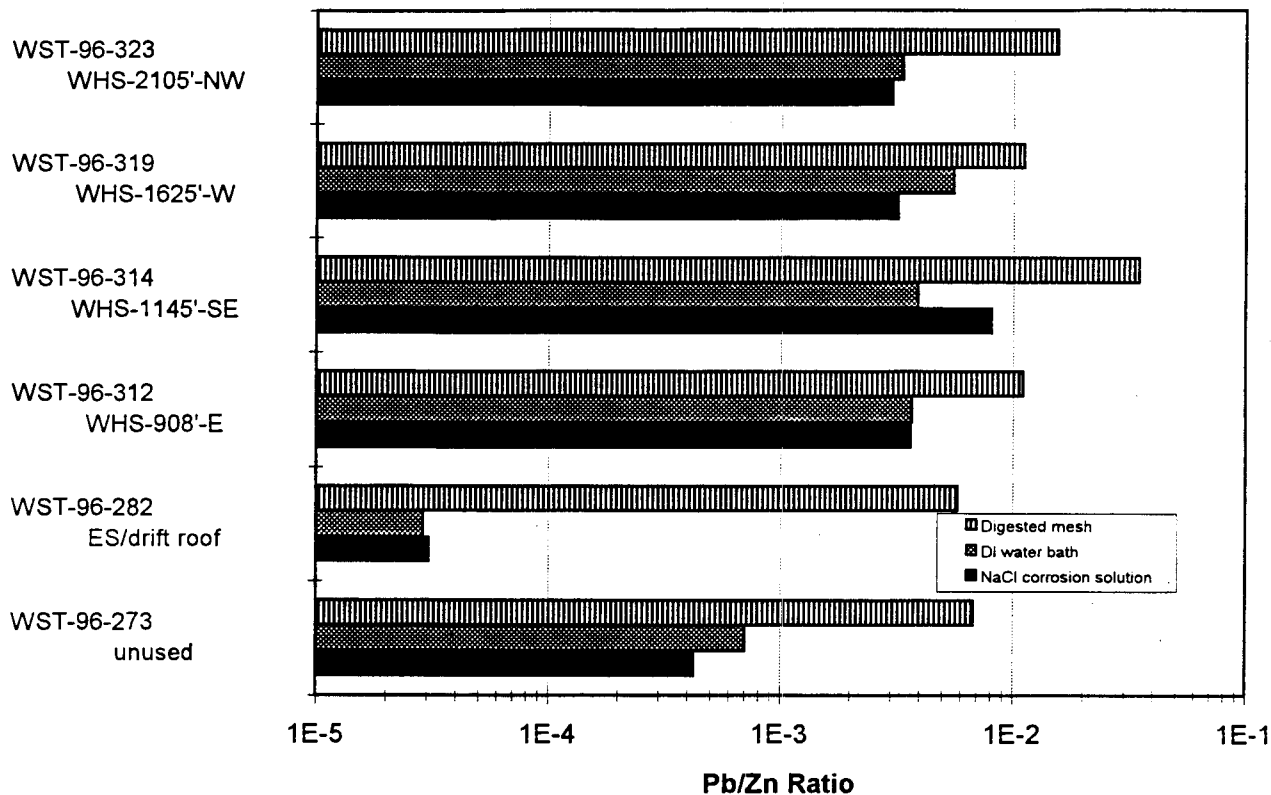


Figure 4

Lead/zinc ratios in solutions obtained from acid digestion of mesh, deionized water bath, and NaCl brine used in corrosion tests. Lower lead/zinc ratios for solutions obtained from deionized water bath and NaCl brine corrosion tests indicate lead loss from the solutions, probably due to precipitation of $PbCO_3$ during sample evaporation.

