X-847

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

December 1, 1961

To: M. E. Ramsey

Subject: SUMMARY OF DIFFICULTIES WITH TRENCH NO. 6

References

1. Waste Effluents Committee Minutes, dated October 17, 1961
2. Letter to K. Z. Morgan, "Location and Operation of Trench No. 6," from W. de Laguna, D. G. Jacobs, and E. G. Struxness, dated October 30, 1961
3. Letter to M. E. Ramsey from F. R. Bruce, dated November 15, 1961
4. Letter to F. R. Bruce from M. E. Ramsey, dated November 15, 1961
5. Letter to J. A. Cox and H. E. Seagren from M. E. Ramsey, dated November 16, 1961
6. Sketch D-43136, Chemical Waste Pit No. 6, Plans and Sections
7. Log of Waste Pit No. 6, dated October 1961
8. Log of Waste Pit No. 6, dated November 1961
9. Letter to G. Morris from G. A. Cristy, dated October 23, 1961
10. Chart of Water Levels in Pit No. 6
11. Record of Chemicals and Elements in Pit No. 6

Without going into the history of the open pits (Nos. 1, 2, 3, and 4), we need only to note that Trench No. 5 (the first covered waste disposal pit) was designed and built on the basis of recommendations from the waste disposal group of the Health Physics Division. When Trench No. 5 was completed it worked satisfactorily but was not adequate to handle all the waste being produced. Due to agitation for abandoning and filling the open pits, it was decided to build another trench. In an attempt to design the new trench in accordance with Health Physics recommendations, a criteria meeting was held on September 7, 1960, between W. de Laguna and representatives from Operations Division (the operators) and Engineering and Mechanical Division (the designer and builder). Having already designed one trench according to Health Physics recommendations, it was assumed that the only unresolved problem was the site of the trench. At the criteria meeting no mention was made of the need (which later became a "bone of contention") for water table exploration of the proposed sites. Three sites were considered (see Reference 6).

Site 1 - along the top of the ridge north of existing Trench No. 5

Site 2a - along the top of the ridge approximately 1400 feet northeast of Trench No. 5

Site 2b - on the spur of the ridge extending south of site 2a.

[Note: It now appears that there is a difference of opinion between Health Physics and E & M on the exact location of site 2a. Actually, there is room between sites 2a and 2b for another trench. Since the general statement made at the criteria meeting indicated either of two sites (not three) on the ridge would be satisfactory, it was left up to the design group to select the exact location at each point.]

Since de Laguna objected to site 1 on the basis of the narrowness of the ridge and the steep side slopes, it was dropped from further consideration. Since it was more economical to use site 2a than to use site 2b, the Operations Division properly chose site 2a.

Design was completed on the project on January 23, 1961. The design drawings were reviewed and approved by Operations Division personnel but were not reviewed by de Laguna or other Health Physics personnel. It now appears that this was a serious oversight.

Although it has never been expressed publicly, we doubt that site 2b would be any more acceptable than site 1, and for the same reasons. The east slope of the hill at 2b is even more precipitous than the slopes at site 1. Further, the only reason for a lower water table at site 2b than at site 2a is the presence of the steep slope.

The trench was built by a lump-sum contractor according to the design. During the construction, a considerable amount of limestone rock was encountered in the western end of the trench, and one large ledge was uncovered at about the center of the trench. This caused no concern to anyone at the time, although it was known by E & M, Operations, and Health Physics personnel. W. de Laguna was not formally contacted for advice during the construction of the trench, but he was visited informally in the field by the E & M Division program engineer. de Laguna's only comment was to the effect that less than one-half of the trench would be effective due to the direction of the strike with relation to the trench.

Before starting to use the trench, it was treated with 20,000 pounds of copper sulfate in solution to increase the effectiveness of removal of Ru^{++} ions. A 10 per cent Na_2S solution containing 10,000 pounds of Na_2S was also pumped into this trench. Waste was started to the trench on September 8, 1961, and was continued intermittently (as rapidly as necessary to keep the trench essentially full) until September 26, 1961 (see Reference 7).

