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ATTACHMENT 5

DEWATERING REPORT

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UMTRA PROJECT

DURANGO DISPOSAL SITE --BODO CANYON

RESULTS AND IMPACTS OF DEWATERING INVESTIGATIONS IN OCTOBER 1989

4005-DUR-R-01-03868-00

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1. INTRODUCTION:

This report provides an update on dewatering activities at the Durango disposal embankment and presents recommendations for the work required to complete the closure of the cell in 1990 (Section 2). In October 1989, test pit investigations were performed and a toe trench was excavated at the eastern slope of the disposal embankment (Figure 1.1). A description and results of the test pit investigations along with the implications of the results relative to the overall dewatering effort are discussed in Sections 3 through 5. Installation and performance of the 17-well dewatering system were previously described in the "Status Report on Dewatering of Disposal Embankment" issued in September, 1989.

Additional studies are still on-going and are described in Section 6. Laboratory analysis continues on samples taken from the test pits. TAC's characterization of the hydrogeological conditions at the Durango site is also proceeding. Results of these studies will be presented in subsequent reports.

Appendices A and B present construction details of the well point system, toe trench and holding pond. Appendix C summarizes the performance of the 17 pumping wells prior to winter shutdown and provides information on pumping rates, drawdowns, and disposition of the wells. Appendix D outlines the chronology of the dewatering effort to date.

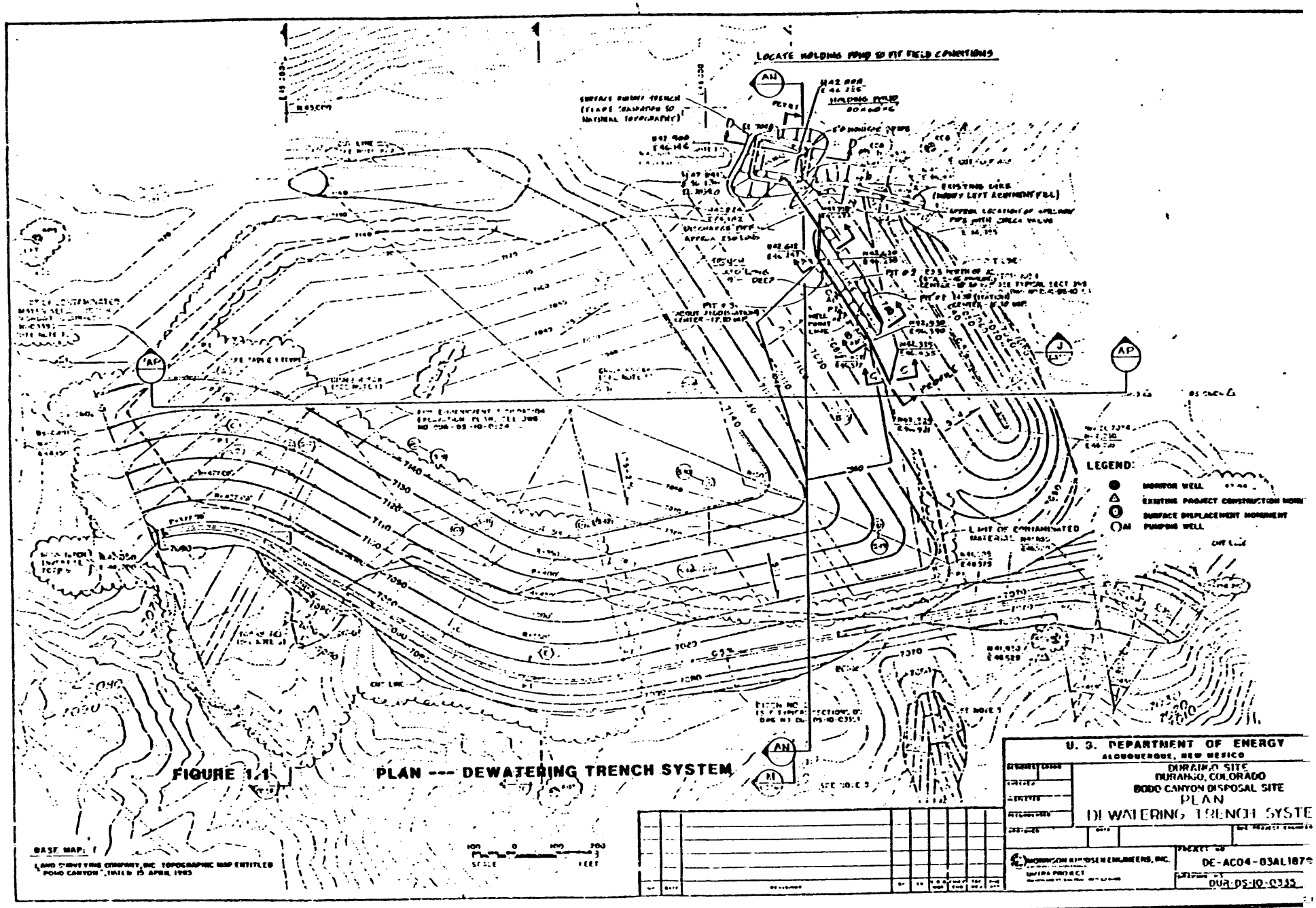


FIGURE 1.1 PLAN --- DEWATERING TRENCH SYSTEM

2. SUMMARY AND RECOMMENDATIONS

In the preliminary analysis for the dewatering of the Durango embankment, it was assumed that the tailings were completely saturated below the indicated phreatic surface (IPS) as observed in monitor wells and piezometers. This hypothesis was questioned after observation of samples and laboratory tests indicated that there might be extensive unsaturated zones below the IPS. The presence of the unsaturated zones, however, was not substantiated at that time and tests were proposed to corroborate their presence. A possible explanation for these unsaturated zones was proposed in the status report of September 1989. At that time it was suggested that differences in horizontal and vertical permeability or entrapment of air could explain the unsaturated zones below the IPS. Since then three test pits were excavated at the toe of the embankment and a more probable mechanism discovered; a perched water table in the tailings. The water appears to be perched above the 1987 winter cover material.

Based on current estimates, the total volume of drainable water initially in the cell was approximately 2 million gallons. Pumping has removed 730,000 gallons and approximately 1.3 million gallons of drainable water remain in the embankment.

The environmental impact of the water in the cell is considerably less than orginally estimated and is currently being evaluated by the TAC to see if groundwater compliance can be met without additional action. Future actions will be based on results from this report, TAC's analyses, recoveries in the pumping wells over the winter, and evaluation of the effectiveness of the toe drain for removing water from the embankment.

It is recommended that the following course of action be instituted based on the data currently available:

- The 17 pumping wells and the 12 remaining well points will be turned on as early as practicable in the spring of 1990 and operated for 3 to 4 weeks. This period will be limited so as not to seriously interfere with construction of the embankment cover. Any water pumped during this time can be treated by the mobile treatment plant.

- After the short pumping period, all wells and well points will be grouted and sealed to facilitate closure of the embankment.

- Monitor well MW 1 and piezometer P7 will be extended through the embankment cover for observation of the water levels after

closure of the cell.

- Cables from the monitor probes in MW 2, 3, and 7 will be extended to a readout location north of the embankment.

- Toe trench will continue operation (possibly for several years) until a decision is made to close the drain. The toe trench can then be grouted or the valve turned off if future use or monitoring of the toe trench is envisioned.

- The holding pond will operate as an evaporation pond unless unexpected large volumes of water accumulate. Excess water may include surface runoff or unexpectedly high flows from the toe trench. A diversion ditch at the base of the backslope cut should be considered to limit surface runoff into the pond. The calculated discharge from the toe trench (Section 5.5) is preliminary and will require verification by on-going field observations. Excess inflow into the pond can either be treated or the valve on the discharge pipe regulated to limit flow until sufficient capacity is available.

- Bi-weekly water level measurements will be recorded from December through March in MW 2, 3 and 7, and all wells/piezometers that are accessible. The water level in the holding pond will also be monitored bi-weekly or at more frequent intervals if water levels begin to approach pond capacity. At the October 5 meeting in Durango, it was agreed that the TAC would take the well readings once a month and MK-F would take the remainder of the readings.

Based on the low pumping rates of water from the wells at winter shutdown and the expected further reduction in these rates with time, long term operation of the pumping wells does not appear to be an effective or efficient method to remove the remaining water from the embankment. Therefore, the 17 dewatering wells should be removed or sealed to facilitate closure of the embankment.

Other considerations may be presented which would neccesitate modification of the above recommendations. The work still in progress needs to be evaluated as quickly as possible so that final decisions can be made expeditiously by all interested parties.

3. TEST PITS AND TOE TRENCH

In October of 1989, the Durango dewatering system was modified to incorporate a toe trench at the base of the eastern slope of the disposal embankment (Figure 1.1). The purpose of the toe trench is: 1) to keep the tailings in the seep area dry through the winter which will allow an expeditious placement of the radon barrier in the spring of 1990 and 2) to prevent water pressure from building up under the radon barrier when the present dewatering effort is terminated. A temporary well point system was installed to facilitate the construction of the toe trench and a lined holding pond was built to the north of the tailings embankment to collect the effluent from the toe drain. Appendices A and B present construction details of the well point system, toe trench and holding pond.

On October 25 and 26, 1989, three test pits were excavated on the eastern slope of the Durango disposal embankment. The test pits were located downgradient of the well point system in the area through which the toe trench was later installed. A location map of the test pits is shown on Figure 3.1. The well point system had been in operation approximately one week when a backhoe excavated Test Pit 1 (Plate 1) through the tailings to the low permeability liner. Between elevations 7048' and 7049' a 6" layer of dark soil was encountered (Plate 2). This layer is the vicinity property (v.p.) material placed as a winter cover in 1987. The sandy tailings above the layer began to slough and seep water while the tailings material beneath the layer remained dry (without seeping water). The well point system just west of the test pit indicated an IPS at elevation 7051' although the soil in the test pit below elevation 7048' was apparently not saturated. This evidence of a perched condition was documented on video tape.

During test pit excavation, samples of tailings, the low permeability liner, and the natural material beneath the liner were retrieved. A 48" corrugated culvert was installed vertically into the test pit to protect the sampling personnel from potential cave-in. Six tailings samples were taken one foot above the low permeability liner. These samples will be tested by the TAC for various soil parameters including density and water content. The low permeability liner was sampled with a split spoon sampler containing brass sleeves (California sampler). Two samples of the liner and an additional 2 samples of the material directly beneath the liner (Plate 3) will be geochemically tested as well as analyzed for density and water content. After sampling, the holes in the liner were backfilled with bentonite powder and the test pit was backfilled with tailings which were compacted with the backhoe bucket.

After discovery of the v.p. layer in Test Pit 1, it was decided to excavate additional test pits further north along the well point line. Test Pit 2 did not intercept the v.p. layer but the pit

appeared relatively dry the entire depth to the liner. There were two small seeps, however, on the south wall of the test pit. Test Pit 2 remained open overnight for sampling the next day, at which time some water had accumulated in the bottom of the test pit. The wet material was removed and sampling of the liner continued. As in the first test pit, the section of liner sampled was filled with powdered bentonite to assure that the low permeability of the liner was maintained.

