Case Study: Landfill Leachate Management System

Integrator Systems Devices Provides Ethernet-based Control System for Landfill Operators in the United Kingdom

The average person living in a developed country produces between a half a ton and one and a quarter tons of waste per year. But where does all this waste wind up? According to the US Environmental Protection Agency, of the estimated 251 million tons of consumer solid waste generated each year in the U.S., approximately 32.5 percent is recycled or composted, 12.5 percent is burned, and the remaining 55 percent is buried in landfills. In the United Kingdom, numbers are equally staggering. Currently, the vast majority of municipal waste in the UK (over 85%) is sent to landfills.

Local governments across the United Kingdom provide land for the establishment of landfills and the disposal of household and other types of waste. But these sites don't remain landfills forever. Typically, landfills operate for 15 years, after which the site must be returned in good condition. This requires the collection, treatment, and discharge of leachate, which is created when moisture and rain water permeate the waste deposited in a landfill. As this water mixes within the solid waste, it picks up contaminates (organic and inorganic chemicals, metals, biological wastes) and becomes leachate.

Containment and treatment of leachate before it reaches groundwater or public sewer systems is critical, not only for maintaining the environmental integrity of the landfill, but also for compliance with regulatory guidelines, such as the Deposit of Poisonous Wastes Act of 1975. Failure to adhere to these guidelines usually results in substantial financial penalties. As a result, automation and control professionals working on landfill projects must treat the leachate and ensure that none is discharged outside of the established discharge parameters. Major concerns include:

- Collection of leachate run-off
- Control of leachate levels in remote wells
- Removal of methane and ammonia from the leachate
- Regulation of leachate pH levels prior to discharge into public sewer systems
- Alarm reporting of any critical issues
- Reporting and historical data collection of all treatment activities
- Enabling of remote access to the landfill's archived data

System Devices

Based in Cheshire, England, System Devices UK Ltd. provides automation systems and support to customers in the United Kingdom and Ireland. The company's expertise covers automation and monitoring systems, supervisory control and data acquisition (SCADA), and robotics. In recent years, the company has provided control systems to landfill operators that not only meet their immediate needs, but are so flexible, they allow for future expansion without having to change hardware or software later in the system's life cycle. According to System Devices' Darren Weissenborn, these leachate management systems use Opto 22 SNAP PAC programmable automation controllers and I/O as the

Leachate runoff

key components that let landfill operator customers connect to, continuously control, and acquire data from pumps, valves, and other equipment at outstations, ponds, control centers, and all over their individual sites.

Specifically, at one landfill located in Lancashire, System Devices has implemented a leachate management system that uses a rack-mounted PAC as its central controller. This controller is Ethernet-enabled, allowing it to exist on a network that supports both wired and wireless connectivity for powerful and comprehensive monitoring and management. The system also includes approximately 128 digital and 36 analog I/O points. Digital inputs include interfaces to conductivity sensors and float switches that detect the presence and level of water across the site. Digital output points actuate ten control valves, as well as dosing pumps that disperse chemicals that treat the leachate. Analog inputs enable tracking of pH levels, chemical tank levels, and pressure readings; and analog outputs change the operating parameters of devices like feed and sludge pumps.

Pumping & Treatment

Landfill sites are typically quite large and are often lined along their perimeters with some type of durable, puncture-resistant synthetic plastic (such as high-density polyethylene) to ensure that any rain water that runs off the waste is collected and not allowed to contaminate surrounding land or water. Weissenborn says that at the Lancashire landfill, runoff is channeled into deep wells dotted around the site and later pumped back to a large lagoon for storage and treatment. It's essential that the levels within these remote wells are controlled so that no overflow occurs. To accomplish this, each well has its own control panel with I/O aggregating data such as flow rates and fill levels.