After the trench was put into operation, Health Physics had seven test wells drilled adjacent to the trench. de Laguna reports that it was due to the high water level in one of these observation wells which led them to make a search 300 feet south of the trench at an elevation of 809.6 (26.4 feet below the bottom of the trench). After the seep was discovered, samples taken from the test wells and the seep were analyzed for fission products (see Reference 11). It was discovered, to everyone's surprise, that Sr^{++} and Cs^{+} was traveling through the ground with very little holdup time. This was the first time in the operation of the waste pits that passage of the waste through shale failed to hold back the Sr^{++} and Cs^{+}.

The use of Trench No. 6 for waste was suspended until the cause of its failure could be determined. Much speculation as to the causes followed. During the investigation many opinions were advanced. The Waste Effluents Committee called a meeting on October 17, 1961, to review the situation. The minutes of this meeting were published (Reference 1). Out of this meeting a series of recriminations arose (References 2, 3, and 4) due to an apparent misinterpretation of statements made at and subsequent to the meeting. Several illuminating statements made at the meeting were not included in the minutes. For example, W. de Laguna said that his opinion had not been asked regarding the actual location of Trench No. 6 but that if it had he would not have predicted a high water table, although in his opinion the principal difficulty with Trench No. 6 was a high water table. Other items not mentioned in the meeting have been included in Reference 1 as an apparent attempt to justify the Health Physics position of claiming that they had the answers all along but were not consulted.

Since the recommendations of the Waste Effluents Committee show that the amount of activity which has been put into Trench No. 6 is so small that it is not a serious hazard, the violence of the recriminations seem to be highly unjustified. If a spirit of mutual understanding and cooperation is to be obtained now or in the future, all groups concerned should avoid trying to throw all the blame on other groups. E & M Division was acting in good faith and evidently made some mistakes which <u>might</u> have been prevented if Health Physics Division personnel had been asked to approve the final drawings. Health Physics personnel could have been more helpful at the criteria meeting by reviewing with the designers and operators the specific requirements for the trench, including the necessity for test wells for location of water table. This could have been accomplished by referring the designers to ORNL 2384 <u>before</u> the fact instead of after the fact.

It is clear now that there is enough experimental evidence available in the Laboratory to have predicted the difficulties encountered with Trench No. 6 if only the Operations Division had had the foresite to ask the proper people. The low pH of the waste evidently had much to do with the failure of the shale to hold back the Cs^{+} (and perhaps the same may be said of its failure to hold back the Sr^{++}). However, no one who had the answers took the trouble to "sound off" loud enough to be heard prior to the incident. Could it be that it was only after it happened that the chemists considered the phenomena involved in order to explain known conditions? This seems unlikely.

As a result of the discussions at the Waste Effluents Committee Meeting, it was decided to make several experiments on Trench No. 6. These experiments involved adding NaOH and Na_3PO_4 to the trench in an attempt to fix the Cs^{+} and Sr^{++} on the shale in the vicinity of the trench. A catch basin was dug in the vicinity of the seep, and the water collected was pumped back into the pit. Routine sampling of the test wells and the seep was initiated. A log was started of water levels in the trench and in the test wells in order to assist in the evaluation of the operation of the trench as an experiment. (See References 7, 8, and 10.) The experiment is continuing, and no definite conclusions have yet been reached as to the effectiveness of the treatment.

Before it can be definitely established that pits or trenches can be used for safe disposal of liquid wastes, a number of questions must be resolved. These are:

1. What types of shale may be used?
2. What are the limits of permeability of the shale which can be effective?
3. What is the minimum depth to water table required?
4. How far must the trench or pit be from precipitous slopes?
5. What chemical pretreatment of the waste is needed? (i.e., how much excess NaOH is required?)
6. Is chemical pretreatment of the trench required or permissible?
7. What control must be set up in the way of test wells, water table measurements, chemical and radiological analyses, etc.?
8. Who is responsible for:
    a. Specification of criteria?
    b. Maintenance of controls?
    c. Operation of the system?
    d. Adequacy and correctness of design?
    e. Location of site?
    f. Financing of the project?

One might well ask why Trench No. 5 works well on the same type waste which caused trouble in Trench No. 6.

Reference 2 raises some management considerations in connection with the responsibility for the waste disposal problem.

Reference 3 raises a question of formal approval of future sites by Health Physics. In view of the violence of criticism from Health Physics, it seems that no other course of action is tenable. E & M and Operations Divisions were under the impression that Trench No. 6 was located at an approved site. Due to the oversight in obtaining formal approval of the drawings, Health Physics can now disclaim any responsibility for site selection.