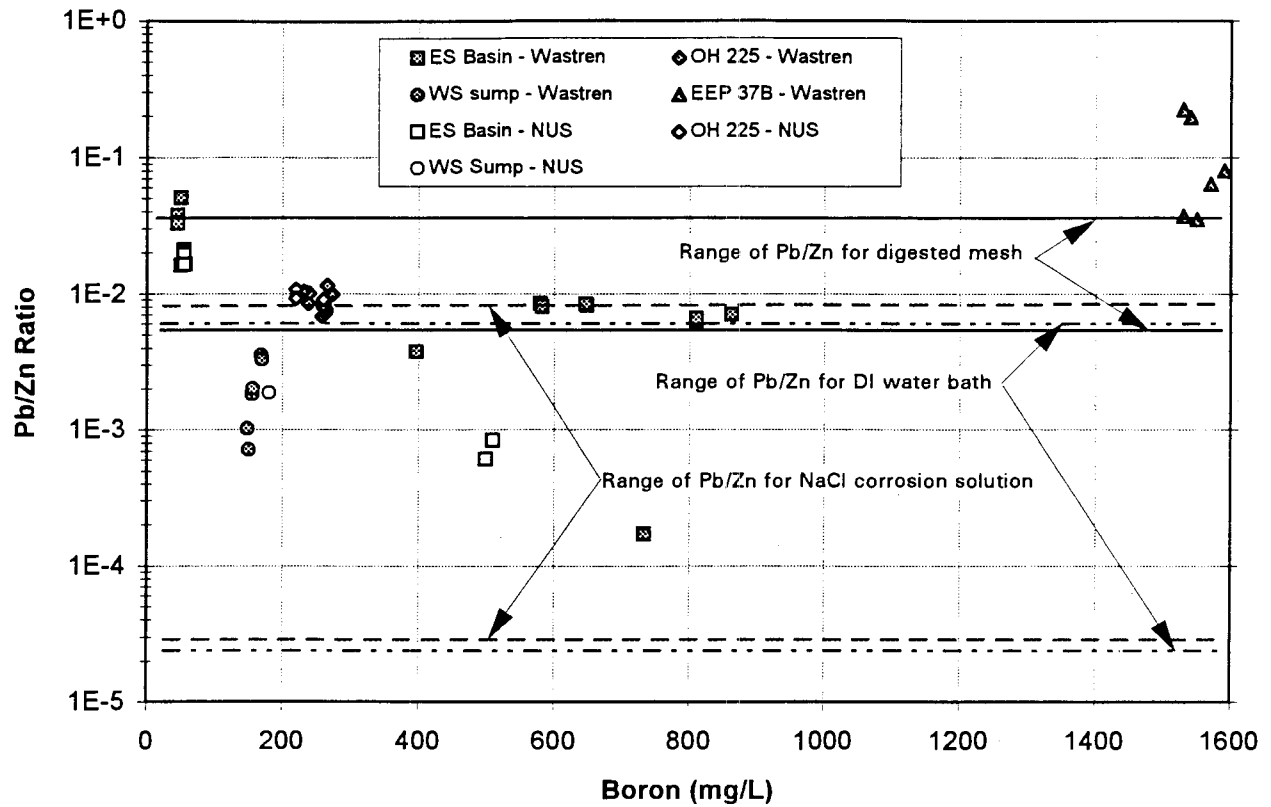


Figure 5

Lead/zinc ratios and boron concentrations for brine samples collected from the Exhaust Shaft (ES) basin, borehole OH225, the Waste Handling Shaft (WHS) sump, and borehole EEP37B. Range of observed lead/zinc ratios in test solutions are shown for comparison to observed lead/zinc values in brine samples. Wastren and NUS refer to the analytical laboratories that conducted these brine analyses.

In Figure 5, the range of Pb/Zn ratios for digested mesh samples (0.0058 to 0.035) overlaps the observed Pb/Zn ratios for most brine samples collected from the ES basin and all samples collected from borehole OH 225. This indicates strongly that the elevated Pb and Zn concentrations in the underground brine samples from the ES basin, OH225, and WHS sump are derived from corrosion of the galvanized mesh present in the ES and WHS. In contrast, the range of Pb/Zn ratios for DI bath and NaCl corrosion solutions tend to fall below the Pb/Zn ratios of the digested mesh samples and overlap the range of Pb/Zn values for some brine samples recovered from the ES basin and all samples recovered from the WHS sump (Figure 5). The lower Pb/Zn ratios in the DI bath and NaCl corrosion solutions is analogous to Pb loss observed in some brine samples collected from the ES basin.

