PROGRESS REPORT OF THE TECHNICAL SUBCOMMITTEE

CONCEPTS FOR CHANGES TO THE TECHNICAL STANDARDS PROPOSED FOR INCLUSION IN PHASE II RULES

JANUARY 24, 1997

DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WASTEWATER MANAGEMENT DIVISION

phase II rules disc
report.9

TABLE OF CONTENTS

SUMMARY

Since 1993 the On Site Sewage Committee and the Agency of Natural Resources have been involved in a long term process to improve the management of on site sewage disposal. The Committee found that Vermont was far behind in adopting new technologies that have been developed since 1982 when the last comprehensive revision of the rules was completed. As a consequence a Technical Subcommittee of the On Site Sewage Committee was formed to conduct, in cooperation with the Agency, an evaluation of available technology and necessary site conditions and make proposals for changes to Vermont's rules that would incorporate new technologies that will work in Vermont's climate and soils.

The Subcommittee has been working intensively since late spring of 1996 in response to the request of the legislature that specific principles for the proposed rule change be developed and presented to the legislature before the rule changes are drafted. The Subcommittee engaged in a very intensive review of on site standards with a goal of maximizing the number of sites that could be developed based on good science while appropriately continuing to protect public health and the environment. The Subcommittee has developed a framework of basic site conditions to be used when new rules are written and the Subcommittee's findings are presented in this report. While the Subcommittee has made good progress on determining the minimum site conditions, which is most important, there is, and always will be, more to do in looking at new treatment technologies.

While the process of assessing the state of the art was occurring, the Department of Environmental Conservation moved forward with the adoption of a limited update to the 1982 rules so that several changes that had wide support could be implemented for immediate use. These rules, often referred to as the "Phase I" rules, were effective on August 8, 1996. These rules added sand filters and at grade systems to the list of solutions for problem sites. The rules also increased the maximum slope on which mound systems can be constructed and increased the types of sand that can be used, making it easier and less expensive to build mound systems.

The State of Vermont, during 1996, also entered into an agreement with the other New England States and the State of New York to participate in a pilot project organized by the New England Interstate Water Pollution Control Commission. This project allows a manufacturer to bring forward a proprietary technology and have their performance claims evaluated. All of the participating states have agreed to accept the Commission's decision on the performance claims as fact, which will speed the introduction of new technologies and reduce the cost to the developers of the new technology.

The issue of so called "black box" technology was also reviewed. Many people were hopeful that there was some kind of technology that would be cheap to use and work even when site conditions are poor. In fact "black boxes" are mostly treatment devices that, while improving the quality of the effluent, do not, even with disinfection, produce harmless effluent that can be spread on the ground. Therefore, the determining factor of whether a lot can be approved for construction still depends on the minimum site conditions needed to carry the effluent away from the leachfield through the surrounding soil. The "black box" may open up a few more lots for development because their treated effluent can be disposed of in a smaller leachfield. However, "black box" technology will not automatically turn an unapprovable lot into one that is approvable.

There was also agreement on the following issues:

O There should be no compromise to allow systems that operate by overland flow or direct discharge to surface waters.

O That graywater contains significant numbers of pathogens and must be considered as sewage.

O That non-discharging systems will be reviewed and included where appropriate.

O That the systems currently approvable are useful and effective systems and will continue to be used on the types of sites on which they are currently approved.

INTRODUCTION
TO
TECHNICAL STANDARDS REVIEW

This report presents the results of an intensive review of the Vermont Small Scale Wastewater Treatment and Disposal Rules, the rules of other New England States, rules of other states believed to be leaders in the area of on site sewage disposal, and the state of the art in existing and emerging technologies. The Agency of Natural Resources working as a member of the Technical Subcommittee of the On Site Sewage Committee, appointed in 1993 by Secretary Chuck Clarke, and reauthorized by Secretary Barbara Ripley, committed to a thorough review of necessary site conditions and available technology. The Subcommittee reviewed technologies and approaches to determine which might function in Vermont. The Technical Subcommittee included several engineers, hydrogeologists, site technicians and soil scientists. Also participating were land use planners and representatives from the Farm Bureau, Vermont Home Builders, and the Vermont League of Cities and Towns. In addition to those who participated on a regular basis, many other interest groups were kept informed through regular mailings. Appendix A lists those people who were members of the Technical Subcommittee. Appendix B is the current mailing list for information from the Technical Subcommittee.