H. E. Seagren

H. E. Seagren

HES:GAC:ds

Ref #1

TX-2701 (1-61)

OAK RIDGE NATIONAL LABORATORY
LABORATORY DIRECTOR'S REVIEW COMMITTEES

may need this for "comments" to MEK re recent letters ?

Committee: Waste Effluents

Meeting Date: October 17, 1961 **Code Number:**

Present:

Members	Experimenters or Operators
W. H. Jordan, Chairman	J. A. Cox
W. A. Arnold	G. A. Cristy
K. B. Brown	W. DeLaguna
G. C. Cain	D. G. Jacobs
F. Kertesz	R. G. Jenness
E. Lamb	L. C. Lasher
M. L. Nelson	S. J. Rimshaw
	A. F. Rupp
	E. G. Struxness

Problems Presented by Leakage from Trench No. 6

Chairman Jordan announced that management requested the Committee to review the situation arising out of the recently noticed leakage of radioactive materials from Trench No. 6.

Cox described the present situation. The trench in question has been in use since September 10. On October 5 sampling revealed the presence of strontium in a seep below the trench. Up to this occurrence none of the earth disposal systems ever failed to retain strontium. The seep occurs about 100 yards below the trench; the liquid seeping through amounts to 0.15 gallons/minute. It is intended to prepare a synthetic soil column by adding clay and shale to the seepage area. Instructions were given immediately to stop release of radioactive waste into this trench. The chemistry of the waste system is currently being studied by S. J. Rimshaw. On the basis of previous studies it appears desirable to add caustic solution to the trenches. As long as this trench cannot be used, Pits No. 2, 3 and 4 will be used again. It is of interest to note that Trench No. 5 which has been in use for more than a year still operates satisfactorily. The reason for this failure might be due to geological or hydrological properties of the region.

DeLaguna reviewed the problem from the geological viewpoint. The recommended location of the trenches was chosen on the basis of experiences gained with the open pits. Reference is made to the "ORNL Seepage Pit Requirements" which was published in the Health Physics Annual Report for July 31, 1957 (ORNL-2384). A copy of these requirements is included in the attachments (received after the meeting).

Pits No. 2, 3 and 4 were located on a ridge with a steep slope east of Pit No. 4. Bed rock in the area of the pits and trenches lies in beds extending east and west and dipping south. Pit No. 1 was used for only a short time and its use was discontinued quite some time ago. Pit No. 2 operates quite well passing 3,200 gallons/day; it contributed only small amounts of ruthenium to the lake. Pit No. 3 passes about 1,000 gallons/day. Most of the liquid moves out in a direction parallel to the bedding of the weathered shale: the unweathered shale below a depth of about 20 to 30 feet is nearly completely impermeable. The side of Pit No. 3 has some limestone ledges which at first were suspected of forming long cracks or channels, but after the pit was filled no such channels were observed. Limestone beds in the pit area have not been responsible for rapid liquid movement but the shale was found to be much more useful for retaining activity than the limestone. If percolation from Pit No. 3 had been more rapid it would have been more successful but it was blocked partially by the location of Pit No. 2.

Pit No. 4 was built below Pit No. 2 and uncomfortably close to the steep bank to the east. While there was some concern about this location, in view of the acceptable operation of the other two pits the location was approved; however, a "patrol road" was built below it in order to monitor for possible seeps. Observation wells were built in this area both before and after the pits were in actual operation. After the pits had been in operation for some time these wells showed the presence of ruthenium and a small amount of cobalt.

Evidence was obtained later that Pits No. 2 and 3 were above the water table when built, however, after the pits were operated for a certain time the water table rose as a result of the seepage and merged with the liquid level in the pits.

Flow from Pit No. 4 was found to be as much as 20,000 gallons/day. The movement of the liquid is both to the east and to the west parallel with the bedding; very little movement of the liquid is observed across the bedding. The end walls contribute virtually nothing to the seepage. Because the waste moves out of the pits in a direction parallel with the beds it appeared logical to build a narrow pit at right angles to the beds, filling it with broken stone. Such a narrow trench filled with stone and covered with dirt would fulfill the same function as the open pits while reducing the radiation field, which on occasion has reached 5 r/hr around the open pits. On the basis of these considerations we recommended a nearby ridge which had a level top and at this site a narrow trench (Trench 5) was dug to a depth of 15 feet. This was filled with rock covered with dirt and when placed in operation performed satisfactorily. Since the trench was put in service the water table level has risen by 10 to 15 feet but it is still well below the level of the trench.