Samples collected from the DI bath were evaporated to dryness and redissolved with DI water prior to analysis (Appendix A). During the evaporation of the initial DI bath solution, the solutions were in contact with the ambient atmosphere, which contains carbon dioxide (CO₂). Carbon dioxide in the atmosphere will equilibrate with the DI bath solution and introduce carbonate into the bath solution, which can result in precipitation of PbCO₃ as the solution is evaporated to dryness. In a similar fashion, bicarbonate and carbonate ions present in the initial NaCl contact solution used in the corrosion tests will remove Pb by precipitation of PbCO₃. Although NaCl corrosion solutions were not evaporated to dryness, the precipitation of PbCO₃ is enhanced at the elevated temperature of 40°C used in the corrosion tests (i.e., the solubility of PbCO₃ decreases as temperature increases). Therefore, the simulation of evaporation by corrosion tests performed at 40°C produces a similar decrease in Pb/Zn values.

6.0 Conclusions

Unused galvanized mesh and galvanized mesh samples recovered from the ES and WHS were subjected to acid digestion and corrosion tests to evaluate the Pb and Zn content and Pb/Zn ratios of the resulting solutions. The Pb/Zn ratio in the resulting solutions was compared to Pb/Zn values in underground brine samples to evaluate the source of elevated Pb and Zn concentrations in brines recovered from the ES basin, borehole OH225, and the WHS. Test results for the acid digestion of mesh samples indicate the range of Pb/Zn ratios is similar to the Pb/Zn values for most ES basin samples and all OH225 samples, which indicates strongly that the source of Pb and Zn in these underground brine samples is the galvanized mesh in the ES. Lower Pb/Zn values in solutions obtained from the DI bath and NaCl corrosion tests overlap with Pb/Zn values observed for ES basin and WHS sump samples that have experienced evaporation and Pb loss. Therefore, the entire range of Pb/Zn values observed in

brines collected from the ES basin, OH225, and the WHS are compatible with corrosion of a galvanized mesh source and subsequent Pb loss from the corrosion solution (i.e., brine) during evaporation.

APPENDIX A
CORROSION TESTING OF
GALVANIZED MESH MATERIAL

**Corrosion Testing of Galvanized Mesh Material
Obtained from the Waste Handling Shaft at the WIPP Site**

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Introduction

Samples of galvanized mesh fencing material were collected from the Waste Handling Shaft (WHS) to characterize the iron (Fe), zinc (Zn) and lead (Pb) concentrations in the mesh and for the purpose of conducting corrosion tests. The corrosion testing was performed with a saturated sodium chloride brine to determine if the galvanized mesh in the WHS and Exhaust Shaft (ES) is the source of Pb observed in brines collected at the ES catch basin, WHS sump, and borehole OH 225. Testing was conducted at IT's Technology Development Laboratory (TDL) in Knoxville, TN.

Galvanized Mesh Samples

On August 2, 1996, two unused mesh samples and eight (8) liters of brine were received at the TDL for corrosion testing. The mesh samples were approximately six inch squares and were shipped in plastic Ziploc bags. The samples were labeled with the following sample designations:

WST-96-273	Galvanized Wire Mesh in Connex	8/1/95	0845
WST-96-274	Galvanized Wire Mesh in Connex	8/1/95	0845
WST-96-275	Connex Lab Brine Water	8/1/95	0900

On August 7, 1996, one mesh sample from the exhaust shaft at the site was received at the TDL for corrosion testing. This sample had visual signs of corrosion and solid salt adhering to the mesh surface. The sample was labeled with the following sample designation:

WST-96-282	Exhaust Shaft	8/5/96	0930
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On August 29, 1996, twelve (12) mesh samples were received from the waste handling shaft at the WIPP site. Two samples were sent from each of 6 shaft horizons. The samples all had visual signs of corrosion and solid salt caked to the mesh. The degree of corrosion and amount of salt caked to the mesh varied among the samples, but all appeared to be more corroded and encrusted than the Exhaust Shaft sample received 8/5. Some samples also had soil mixed in with the salt solids adhering to the mesh. Four of the horizons were selected for corrosion testing and the sample descriptions are listed below. The samples were selected to provide the widest range of sample types based on sampling horizon and visual appearance.

WST-96-312	908' East of WS	8/27/96	0835
WST-96-314	1145' SE of WS	8/27/96	0855
WST-96-319	1625' West of WS	8/27/96	0910
WST-96-323	2105' NW of WS	8/27/96	0930

Sample Preparation at the Laboratory

Prior to conducting laboratory corrosion testing, the mesh samples (including encrusted salt, if applicable) were weighed to the nearest 0.1 milligram and the weight recorded. If loose salt was found in the sample bag, it was weighed with the sample and included with the total recorded weight.

All of the used mesh samples contained encrusted salt and underwent sample washing to remove the salt. The samples were subjected to a deionized water bath in 9" x 13" pyrex baking dishes. The samples were submerged in the water and were moved around just enough to allow dissolution of the encrusted solids. The mesh samples were then removed from the bath, dried and reweighed.

During the washing process in the bath, small particles of soil, mesh coating and corrosion solids were loosened from the mesh samples and collected in the bottom of the pyrex washing dish. These solids were collected by filtration, dried in desiccators and weighed separately. The encrusted salt weight for each sample was obtained by subtracting the washed mesh weight and the collected solids weight from the as received mesh sample weight using the following formula:

$$\text{encrusted salt (g)} = \text{as received mesh (g)} - \text{washed mesh (g)} - \text{collected solids (g)}$$

The exhaust shaft mesh sample (WST-96-282), received 8/7, did not have as much encrusted salt as the samples received on 8/29. The wash/bath solution for this sample was evaporated to dryness and the salt was then washed with a volume of deionized water to make a 5 molar salt (sodium chloride) solution. The volume of water used was determined by the following formula:

$$\text{volume of solution (ml)} = \text{mass of encrusted salt (g)} * (1,000 \text{ mL}/292.215 \text{ g})$$

The volume of water needed to make a 5 molar solution for this sample was small (8 mL) and not all of the salt would go into solution. The volume was eventually increased to 25 mLs including dish rinses to dissolve all of the salt solids. Because of this problem, plus the fact that the solutions were diluted for analysis, the bath solutions for the subsequent samples were not adjusted in volume to obtain a 5 molar salt solution. Instead the salt concentration of the resulting solution after collecting the bath solution and dish rinses was calculated and provided using the following formula:

$$\text{salt conc. (M)} = (\text{mass of encrusted salt (g)}/58.44 \text{ g/mole})/(\text{total volume of solution (L)})$$

The unused mesh sample and its duplicate were also washed for comparison, but only one of the bath/wash solutions was concentrated to 8 mLs for analysis. Data from the bath/washing steps are included in Table 1.

Table 1
Summary of Salt Washing Data from Mesh Samples

Mesh Sample No.	Lab ID	Weight As Received (g)	Weight After Washing (g)	Weight of Solids Collected (g)	Weight of Encrusted Salt (g)	Bath Solution Volume (mLs)	Salt Conc. of Bath Solution ^a (M)
WST-96-273 ^b	GG7735	35.7017	35.7023	0	0	8	0
WST-96-274 ^b	GG7735 Dup	35.4381	35.4381	0	0	-	-
WST-96-282	GG7786	163.6747	161.0067	0.3291	2.3389	25	1.60
WST-96-312	GG7805	254.7239	150.2463	9.8150	94.6626	520	3.12
WST-96-314	GG7807	502.4339	389.4909	36.7339	76.2091	1044	1.25
WST-96-319	GG7812	263.9428	209.8090	2.5185	51.6153	943	0.94
WST-96-323	GG7816	266.6322	237.5974	1.5192	27.5156	475	0.99