Test Pit 3 was excavated approximately 50 feet north of Test Pit 2. The v.p. layer was not encountered in this test pit and the pit remained dry during excavation and sampling. In order to evaluate changes in moisture content with depth, a sample of tailings was taken at three different elevations: 7052 feet, 7048 feet, and 7045 feet. Two samples of the liner were also taken. Test Pit 3 was backfilled in a manner similar to the previous pits.

Results of the laboratory tests on the test pit samples are not yet available (see Section 6 - Work In Progress) but will be addressed in a subsequent report.

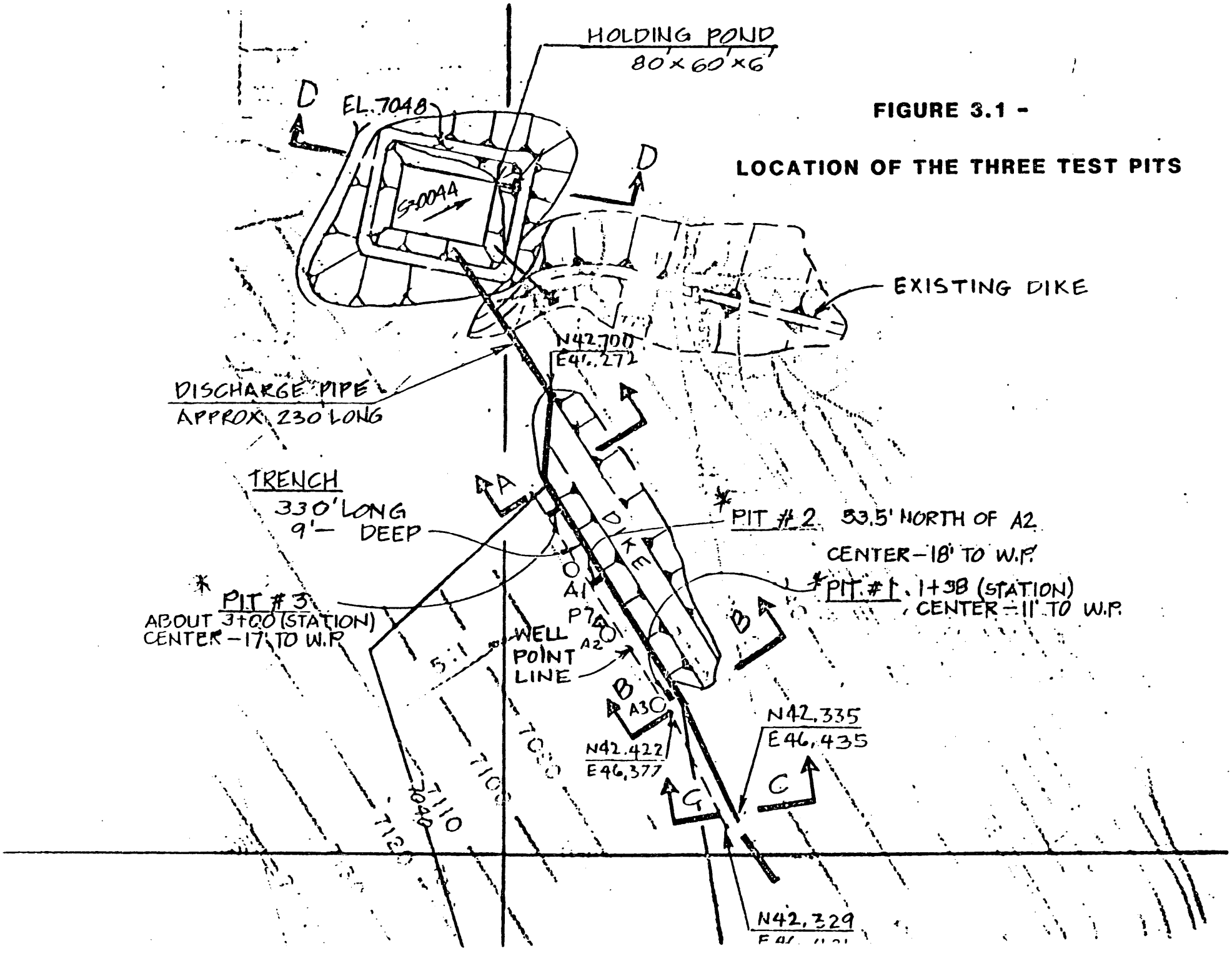
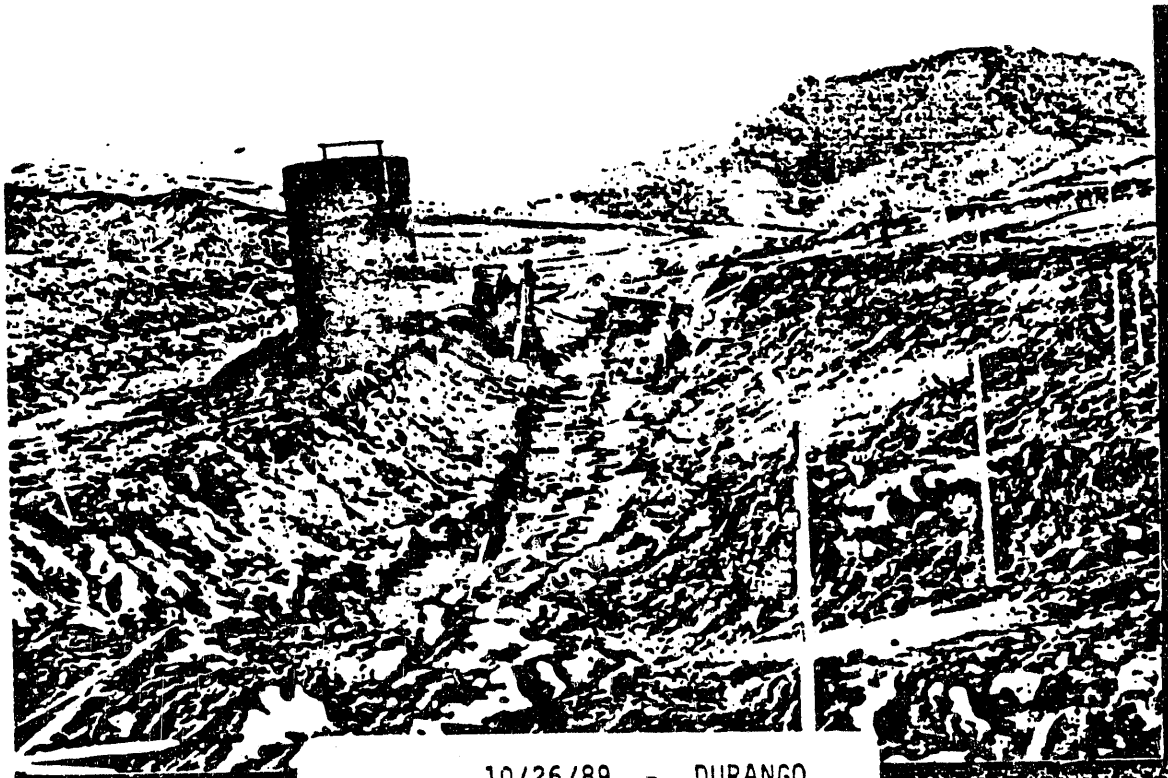


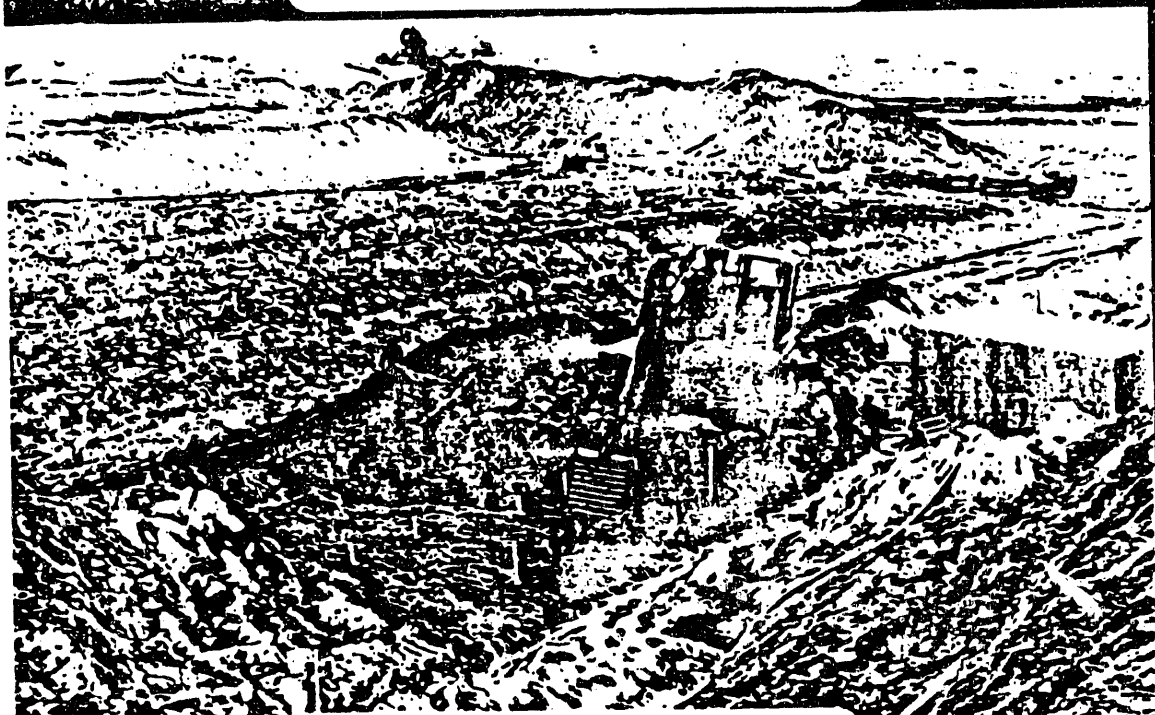
FIGURE 3.1 -

LOCATION OF THE THREE TEST PITS



10/26/89 - DURANGO

EXCAVATION OF TEST PIT #1 NEAR WELL PTS.



