Technical Memorandum for
Pond Liner Leak Detection Testing

Introduction

HydroGEOPHYSICS Inc. (HGI) has been advancing the field of leak detection and location in HDPE lined ponds, landfills, and heap leaches using electrical methods for over 18 years. Typically, the ASTM standards for leak detection are not always successful in complex lined systems. To demonstrate the effectiveness of locating leaks using electrical methods HGI constructed a scaled pond environment using a 10x15 foot EPDM rubber geomembrane liner.

In addition, HGI tested the applicability of a low cost permanent monitoring system, designed to be installed prior to, and beneath the liner, detecting the first signs of a leak and providing an approximate location of the damaged section (Phase I).

Previous Characterization and Monitoring Studies

Ponds can be utilized in many types of environments and configurations. Leak detection services are often required when ponds are storing hazardous or environmentally sensitive material. HGI has experience in monitoring ponds in the following industries:

- Mining
- Chemical companies
- Power plants
- Municipalities

Every lined system is slightly different than the next, presenting complexities related to infrastructure and overall construction of the lined system. Ponds are typically either single or double lined. A double lined pond is used to safeguard the local environment in the event of a leak. Single lined ponds increase the need of a leak detection system, therefore, HGI constructed a real world test showcasing this configuration.

Methodology

HGI uses geophysical techniques to locate leaks based on the electrical properties of a lined system. Electrical resistivity has been proven the most effective method for leak detection. The general principles are:

1. An electric current is generated.
2. In the presence of a leak the current flows more readily; current should not be able to be transmitted through a non punctured liner.

2302 NORTH FORBES BLVD., TUCSON, ARIZONA 85745
Phone 520.647.3315 / Fax 520.647.3428
www.hgiworld.com

3. Results are recorded using a variety of different receiver arrays.

The transmitter circuit is established through the use of stainless steel electrodes that are placed in different locations relative to the liner. The test pond will be a scaled version of a typical pond, where the method can be extrapolated to a large scale pond. HGI has experience in ponds with dimensions up to 1500 x 1000 feet with great success.

Construction of the Mock Pond

HGI constructed a test pond (Figure 1) on a secure parcel of land owned by our parent company Columbia Energy & Environmental Services (CEES). CEES has the experience and equipment required for pond construction. Electrodes for the Phase I survey were installed in a rectangular grid before the liner was deployed, with wires attached to each and run to a central hub. This setup mimics a scenario where a leak detection system is established prior to a pond being installed.

Figure 1: Pond Construction

Once the liner was installed and secure, standard tap water was added to the pond. One pound of salt was added to the water to reduce the resistivity, and to better represent a typical solution found in a pond.

Phase I

Before the EPDM rubber geomembrane liner was installed a plastic liner commonly used for home landscaping was installed to ensure construction of the pond was adequate. This configuration was used for testing the applicability of a low cost permanent monitoring system. This system is designed to be installed prior to the liner construction, detecting the first signs of a leak and providing an approximate location of the damaged section(s).

Twenty-four electrodes were installed beneath the liner in a regular grid pattern for this test. Background testing using the plastic liner was performed prior to the introduction of a leak to test the integrity of the liner. The general rule is that electricity cannot flow through an intact liner. After background data was collected a leak was introduced to the plastic liner.

The results of this effort are shown as horizontal slices through the subsurface at a variety of depths in Figure 3. The x axis represents hours after the leak initiation, while each row is a different depth below ground surface. The left column shows the baseline condition, while each additional column shows a percent change with time in relation to the baseline survey. This residual method is used to help identify small changes in resistivity that helps pinpoint a leak event.