assumes all soluble weight to be sodium chloride
used mesh samples

Laboratory Testing of Galvanized Mesh Samples

Corrosion testing was performed as described in ASTM procedure G31-72 on a sample of unused mesh and a duplicate, five samples of washed used mesh and one corrosion blank. The corrosion tests were performed in 600 mL tall beakers using approximately 600 mLs of the brine solution provided to the laboratory. The beakers were placed on a temperature controlled heating/stirrer plate and were maintained at 40°C. A Teflon stir bar in the beaker provided agitation of the solution at 250 RPM. A sub-section of the washed galvanized mesh of about a 4 inch square was weighed and then submerged in the brine solution using nylon fishing line to suspend the sample in solution. A proportionate amount of the solids collected during the sample washing procedure for each sample was also added to the corrosion brine solution for that sample. The amount of solids added was in proportion to the weight of mesh used in the corrosion test compared to the total sample weight washed. The beakers were loosely covered with squares of Parafilm to allow exposure to air, but minimize the loss of fluid during the test. The tests were conducted for at least seven days and the mesh was removed from solution once each day to allow it to dry in air. Also, just prior to re-submerging the sample after drying each day, the total solution volume was adjusted to the starting weight by addition of deionized water. At the

end of the testing period, the corrosion solution was filtered using a glass fiber filter and the filtrates were prepared for analysis. Data from sample weights used in the testing are summarized in Table 2. The mesh samples used in the testing were rinsed with deionized water and allowed to air dry prior to taking a final weight. As shown, in some cases there was a net gain of weight by the mesh from corrosion testing. This may be due to corrosion of the metallic mesh to form metal oxides, which would provide a net gain in weight.

Table 2
Summary of Mesh Weight Data from Corrosion Testing

Mesh Sample No.	Lab ID	Initial Mesh Weight (g)	Final Mesh Weight (g)	Mesh Weight Change (g)	Weight of Bath Solids Added (g)	Final Corrosion Liquid Weight (g)
Blank	Corr. Blank	0	0	0	0	679.87
WST-96-273*	GG7735	35.7021	35.7967	0.0946	0	742.22
WST-96-274*	GG7735 Dup	35.4373	35.5402	0.1029	0	761.20
WST-96-282	GG7786	73.4623	73.7809	0.3186	0.1510	922.58
WST-96-312	GG7805	88.9541	88.5490	-0.4051	5.8180	737.70
WST-96-314	GG7807	98.2356	96.2799	-1.9557	9.2529	650.48
WST-96-319	GG7812	75.3123	75.2074	-0.1049	0.9057	776.14
WST-96-323	GG7816	64.7812	64.9688	0.1876	0.4151	726.75

*Unused mesh samples

Analysis of Samples

All of the galvanized mesh samples were analyzed by digesting approximately 1 gram of the wire cut from the sample after washing. Some of the samples maintained a white coating after washing that was not removed for analysis. A microwave digestion procedure was used to dissolve the sample. The resulting digestates were then analyzed by ICP using EPA Method 6010 for Fe, Zn and Pb. The results of analysis are contained in the attached analysis results summary (Table 3).

The brine solution provided for the corrosion tests, the wash/bath solutions for the samples received on August 2 and 5, 1996, plus the corrosion test solutions for these samples were also analyzed by ICP using EPA Method 6010 for Fe and Zn. The brine solution was analyzed in triplicate. The results of these analyses are contained in the attached analysis results summary (Table 3). The solution samples were also analyzed by graphite furnace atomic absorption (GFAA) using EPA Method 7420 for Pb, but the high brine concentration matrix prevented analysis by standard techniques.