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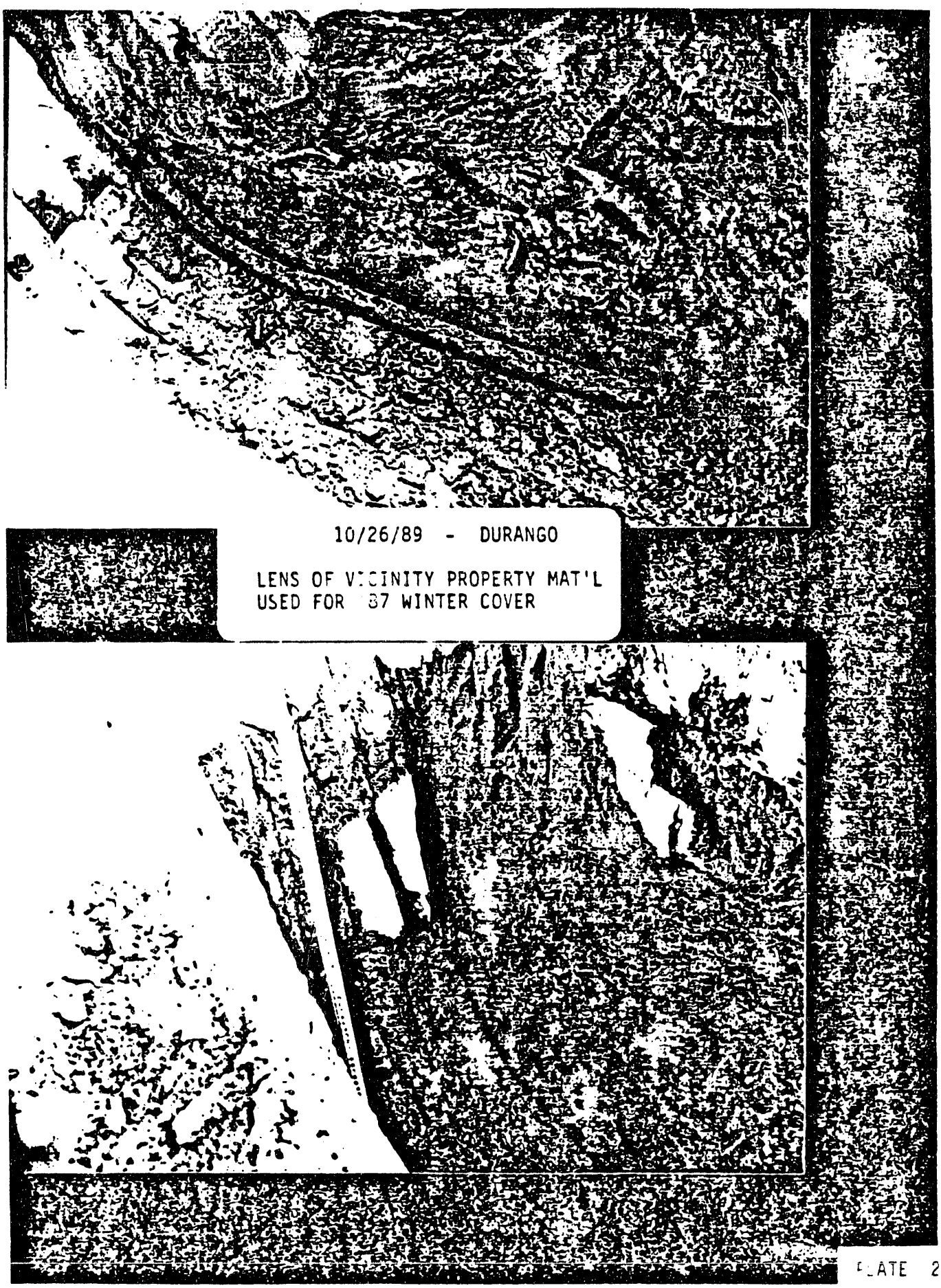
STAKED BOUNDARY FOR TEST PIT #1

PLATE 1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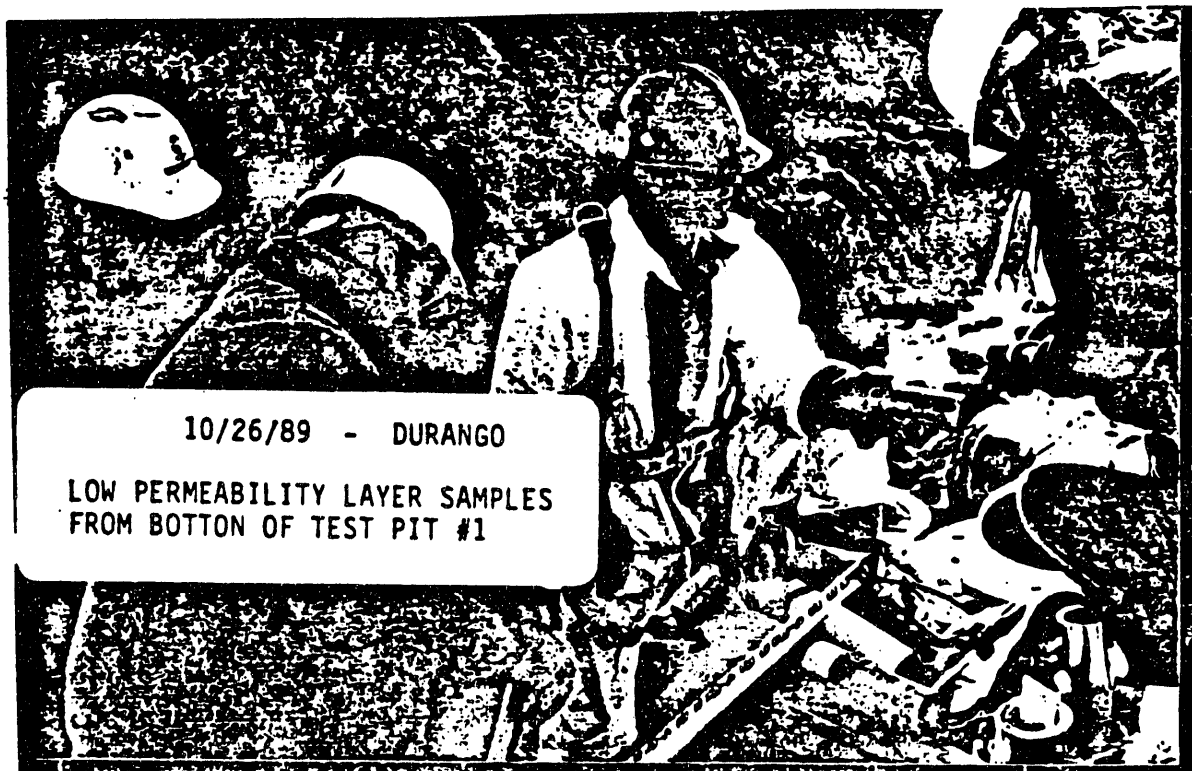
LENS OF VICINITY PROPERTY MAT'L
USED FOR 87 WINTER COVER

PLATE 2



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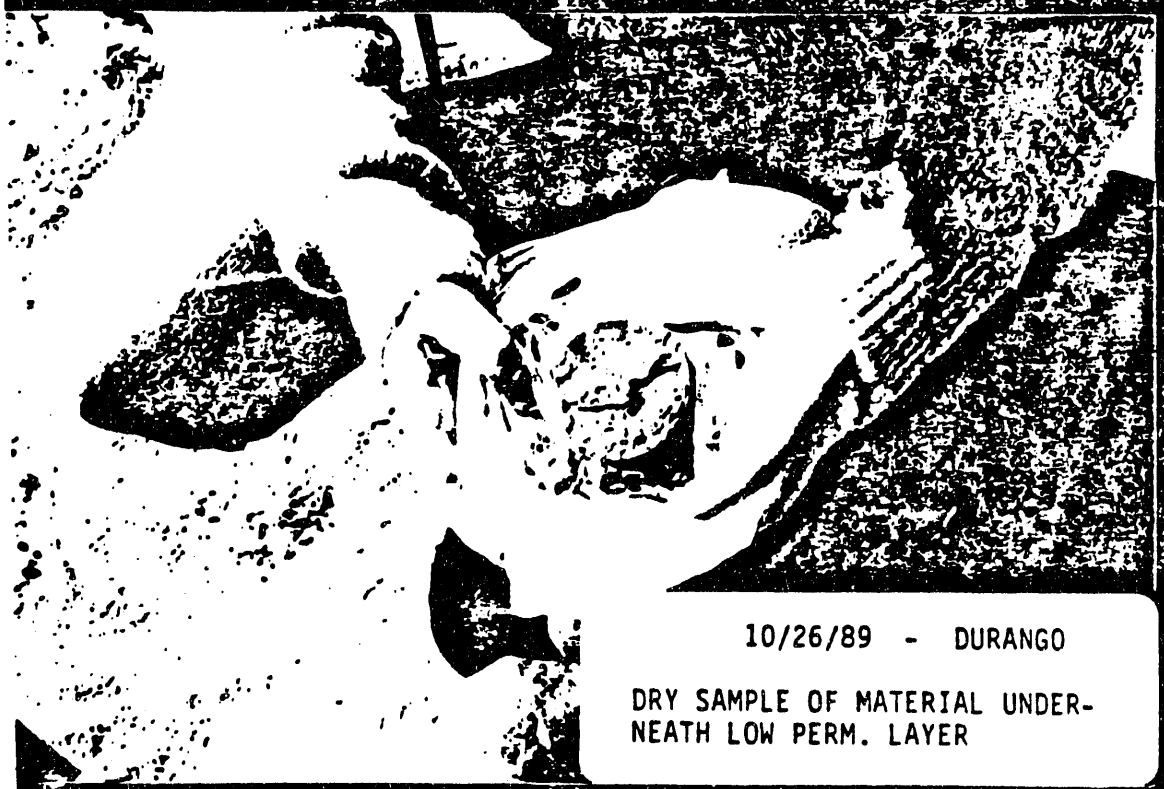
LOW PERMEABILITY LAYER SAMPLES FROM BOTTON OF TEST PIT #1



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DRY SAMPLE OF MATERIAL UNDER-NEATH LOW PERM. LAYER

4. WINTER COVER '87

At the end of the construction season in 1987, approximately 6 inches of vicinity property (v.p.) material were placed on top of the tailings embankment to limit erosion during winter shutdown. The material consists primarily of clayey topsoil and vegetation. A sample of the v.p. material retrieved during the toe trench excavation is currently undergoing laboratory testing (Section 6). The areal extent of the 1987 winter cover was documented in the photograph shown in Plate 4 and is illustrated in plan view on Figure 4.1. From this photo and quality assurance (Q.A.) data collected during placement of contaminated material in October and November of 1987, the surface elevation contours of the v.p. winter cover were estimated (Figure 4.2). The Q.A. data consisted of elevations and coordinates of samples tested for density and moisture requirements. Figure 4.3 shows the elevations of the points used to contour the pile surface as it existed prior to the winter of 1987.

In the winter of 1987, the embankment surface dipped to the northeast from a maximum elevation of 7070 feet to an elevation of 7045 feet near the middle of the embankment dike. The northeastern corner of the embankment was not covered with the vicinity property material. This corner also acted as a sump where water accumulated from snowmelt. During the following construction season, the ponded water was removed and the saturated contaminated material was excavated, spread in a thin lift on top of the dry material adjacent to the sump region, and allowed to dry prior to compaction.

During installation of the toe trench, the v.p. material layer was mapped as the trench excavation proceeded from north to south. The layer first appeared at elevation 7046 feet adjacent to well A-2 and was evident for the rest of the trench excavation to the south. Figure 4.4 shows the elevations of the v.p. material mapped during the toe trench excavation.