Figure 3: Phase I Results – Top Depth Slices

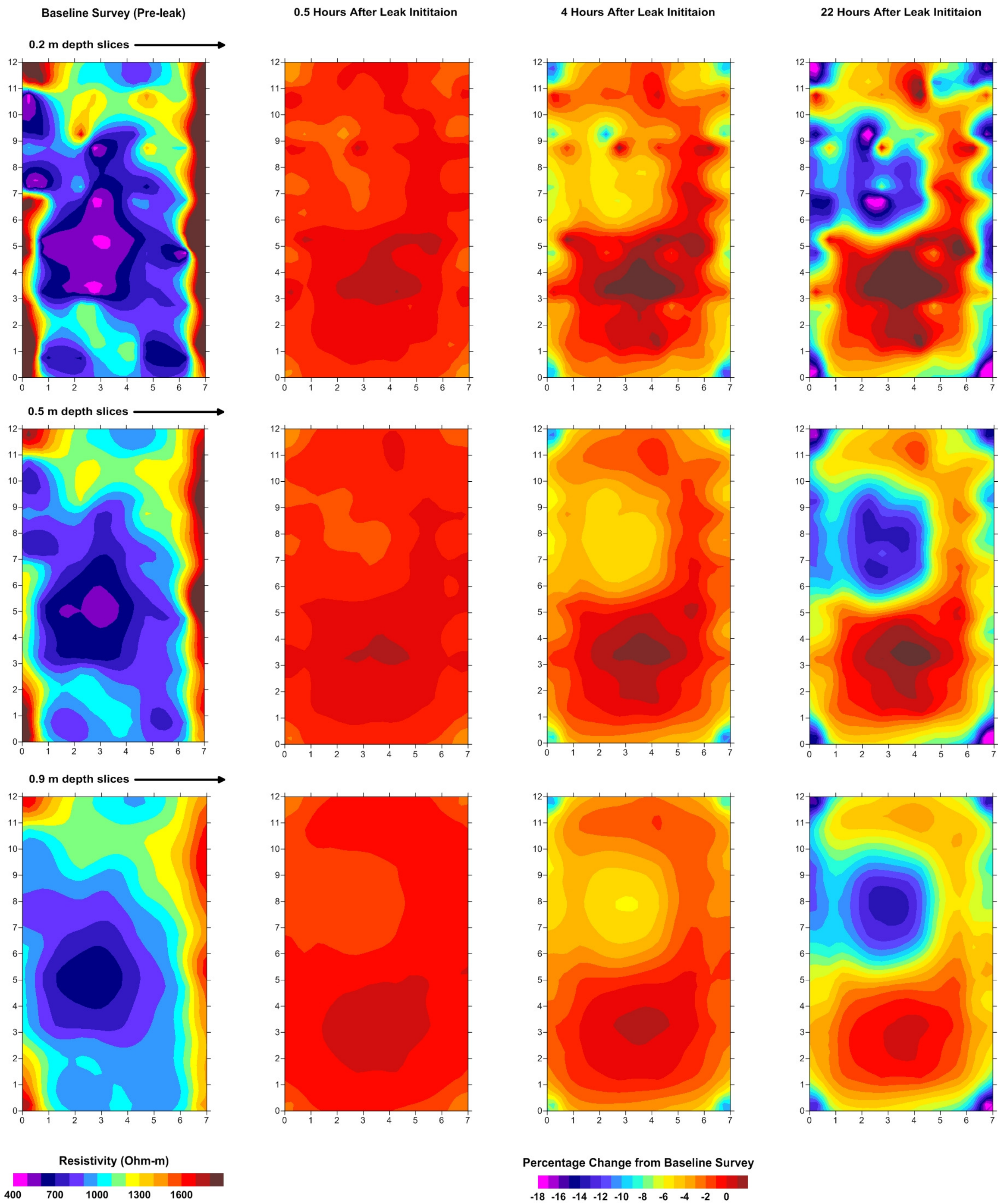
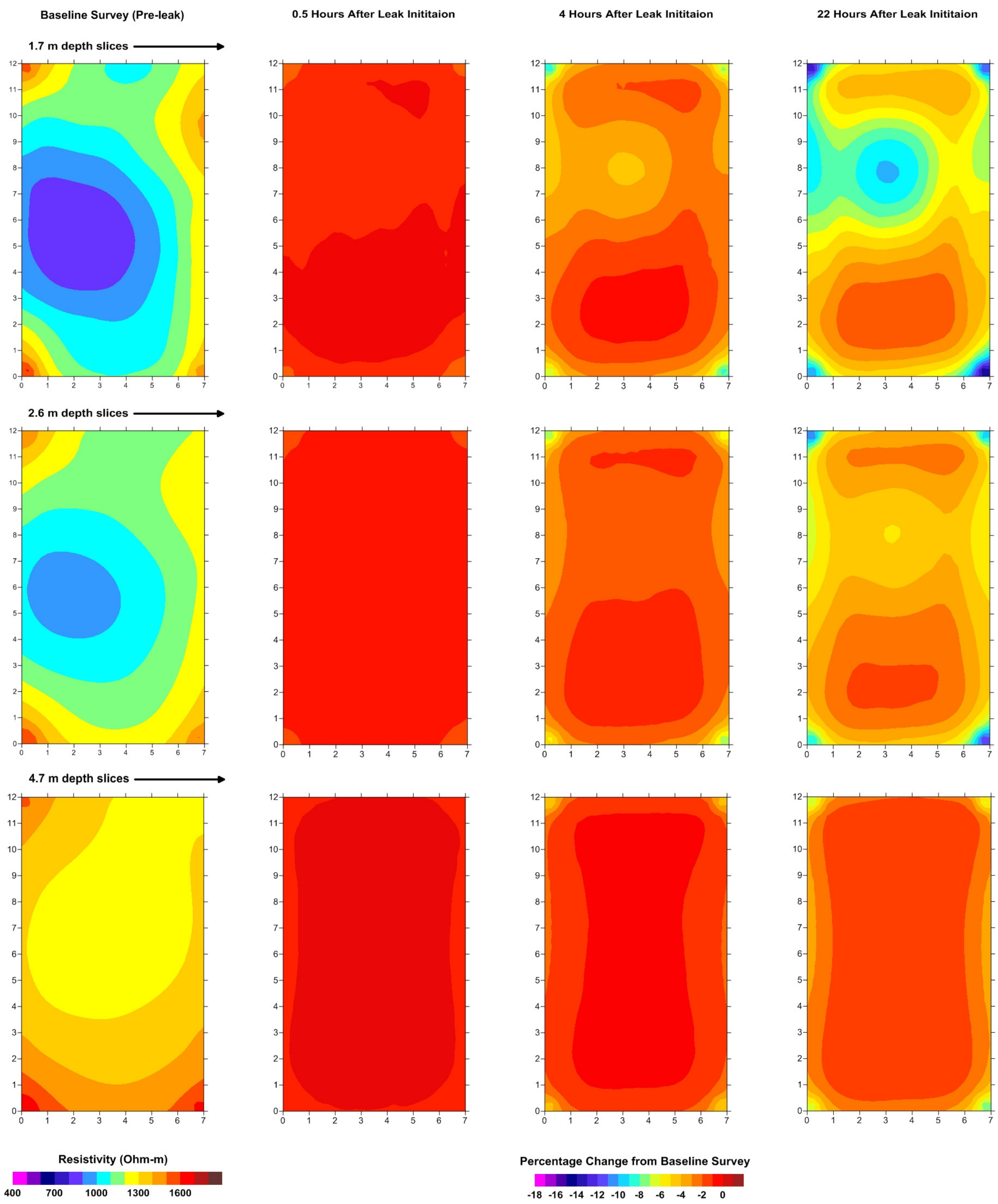


