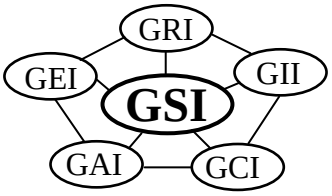
Geosynthetic Institute
475 Kedron Avenue
Folsom, PA 19033-1208 USA
TEL (610) 522-8440
FAX (610) 522-8441



GRI White Paper #13

Results of a Worldwide Regulatory Survey on Allowable Hydraulic Head Within Landfill Sumps

by

Robert M. Koerner and Jamie R. Koerner
Geosynthetic Institute
475 Kedron Avenue
Folsom, PA 19033 USA

Phone: 610-522-8440
Fax: 610-522-8441

E-mail:
robert.koerner@coe.drexel.edu
jrkoerner@verizon.net

November 19, 2008

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1.0 Background

On January 12, 2007 the institute issued GRI Report #32 entitled:

"GRI's Third Survey of Solid Waste Landfill Liner and Cover Systems: Part I – USA Status"

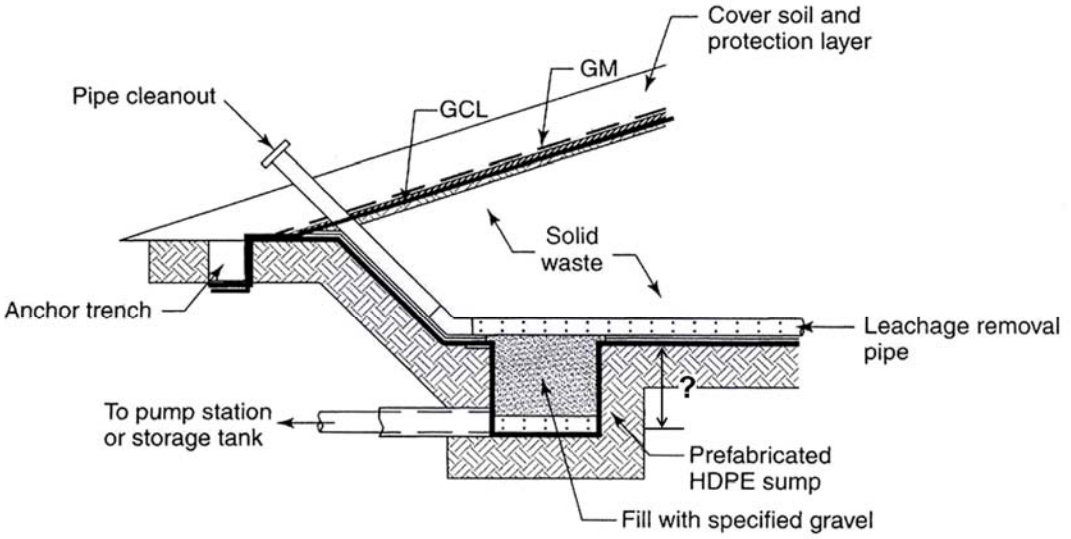
This was followed on October 24, 2007 when the institute issued GRI Report #34 entitled:

"GRI's Second Worldwide Survey of Solid Waste Landfill Liners and Cover Systems"

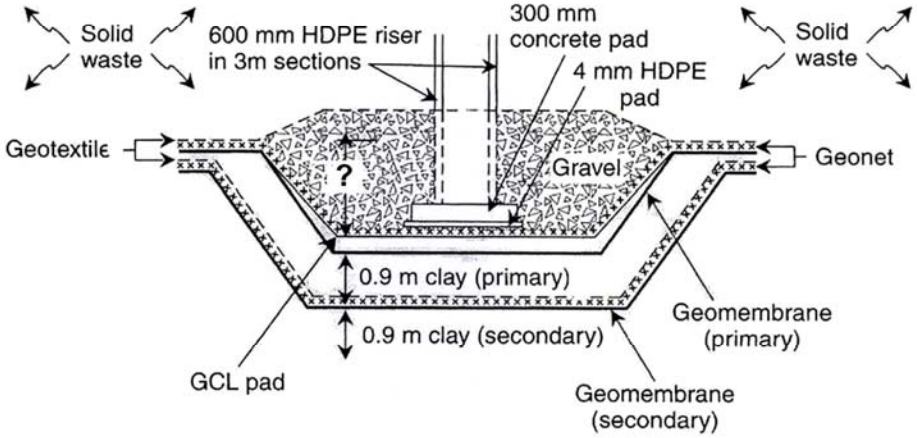
In both of these reports we noted that the maximum leachate head *on the liner* at the base of a landfill was either 300 mm (12 inches) in the U.S., or 300 to 500 mm in other countries. Subsequently, an additional issue arose from several members; *"What is the maximum allowable leachate head on the geomembrane specifically in the landfill's sump area"?* This is a logical question to ask since leachate removal design has significantly changed over the past 10-15 years from a completely gravitational hydraulic system (where the above relatively low heads could readily be maintained) to one where sumps are located at the lower point in the landfill or individual landfill cell.