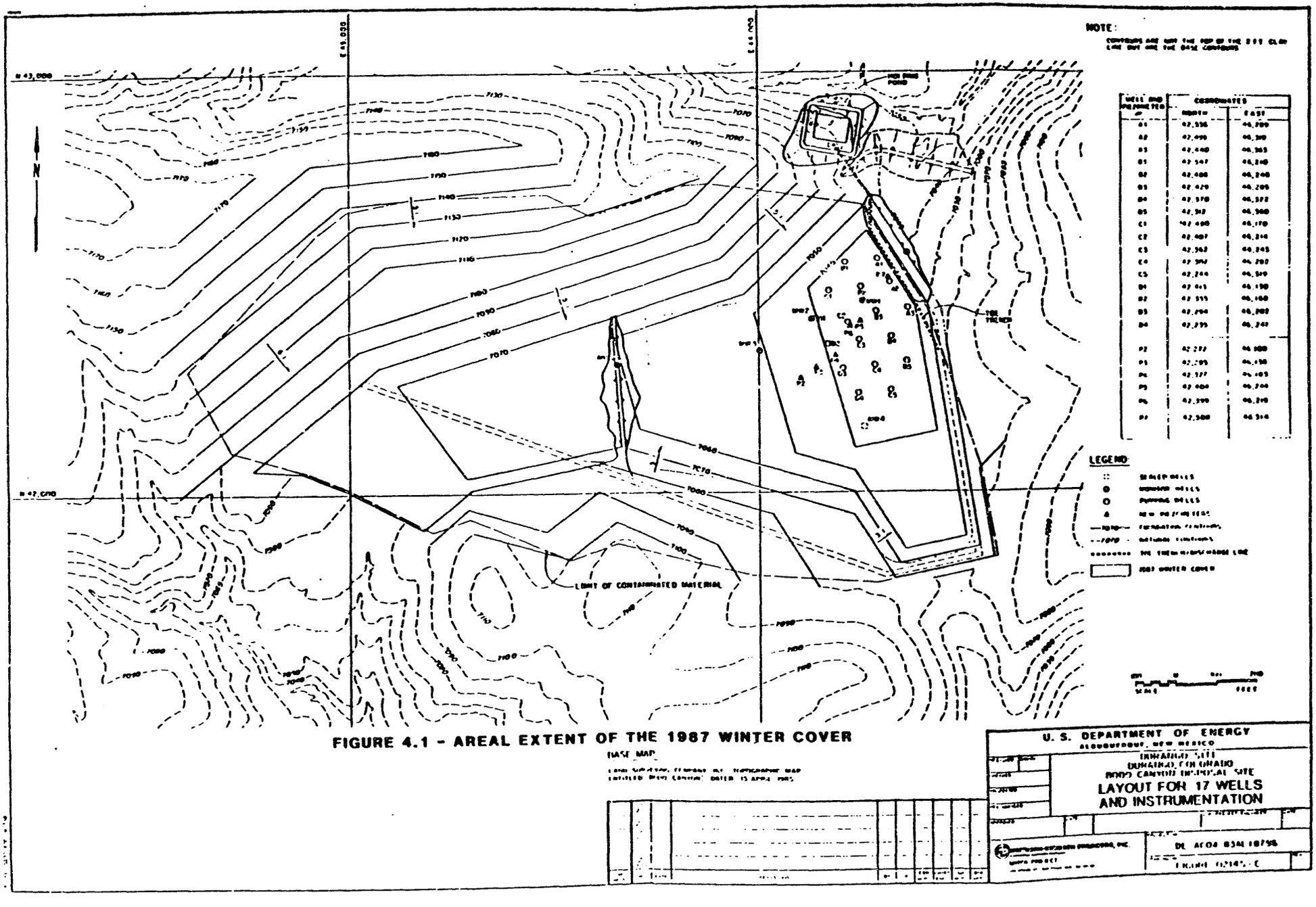


FIGURE 4.1 - AREAL EXTENT OF THE 1987 WINTER COVER

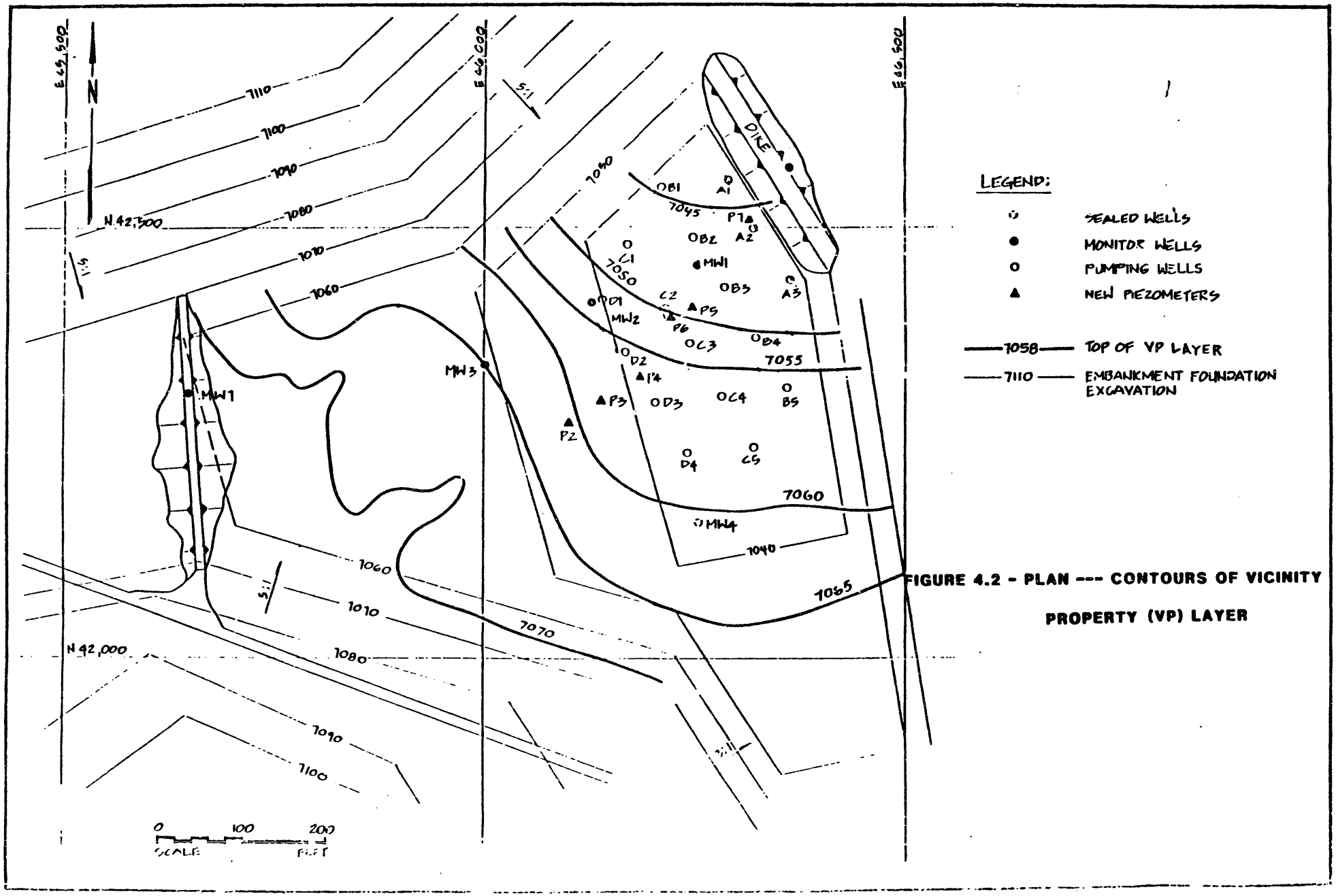
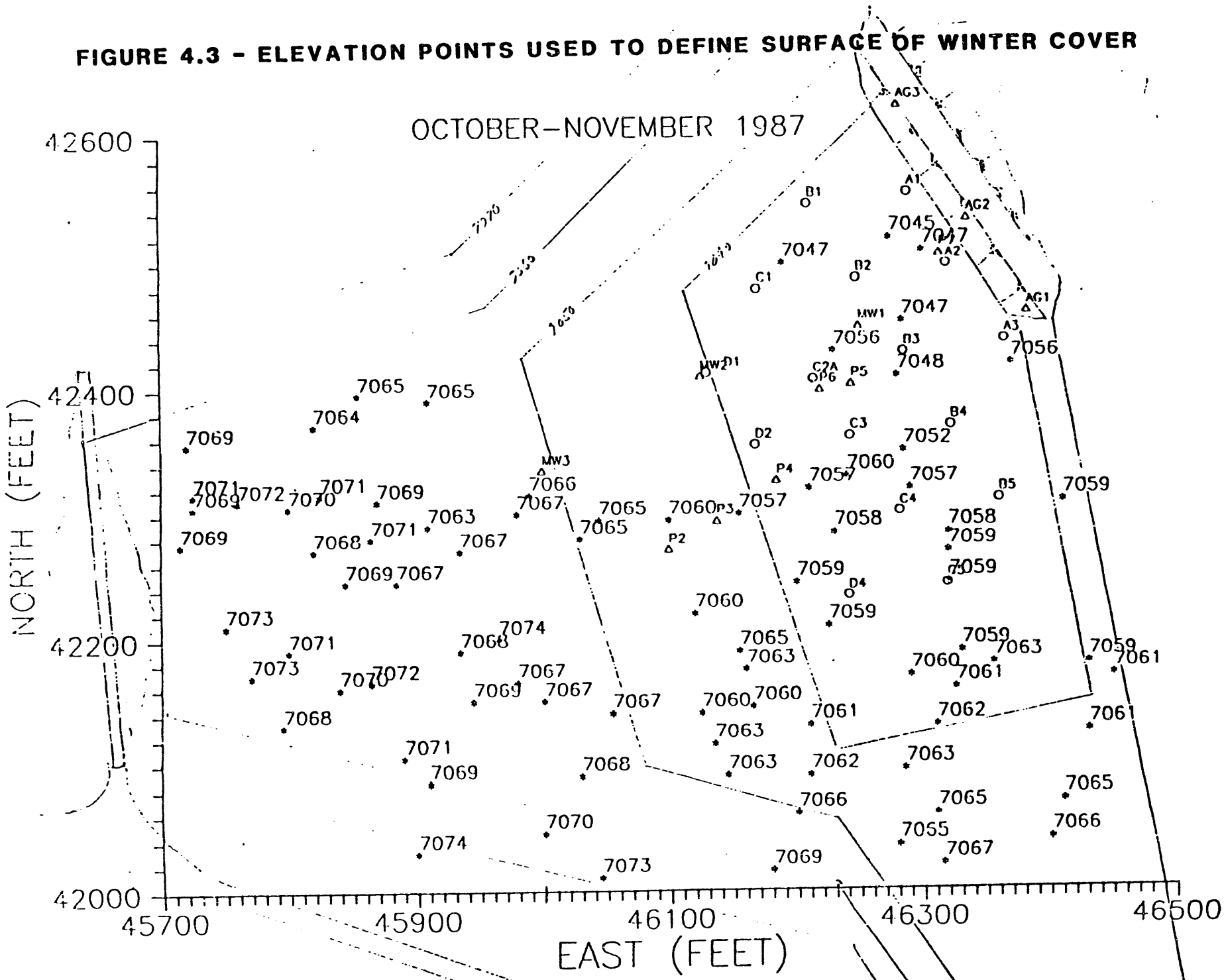