Figure 3 cont.: Phase I Results – Bottom Depth Slices

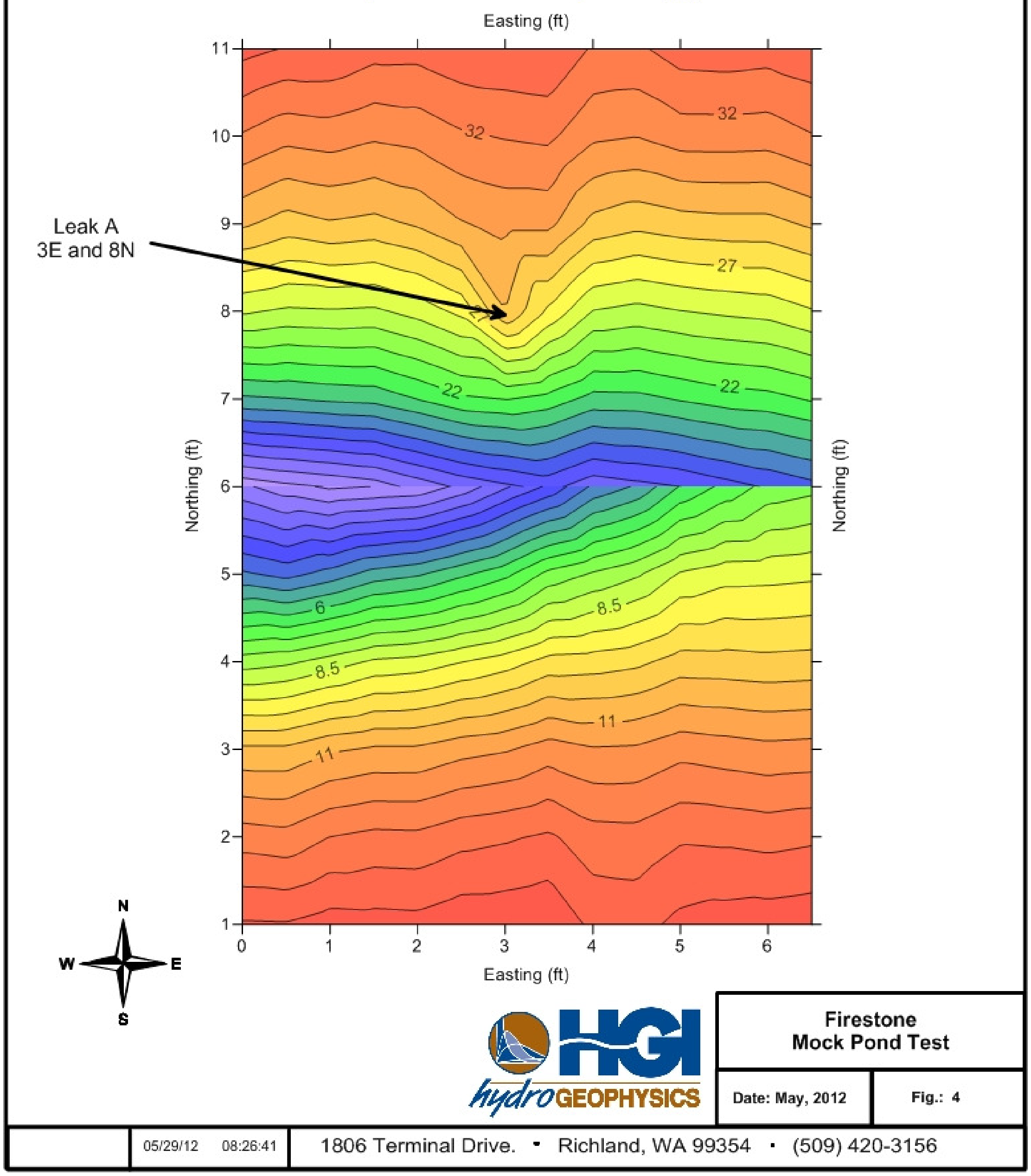


Phase II

Phase II was performed using an EPDM rubber geomembrane liner. As opposed to Phase I this testing is designed to provide leak detection for existing ponds. HGI installed the liner over the existing pond to create an environment to show the effectiveness of HGI's leak detection methods on the rubber liner.

Two leak configurations were tested. Configuration 1 has one leak, located at 3E, 8N. After collection, the resistance data are filtered, gridded, and contoured. The results of this test are shown in Figure 4, with an arrow indicating the leak.

Figure 4: Leak Detection Results for Test 1, Configuration 1 (1-foot line spacing)



For the next configuration a second leak was added at 5E, 3N. The results of this test are shown in Figure 5. The second leak was placed close to side slope of the liner, a common location in lined ponds from our experience.