"The panels interface to the individual pumps associated with each well," says Weissenborn. "They each connect to float sensors that control when and how long pumps need to run based on a level set point. We monitor temperature, level, pump status, and any fault status through a wireless Ethernet link communicating via Modbus/TCP, an application-level industrial protocol supported by both our [Acromag-brand] I/O and the Opto 22 hardware ."

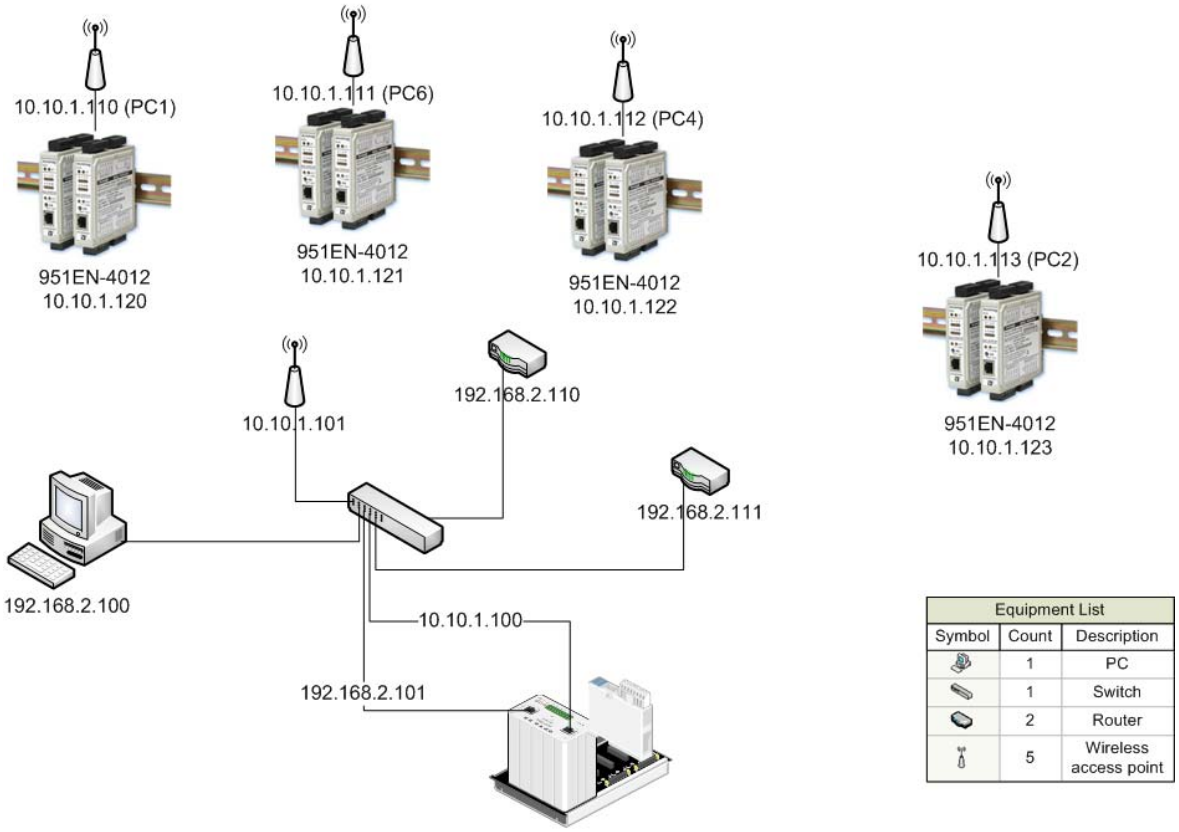
Weissenborn says that although monitoring and data acquisition is performed through the distributed control panels, all control is exercised by the central SNAP PAC located at the Site Control Cabin. The control programs for the SNAP PAC were designed by System Devices to optimize throughput, closely regulate levels in both the lagoon and the remote wells, and automate decisions like whether or not well contents can be pumped to the lagoon. For example, the SNAP PAC provides a voltage output to inverters (aka variable speed drives) to set pump speeds. Different voltages are used to slow down or speed up the pumps based on conditions in the lagoon and remote wells. When levels are within acceptable tolerances, the control system automatically slows down processing. This not only optimizes operations, but also extends the lifespan of the landfill's expensive pumping equipment.