There are many variations on sump design and the following sketches show three different approaches. In all three sketches the essential question is; "Does the maximum head on the liner beneath the waste also apply in the specific sump area?" This White Paper answers this question from a regulatory perspective.

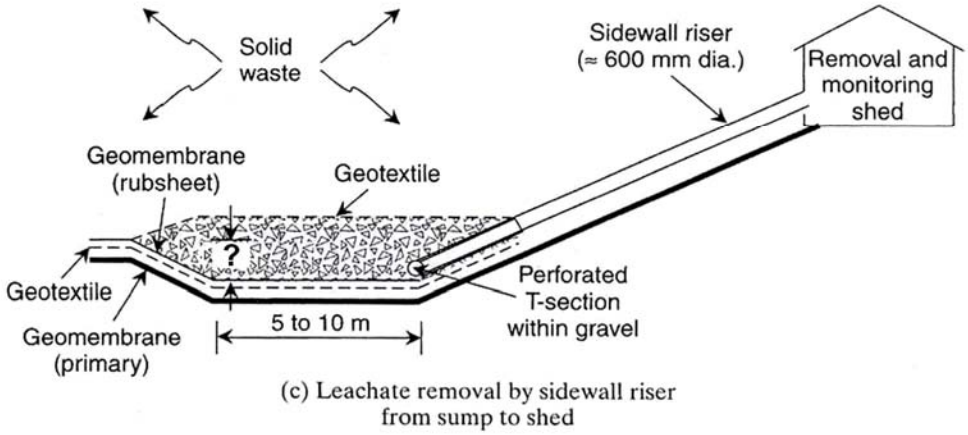
Two separate surveys to regulatory agencies were sent so as to determine the status of allowable leachate heads specifically in sump areas. One was to the fifty U.S. state environmental agencies (since the states rather than the federal government grant permits), the other was a worldwide survey to various national environmental agencies (some of which also have states or provinces that grant permits).



(a) Leachate removal by gravity flow from bottom of sump.



(b) Leachate removal from vertical manhole extending up from sump



(c) Leachate removal by sidewall riser from sump to shed

Various leachate removal designs for primary leachate collection systems.
(after, “Designing With Geosynthetics”, R. M. Koerner)

2.0 Allowable Leachate Head in Sumps; Status in the USA

It first should be noted that the federal U.S. Environmental Protection Agency sets minimum technical guidance for landfills, but relinquishes the actual permitting process to the individual states. Also, for both hazardous and nonhazardous landfills, the federal guidance only prescribes a maximum of 300 mm (12 inches) leachate head on the liner. *Federal regulations are completely silent on any specifics within sump areas.*

A summary of the results from the fifty U.S. states (some gave more than a single answer) is given below in which a tremendous variation of individual approaches to allowable leachate heads in sumps is easily noticed.

- Completely silent on sumps = 20 states
- 30 cm (12 inches) everywhere including sumps = 14 states
- 30 cm (12 inches) except in sump area = 11 states
- 60 cm (24 inches) allowed in sump area = 2 states
- 90-105 cm (30-36 inches) allowed in sump area = 2 states
- Adequate depth for efficient pump operation = 1 state
- Case-by-case depth based on design = 8 states
- Other = 12 states

The specific state-by-state details follow along with twenty-seven notes which accompanied the responses. *To say that there is little uniformity among the states in the U.S. in regard to allowable leachate head in sumps is a decided understatement.*