Before the Subcommittee began work there was significant discussion about the parameters under which the decisions would be made. It was decided that there were two basic requirements for any system which could not be compromised:

1. The system could not discharge directly to the waters of the State, regardless of the level of treatment, and

2. That the design of the system could not be based on a discharge by overland flow.

Note: spray disposal systems, which are currently permitted under the rules, apply effluent to the surface of the ground but dispose of the effluent by infiltration into the ground, not overland flow.

Condition #1 was based on current state law that requires a waste management zone for each discharge. Obtaining permission to discharge requires a determination that it is in the public interest and that current uses be maintained, something that would be difficult to do with a large number of small discharges. Moreover, the State has been working diligently since 1969 to eliminate as many unnecessary discharges of all kinds to waters of the State, including those associated with farming, logging, general site development, as well as discharges of sewage, whether treated or not. It did not seem reasonable to propose to reverse this concept.

Condition #2 was based on a belief that one of the most important factors in public health protection is the separation of effluent from people. By keeping the effluent underground, and away from water supplies, the threat to humans is minimized. Some high tech systems, especially ones using disinfection, claim to produce effluent that is safe to discharge to the surface of the ground. Because even the best systems fail occasionally, and because all of the advanced systems depend on the ability of humans to maintain and pay for maintaining the systems, the Subcommittee felt that it is likely that partially treated/partially disinfected effluent would be at times discharged to the surface of the ground creating an immediate potential health hazard. Keeping the effluent below the surface of the ground creates a significant level of safety that requires less dependence on equipment that will eventually fail or on human commitments to providing proper operation of the system.

HOW THE WORK WAS DONE

The Subcommittee prepared a systematic approach to this extremely involved task. It was decided that the most important issue was to define the minimum site conditions necessary to support a functioning septic system. With this in mind, the committee began by listing as many of the issues that needed to be considered as possible. The committee ranked the issues and addressed the most important issues first. We believe that all of the most critical issues have been resolved to the Committee's satisfaction. The committee is continuing to work on the remaining issues and has both a meeting scheduled for February 12, 1997 and a commitment to continue meeting until all of the issues have been satisfactorily addressed.

At this time the committee has the issues separated into three categories. The first category includes the issues on which there is agreement and the Agency presently proposes to include in any revision to the rules. The second category includes issues that have been discussed and where there is agreement that some revision to the rules is needed, but where consensus has not been reached. This lack of consensus is primarily due to lack of time to discuss the issues or the need to collect data in order to make a valid decision. The third category includes all of the issues that have been suggested for discussion, but which have not been taken up yet, most of which are technical details and not broad concepts.

This report does not represent the end of the process. The Agency is committed to not only including the agreed upon issues in any future revision to the rules, but also to continued progress on the rest of the issues. The Agency is also committed to designing any future rules in a way that will allow new products based on similar technologies or that produce similar results to be easily approved for use in Vermont. One important step towards this goal has already been accomplished with the agreement to participate in the New England Interstate Water Pollution Control Commission pilot study to certify the validity of claims by manufacturers of proprietary technologies. This agreement means that each participating state agrees to accept these certified claims as valid when the manufacturer applies to use the technology in a particular state. While the certification does not mean that the technology can automatically be used in every state in exactly the same way, for instance, states give more or less credit for reduction in leachfield size based on effluent quality, it means that the manufacturer will not have to do a new round of expensive testing for each state where the technology is proposed for use. This agreement is included as Appendix C.

Also included is a review of the changes in technologies that have already been put into use since the beginning of this review process. These changes were effective as of August 8, 1996 as part of the revision to the Small Scale Wastewater Treatment and Disposal Rules.

One thing that is clear based on the work to date is that not every site is suitable for a septic system. The decisions that have been made, both the ones that are already implemented and those proposed for Phase II of the rules, will allow a larger percentage of lots to be developed with a septic system, but under the two basic criteria of no direct discharge to surface waters and no overland flow, some sites such as wetlands, very shallow soils, soils that are very dense and impermeable, and bare rock will continue to be unacceptable for on-site sewage disposal.