In order to study the distribution of activity around the pits auger holes were drilled 5 feet from the edge of Pit No. 2; later similar holes were drilled opposite Pit No. 4. Sampling the liquid in these holes showed only very small amounts (a few counts per minute) of cesium or strontium; however, it should be emphasized that sampling by means of auger holes does not give the data for a complete, quantitative material balance. A detailed report on this attempted sampling is in preparation.

When Pit No. 4 is completely abandoned and filled in, it is expected that the water table will drop. This will leave the strontium and cesium activity suspended in the shale immediately adjacent to the pit and above the water table. This will also be the case with Trench 5; the case of Pits 2 and 3 is uncertain.

Trench No. 5 has operated quite well for over a year taking care of about 1/2 of the intermediate-level liquid radioactive waste from the Laboratory. It was then decided to build another similar one, and a reconnaissance was made of a nearby similar ridge. On the basis of this examination two possible sites for Trench No. 6 were suggested for further study (see attached map). Experience has shown that it is unwise to attempt to estimate the depth of the water table under these ridges and test holes were recommended. One of our test wells near where Trench No. 6 was actually built showed depths to the water table of from 14 to over 20 feet, but the minimum is probably less. In view of the seasonal variations the exact depth of the water table below Trench No. 6 is not known but while it was being dug the shale was dry to a depth of 15 feet. On the basis of past experience it is quite possible that the water table will rise above the bottom of the trench in wet weather, even after the trench is abandoned. The depth to the water table at the suggested locations is greater.

Although some shallow auger holes were apparently drilled, neither the sites suggested nor the test drilling recommended were actually made use of. The first observation wells around Trench No. 6 were drilled after the trench was in service. The first observations were made about 10 days ago (October 5) and the depth of water in these wells (seven) varied from 12 to 18 feet. It was this very shallow depth to water that lead to the search for the seep below the trench, and it should be kept in mind that the highest water table will come in January or February when the weather is rainy and the effect of evaporation is negligible. Also the flow of seep will probably increase materially at this time. There is some limestone in the area of Trench No. 6 but it is unlikely that it contributes materially to the flow of waste to the seep. In checking the various holes very little activity was found in the ones north of the trench but in the three holes to the south quite considerable amounts of activity were noticed.

When the trench was built on this site it was felt that it would percolate through the shale too slowly; actually the present rate is 4,000 to 5,000 gallons/day. The evidence suggests that as the water table came up due to seepage from the trench, the flow was concentrated at a shallow depth into the draw to the south. Logging the holes with a GM probe suspended on a cable shows concentrated flow in this one direction. There is little or no flow through the shale in depth, largely because of the location and orientation of the trench.

If waste continues to pour into this trench the water table will continue to be high and the radioactive materials absorbed on the shale will be soaked and leached annually by the ground water. Geologically the trench has been improperly located; however, potentially favorable locations for trenches are still available assuming that test drilling shows a favorable depth to the water table. Construction of a new properly located trench appears to be more desirable than trying to improve a basically poorly located one. The effectiveness for long-term retention of strontium by attempted remedial action at the seep is problematical.

Although some auger holes were drilled in one of the locations suggested for study no systematic investigations of these areas has yet been made. A detailed topographic map of the area would be desirable. The presently available topographic map was made from aerial photographs but because the area is heavily wooded the topography is not accurate. It should be emphasized that even under the best conditions there is a certain amount of gamble in any trench location, but that careful site selection (including test drilling) can reduce the hazard.

In the discussion it was brought out that the actual choice of the site of Trench No. 6 was made by Engineering and Mechanical Division on the basis of cost estimates. It appears that at that time the possible geological objections were not known to them. A large amount of the $30,000 cost of the trench is due to the construction of the required new pipe line. Construction of the trenches was pushed in order to make them available as rapidly as possible for replacing the open pits. Proposed treatments to improve the present situation include sealing the top and the use of stabilizing compounds.

Lasher gave the curie amount of radioactive materials in this trench: strontium-90, 110; strontium-89, 15; total ruthenium, 52; cesium, 338; rare earths, 130. These amounts are negligible compared to those in the other trenches and pits. In order to make sure that this material will not migrate anywhere else the whole trench will be covered over.

