LIQUIDS COLLECTION, MANAGEMENT AND LANDFILL GAS IMPACTS AT THE OII LANDFILL

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ABSTRACT

The former Operating Industries, Inc (OII) Landfill is a National Priorities (NPL) site located in Monterey Park, California, approximately 12 miles east of downtown Los Angeles. It accepted approximately 30 million tons of municipal solid waste and a over 300 million gallons of liquid waste prior to its closure in 1984. When the landfill began operation in 1948, it was situated in a rural area. Today, the 145-acre landfill abuts residences located in the City of Montebello, some as close as 25 feet, as well as industrial and commercial facilities.

As part of the Superfund remediation, over 350 landfill gas (LFG) extraction wells were installed for the LFG collection and control system. Of these wells, 150 were fitted with liquid extraction pumps. Some of the wells are located in soil along the perimeter of the landfill to be used as both LFG migration and perimeter liquids control. Others are located within the landfill boundary. Over 20,000 linear feet of liquid conveyance piping support the well/pump network. Approximately 20,000 gallons per day is conveyed to an on-site leachate treatment plant (LTP).

Early in the design of the LFG collection well field, one of the primary concerns was the possible occurrence of perched liquids within the refuse mass and their impact on the LFG collection well field coverage. The installation of a liquid pump in LFG extraction wells located in saturated refuse has allowed for an improved well installation, and increased LFG capture.

Additionally, using pumps in the LFG extraction wells appears to have decreased the moisture content of the refuse around the wells. This has been indicated by a steady decline in the well field liquid delivered to the LTP, and also in the field observation of drill cuttings of new wells.

One of the principal reasons for the success of the liquids management system has been a proactive operations and maintenance program for the liquid collection system.

SITE BACKGROUND

The OII landfill is a 190-acre site located approximately 12 miles east of downtown Los Angeles divided by California highway 60 (the Pomona Freeway), on the border between the cities of Monterey Park and Montebello. The east/west 60 freeway divides the site into two portions, or "parcels": the North Parcel consists of 45 acres of largely non-landfill area and a 140-acre South Parcel. The North Parcel is to be developed into a shopping center, and the South Parcel will continue to be remediated as a Superfund site under the direction of the United States Environmental Protection Agency (USEPA) in cooperation with California State environmental agencies.

Disposal operations began in 1948 when the Monterey Park Disposal Company leased 14 acres under an operating agreement with the City of Monterey Park in which the site would serve as a municipal landfill. In 1952, the site became privately owned and subsequently expanded to 218 acres by 1958. The Pomona Freeway, completed in 1964, removed 28 acres from the site and the affected refuse was relocated to the South Parcel. The Los Angeles County Regional Water Quality Control Board (RWQCB) classified the site as Class II-I in 1954, and it was permitted to accept Group 2 and 3 wastes and certain liquids. In 1976, the

RWQCB permitted the disposal of liquid in a portion of the landfill in a ratio up to 20 gallons per cubic yard.

After receiving approximately 300,000,000 gallons of liquid waste, the landfill stopped accepting all types of liquid in 1983. In 1984, the landfill stopped accepting solid waste. By 1986, the site had been placed on the NPL and became a Superfund site. Beginning in the early 90s', USEPA entered into a Consent Decree (CD-3) to perform work related to the cover, the storm water system, and the landfill gas control system.

As part of the work performed under the Consent Decree, a Leachate Treatment Plant (Figure 1) was designed and installed for the collection and treatment of on-site liquids. Liquids were collected through trench drains located along the perimeter of the landfill and interior wells to mitigate surface seepage and off-site migration. Perimeter liquid collection and control was further increased with the installation of bedrock LFG and liquid extraction wells along the southwest portion of the landfill. The next phase for liquid collection and control was the installation of the final cover and LFG collection system.

Figure 1 – Leachate Treatment Plant (LTP)

FINAL COVER

The final cover is considered to be one of the early evapotranspirative landfill cover systems. The side-slope cover consisted of a 2-foot earthen foundation layer, a 4-foot silty layer, and an overlying vegetation layer. The slope varied in pitch from 1.5-3 to 1. The steeper slopes on the north side were reinforced by layered HDPE mesh integrated in the cover. The top deck cover system consisted of a 2-foot foundation layer, a geosynthetic clay liner, and a 2-foot silty soil layer overlain by vegetation.