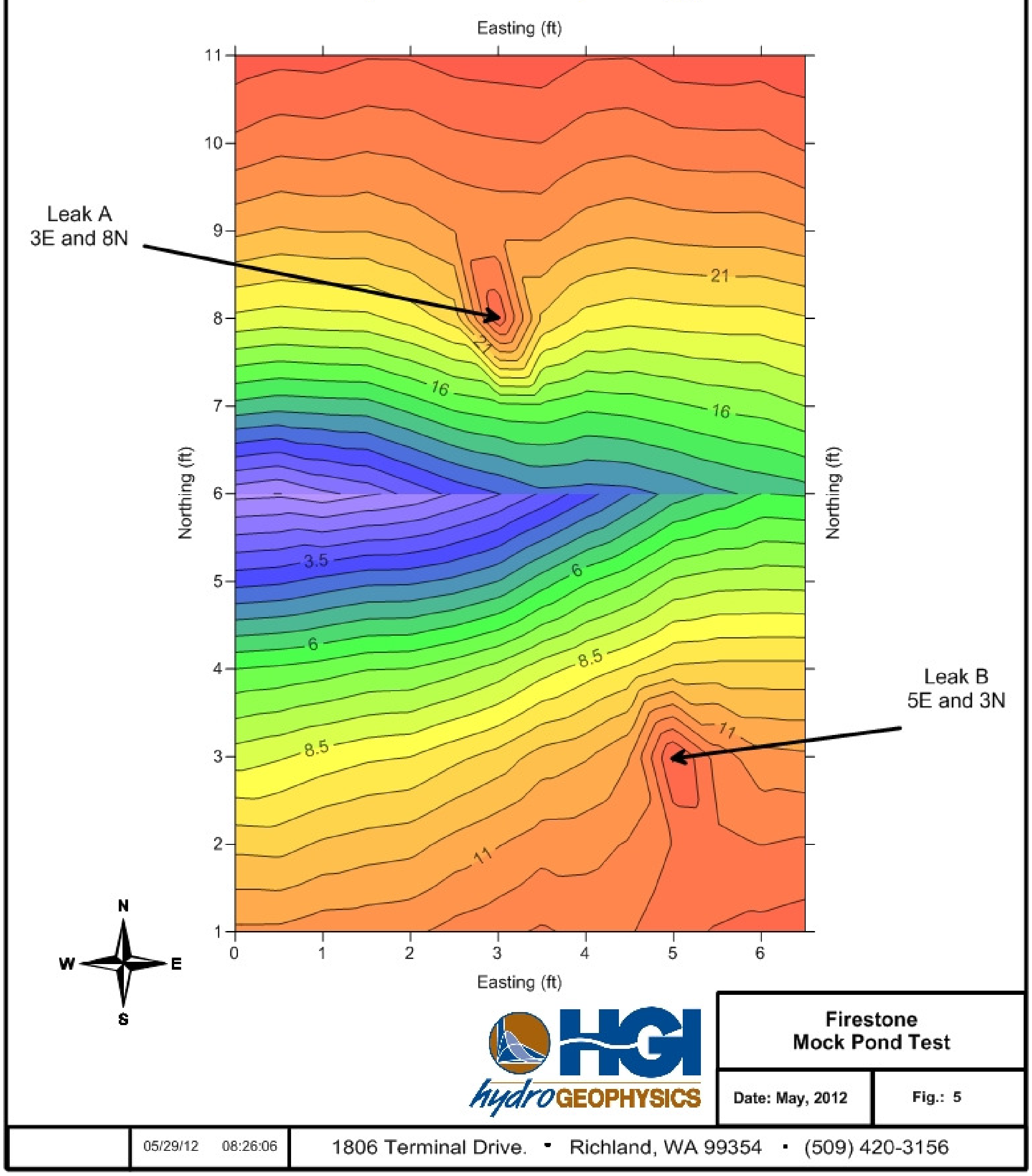
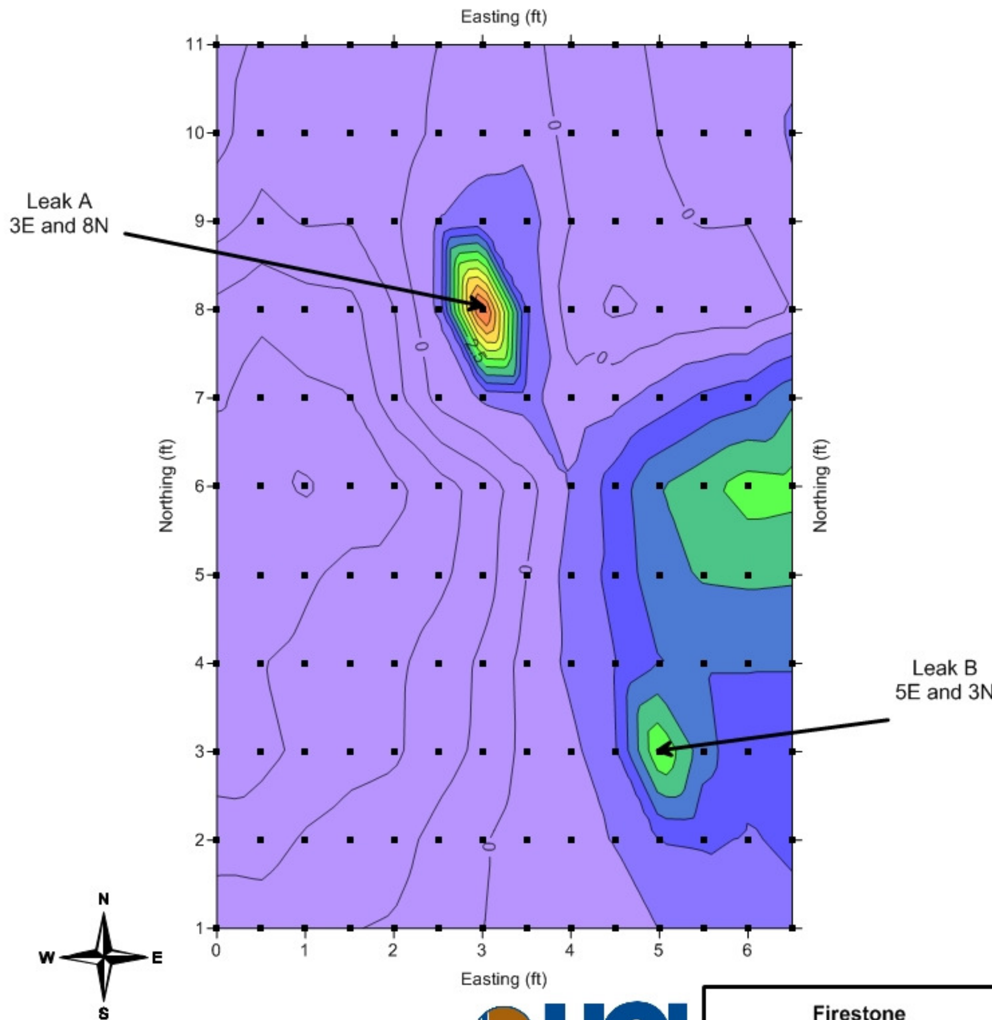


