How to Plan and Design a Landfill Gas Collection System

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Most landfill gas design engineers are accustomed to preparing design drawings to incorporate the installation of a gas system into an existing landfill that has been accepting waste for many years. The landfill may require a gas system per the New Source Performance Standard (NSPS) regulations or may be adding gas collection for odor control or as a beneficial use project. Either way, the landfill gas system design is going to come as a secondary feature to the already existing landfill or landfill cell. In this article, we will look at including considerations for the landfill gas system during the landfill bottom liner design process. By considering the landfill gas system during the early stages of the landfill's life, it is possible to improve collection efficiencies, lower operating costs, and save time in the future.

Every landfill gas collection and control system (GCCS), whether regulated or not, has various engineered features such as vacuum source, gas collection piping, gas extraction points, and liquids management features that must be designed and constructed for proper operations. Although there may be many areas where early design considerations would be beneficial, we will focus on the blower/flare station, leachate cleanout tie-ins, extraction well targets, and use of perimeter off waste header lines.

Blower/Flare Station

The blower/flare station should be located during the overall landfill layout planning in an area that will be sheltered from surrounding neighbors to avoid the public perception of odors, have a safe perimeter from other above-grade objects, and will never receive waste. If the location is in an area that will receive waste in the future, then it will have to be moved at a later date, which will increase the overall system cost. The location should be away from landfill traffic and surrounding neighbors for safety and public perception of odors from gas combustion. A location where high voltage electrical and possibly leachate disposal infrastructure are available works best. The location must also be designed for vehicle access by a lull or truck with a hoist so that maintenance can be performed on the blowers, motors, and flare stack. There must be a perimeter area with a radius of 75 to 100 feet with no above-grade infrastructure such as utility poles or trees, which could be impacted by heat radiating from the flare's flame.

Leachate Risers

Leachate risers for cleanouts and pumps are typically located on the landfill's perimeter, mostly at the toe of the slope, along the liner's edge near the anchor trench. Since the leachate collection system is installed prior to waste being placed, these pipes are the first to see landfill gas as the cell is filled. The gas that is generated as waste is placed and encapsulated will quickly migrate into the leachate riser and cleanout pipes, causing odors and possibly an explosive environment. Since these pipes terminate at the landfill perimeter, they can be cause for odor concerns. The normal methodology for gas collection from a leachate cleanout or riser during installation of the GCCS is to tie into the riser upslope of the toe of the landfill after it is buried in waste (Figure 1).

Instead of waiting to tie into the leachate pipe after waste is placed, which involves excavation in waste and saddling into an existing pipe, a better method would be to install the tie-in point with the original liner and leachate riser construction well before the gas system construction. A valve can be added to the tie-in to seal off the pipe until gas system construction. The valve may not be used for several years, but once the GCCS is installed and can access the riser, there is already an above-grade tie-in to connect to the GCCS. This minimizes excavation and eliminates using a branch saddle, which can be a potential point of leakage. The pre-installed tie-in can also be used for connection to a passive flare should the riser contain significant gas that needs to be mitigated prior to the GCCS installation.

Extraction Well Targets

Vertical extraction wells are an integral part of the GCCS at any landfill, but they are typically not installed until there are over 50 feet of waste in place, and they are normally offset from the bottom liner system at least 15 feet. Vertical wells provide for efficient gas collection deep within the waste mass, yet when liquid accumulates inside the well casing, this can make them ineffective and potential points of non-compliance in a regulated system. In wetter regions like the southeast United States, and at landfills where they have accepted liquids or recirculate leachate, water in the

wells is a significant issue. These trapped liquids are typically removed from the well casing by pneumatic pumps and then pumped to the leachate collection system via a common or dedicated force main. There can be considerable cost associated with the purchase, operation, and continued maintenance of these pumps. The cost for pumps and routine maintenance can be thousands of dollars per gas extraction well. What if there was a way to limit or even eliminate these costs?

Extraction well targets are a possible solution to minimize the pumping of liquids from vertical gas extraction wells. The idea is that a well target is placed above the protective cover of the bottom liner system or even in the first lift of waste. The location of the target is chosen based on a gas system design performed before waste has been placed in the cell, during the design of the landfill bottom liner system. The landfill will have a fill sequencing plan for waste placement over time, and the gas system can be integrated into the sequence plan; thus, future vertical extraction well locations are known and designed before any waste is placed. The targets are then constructed in these locations from a material such as granite or other inert non-calcareous aggregates that are readily available at or near the landfill. The targets are sized to be roughly 10 feet by 10 feet and between 8–15 feet deep. Figure 2 shows the placement of these targets in early lift. The target should be surveyed in place and include, at minimum, measurements at all four corners and the center.