FIGURE 4.2 - PLAN --- CONTOURS OF VICINITY PROPERTY (VP) LAYER

FIGURE 4.3 - ELEVATION POINTS USED TO DEFINE SURFACE OF WINTER COVER



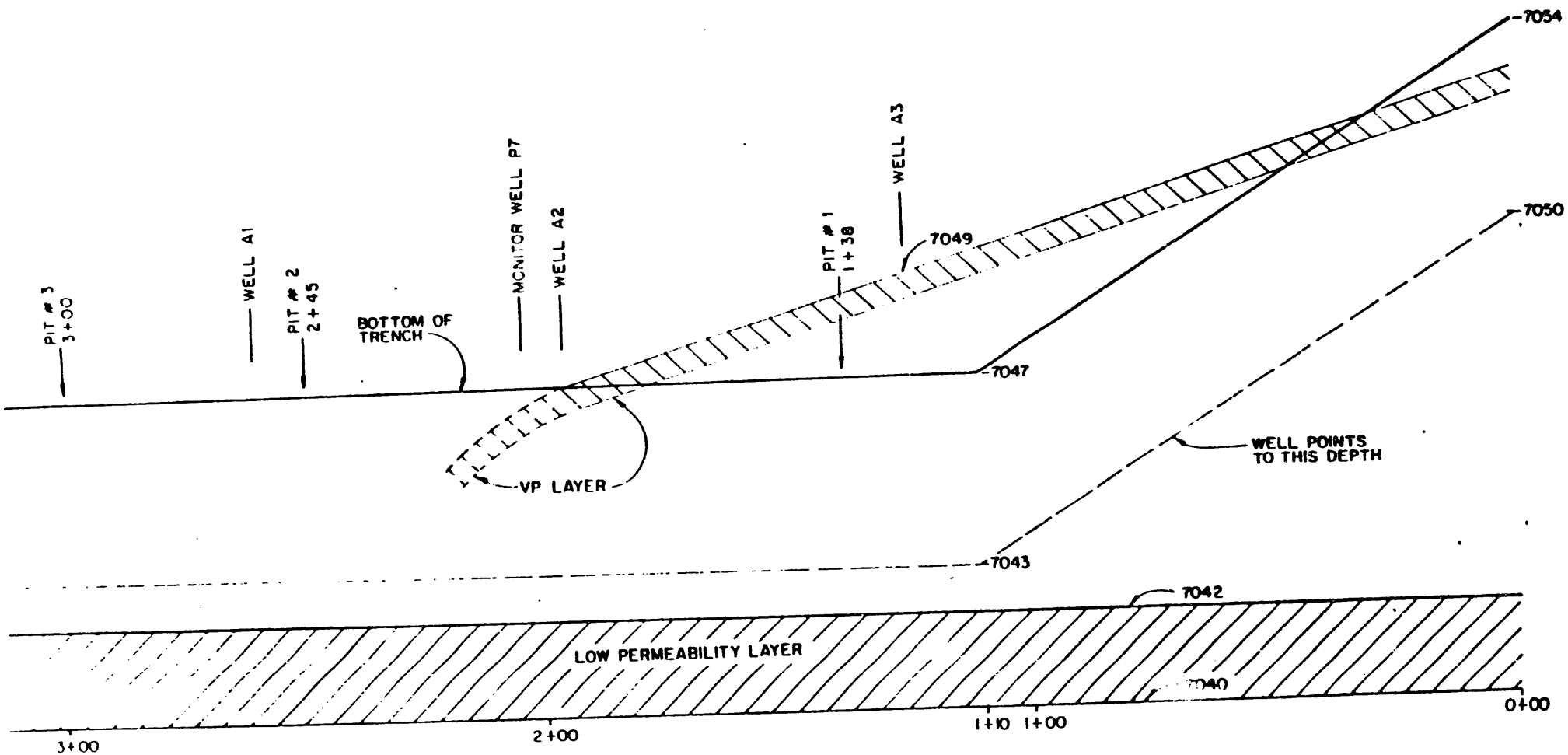


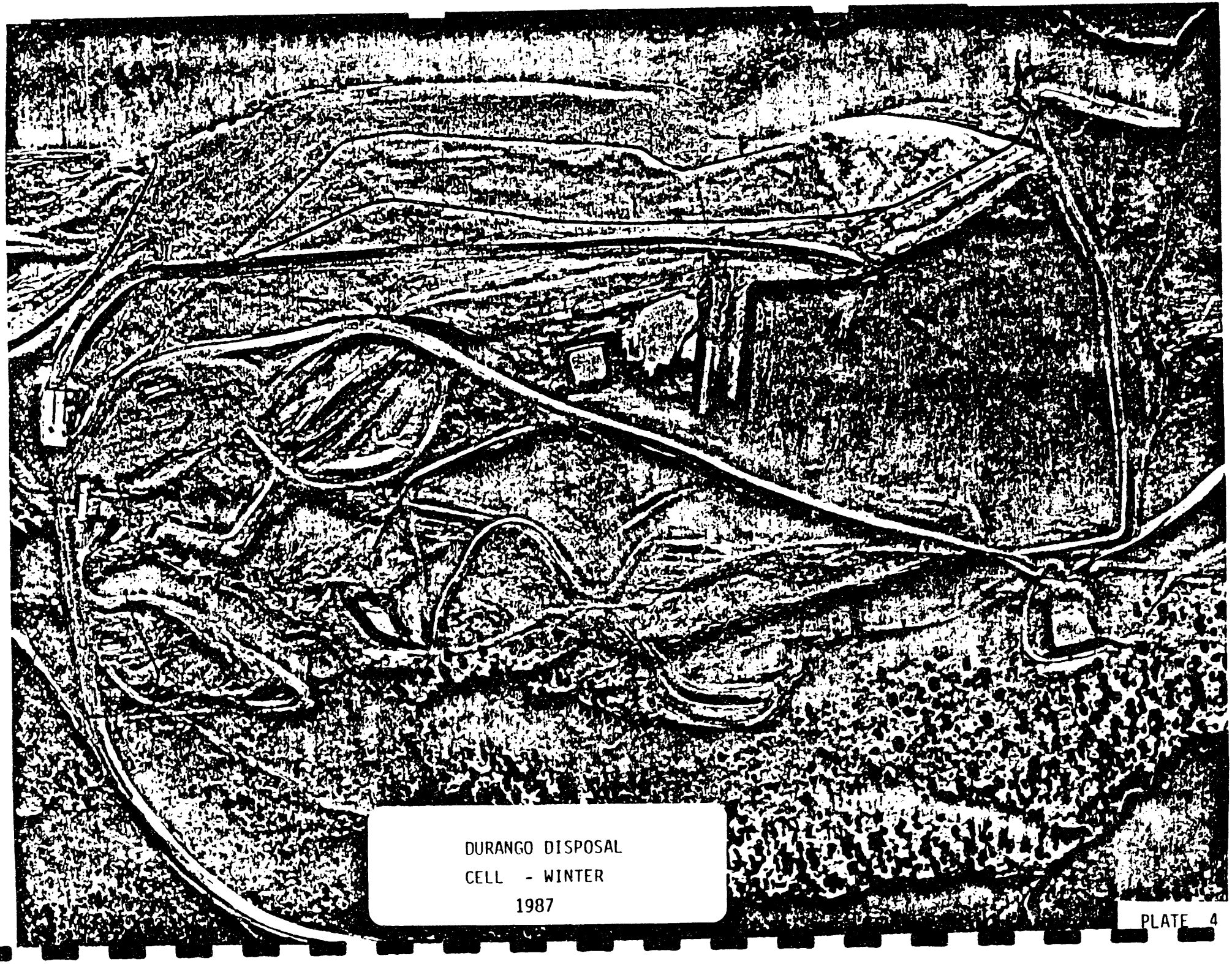
FIGURE 4.4

DEWATERING TRENCH PROFILE

SHOWING VICINITY PROPL. LAYER

20 0 20 40 HORIZONTAL SCALE FEET

2 0 2 4 VERTICAL SCALE FEET



DURANGO DISPOSAL
CELL - WINTER
1987

PLATE 4

5. CONCLUSIONS

The possibility that the tailings might not be completely saturated below the IPS and the evidence which led to that hypothesis were discussed in the September 1989 status report. At that time, a tentative mechanism was postulated for the presence of variations in saturation below the IPS; a greater horizontal than vertical permeability of the tailings and air entrapment in the tailings. A more probable explanation of the mechanism was discovered during excavation of the test pits. Direct observation of the tailings in the test pits indicated that water was perched above the v.p. material and that there were extensive areas below the v.p. layer which were not saturated. During excavation of Test Pit 1, a water surface elevation (IPS) at 7051 feet was measured in the well points adjacent to the test pit. Direct observations in the test pit, however, indicated that the tailings below elevation 7048 feet were well below saturation.

Supporting evidence for the perched water hypothesis is also given by the graph of average flow rate for each of the 17 pumping wells versus thickness between the IPS and the 1987 winter cover at each well location (Figure 5.1). There appears to be good correlation between these two parameters. This indicates that saturated thickness probably corresponds to the thickness between the IPS and the v.p. layer since flow rate from a pumping well is proportional to saturated thickness. This helps explain the great variability in flow rates in the pumping wells. The highest flow rates were obtained in the northern wells where the saturated thickness was maximum and the lowest flow rates in the southern wells where the saturated thickness was minimum. The 1987 winter cover sloped in the direction of Well A-1 which had the highest sustained flow rate of all of the 17 wells. Figure 5.2 presents the final flow rate versus the saturated thickness for all wells.

The recently discovered perched water condition significantly changes previous calculations of saturated thickness, volume of water present in the embankment, and environmental impact due to water in the tailings. Previous calculations assumed saturated conditions between the IPS and low permeability liner. The following are revised calculations based on the saturated thickness extending only from the IPS to the v.p. layer. Cross sections of the embankment showing the original IPS prior to pumping, the IPS after shutdown of all pumping wells in November 1989, and the v.p. layer are shown on Figures 5.4 through 5.7.

5.1 Saturated Thickness and Volume of Water

Previous estimates assumed that the tailings were saturated

from the top of the low permeability liner to the IPS and that the specific yield of the tailings was 20%. Calculations based on these assumptions indicated that there were 15 million gallons of drainable water in the embankment.

Figure 5.8 shows contours of both the initial IPS and the top of the v.p. layer. Assuming that the 1987 winter cover defines the bottom of the saturated layer within the embankment, a contour map of saturated thickness was derived (Figure 5.9) and a revised estimate of the total drainable volume of water was computed. Calculations now indicate approximately 2 million gallons of drainable water may have been perched above the 1987 winter cover material. This calculation is based on a specific yield of 12% (see section 5.2).

By November 2, 1989, the 17 well dewatering system had pumped approximately 630,000 gallons of water and the well points had removed 100,000 gallons of water from the cell. Total water removed is approximately 40% of the estimated 2 million gallons of drainable water present in the embankment prior to pumping.

5.2 Transmissivity, Specific Yield and Permeability

Values of specific yield and transmissivity for the tailings were presented in Appendix C to the September 1989 status report on dewatering of disposal embankment". Based on long term drawdown, average values of transmissivity ranged from 31 to 45 gpd/ft. Specific yield was estimated to be 0.12. These values should not change because of the change in saturated thickness. However, the value of the permeability would increase slightly due to the decrease in saturated thickness.