A modified sample preparation procedure¹ for Pb analysis was tried on the brine samples. This procedure used a Chelex resin for separation of Pb from the brine matrix to allow analysis. The procedure used 2 mLs of sample and 2 mLs of an ammonium acetate diluent with 0.3 grams of Chelex 100. The mixture was shaken for 30 minutes and then centrifuged. The supernatant liquid was then decanted and discarded and the resin was washed twice more in the same manner, once with ammonium acetate solution and once with deionized water. The Pb on the resin was then removed by shaking the resin with 4 mLs of 10 percent nitric acid for one and one half hours. The nitric acid solution was then removed, diluted 1:1 with deionized water and analyzed by GFAA. The results from these steps allowed analysis to 40 ppb, but Pb was only detected in one of the solutions and spike recoveries were less than 50 percent. The results of analysis are contained in the attached analysis results summary (Table 3).

It is felt that the Pb result that was obtained from the bath solution for the unused mesh (960 ppm) may have been due to contamination of the sample while evaporating in the hood in its open pyrex dish. This solution, however, is the only one that does not have a chloride concentration and this may be a factor as to why this is the only solution in which we detected and measured a concentration for Pb.

The wash/bath solutions and the corrosion test solutions for the samples received on 8/29 were not analyzed at the TDL, but were sent to an outside lab for analysis. The wash/bath and corrosion test solutions for the samples received on 8/2 and 8/7 were also sent to the outside lab for re-analysis by ICP/MS for Pb.

¹L. Rasmussen, Anal. Chim. Acta, 125, 117-30, (1981). "Determination of Trace Metals in Seawater by Chelex-100 or Solvent Extraction Techniques and AAS."

TABLE 3 - ELEMENTAL ANALYSIS SUMMARY FOR WIPP CORROSION TESTING

TDL SAMPLE ID	CLIENT ID (MESH)	CONCENTRATION			GFAA LEAD ug/L	QC RESULTS	
		IRON mg/L	ZINC mg/L	LEAD mg/L		LEAD SPIKE VALUE	Spike % Recovery
<u>WIRE MESH SAMPLES</u>							
PREP BLANK 8/22/96	QC SAMPLE	<0.60	<0.50	<9			
GG7735	WST-96-273*	897000	86300	590			
GG7735 DUPLICATE	WST-96-273*	903000	70700	400			
GG7735 MATRIX SPIKE (LEAD)	QC SAMPLE	857000	103000	1280		618	112
GG7786	WST-96-282	961000	23900	140			
GG7786 DUPLICATE	WST-96-282	942000	22100	140			
PREP BLANK 9/25/96	QC SAMPLE	<0.60	<0.50	<9			
GG7805	WST-96-312	939000	32400	360			
GG7807	WST-96-314	810000	5160	180			
GG7812	WST-96-319	905000	85100	950			
GG7816	WST-96-323	970000	35500	550			
<u>BRINE IN TRIPLICATE</u>							
PREP BLANK 8/30/96	QC SAMPLE				<40.0		
GG7737 INITIAL BRINE 1	WST-96-275	<0.10	1.1		<40.0		
GG7737 INITIAL BRINE 2	WST-96-275	<0.10	1.1		<40.0		
GG7737 INITIAL BRINE 3	WST-96-275	<0.10	1.1		<40.0		
<u>WATER BATH SOLUTIONS</u>							
GG7735 (NEW)BATH SOL	WST-96-273	0.2	10.2		960		
GG7786 BATH SOL	WST-96-282	0.27	354		<40.0		
<u>CORROSION TEST SOLUTIONS</u>							
GG7735 CORR LIQ	WST-96-273*	<0.10	65		<40.0		
GG7735 CORR LIQ DUPLICATE	WST-96-273*	<0.10	62		<40.0		
GG7786 CORR LIQ	WST-96-282	<0.10	120		<40.0		
GG7786 CORR LIQ (Matrix spike)	QC SAMPLE				240	500	48***
GG7786 CORR LIQ (Spike duplicate)	QC SAMPLE				240	500	48***
CORROSION METHOD BLANK	QC SAMPLE	<0.10	1.1		<40.0		