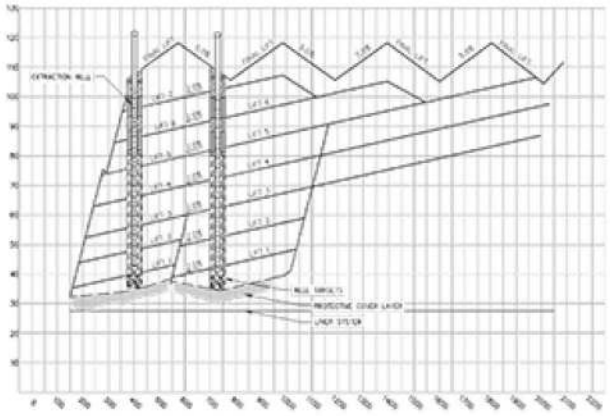

Figure 2. Tie-in to leachate system riser installed prior to waste placement

A vertical gas extraction well is installed directly over the target once the lifts of waste are of sufficient depth to warrant it. The bottom of the well is terminated when the target is reached and the known material is brought to the surface in the drilling spoils. The well casing is placed on top of the target at the bottom of the borehole and normal well construction continues, including aggregate material placed in the annular space to a specified depth below grade, sealed with a bentonite or other impermeable material, and then backfilled to the surface. This well casing can now drain directly to the leachate drainage layer at the bottom of the landfill and may not need to have a pump installed to remove liquids. This is a low-cost, easy to construct feature that potentially reduces the need for costly well pumps, while still maintaining a well with reduced liquid accumulation and efficient gas collection.

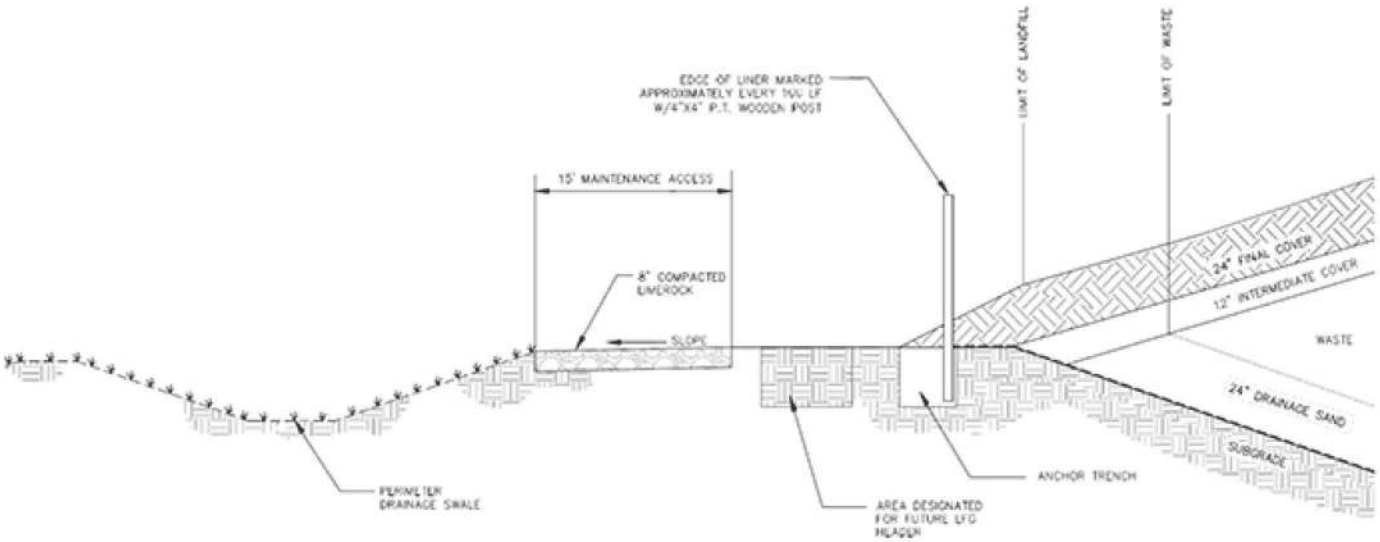

Figure 3. Landfill perimeter cross-section with area allocated for LFG header

External Header Piping

During development of new landfill cells and overall site plans, the location of current and future infrastructure such as roads, stormwater swales, leachate force mains, and electrical lines are reviewed and considered before any construction occurs. What is usually not considered is where the landfill gas lines will be located and how they will interact with the other infrastructure onsite. Normally, all the other elements are in place and the landfill gas piping is placed in the waste along the perimeter slopes and very seldom exits the waste footprint.

Much like the blower/flare station location discussed earlier, a new methodology is to include the location of the final gas design piping or at least allot the real estate outside the waste perimeter for landfill gas header piping during the initial planning of a landfill cell. There are several advantages in the long run if this consideration is taken. The pipes are not buried very deep, which is often the case when headers have to be placed on internal slopes. Instead, the

slope of the pipe outside of waste can be minimal because the pipes will not settle and water in as they do in waste, which will lower the number of sumps required over the same distance. Although it is sometimes necessary to place the header in waste, considering the ultimate location before designing the landfill cells can lead to fewer headaches and greater cost savings.

Conclusion

What we hope to have presented here are some engineering ideas that allow landfill gas design engineers to get involved in the landfill design process early. When considerations are made for landfill gas extraction elements before landfill gas collection is required, and in some cases, before waste is placed, there can be significant benefits, not the least of which is more efficient construction of gas collection elements such as leachate riser tie-ins and exterior header piping. The gas system operator will benefit by having fewer pumps to operate and maintain and shallower headers that are more easily accessible. Like many engineering concepts, the idea of planning ahead can lead to long-term benefits for all the stakeholders at the landfill. MSW

About the Author

Daniel Cooper

Daniel R. Cooper, P.E., is vice president with SCS Engineers in Tampa, FL. Jason Timmons, P.E., is a solid waste engineer with Sarasota County Florida Public Utilities. Stephanie M. Liptak is a staff engineer with SCS Engineers in Tampa, FL.