5.3 Environmental Impact

Results of recent investigations have provided a better understanding of the conditions at the Durango cell. The v.p. layer appears to form an "impermeable" zone within the tailings. As described in Section 5.1, the estimated amount of drainable water, which is believed to be perched above the v.p. layer, is considerably less than originally estimated. Lateral flow to the toe trench is also expected to be greater than originally estimated due to the approximate 5% slope of the v.p. layer.

The potential environmental impact due to the water in the tailings is now believed to be significantly less than originally estimated. The reduction in impact is due to the amount of water in the embankment being significantly less than originally estimated, the 1987 winter cover (v.p. layer) acting as a barrier to the vertical migration of water to the bottom of the cell, and a significant thickness of low permeability clay being present beneath the cell. These conditions are being modelled by the TAC to evaluate the environmental impact and determine if ground water compliance can

be achieved.

5.4 Flow to the Toe Trench

Figure 4.4 shows the relationship between the 1987 winter cover material and the toe trench. Water flowing down gradient above the v.p. layer should be drained by the trench. Based on an average saturated thickness of 10 feet above the 1987 winter cover, the following flows from the toe trench were calculated. These values are estimates only and should be verified by field observation.

Day	Estimated Flow from Toe Trench
1	2910 gpd
10	938 gpd
30	539 gpd
60	378 gpd
90	306 gpd

Flow from the toe trench was measured at approximately 1440 gpd on Nov. 13, 1989, four days after the well point system was discontinued. To monitor the performance of the toe trench and predict long term flow rates more accurately, flows will be measured periodically through 1990.

5.5 Evaporation from the Holding Pond

Preliminary calculations were made of the holding pond's ability to perform as an evaporation pond. The initial calculation was based on estimated flows from the toe trench (Section 5.4), an evaporation rate of 42 inches/year, an average annual precipitation at the site of 19 inches, and the assumption that all runoff from the backslope to the north and west enters the pond. Results indicate that the pond would reach 59% of capacity in October 1990. Assuming the pond is emptied and the water treated in the portable plant in April 1990, the pond would reach 50% capacity by April 1991. Eventually, the pond would fill since inflow exceeds evaporation.

Another evaluation was made assuming a ditch is installed to divert runoff from the backslope away from the pond. Toe trench flows, precipitation and evaporation rate were assumed to be the same as above. If the flow from the toe trench reaches a steady state of 100 gpd after 1 year, the pond would reach a steady state water depth of 2.1 feet (pond capacity of approximately 24%). If, however, flow from the drainage trench should continue at its current rate of approximately one gallon per minute rather than decreasing as projected, the pond's capacity would eventually be

exceeded and it could not act solely as an evaporation pond.

FIGURE 5.1 - ORIGINAL SATURATED THICKNESS ABOVE VP LAYER VS AVERAGE FLOW

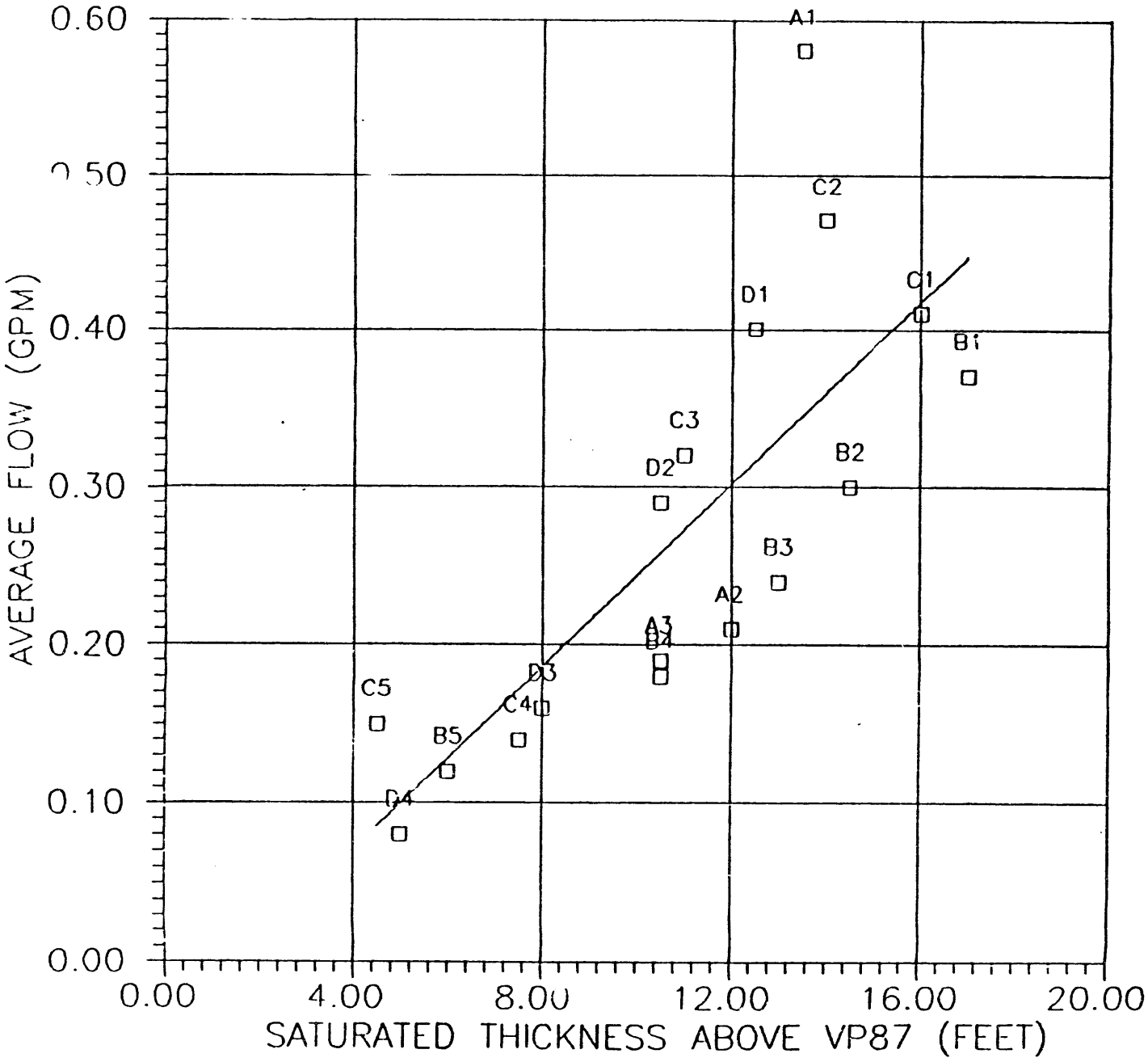


FIGURE 5.2 - ORIGINAL SATURATED THICKNESS ABOVE VP LAYER VS FINAL FLOW

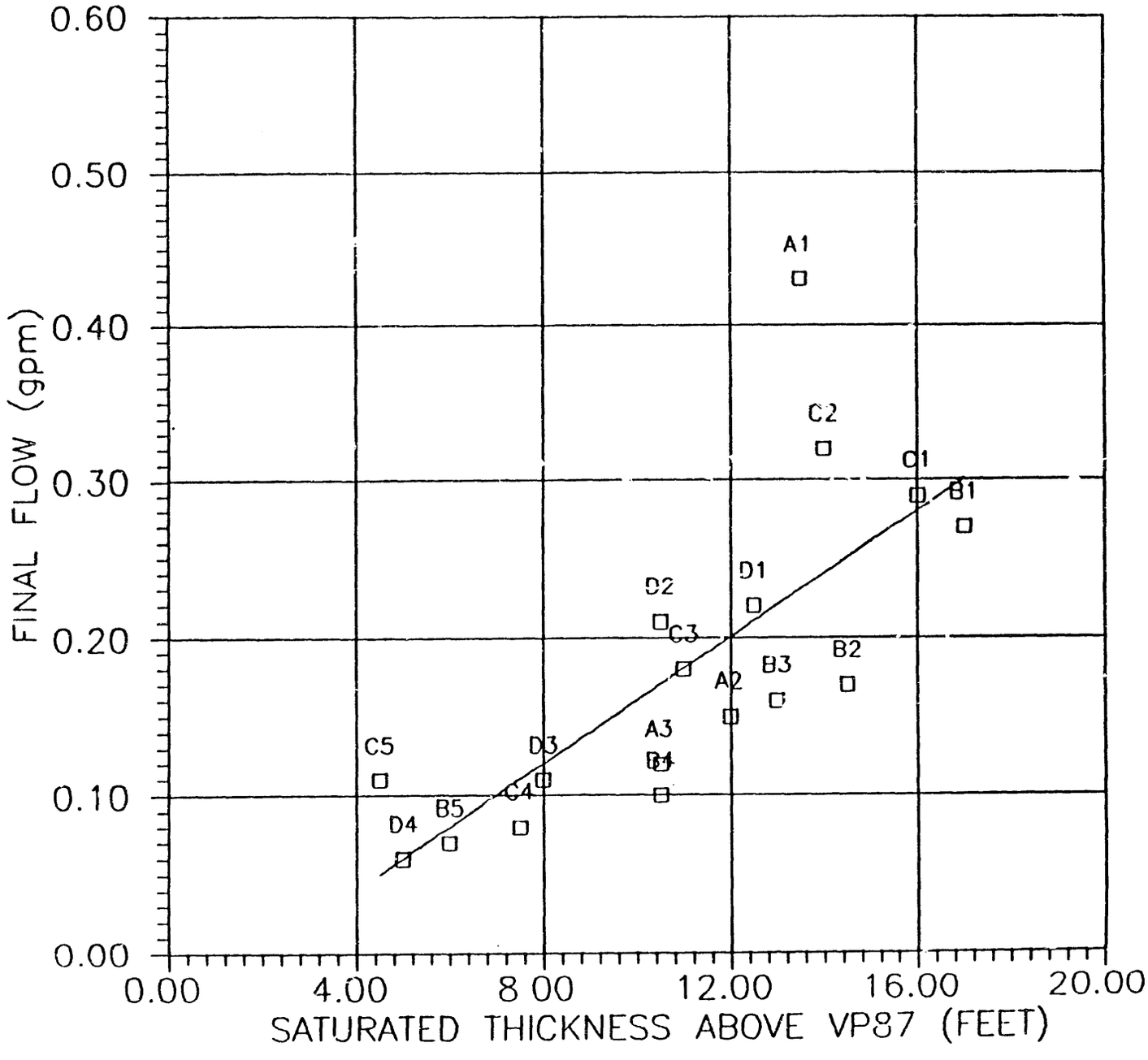
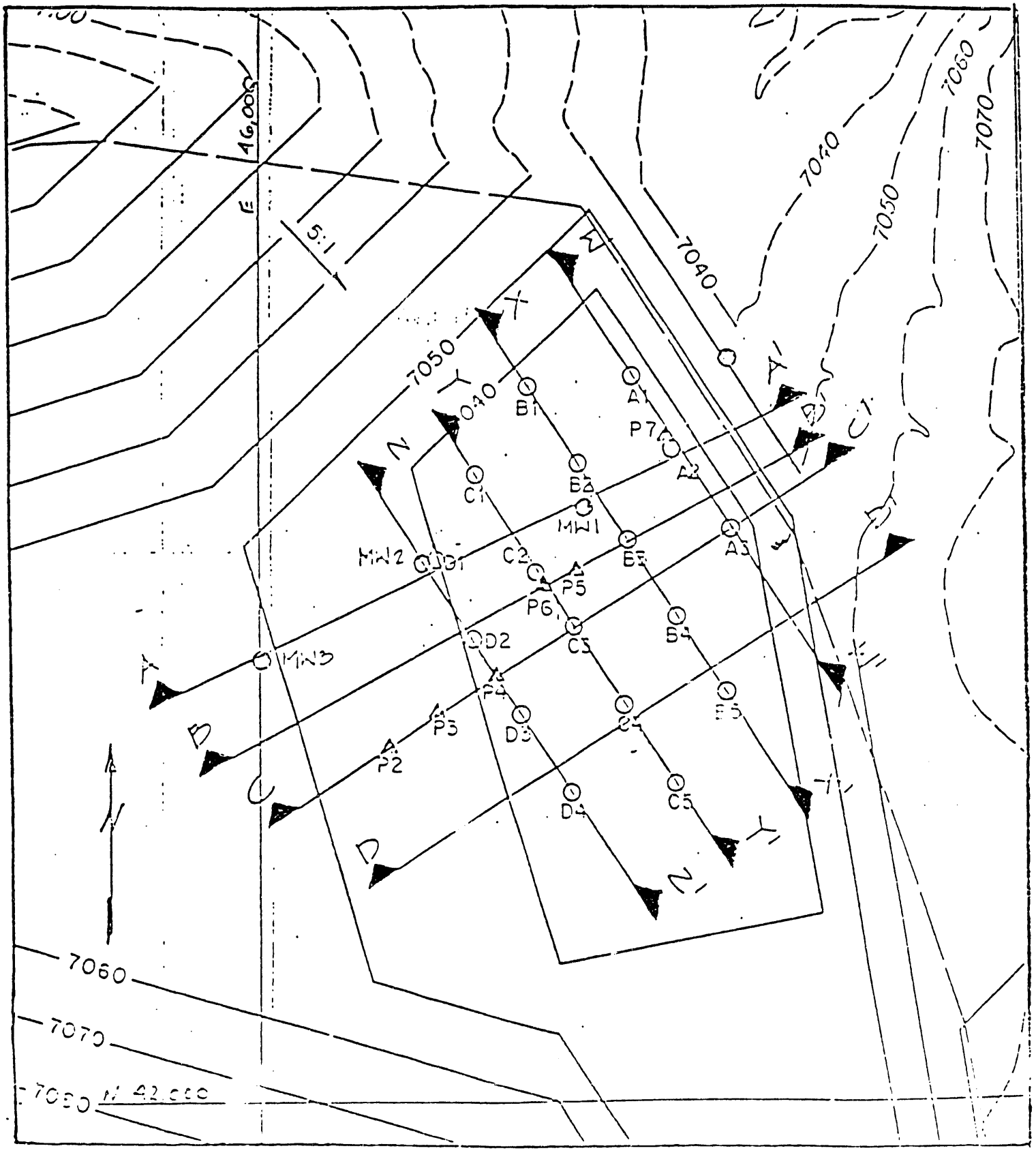