* UNUSED MESH

***GFAA RESULTS- SPIKE RECOVERY IS OUT OF CONTROL LIMIT (75-125%) DUE TO MATRIX INTERFERENCE.

APPENDIX B
ANALYTICAL RESULTS FOR
DEIONIZED BATH AND CORROSION SOLUTIONS

Sample Identification

WST-96-275	GG7737	Contact solution for corrosion tests
WST-96-273	GG7735 corr	Corrosion test solution for mesh sample WST96273
WST-96-273	GG7735Dcorr	Duplicate corrosion test solution for mesh sample WST96273
WST-96-282	GG7786 corr	Corrosion test solution for mesh sample WST96282
WST-96-312	GG7805 bath	Bath solution for mesh sample WST96312
WST-96-312	GG7805 corr	Corrosion test solution for mesh sample WST96312
WST-96-314	GG7807 bath	Bath solution for mesh sample WST96314
WST-96-314	GG7807 corr	Corrosion test solution for mesh sample WST96314
WST-96-319	GG7812 bath	Bath solution for mesh sample WST96319
WST-96-319	GG7812 corr	Corrosion test solution for mesh sample WST96319
WST-96-323	GG7816 bath	Bath solution for mesh sample WST96323
WST-96-323	GG7816 corr	Corrosion test solution for mesh sample WST96323
WST-96-282	GG7786 bath	Bath solution for mesh sample WST96282
WST-96-273	GG7735 bath	Bath solution for mesh sample WST96273

ANALYTICAL RESULTS

Customer ID: WST-96-275
 Ticket ID: GG7737

Date: October 18, 1996
 Lab ID: 240313

Requestor: RICH ABITZ
 Sample Matrix: BRINE
 Project Number: L30A90000

Case: 15112
 Date Received: Oct 4, 1996
 Date Collected: Aug 1, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI's	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	~14.2	B	UG/L	10/15/96	AS-5 R05
Lead	31.1		UG/L	10/09/96	AS-6 R06
Zinc	1310		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-273
Ticket ID: GG7735 CORR

Date: October 18, 1996
Lab ID: 240314

Requestor: RICH ABITZ
Sample Matrix: BRINE
Project Number: L30A90000

Case: 15112
Date Received: Oct 4, 1996
Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI's	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	~30.2	B	UG/L	10/15/96	AS-5 R05
Lead	25.1		UG/L	10/09/96	AS-6 R06
Zinc	58500		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-273
Ticket ID: GG7735DCORR

Date: October 18, 1996
Lab ID: 240315

Requestor: RICH ABITZ
Sample Matrix: BRINE
Project Number: L30A90000

Case: 15112
Date Received: Oct 4, 1996
Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI's	UNITS	DATE ANALYZED	METHOD ANALYSIS
Iron	79.9	B	UG/L	10/15/96	AS-5 R05
Lead	28.5		UG/L	10/09/96	AS-6 R06
Zinc	50800		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-282
Ticket ID: GG7786 CORR

Date: October 18, 1996
Lab ID: 240316

Requestor: RICH ABITZ
Sample Matrix: BRINE
Project Number: L30A90000

Case: 15112
Date Received: Oct 4, 1996
Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI's	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	~480	B	UG/L	10/15/96	AS-5 R05
Lead	6.0		UG/L	10/09/96	AS-6 R06
inc	206000		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-312
Ticket ID: GG7805 BATH

Date: October 18, 1996
Lab ID: 240317

Requestor: RICH ABITZ
Sample Matrix: BRINE
Project Number: L30A90000

Case: 15112
Date Received: Oct 4, 1996
Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI's	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	1500		UG/L	10/15/96	AS-5 R05
Lead	14.9		UG/L	10/09/96	AS-6 R06
Zinc	4020		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-312