Jacobs reviewed the problem from the chemical viewpoint. Strontium causes the chief concern; the cesium is much less important. Recent pH measurements at the seep showed that the solution pumped out had a pH of 10*. In the past few years these solutions contained an average of 0.2 molar NaOH. Accordingly, the hydroxyl concentration is considerably reduced; the soil acts as a weak acid buffering system neutralizing the basicity of the solution. The pH value of the Conasauga shale is between 4.5 and 5.2. Addition of 0.2 molar sodium hydroxide solution in the shale will have a neutralizing effect at a considerable distance from the point of introduction. While the hydroxyl concentration of lower pH solution will be lowered much nearer the point of discharge, strontium in the waste amounts to about 100 curies as compared to a total activity of 400 to 500 curies. In the past about 85% of the activity was due to cesium, 1 to 2% to strontium. It is known that whenever the pH value is low the strontium will start to move and it should be remembered that the soil in that area is loaded with calcium. There is too much calcium in the soil to make possible much pickup of the strontium and accordingly any strontium that is already moving will continue to move and will not be retained. However, if the pH is increased to a very high value and the calcium is replaced by sodium then the situation will be reversed. Thus it can be concluded that the trench did not have a good opportunity to perform as planned in view of the pH value of 9.8 at which calcium hydroxide and even more strontium hydroxide are quite soluble. The pH value of the seeps at several hundred feet distance is 4.9. Under these conditions, about 80% of the exchange sites are occupied by calcium and sorption of strontium is low.

The lowering of the pH is due to decaying plants forming humic acid. From the behavior of the cesium it can be concluded that the solution passes through the soil very rapidly resulting in poor contact. This behavior suggests channeling.

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* Titration indicated a hydroxyl concentration of 0.04 M, corresponding to pH 12.6.

TX-2703 (1-61)

Committee: Waste Effluents
Meeting Date: October 17, 1961
Subject: Problems Presented by Leakage from Trench No. 6

No complete clay mineral analysis of this site has been made yet; in the original pit area the active material consisted mostly of illite. Other shale constituents amounted to about 20%.

With respect to strontium phosphate fixation at high pH values, it should be remembered that the strontium phosphate $Sr_3(PO_4)_2$ is more insoluble than the corresponding calcium salt and so strontium will be taken up. At the lower pH values the compound $SrHPO_4$ is more soluble than the $CaHPO_4$. If strontium containing waste together with phosphate ions are passed over calcium carbonate, apatite will be formed. The calcium carbonate as such will not pick up strontium. Only after the apatite lattice is formed can strontium sorption be initiated. In the present case the phosphate reaction has not proceeded far enough to start picking up the strontium. One way to accelerate this is to add phosphate into the waste before it is released in order to start the first part of the reaction. Rimshaw added that the pits are filled with calcium carbonate. If the carbonate rocks could be coated with phosphate the resulting system would be very efficient. A similar method is used by the French in Saclay. The behavior of this salt is greatly dependent on the pH: increasing the pH value above 10, the retention of the strontium will be improved but not that of cesium.

During the discussion it was brought out that the analysis of the seep is not consistent with the inventory because all the material does not come out and it is difficult to determine the exact concentration held on the shale. The opinion was expressed that the difficulty may be due to a problem arising at the end of the trench. That area could be closed off with a cofferdam.

Cristy presented the results of the seismographic investigations. Unfortunately at present the seismographic method is not as precise as would be desirable. At the time the trench was dug large rock formations were found in the middle of the desired location. In view of the great cost of rock removal seismographic soundings were taken in order to determine the depth of the rocks before starting drilling operations. The instrument based on the determination of the rate of propogational sound waves stops counting after the first shock wave hits the sensor. The depths can be calculated from the difference of velocity of the waves which is about 1100 ft/second in air and 5000 ft/second in solid rock. The soundings gave values of 35 to 50 ft of average depths. In some cases rock was found close to the surface. No consistent readings were obtained throughout the area. The results only allow the conclusion that in certain locations there is some rock close to the surface throwing the seismographic readings off.

Jordan expressed the opinion that it is fortunate the trouble was found so soon. At present the situation does not constitute a hazard but it would if the waste disposal would be continued. He felt that the exact reason for the difficulty and solution to overcome it must be known before the trench can be used again.