FIGURE 5.3

LOCATIONS OF CROSS-SECTIONS THROUGH THE 17 WELL DEWATERING SYSTEM



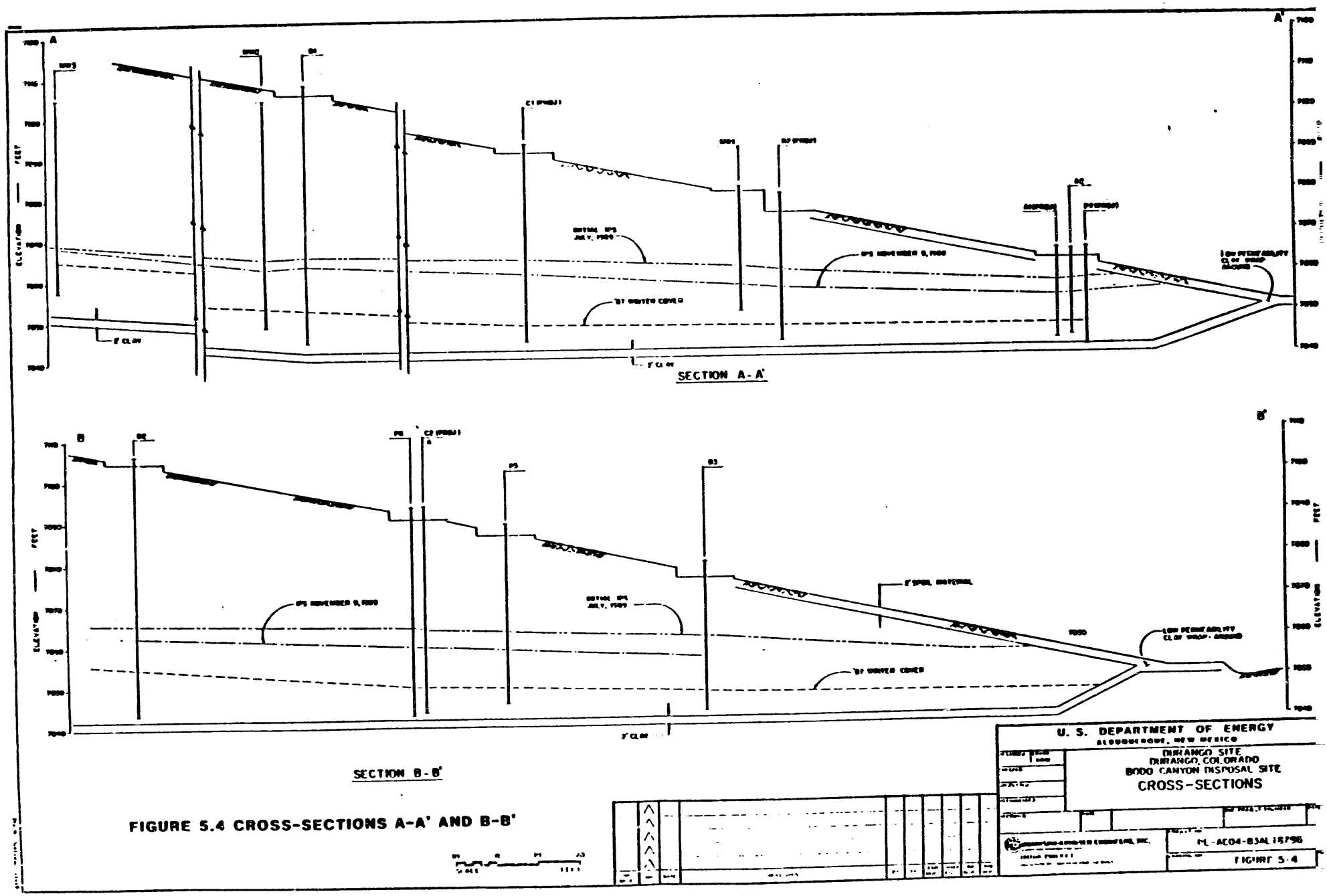


FIGURE 5.4 CROSS-SECTIONS A-A' AND B-B'

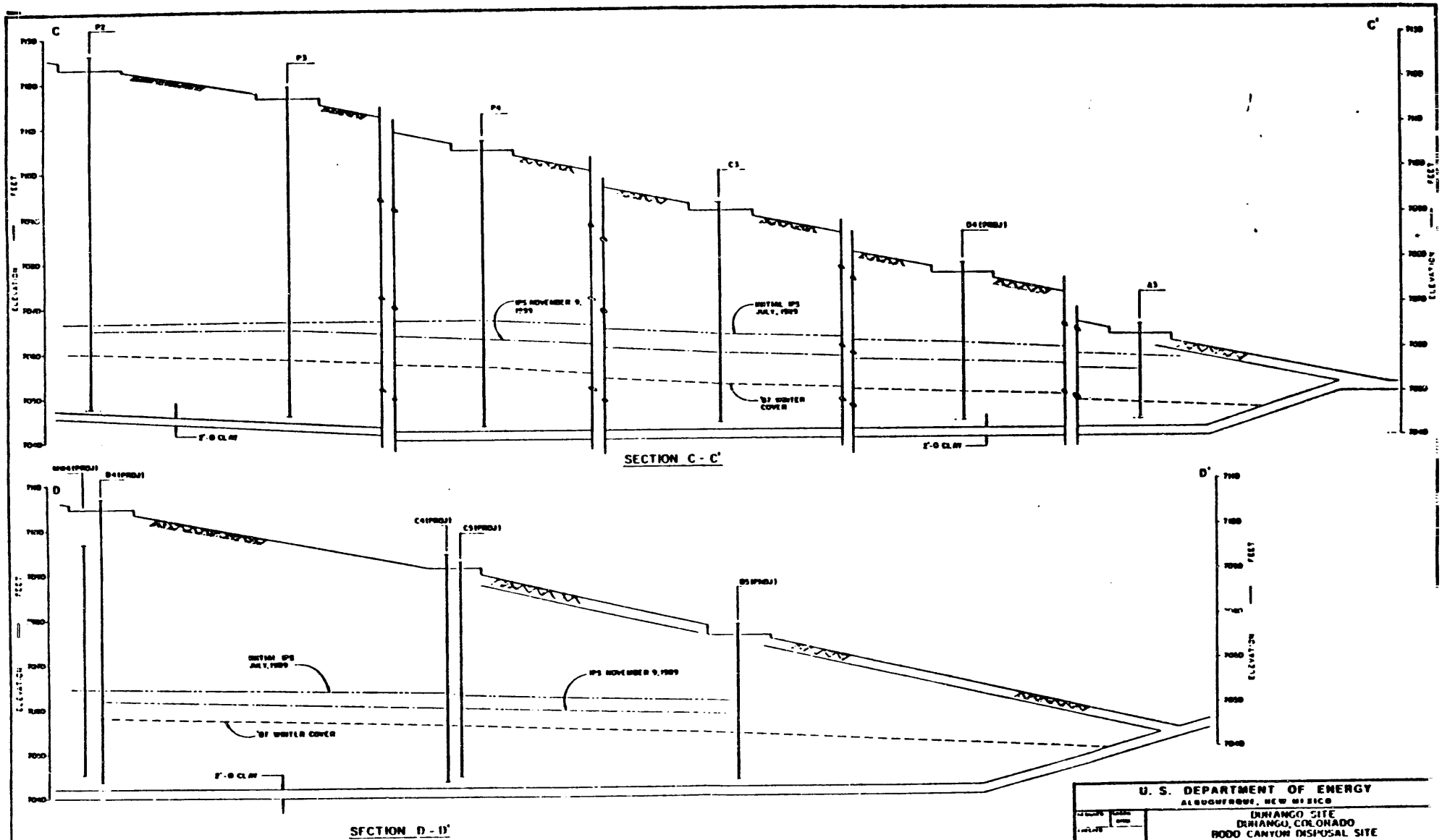


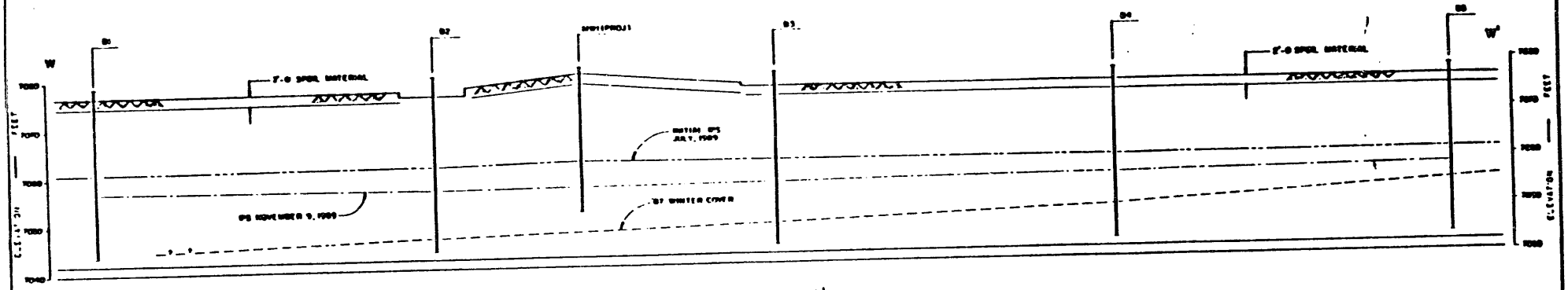
FIGURE 5.5 CROSS-SECTIONS C-C' AND D-D'