Bunds like this help keep landfill runoff contained so it doesn't contaminate the surrounding area.

A brick wall designed to contain leachate in the event of overflow or spillage was constructed on the landfill site. Most of the leachate processing takes place in this "bund" area. Weissenborn says the leachate is tested for acceptable levels of ammonia and pH. The control system regulates dosing pumps that add the appropriate neutralizing agents, and pH conditioners to increase or decline the pH and otherwise treat the water in order to prevent pipe corrosion and dissolution of lead into water supplies. Once the ammonia and pH levels of the leachate are in compliance with all regulatory guidelines, it can finally be discharged into the public sewer system.

HMI and Alarming

According to Weissenborn, if conditions at the landfill ever deviate out of their prescribed operating ranges, it's important that the control system contains the fault and reports it immediately. Therefore, System Devices' leachate management system has been configured to alarm on low chemical levels; improper valve and pump states; pump failures; and dangerous pH, methane, and ammonia levels. The entire



Analog and digital I/O communicated wirelessly via Modbus/TCP to a network switch that then passes acquired data to the controller.

system and all alarms are viewable via HMI screens running on the site's SCADA PC in the Site Control Cabin. Any alarm states detected by the system are reported on the computer screen so the issue can be acknowledged and rectified. For off-site notification, the Opto 22 SNAP PAC controller sends SMS alerts (i.e., text messages) to designated individuals' cell phones whenever the site experiences crises like power losses or electrical contactor failures. There are also alarms for pump failures and low chemical levels.

Data Archiving

All well conditions are monitored 24/7 via secure wired and wireless Ethernet connections that encompass the entire site. All gathered data is logged and stored on the SCADA PC's hard drive for historical archiving and compliance reporting. To better enable this, System Devices designed a network architecture that takes full advantage of the SNAP PAC's dual Ethernet interfaces.

"We've successfully segmented our network and use one of the controllers' Ethernet ports exclusively for monitoring and control, and the other for communicating to PCs and databases," says Weissenborn. "This design offers better management of network traffic and lowers risk by establishing a built-in firewall that shields and safeguards landfill operations from viruses or other threats that might creep onto the corporate network."

Remote Access

Landfill operators must be sure that their automation systems not only optimally manage the processing of leachate, but that they also aggregate data confirming that the criteria for elimination and dispersal of contaminants has been met and no discharge into the public sewer system took place during any period of non-compliance. And because landfill sites are usually far removed from most of the population, these same automation systems must offer secure, remote

access to the individuals responsible for the site. To accommodate this, System Devices designed its system to notify off-site personnel of problems via SMS, and then allow remote access via ADSL broadband modem and secure virtual network computing (i.e., desktop sharing) software. This way, respondents are able to confirm problems, identify the causes, and initiate corrective actions from wherever they may be.

"We now have a leachate management system for which we've designed control programs that define the operational parameters of all field devices and equipment at our landfill site," says Weissenborn. "The system also provides historical data that can be stored on computer systems for long periods of time. Perhaps best of all, it's modular and adaptable, so we can easily customize and build variations of this system for other landfill customers."

About Opto 22

Opto 22 develops and manufactures hardware and software for applications involving industrial automation and control, remote monitoring, and data acquisition. Opto 22 products use standard, commercially available networking and computer technologies, and have an established reputation worldwide for ease-of-use, innovation, quality, and reliability. Opto 22 products are used by automation end-users, OEMs, and information technology and operations personnel. The company was founded in 1974 and is privately held in Temecula, California, USA. Opto 22 products are available through a worldwide network of distributors and system integrators. For more information, contact Opto 22 headquarters at +1-951-695-3000 or visit www.opto22.com.

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