Figure 5: Leak Detection Results for Test 1, Configuration 2 (1-foot line spacing)

Additional processing was applied to the 2 leak configuration, to remove the background trends by calculating the residual value. This was done to highlight the leak location as shown in Figure 6. There is a polarity response at (6.5E, 6N), which is common to see for this method, and does not represent a leak event.

Figure 6: Leak Detection Results for Test 1, Configuration 2 Residuals (1-foot line spacing)



HGI hydroGEOPHYSICS

Firestone Mock Pond Test	
Date: May, 2012	Fig.: 6

05/29/12 08:26:19 2302 North Forbes Blvd. • Tucson, Arizona 85745 . (520) 647-3315

Data Processing

Data are typically processed the night after acquisition, with a contour map for the area surveyed available by the following morning. This quick turnaround is key to quickly locating and repairing the leak efficiently.

For this test, a test director was asked to locate the leak(s) with no previous knowledge of their location. All leaks were properly located, at their exact locations by the data processor for both phases.

Conclusions

A comprehensive electrical resistivity based leak detection project was completed to test the applicability of providing leak detection services. Tests were performed with multiple configurations of leaks introduced. All of the plotted results highlight the introduced leaks with high confidence. The actual versus plotted leak locations vary by less than 4 inches.

A subliner test was also performed designed to be a first response system by continuously recording data and looking for anomalies which represent a leak event. This subliner test was able to locate the leak within a matter of hours with an accuracy of 1 foot.