Date: October 18, 1996

Ticket ID: GG7805 CORR

Lab ID: 240318

Requestor: RICH ABITZ

Case: 15112

Sample Matrix: BRINE

Date Received: Oct 4, 1996

Project Number: L30A90000

Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI's	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	13300		UG/L	10/15/96	AS-5 R05
Lead	89.6		UG/L	10/09/96	AS-6 R06
Zinc	24400		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-314
 Ticket ID: GG7807 BATH

Date: October 18, 1996
 Lab ID: 240319

Requestor: RICH ABITZ
 Sample Matrix: BRINE
 Project Number: L30A90000

Case: 15112
 Date Received: Oct 4, 1996
 Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI's	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	~280	B	UG/L	10/15/96	AS-5 R05
Lead	84.5		UG/L	10/09/96	AS-6 R06
Zinc	21400		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-314
 Ticket ID: GG7807 CORR

Date: October 18, 1996
 Lab ID: 240320

Requestor: RICH ABITZ
 Sample Matrix: BRINE
 Project Number: L30A90000

Case: 15112
 Date Received: Oct 4, 1996
 Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI'S	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	1030		UG/L	10/15/96	AS-5 R05
Lead	1740		UG/L	10/09/96	AS-6 R06
inc	214000		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-319
Ticket ID: GG7812 BATH
Requestor: RICH ABITZ
Sample Matrix: BRINE
Project Number: L30A90000

Date: October 18, 1996
Lab ID: 240321
Case: 15112
Date Received: Oct 4, 1996
Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI's	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	~211	B	UG/L	10/15/96	AS-5 R05
Lead	81.1		UG/L	10/09/96	AS-6 R06
inc	14500		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-319
 Ticket ID: GG7812 CORR

Date: October 18, 1996
 Lab ID: 240322

Requestor: RICH ABITZ
 Sample Matrix: BRINE
 Project Number: L30A90000

Case: 15112
 Date Received: Oct 4, 1996
 Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI's	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	8400		UG/L	10/15/96	AS-5 R05
Lead	2470		UG/L	10/09/96	AS-6 R06
Zinc	766000		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-323
Ticket ID: GG7816 BATH

Date: October 18, 1996
Lab ID: 240323

Requestor: RICH ABITZ
Sample Matrix: BRINE
Project Number: L30A90000

Case: 15112
Date Received: Oct 4, 1996
Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI'S	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	7284	B	UG/L	10/15/96	AS-5 R05
Lead	47.9		UG/L	10/09/96	AS-6 R06
Zinc	14200		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-323
Ticket ID: GG7816 CORR

Date: October 18, 1996
Lab ID: 240324

Requestor: RICH ABITZ
Sample Matrix: BRINE
Project Number: L30A90000

Case: 15112
Date Received: Oct 4, 1996
Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI'S	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	1410		UG/L	10/15/96	AS-5 R05
Lead	663		UG/L	10/09/96	AS-6 R06
Zinc	218000		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-282
Ticket ID: GG7786 BATH

Date: October 18, 1996
Lab ID: 240325

Requestor: RICH ABITZ
Sample Matrix: BRINE
Project Number: L30A90000

Case: 15112
Date Received: Oct 4, 1996
Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI's	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	~501	B	UG/L	10/15/96	AS-5 R05
Lead	~11.1	B	UG/L	10/09/96	AS-6 R06
inc	360000		UG/L	10/15/96	AS-5 R05

ANALYTICAL RESULTS

Customer ID: WST-96-273
 Ticket ID: GG7735 DBAT

Date: October 18, 1996
 Lab ID: 240326

Requestor: RICH ABITZ
 Sample Matrix: BRINE
 Project Number: L30A90000

Case: 15112
 Date Received: Oct 4, 1996
 Date Collected: Sep 30, 1996

ANALYSIS REQUESTED	RESULTS	RESULT QUALI's	UNITS	DATE ANALYZED	METHOD OF ANALYSIS
Iron	~508	B	UG/L	10/15/96	AS-5 R05
Lead	995		UG/L	10/09/96	AS-6 R06
Zinc	14000		UG/L	10/15/96	AS-5 R05