LANDFILL GAS COLLECTION SYSTEM

Early in the design of the LFG collection well field, one of the primary concerns was the possible occurrence of perched liquids within the refuse mass and their impact on the LFG collection well field coverage. Considering that the presence of perched liquids could only be assumed, actual location and amount of liquids would be difficult to determine, and that historical daily cover and cell isolation practices were not to current standards, it was concluded that the concept of perched liquids would only have minor impact on the well field coverage. The final cover LFG collection system was to be designed and installed based on current practices.

Prior to the final closure work, a number of LFG extraction wells had been installed to support a high Btu gas processing plant. Additional wells were added over time for migration control. The existing wells varied in design and depth depending on the technology of the time. Extraction well size and materials ranged from 2-inch diameter PVC and HDPE to 13-inch diameter steel. Drilling methods included standard, dual casing hammer, and simple pile driving. Upon review of each of the existing well gas production, depth, screen placement, and general casing condition, some of the wells were selected to remain in service as part of the final LFG system with the remaining wells to be abandoned.

As part of the review, each of the wells was sounded for total depth and the depth to the liquid level. The intent behind determining the liquid level was to be able to develop a model of the liquid layer. General criteria were developed to filter which wells should be used for determination of the actual liquid levels within the landfill. Using the liquid depth in these wells, a liquid depth model (Figure 2) was developed as an estimate of the liquid depth to be expected in the landfill.

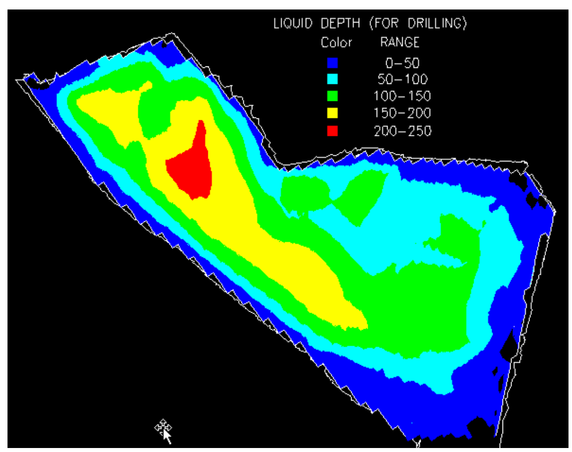

Figure 2 – Liquid Depth Model

Using the bottom contour data developed from historical records, a computer model was generated representing the landfill's bottom surface (Figure 3). A similar model was generated for the proposed final cover surface. With the use of these two surfaces, the approximate depth of the landfill could be determined at any location.

Figure 3 – Bottom of the Landfill Model

The wellfield was initially laid out based on standard practice spacing. The depth for each well was then set based on the depth of the landfill at each of the locations. Using the depth of the landfill and the well general location, such as side slope or top deck, a radius of influence was calculated for each well. This was the first step in an iterative process of moving and adding well locations in order to develop a comprehensive well field coverage map (Figure 4).

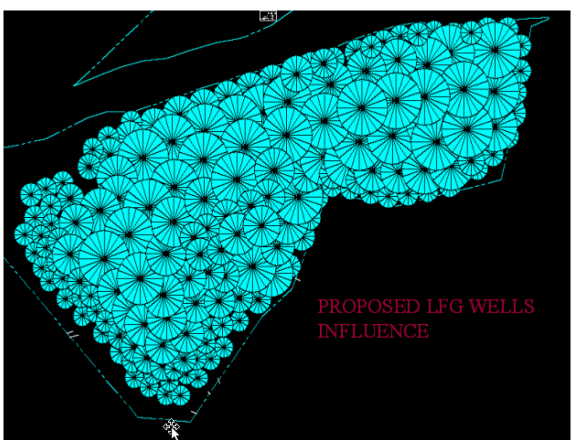

Figure 4 – Proposed LFG Well Field Radius of Influence Coverage Map

With the coverage map as the baseline design, a target depth was assigned to each of the wells. The well depths were then analyzed with respect to the assumed liquid depth based on the liquid surface model. It was assumed that below this liquid level the LFG generation and collection would be minimal. Thus, each of the wells was assigned a design depth, which correlated to the assumed liquid depth. A new coverage map was generated based on the recalculated radius of influence. Again, an iterative process was used to relocate and add or remove wells to the original design, in order to develop a comprehensive well field coverage map. During this process it was also determined that some of the wells would require a pump in order to maintain a minimum radius of influence for LFG collection. For these wells, it was assumed that, as liquid was pumped down, a cone of depression would be generated in the liquid zone and allow for improved gas generation and collection.