Individual U. S. State Regulations on Allowable Leachate Head in Landfill Sumps

State	Completely Silent on Sumps	12" (30cm) Everywhere Including Sumps	12" (30cm) Except in Sump area	24" (60cm) Allowed in Sump Area	30-36" (90-105cm) Allowed in Sump area	Depth for Efficient Pump Operation	Case by Case Based on Design	Other
Alabama		X						
Alaska		X						
Arizona	X (1)							
Arkansas		X						X (2)
California						X (3)		
Colorado			X					
Connecticut			X					
Delaware	X							X (4)
Florida			X				X (5)	
Georgia		X						
Hawaii	X							
Idaho	X							
Illinois	X							X (6)
Indiana					X (7)			
Iowa								X (8)
Kansas	X				X (9)			
Kentucky	X							
Louisiana		X						X (10)
Maine			X (11)					
Maryland	X						X (12)	
Massachusetts		X						
Michigan			X					X (13)
Minnesota	X						X (14)	
Mississippi			X				X (15)	
Missouri	X							X (16)
Montana		X						
Nebraska	X						X (17)	
Nevada		X						
New Hampshire			X (18)					
New Jersey			X					X (19)
New Mexico	X						X	
New York			X					
North Carolina	X			X (20)				
North Dakota		X (21)						
Ohio	X						X (22)	
Oklahoma		X						
Oregon	X							
Pennsylvania			X					X (23)
Rhode Island	X (24)							
South Carolina		X						
South Dakota		X						
Tennessee	X							
Texas								X (25)
Utah	X							X (26)
Vermont		X						
Virginia			X					
Washington				X (27)				
West Virginia		X						
Wisconsin	X							X (28)
Wyoming	X						X	

Footnotes:

1. “If the leachate depth in the sump area needs to be greater than 30 cm to accommodate the pump, then that is fine.”
2. “The historic interpretation is that the measurement can begin at the top of sump, allowing adequate sump depth for proper pump immersion.
3. “Restricts the sump depth to a minimum that will assure efficient pump operation. Thus, the sump is subjected to a different standard than is the rest of the liner system.”
4. “Our regulators disregard sumps when reviewing head on liner.”
5. “Sumps and leachate collection trenches are exempt from our maximum leachate head requirements. For sumps, designers usually add about 12-inches of head above the pump intake to get leachate into the pump.”
6. “In the mid 1990’s, we said that the maximum of one foot head on the liner applied to the sumps as well. More recently, we have been more flexible, especially when the hydraulic barriers in the sump exceed those in the other lined areas of the landfill.”
7. “Regulations do not specify maximum leachate head in the sump, but recognize that leachate levels will exceed one foot and thus require a double liner system in the sump area.”
8. The leachate collection system shall have a method for accurately measuring the leachate head on the liner at the system’s lowest point(s) within the MSWLF unit (e.g., sumps).”
9. “It would depend on the sump design; if double composite (preferred), the maximum would likely be 36 inches.”
10. “Maximum leachate head in sump may be dictated by the suction clearance minimum on the pump/pipe outlet.”
11. “Twelve inches everywhere across the liner system *except* in the sump area, where no limit is listed.”
12. “Current regulations do not exempt sumps from the 12” maximum of leachate. The specific amount of head allowed in sump is determined as part of the design development and approved when a permit is issued. Pumps used to remove leachate from the sump must be sized to ensure removal of leachate at the expected rate of leachate generation.
13. “The maximum leachate depth in the sump mainly depends on both leachate collection system design and the size of the sump.”
14. Regulations do not specify maximum leachate head allowed in the sump but state the following “the leachate collection system must have sumps and liquid removal methods (pumps) of sufficient size to collect and remove liquids from the sump and prevent liquids from backing up into the drainage layer.”
15. “Do not have a standard limit on the leachate head in the sump area, but look at this on a case by case basis, considering the design and site geologic conditions. The maximum head in the sump area that we have approved is about 30 inches.”
16. “Regardless of the leachate levels in the sump, levels outside the sump (on the liner proper) must be less than 12 inches.”
17. “A designer can lower the bottom of the sump to provide any amount of head he needs. However, if he does, we usually require that the sump be double lined.”
18. “Do not allow a hydraulic head greater that one-foot to exist on any portion of the liner system, excluding the leachate collection sumps, if any, for longer than seven days.”