Rupp pointed to the great investment represented by the trench and indicated that it would be very desirable to use them up to the limit of their capacity, perhaps to dispose 500 to 1000 gallons per day after a safe limit is established on the basis of the current investigation. Of course, more data are needed for intelligent action. No more ditches will be constructed for waste disposal. It is hoped that the recirculation system to be installed will help reduce the volume of the waste effluents and improve the situation.

The public relation aspect of the pits still in operation must be considered by the Committee; the ruthenium which is in the system must be removed. It is very advantageous that the current waste effluents contain very little ruthenium.

Recommendations:

The exact mechanism whereby the strontium and other isotopes have moved so rapidly to nearby wells and seeps is not understood, although several possibilities have been considered. The Operations Division plans to continue their investigation in hopes of salvaging some use of the trench. Meanwhile, no more radioactive liquid is being dumped into the trench.

The choice of location of Trench No. 6 appears to be unfortunate in that it is so near to ground water. It may even be that during the rainy season the level of ground water may be above the bottom of the trench, even if no liquid is pumped into the trench. Thus, even after the trench is abandoned there will be continued leaching of the radioactivity absorbed on the soil.

The amount of radioactivity that has been dumped into Trench No. 6 is relatively small (some 100 curies of strontium) and does not appear to be a serious hazard. However, if plans should develop to put some waste into this trench, the Committee would like to review such plans before they are executed. The Committee endorses Operations' plan to add caustic to Trench No. 6 and recommends that all waste be treated with caustic before being dumped into any pit. This should help tie up the radionuclides in the soil.

Submitted by W H Jordan for
Francois Kertesz, Executive Secretary
Laboratory Director's Review Committees

October 25, 1961

FK:bMcH

Attachments: 2

TX-2705 (1-61)

LABORATORY DIRECTOR'S REVIEW COMMITTEES

Committee: Waste Effluents
Meeting Date: October 17, 1961
Subject: Problems Presented by Leakage from Trench No. 6

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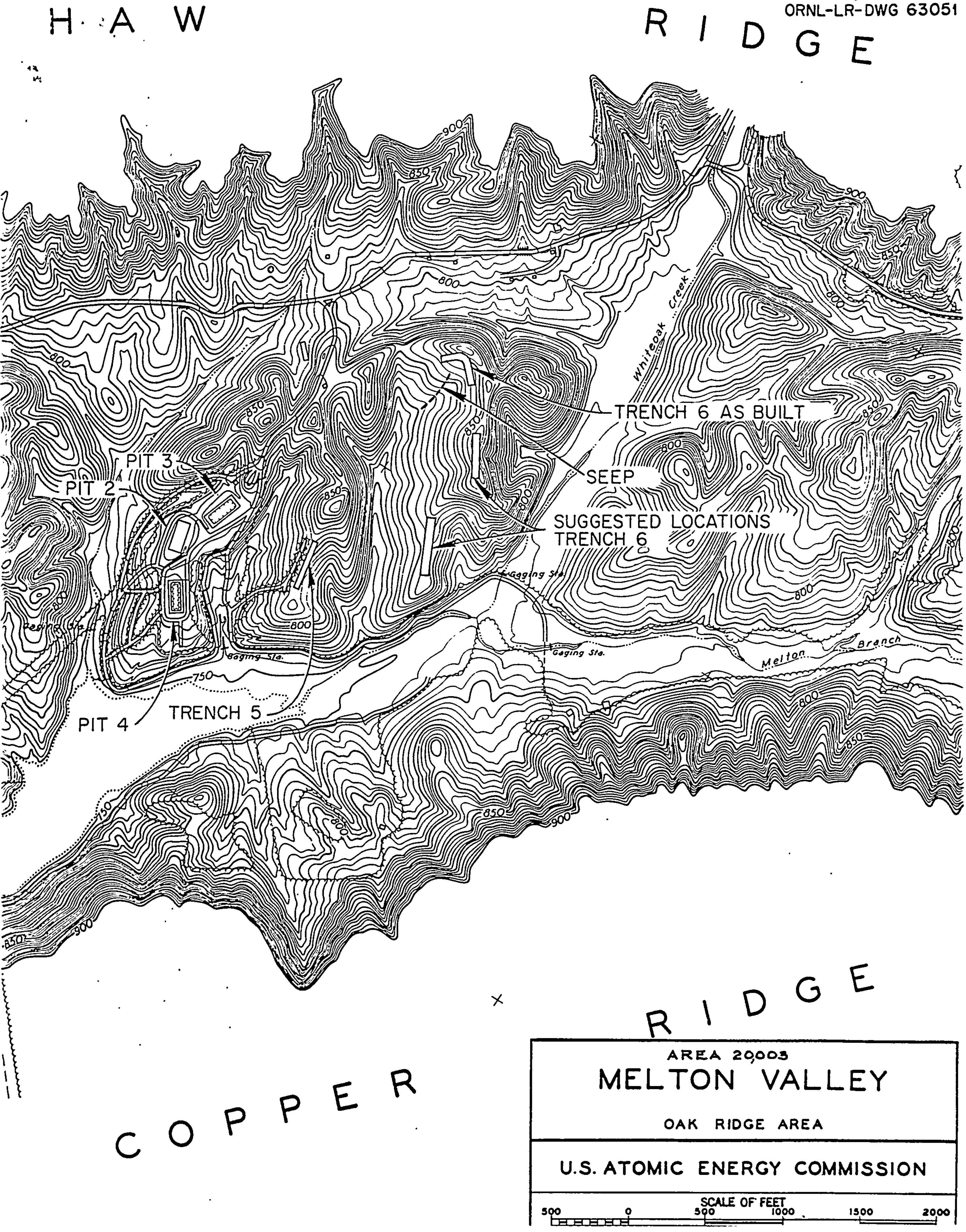