The intent behind this design methodology was to assign a target and a design depth to each of the wells to be installed. The screen depth, which is the primary variable in a radius-of-influence calculation, would be based on the worst case well depth scenario, i.e., essentially the design depth. Upon drilling each well, the design depth became the minimum depth to be achieved and the target depth became the maximum.

Prior to drilling in the liquid zones, the initial concern was that drilling in areas with extensive liquids could not reach the required well depth. Upon actual drilling, the cuttings were found to be more of wet, mixed refuse than saturated. The mixed material was fairly easy to drill through and lift with a standard auger. Although there were some cases where the drill cuttings were too wet to raise and excessive borehole caving occurred, the majority of the wells were drilled past the design depth.

During drilling, one of the field observations resulted in an operational change. Once a borehole was drilled, it appeared to act as a liquid sink (or sump). As a result, a partially drilled hole left overnight, would begin to fill with liquid. Typically the well could not be drilled any farther due to excess liquid and the difficulty lifting saturated refuse (Figure 5). Furthermore, if a well was drilled to depth, and left overnight, it was likely to cave in significantly. Because of the liquids and the caving, it was determined that in suspected wet areas, a well needed to be drilled and installed the same day.

Figure 5 – Drilling in Saturated Refuse

After a portion of the wells were installed, wells with liquids were sounded, developed, and resounded. During the development, it was observed that most of the wells with liquids would recharge to a fixed level overnight. Liquid materials varied within the well field from a black, water-like material, to a thick oil-like material. Liquid temperatures also ranged from 80 to 160 degrees Fahrenheit.

Because many of the wells could be drilled past the design depth, it was assumed that the refuse was only partially saturated to the depth of the well, and that by pumping the liquid out, a cone of depression could be generated in the wells, which would increase the gas generation and collection. Based on this, if a well had in excess of twenty feet of liquid, or less than ten percent of the screen section above the recharged water level, a pump would be installed.

Earlier studies were conducted at the landfill on the performance of submersible pumps, which lead to the use of the Clean Environment (CEE) autopump in early wells (Figure 6). Because of previous success with the CEE pumps, the same model pumps were used for the final cover wells. The pump inlet was at the top with the intent of minimizing pickup of solids that settled at the base of the extraction wells. A fiberglass body was used along with stainless steel internal components to help protect against corrosive materials. Each pump was equipped with a pressure regulator, a pulse counter, and a bubbler tube. A bundle using Goodyear Gorilla hose was used for the liquid and air discharge, and the compressed air supply lines. Compressed air was supplied from two 60-horsepower air compressors to the pumps through a network of HDPE piping routed coincident with the LFG piping. Discharge from the pumps was routed to the LTP through an additional network of HDPE piping.

Figure 6 – CEE Liquid Extraction Pump

When pumps were initially placed in service, up to 70,000 gallons per day (GPD) of leachate were being pumped from the well field. The LTP was designed for a maximum of 24,000 GPD and upgraded to 80,000 GPD. How long the large volume of leachate could be pumped was unknown, although it was anticipated a decline would occur once the free liquids built up in the wells during construction were removed. In order to avoid exceeding treatment capacity, sections of the compressed air line were turned off to temporarily disable the connected pumps. Generally, it took two weeks, for the well output to decline to a steady state, allowing more well pumps to be brought on-line.