19. “There is flexibility with regard to the maximum leachate head allowed in sumps and manholes. Sumps are evaluated separately from the bottom liner system.”
20. “Regulations are silent on sumps, so we employed our best engineering judgment to ensure that the spirit and intent of the regulation was followed. In practice, we allow 24 inches in sump area with the rational that the composite liner and the sump were essentially two different engineered components. The sump area is reinforced either with a double liner or additional GCL under the sump.”
21. “Other than for large industrial landfills, sumps are assumed part of the leachate control system and have a 12 inch head limitation. In actuality, we see some variances in sumps, but facilities strive for 12 inches.”
22. “No abuses noted. Somewhat checked by citing criteria, however, we are considering rule changes which could lead to abuses, so we are investigating size/head limitations to sump designs.”
23. “We require a minimum slope of 2% for leachate collection systems. This should allow the leachate head in the sumps to *exceed* 30cm without back-up.”
24. “We will require sufficient information that shall show that the submersible pump will perform adequately to convey the leachate so as not to exceed one ft on the primary liner. Also, there is a contingency plan to ensure continuous and adequate performance.”
25. “We require that sumps be designed and operated to ensure that the maximum leachate head on the liner is less than 12 inches.”
26. “We do not have a specific depth but if a facility is going to have more than 12 inches in the sump, then the sump must be double lined.”
27. “The one foot head on the liner with the two foot sump allowance only applies to the standard design. Our rule allows for alternative equivalent designs, including unlined landfills, which are silent on leachate head.”
28. “Staff evaluates the pump-on and pump-off elevation settings proposed in plans. Our goal is that leachate levels in sumps be controlled so that they do not exceed the invert elevation of the trenches draining into the sump.”

3.0 Allowable Leachate Head in Sumps – Worldwide Status (Except USA)

The previous survey of states within the United States insofar as their regulations on leachate head in sumps is counterpointed by this second survey which focuses on the same issue but for international countries. Collected and compared are regulations from eighteen countries and/or twenty-one states or provinces in those countries. Also included are the regulations of the European Union whose regulations will supersede those of the member countries in the near future.

A summary of the results from these countries and their states or provinces is given below in which it is seen *that the great majority are silent on the sump issue.* That said, most do have regulations on the maximum head on the liner itself which is often 300 mm.

- Completely silent on sumps = 17
- 30cm (12 inches) everywhere including sumps = 2
- 30cm (12 inches) except in sump area = 2
- 60cm (24 inches) allowed in sump area = 0
- 90-105cm (30-36 inches) allowed in sump area = 3
- Adequate depth for efficient pump operation = 4
- Case-by-case depth based on design = 5
- Other = 0

The specific country-by-country (or state or province) details follow, along with nineteen notes which accompanied the regulations or specific individual responses.

International Countries and State Regulations on Allowable Leachate Head in Landfill Sumps

Country/State	Completely Silent on Sumps	12" (30cm) Everywhere Including Sumps	12" (30cm) Except in Sump area	24" (60cm) Allowed in Sump Area	30-36" (90-105cm) Allowed in Sump area	Depth for Efficient Pump Operation	Case by Case Based on Design	Other
Australia:								
New South Wales							X (1)	
South Australia		X (2)						
Tasmania						X (3)		
Victoria			X (4)			X		
Queensland						X (5)		
Belgium:								
Flanders							X (6)	
Botswana	X (7)							
Canada:								
Alberta							X	
British Columbia	X							
New Brunswick					X (8)			
North West Territories	X							
Nova Scotia	X							
Nunavut	X							
Ontario	X							
Prince Edward Island	X							
Quebec			X					
Saskatchewan	X							
Yukon	X							
European Union	X							
Germany:								
Lower Saxony						X (9)		
Hong Kong							X (10)	
Ireland					X (11)			
Israel	X (12)							
Japan	X							
Korea		X (13)						
Netherlands	X (14)							
Spain							X (15)	
Taiwan	X							
Thailand	X							
United Kingdom:								
England	X (16)							
Scotland	X (17)							
Wales					X (18)			
Vietnam	X (19)							

Footnotes:

1. "As specified in the approved Construction Quality Assurance Program."
2. "The sump must be located at the lowest point of the cell to facilitate monitoring and removal of leachate so that the maximum head of leachate on top of the base liner is less than 0.3m."
3. "The sump should be recessed below the liner to ensure that the pumping equipment remains operational."
4. "The maximum leachate head on the liner (as measured at the lowest point of the liner) for a landfill situated above the watertable is 0.3 meters. The leachate head in the sump may exceed 0.3 meters as the sump is generally recessed below the level of the liner; some liquid is usually necessary to protect the pump in the sump."
5. "The leachate head in the sump may exceed 300mm as the sump is generally recessed below the level of the liner and some liquid may be necessary to protect the pump in the sump."
6. "The leachate level in the collecting sumps may not become higher then half of the height of the lowest drains which discharge into the sump. The legislation in Flanders prescribe a leachate drainage system with a thickness of at least 40cm so the maximum leachate level on the liner is about 20cm."
7. "Gravity flow of leachate from the upper collection layer (or from the leakage detection layer) is then directed to sumps, possibly using perforated collection pipes, from which it can be collected for treatment."
8. "Leachate in a sump would be limited to a maximum of 1 meter below top of lined portion of adjacent berms. Leachate on the rest of the liner (beyond the ponded leachate at or around the sump) is limited to 300mm."
9. "You may construct the sump with a depth below the base level of the landfill appropriate for your pumping. There are no regulations on this issue. The regulation requires in principle the leachate removal by gravity."
10. "Leachate management of the landfills in Hong Kong are managed under the relevant contracts engaged between the Government of Hong Kong Special Administrative Region and the landfill contractors."
11. "Leachate levels do not exceed a level of 1.0m over the top of the liner at the base of the landfill. This is implemented by way of condition in the landfill licenses."
12. "There is no reference to the head in the sumps."
13. "Are your state regulations silent on this issue? Yes, no special issue in this problem.
14. "Maximum leachate allowed in landfills is given in the Council Decision of 19 December 2002."
15. "No general requirement at national level regarding a limit on the leachate head in sumps in landfill cells. Notwithstanding, the technical conditions required to every specific landfill are set by regional authorities when they authorize the installation."
16. "We require that the depth of a leachate head is determined by risk assessment."
17. "In Scotland, we seek to minimize the depth of leachate head at landfills, although the exact figure for each sit is determined by risk assessment."
18. "Generally 1m, but sites are allowed higher heads based on risk assessment."
19. "Achieving acceptable levels of leachate treatment is a major problem at current landfill sites."

4.0 Summary and Conclusion

The topic of this White Paper was prompted by the gradual change over a fifteen-year period from gravitational leachate collection systems at the base of landfills to the use of sumps at the low end of the landfill or individual cell of the landfill. The advantage of this change is that penetration of the liner system and supporting earthen berms is no longer necessary. The disadvantage is that sumps must have sufficient depth so as to accommodate submersible pumps which need enough hydraulic head to properly function over long periods of time.

Unfortunately, regulations by all federal agencies which set minimum technology guidance for landfills only present requirements for the allowable leachate head on the liner. They invariably are silent on the allowable leachate head within the sump itself. This omission has the effect of transferring this important decision to the permit granting environmental agency, which is usually the state or province in which the landfill is located.

In order to assess the "state-of-the-regulations" we conducted two separate surveys. One was to the fifty state environmental agencies in the United States, the other was to international countries (or their states or provinces) worldwide. The following are the summary findings:

- While approximately half of the U.S. states are silent on the issue, the other half are fully involved in the situation and responded accordingly.
- This second half either prescribes the allowable depth of leachate in the sump or addresses the issue on a case-by-case basis.
- The situation was at least known by essentially all of the state agencies even though many have no formal requirements.
- Internationally, the issue is not nearly as addressed and in many countries is not even known to be an issue or a concern.

- The slight tendency in international countries (or their states or provinces) is to allow for such a depth to provide efficient pump operation or a decision is made on a case-by-case basis.

Knowing that leakage through geomembrane liners is directly a function of the height of leachate head above an imperfection, it appears to the authors that clear guidance should be given by the regulatory community. Landfill designers do have options (e.g., sump dimensions in particular) but must know the specific constraints involved. In this regard, it behooves landfill designers to be cautious with respect to sump design and at the minimum obtain regulatory commitments (in writing or, at least, verbally) before proceeding to final design along with plans and specifications for a particular project.