ORNL SEEPAGE PIT REQUIREMENTS

Seepage pits for the disposal of intermediate-level liquid waste have been in operation in Melton Valley for several years, and despite their many defects, will have a limited but valuable function for some time to come. Study of the present pits has suggested valid criteria for the selection of future sites.

The Conasauga shale appears to be the only local formation that should be considered for liquid waste disposal. The reasons for this have been given at length elsewhere. The present pits are in the gray calcareous shale of the Conasauga formation. Pits located in the red noncalcareous shale or in mixed limestome and shale will have somewhat different operating characteristics.

The pits should be located in areas where the normal depth to the water table is 30 or 40 ft. Where this depth is less, 15 to 20 ft, it is unlikely that the rate of seepage will be rapid enough to make the cost of the operation attractive. This depth-to-water requirement is best met on the crests of ridges running south into Melton Valley from Haw Ridge on the north. The length of the pit should extend from northwest to southeast across the strike of the shale so as to cut the maximum number of bedding planes. The slope of the sides of the ridge should not be so steep as to intercept the uplifted water table which will extend out from the pit after it is in operation. The side-hill slope of 20 ft in 100 is perhaps the limit for safe operation, and a slope of 30 ft in 100 has been known to lead to trouble; this value, however, will vary from site to site and each pit should be tested with water as it is built. Construction and operation will be easier if the top of the ridge is flat. A sloping ridge crest will require modification of the present simple pit design.

A part of the Melton Valley topographic map is shown in Fig. 41. The present operating pits are shown at I. The next ridge to the east, II, will probably be the site of the next disposal pit. The topography here is favorable, and four test wells have shown a depth to the water table of about 40 ft. Still farther east, ridge III is also topographically suitable, although the steep eastern slope may require that the pit be located 50 or 100 ft west of the ridge crest. East of White Oak Creek there are several suitable ridges, although test wells and a study of ground-water conditions would be required before any decision could be made. East of the area shown in Fig. 41 the topography is less favorable and the pits would have to be smaller and more scattered. Present understanding of the problem suggests that the best area for waste disposal pits extends about 2 miles east of the present operating pits. The results of studies to date suggest that this area should be reserved for future disposal of intermediate-level liquid waste.