DETERMINATION OF MINIMUM SITE CONDITIONS

The most important issue in determining whether lots are suitable for a septic system is the minimum site conditions. The minimum site conditions generally consist of:

1. The depth to bedrock
2. The depth to impermeable soil
3. The depth to the seasonal high water table
4. Slope
5. Percolation rate

In attempting to agree on what the minimum site conditions should be in any proposed regulations, the group decided that the absolute limit should be based only on science and not on any effect that changes in the limits might have on land development patterns. Using this approach it was agreed that the scientific limit was not the ability to apply the effluent to the site or the ability to treat the effluent before applying it to the site, but that the limit was the ability of the site to move water away from where the leachfield is located so that the system could continue to operate without ponding. Therefore the Subcommittee looked at what the minimum conditions must to be to move clean water away from the site. In looking at Vermont as a whole, the soil types that present the greatest limitations are silts and clays. These soils are the most difficult because water moves slowly through these fine grained soils. Because the water moves slowly, it often rises close to the surface of the ground during periods of wetness, typically during the spring when the effects of snow melt, rainfall, and lack of evapotranspiration are combined. While these soils, particularly the clays, are most common in the Champlain Valley, they occur throughout Vermont. As the soils become coarser in texture they are easier to deal with because water moves more freely through the soil.

There was a great deal of discussion, led primarily by the hydrogeologists on the committee, on the proper approach to use. The Subcommittee started by using Darcy's law which is a thoroughly accepted concept of a soil's capacity to move water, which is expressed by the equation

$$Q = K \text{ times } I \text{ times } A$$

Q is the quantity of water
K is a constant related to the soil type
I is the slope of the site
A is the cross section area that the water flows through

If the values for K, I,and A are known, the amount of water that can be transmitted through the soil can be easily calculated. The committee constructed mathematical models by making assumptions for A, I, and K. These assumptions were then compared to existing site conditions to determine if a system based on the assumptions could be constructed in the field. Appendix D includes examples of the assumptions and data collected in the field that supports the following conclusions. In addition, work from other states was considered and found to support the approach agreed to by the committee.

The committee agreed that the minimum site conditions should keep the effluent 6" below the ground surface, and therefore calculated that the minimum conditions, without doing a detailed and site specific hydrogeologic analysis, should be:

1. A minimum slope of 3% in fine-grained soils. The ability of a site to move water away from the septic system is directly related to the slope. The committee felt that sites with at least 3% slopes are relatively common, even in the Champlain Valley

2. There must be at least 18" of soil with a percolation rate of faster than 120 m/i. Soils with rates slower than this have very little capacity to move water and ordinary percolation tests become less accurate.

3. The site must have at least 12" or the thickness of the "A" soil horizon plus 4", whichever is greater, above the seasonal high water table. Sites with less than 18" to the seasonal water table would require the installation of a drain, intended to lower the watertable to at least 18", and with a watershed uphill which causes water to run down onto the proposed septic system area. Sites without watersheds are unlikely to be affected by the installation of a drain.

4. The linear loading rate must be 2 gallons per day per foot or less. The linear loading rate is determined by dividing the number of gallons of effluent by the length of the leachfield as measured along the contour of the ground.

5. There must be at least 2' of naturally occurring soil above bedrock.

6. The favorable site conditions must continue at least 25' downhill of the system.

These are the basic conditions needed to move water away from the leachfield area so that the effluent would not pond on the surface of the ground at the toe of the system. The information required to make the required decisions can be determined with ordinary soils examinations using test pits and regular percolation tests. Additional site specific information may be collected which may be used either to evaluate a site with less than these minimum conditions or to increase the linear loading rate and thereby reduce the length of the system. Calculations based on collecting additional site specific data would have to demonstrate that the effluent would remain at least 6" below the ground surface while the system was in operation.

The approach in the current rules is adequate for sites with at least 2' to the seasonal water table, and any revision to the rules will continue to include these basic site evaluation and system design techniques.

OTHER ISSUES THAT HAVE BEEN DECIDED

1. Slope

   The issue of the maximum slope on which various types of systems should be constructed was examined. Based on field experience in Vermont and other states it was decided to increase the maximum allowable slopes for the various types of systems as follows:

	current	proposed
Inground systems	20%	30%
Mound systems	20%	30%
At grade systems	12%	20%

   Site specific proposals, based on appropriate information, may also be made to increase the slope limitation.

   Note: In some cases it may be difficult to operate some kinds of equipment on the steepest permissible slopes. However, because the systems are capable of functioning on the steep slopes it was decided to include them as part of the attempt to include as many workable systems as the science would support, even when the installation may be difficult.

2. Watertable separation distance

It was decided to continue the current practice of having at least two different separation distances between the bottom of the leachfield and the watertable, based on two levels of effluent quality. The current rules require 3' between the bottom of the leachfield and the watertable for septic tank effluent and 2' for treated effluent with less than 30 mg/l of BOD and TSS.