The LFG collection system was completed in phases that coordinated with the completion of the final cover. The construction phases were based on geographic areas of the landfill, e.g., the southeast, top deck, or west area. Completion of the LFG well field in an area included installing the well, testing the well for liquids, and finally installing the pump if required. The LFG headers and the compressed air and liquid lines were then installed. This phased construction resulted in a number of the pumps malfunctioning due to clogged valves as a result of sludge settlement in the well prior to being turned on. As long term operation and maintenance began, it was observed that as many as two thirds of the well pumps had either stopped or were malfunctioning.

One of the challenges with the pneumatic internal well pump is that, when the popit valve sticks mid stroke, compressed air can be forced into the well. This can often be determined by a low pulse counter rate for the pump, and also a high oxygen reading in the well. The other problem is that many of the wells rely on the pumps to draw down the liquid in order to maintain an open screen section and thus LFG extraction.

Figures 6 and 7 are shown to indicate the impact of a malfunctioning pump within a LFG extraction well. The bubbler reading is a measurement of the amount of liquid within the well above the top of the pump. An increase in this value is an indication that a pump is malfunctioning. As shown, when the pump was out of order, a sporadic and low LFG extraction rate was generated with a significant vacuum applied to the well. Following repair of the pump, the bubbler readings were lowered to zero, indicating a functioning pump. Also shown is the improve LFG extraction per the amount of applied vacuum.

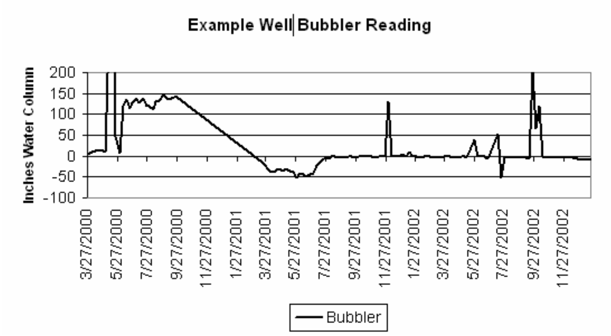

Figure 6 – Example Well Bubbler Tube Reading Over Time

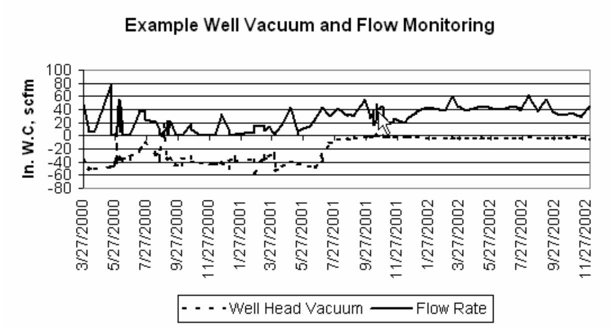

Figure 7 – Corresponding Well Vacuum and Flow for the Example Well

Once a pump failure is observed, a focused effort was set in motion to mitigate the problem. This involved more training for the field staff both on what to observe in the operation and how to rebuild and maintain the pumps. A list was made of all the malfunctioning pumps and the problem was attacked one pump at a time. With two full time crews of three each, after approximately two months, all the pumps were repaired and a regular maintenance schedule was developed.

As part of the regular LFG well monitoring, the bubbler tubes are used to measure liquid levels in the wells. If a well begins to show signs of rising liquid level, the pump is scheduled to be removed, cleaned, repaired, or replaced. A minimum six-month maintenance interval was required for each of the pumps which involved removing the pump from the well, cleaning, inspection, and replacement of parts, as necessary.

SUMMARY

The ability to install liquid extraction pumps in LFG extraction wells, allows for deeper well installation in areas of saturated refuse. The recharge rate of a well located in saturated refuse is typically less than the capacity of the pump. The extra pump capacity allows for the liquid pumping to create a cone of depression in the liquid region and improve the over all LFG capture. LFG wells located in liquid regions have shown a LFG production of as much as 3 times greater than the same type of well in dry portions of the landfill.

Over time, new and replacement LFG extraction wells have been installed in liquid regions and shown an indication of decreased moisture content in the refuse. The recharge rate of liquid from the overall well field appears to be decreasing. The total amount of liquid collected at the LTP has decreased from approximately 30,000 GPD in 1999 at the end of the final cover construction to 15,000 GPD in 2003.

A continual operations review and maintenance program has proven to be one of the keys to a successful LFG and liquid collections system.