Ref. 11

RECORD OF CHEMICALS & ELEMENTS IN PIT №6, H.P. OBSERVATION WELLS AND SEEP

10-9-61

	CHEMICAL OR ELEMENT	Ru	Cs	Sr^{90}	Co^{60}	RARE EARTHS	SO_4	Na	Ca	NO_3	GROSS	REMARKS
SEEP	COUNTS Min./ml.		0.8	31		33					1.7×10^3	pH 5.7
SEEP	DISINTEGRATIONS Min./ml.	2.3×10^4	4.48	548.7	2.9×10^3	330						
SEEP	mg./ml.						0.6	0.47	0.097	0.8		

10-16-61

	CHEMICAL OR ELEMENT	Ru	Cs	Sr^{90}	Co^{60}	RARE EARTHS	SO_4	Na	Ca	NO_3	GROSS	REMARKS
WELL #5	COUNTS Min./ml.		1.7	7.7		6.2					1.1×10^3	pH 8.03
WELL #5	DISINTEGRATIONS Min./ml.	2.01×10^4	9.52	135	1.72×10^3	62						
WELL #5	mg./ml.						1.28	0.5	0.515	1.08		
WELL #6	COUNTS Min./ml.		0.33	10		1					2.2×10^3	pH 7.78
WELL #6	DISINTEGRATIONS Min./ml.	2.68×10^4	1.848	175	1.8×10^3	10						
WELL #6	mg./ml.						2.55	1.23	0.7	1.03		
WELL #7	COUNTS Min./ml.		8.53	14		3.2					2.35×10^3	pH 8.03
WELL #7	DISINTEGRATIONS Min./ml.	3.7×10^4	47.768	245	6.37×10^3	32						
WELL #7	mg./ml.						0.438	0.6	0.068	0.664		
SEEP	COUNTS Min./ml.		0	41.7		—					2.62×10^3	pH 6.4 Filtered Sample
SEEP	DISINTENGRATIONS Min./ml.	2.85×10^4	0	738.09	2.8×10^3	—					730	
SEEP	mg./ml.											

Estimate of total waste elements put in trench:
Sr - 130 Curies (Sr^{90} - 110 Curies)
Ru - 39 " (Ru^{103} - 13 ")
Cs^{137} 338 "
Co^{60} 21 "
Rare Earths 130 Curies

P'

RECORD OF RADIOACTIVITY IN H.P. OBSERVATION WELLS & SEEP AT PIT Nº 6

DATE	LOCATION	Sr DISINTEGRATIONS Min./ml.	Cs DISINTEGRATIONS Min./ml.	GROSS β COUNTS Min./ml.	REMARKS
10-26-61	WELL #5	106	43.07	3.81×10^3	pH 7.0
	WELL #6	55	0	3.59×10^3	pH 7.0
	WELL #7	120	18.04	1.81×10^3	pH 7.0
	SEEP	711	1.12	1.89×10^3	pH 6.0
10-27-61	SEEP	826	0.78	2.06×10^3	pH 6.0

P2

RECORD OF CHEMICALS & ELEMENTS IN H.P. OBSERVATION WELLS AND SEEP

Date / Location	Ru^{106} Disintegrations Min./ml.	Cs^{137} Disintegrations Min./ml.	Sr^{90} Disintegrations Min./ml.	Co^{60} Disintegrations Min./ml.	Rare Earths Disintegrations Min./ml.	SO_4 mg./ml.	Na mg./ml.	Ca mg./ml.	NO_3 mg./ml.	pH
11-3-61										
WELL 5	2.4×10^4	19.94	6.08×10^3	1.19×10^3	180	0.855	0.529	0.695	1.41	7.43
WELL 6	6.48×10^4	2.29	105	2.23×10^2	60	4.66	2.96	0.049	2.19	7.24
WELL 7	1.29×10^4	12.74	48	1.64×10^3	30	0.123	0.311	0.316	0.242	7.57
SEEP	1.82×10^4	11.17	4.4×10^3	1.19×10^3	100	0.682	0.574	0.155	1.36	5.91
11-10-61										
WELL 5	—	21.62	4.97×10^2	—	—	0.46	0.516	0.238	1.18	7.72
WELL 6	—	5.87	88	—	—	2.5	0.215	0.640	1.62	6.64
WELL 7	—	2.60	58	—	—	0.079	0.228	0.033	0.137	7.73
SEEP	—	2.51	287	—	—	0.46	0.526	0.195	1.13	7.03
11-20-61										
WELL 5	—	23.8	479	—	—		0.353	0.083		
WELL 6	—	1.11		—	—		0.06	0.02		
WELL 7	—	66.3		—	—		0.2	0.021		
SEEP	—	< 1.0	196.2	—	—		0.353	0.085		