There was much discussion about reducing the distance to less than 2' based on higher levels of treatment and disinfection. Ultimately, the majority decision was that there was little support for relying on disinfection to reduce the requirements for effluent disposal. The issue was discussed mainly as it related to reducing the isolation distance to water supplies. The Department of Health and the Water Supply Division had strong objections to the concept because of the inevitability of failure of any disinfection system because of its mechanical nature and the need for human operation. Once untreated effluent is in the ground, recovery or treatment is virtually impossible, and protecting a water supply system against the possible two year survivability of pathogens would require removing the water system from operation for that period of time. Even this drastic step presumes that someone would be aware of the failure of the treatment system and willing to report the failure. Also, the addition of chlorine, the customary method of disinfection, may result in the formation of trihalomethanes, a cancer causing agent, that we would prefer not to discharge to ground water.

Reducing the vertical separation distance from 2' to something less based on higher levels of treatment, but without any reduction in separation from water supplies was also examined. The opinions on this issue were more divided with some believing that the isolation distance should be reduced based on current information. While most of the Subcommittee members believe that this issue should be further studied, the majority decision was that the Subcommittee was not ready to change at this time. This decision was based on the fact that very few additional sites would be approvable by making the change and that relatively little data is available from installed systems.

There are several national studies developing additional data addressing this issue, and the Subcommittee is committed to continuing work on this issue as new information becomes available. It is possible that additional changes may be accepted even prior to writing the phase II rules.

3. Reduction in isolation distance to wells

The Subcommittee, with the concurrence of the Water Supply Division, agreed that there should be a method to reduce the minimum isolation distance to a well to less than the currently permitted 100', when appropriate. The current rules do not allow for reduction under any circumstances, while the science has progressed to the point where, in some circumstances, it can be demonstrated to a very high degree of certainty that pollution of the water supply will not occur with a reduction in isolation distance. While the evidence to support a reduction will in some cases be complex and/or expensive to obtain, this change moves towards making decisions based on the available science as opposed to being strictly limited by prescriptive statements in the rules.

4. Graywater

The Subcommittee also reviewed the issue of graywater disposal. Based on the fact that graywater contains all of the same pathogens as a combined waste stream, and in some cases even has organic loadings as high as the combined waste stream, it was decided that gray water should continue to be considered as sewage.

5. Failed systems.

The Subcommittee discussed this issue at length. The current rule is that, while the requirements of the rules can be waived as needed in order to install a replacement system, the replacement system must come as close to meeting the rules as possible, regardless of cost. With the recent addition of treatment technologies and the proposal to add more, many people were concerned that by "stacking" technologies, for example requiring both a sand filter and a mound system, that the expense of systems would become even more prohibitive.

In fact the committee decided to move in the opposite direction, and agreed, for the first time, that replacement systems would not automatically be required to come as close to meeting the rules as possible. **At the same time the Subcommittee felt that reasonable improvements in protection of health and the environment should be required.** For example, if the existing failed system was only 75' from a water supply but could easily be relocated to be at least 100', then it should be relocated. If on the other hand, there was no demonstrated contamination of the well, and the well appeared to be at no significant risk,and it would be very expensive to move the replacement system further away, it probably would not be reasonable to require the relocation.

While there was quick agreement that the bottom line is that the situation could not be made worse and that the "best fix" no longer would require the maximum possible compliance with the rules, it was not possible to write down rigorous outline for how to make the decision. Suggestions related to the maximum amount of money that would be required were not able to accommodate situations where the threat to a water supply was severe and the cost to improve the situation was great. There was also concern about the need for some guidance on how to decide what criteria should and should not be waived, particularly so that programs administered at the town level would be somewhat consistent from town to town and with the state approach. One possible approach is grouping the issues of lesser and greater importance with the understanding that the rules related to the items of lesser importance would be waived first. Ultimately, it was decided that the process would have to depend on giving authority to the individual regulator to use their best judgement supported with written guidance on relative weight of various requirements. Review of the individual decisions by supervisors and through the appeal process would provide direction and oversight to ensure that decisions were properly balanced between protection of health and the environment and the cost effectiveness of the required repair. The variance process should require written documentation of the variances and how the decisions were made relative to each variance.

The Subcommittee believes that the determination of reasonable cost should not be related to the finances of an individual owner because in some cases the system owned by a person of very limited resources may pose a very great threat to someone else's health. These situations should be resolved by providing financial assistance sufficient to construct a proper replacement system.

ISSUES THAT HAVE BEEN DISCUSSED BUT NOT COMPLETED

1. Design Flows

   The recently adopted changes to the rules changed the design flows for mobile home parks when 5 or more homes are connected to the same system. The rules also allow for a 20% reduction in design flow for project connected to a municipal collection system. The 20% reduction is based on the averaging effect that occurs when multiple units are joined together. The Subcommittee agrees that each of the numbers should be reviewed both for use with individual units and for how the design flow should be revised when multiple units are connected together.

2. Effluent treatment levels

   The Subcommittee decided that in order to reduce the separation between the bottom of the leachfield and the water table from 3' to 2' that the current effluent limits of 30 mg/l of BOD and TSS should be reduced to 20 mg/l as these levels are easily and consistently reached by sand filters currently approvable under the recently adopted rules. It did not seem reasonable to continue with a standard that provided less protection than commonly available technology can provide.

3. Seasonal high water table monitoring

The method for monitoring of seasonal water tables will have to be revised to reflect the changes in the minimum site conditions. The current method, if used to determine that a site had at least 12" to the water table, would allow the water level to be 12"-18" above the critical depth (12") for up to 10 days. As this would be up to six inches above the surface of the ground it is clearly not an appropriate test.

4. Coordination with the wetlands program

   The proposed changes to the rules need to be reviewed for compliance with the wetlands rules.

5. Use of soils identification instead of percolation tests

A plan should be developed to prepare for and to convert to a soil identification approach for leachfield siting and sizing. Accurate soil determinations have the benefit of judging the soil as a whole as opposed to using 2 or 3 tests that measure only a very small area and are greatly influenced by minor soil inclusions. The new method would also reduce costs slightly because soil identification takes less time than a properly run percolation test.

6. Non-discharging system

   Systems such as composting and incinerating facilities need to be reviewed and included in the rules. More data is needed relative to operation of composting toilets to determine if they actually operate as designed. The design is based on reaching high enough temperatures for a sufficient amount of time to greatly reduce the pathogens. Information is needed to determine if the way the units are actually operated provides proper treatment and if all composting toilets are essentially equivalent.

ISSUES DEFINED BUT NOT YET DISCUSSED

1. Working with old fill sites.

   The Subcommittee needs to determine how to evaluate sites that have been filled in the past to determine if the site is usable now. Because the current method of evaluating site conditions depends on looking at how the soil has weathered over the years for clues on where the highest water table occurs, the current rules have not allowed for consideration of sites that have been filled in the past. It is likely that some method can be developed to judge these sites, though it may require more advanced or time consuming testing.

Note: The Phase I rules did allow for construction of a mound system on top of fill material provided that the native soil underneath the fill was suitable for a mound system. This approach still does not allow for the fill to be the actual receiving layer for the disposal of the effluent.

2. Application methods

This issue is related to the different shapes of beds, trenches, leaching chambers, gravel-less systems. The question is how to decide what the equivalent amount of leaching trench is for some particular unit of another type of system.

PHASE I RULES

On August 8, 1996 new rules, entitled "Small Scale Wastewater Treatment and Disposal Rules" were adopted. These rules were intended to include a limited number of revisions that had nearly universal support and were also intended to demonstrate that the Agency could make progress on this difficult issue. The new rules are a significant change in dealing with sewage disposal in that, for the first time, treatment units are permitted as part of the system. The rules allow systems using approved treatment units to reduce the size of the leachfield by 50% which means that some lots that had room for a primary system but not a replacement system may now have enough room for both. The rules also allow a reduction in the distance between the bottom of the leachfield and the water table from 3' to 2' for systems producing effluent that meets the standards of 30 mg/l for BOD and TSS. This means that some sites that would have required a mound system might pass with an at-grade system or an inground system, either of which would save money.

The new rules also allowed the use of an at-grade system. The at grade system is constructed by plowing the surface of the ground with a mold board plow or the teeth of the bucket on a backhoe, the same as for mound systems, and then placing the crushed stone right on the plowed surface. A pressure distribution system, the same as for a mound, is then installed and the whole system is covered. Because no special sand fill is required, this system is less expensive than a mound system. The at grade system can be used in situations that used to require a mound system but were nearly suitable for an inground system.

The slope requirements for a mound system were revised from 12% to 20%. This is based on field experience and information from other states. This change will be particularly useful on glacial till sites that are commonly found at the higher elevations in Vermont and will allow additional lots to be approved for construction. The requirements for the sand needed to build mound systems was also revised. The revision replaced the single sand specification with three different specifications that should increase the number of pits available to choose from and thereby reduce the cost at the pit and the cost of trucking.

The requirements for monitoring to determine the seasonal high water table were changed to allow the water table to be above the critical depth more days during the monitoring period than in the past. This should increase the number of lots that pass the test.

While these revisions are only part of what needs to be done to have a fully up to date set of rules, they nonetheless represent a useful step forward that the Agency wanted to implement without delay. This will allow people to benefit from these changes during the time period needed to do a more complete revision.

APPENDICES

A. List of Subcommittee members

B. Current Mailing list

C. Agreement with New England Interstate Water Pollution Control Commission

D. Calculations and data related to minimum site conditions

E. Changes implemented in the Phase I rules

TRENCH TEST EXAMPLES **CRAIG HEINDEL** **11-19-96**

TEST	LOCATION	SOIL	TRENCH TEST K_1 FT/DAY	POINT TEST K_1 FT/DAY	TRENCH TEST WATER DEPTH BELOW GRADE	SITE SLOPE	PERC RATE MIN PER INCH	DEPTH TO IMPEDING	DEPTH TO SHWT
1	CHARLOTTE	STETSON (PEBBLY LAC. BEDS)	34 FT/DAY	5 FT/DAY	1.0'	10%	28 M/I	2.0'	--------
2	WILLIAMSTOWN	TILL	40 FT/DAY	6 FT/DAY	1.5'	8%	10 M/I	2.7'	2.7'
3	DORSET	ABLATION TILL	7 FT/DAY	2 FT/DAY	4.0'	16%	?	--------	5.4'
4	CHARLOTTE	TILL (STOCKBRIDGE - NELLIS)	64FT/DAY	10 FT/DAY	1.0'	7%	6 M/I	2.5'	2.5'
5	MANCHESTER	TILL	31 FT/DAY	15 FT/DAY	1.0'	12%	?	2.1'	2.1'
6	NEWPORT	SAND FINE GRAVEL	82 FT/DAY	14 FT/DAY	4.0'	5%	?	7'	7'
7	CHARLOTTE	TILL	44 FT/DAY	15 FT/DAY	1.0'	5%	15 M/I	2.4'	---------
8	WILLIAMSTOWN	ABLATION TILL GRAVEL LENSES	90 FT/DAY	14 FT/DAY	1.0'	6%	6 M/I	--------	4'
9	BENNINGTON	SILT-CLAY	82 FT/DAY	22 FT/DAY	0.0'	10%	?	1.4'	1.0
10	DORSET	SILT-CLAY	14 FT/DAY 10 FT/DAY	4 FT/DAY	1.0'	12%	14 M/I	2.6'	----------
11	SHELDON	SILT-CLAY	4 FT/DAY 154 FT/DAY	2 FT/DAY 60 FT/DAY	0.3' 0.2'	5% 7%	? ?	1.3' 1.9'	---------- ----------

APPENDIX D

SUPPORTING CALCULATIONS

Using Darcy's Law for flow through a soil we identified the magnitudes of hydraulic conductivity, K, that a soil must have in order to meet the agreed upon assumptions and design parameters.

Darcy's Law $Q = KIA$ or $K = Q) (IA)$

- **Q** is the daily flow in cubic feet, or #gpd) 7.48 gal/cubic foot
- **K** is the hydraulic conductivity in feet/day
- **I** is the hydraulic gradient which for initial calculations is assumed to be the ground slope
- **A** is the transmitting area required to move the flow Q through the soil. Assuming an 18" A+B soil horizon and a 6" freeboard there remains a 1' thick transmitting zone; therefore the required area equals one times the length of the system along the contour, or the length of the system.

Results:

Using a slope of 3%.
Using a daily flow of 405 GPD.
Using areas of 100, 150, and 200 ft^2,
which yields systems of 100, 150,
and 200 ft long, respectively.
The resultant K required is determined.

	Q = 405 gpd
A = 200 ft^2	K = 9 ft/day
A = 150 ft^2	K = 13.5 ft/day
A = 100 ft^2	K = 18 ft/day

Using a slope of 5%.
Using a daily flow of 405 GPD.
Using areas of 100, 150, and 200 ft^2,
which results in systems 100, 150,
and 200 ft long, respectively.
The resultant K required is determined.

	Q = 405 gpd
A= 200 ft^2	K = 5.4 ft/day
A= 150 ft^2	K = 8.1 ft/day
A = 100 ft^2	K = 10.8 ft/day

Adapted from David Cotton 9/24/96 report