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

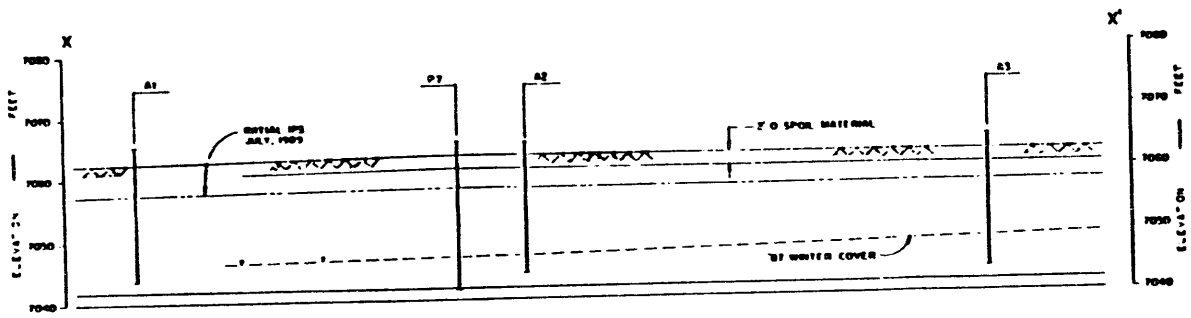
DURANGO SITE
DURANGO, COLORADO
RODO CANYON DISPOSAL SITE
CROSS-SECTIONS

DE-AC04-83AL18796

FIGURE 5.5



SECTION W - W'



SECTION X - X'

FIGURE 5.6 CROSS -SECTIONS W-W' AND X-X'

SCALE FEET

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DURANGO SITE
DURANGO, COLORADO
BODO CANYON DISPOSAL SITE
CROSS-SECTIONS

DE-AC04-83AL18756

FIGURE 5 6

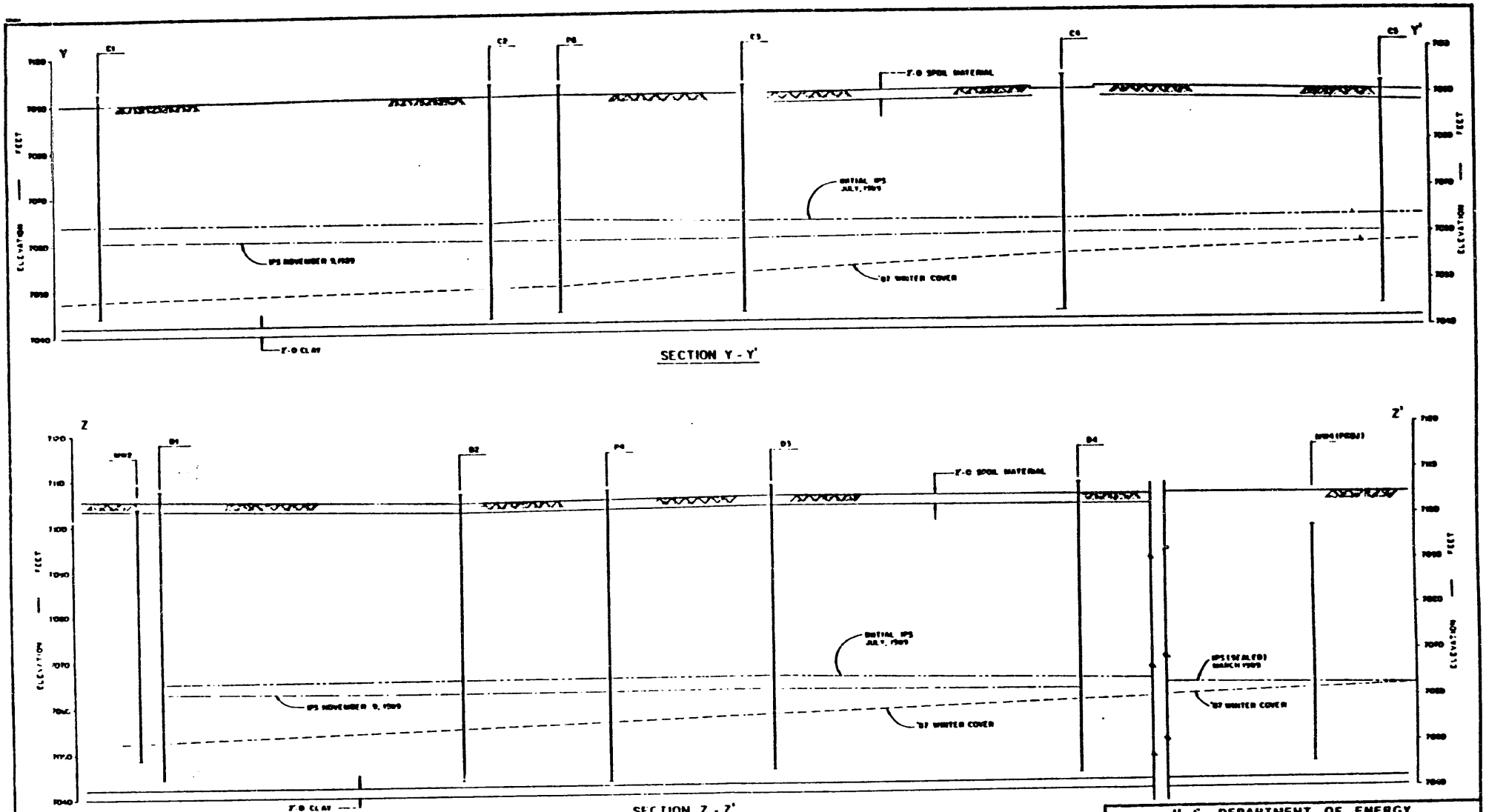


FIGURE 5.7 CROSS-SECTIONS Y-Y' AND Z-Z'

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

DURANGO SITE
DURANGO, COLORADO
BODO CANYON DISPOSAL SITE
CROSS-SECTIONS

DE-AC04-83AL18796

FIGURE 5.7

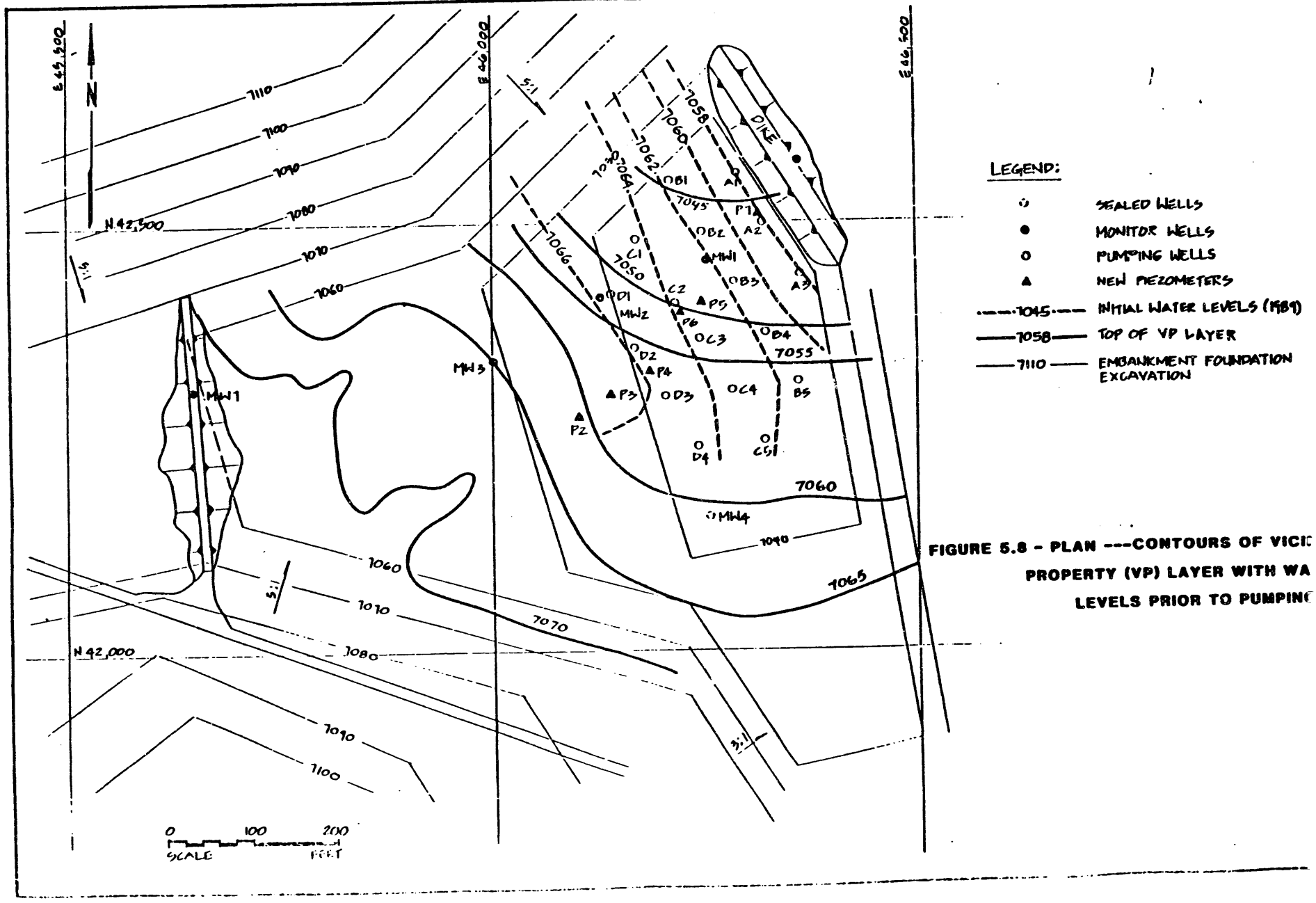


FIGURE 5.8 - PLAN ---CONTOURS OF VICI
PROPERTY (VP) LAYER WITH WA
LEVELS PRIOR TO PUMPING

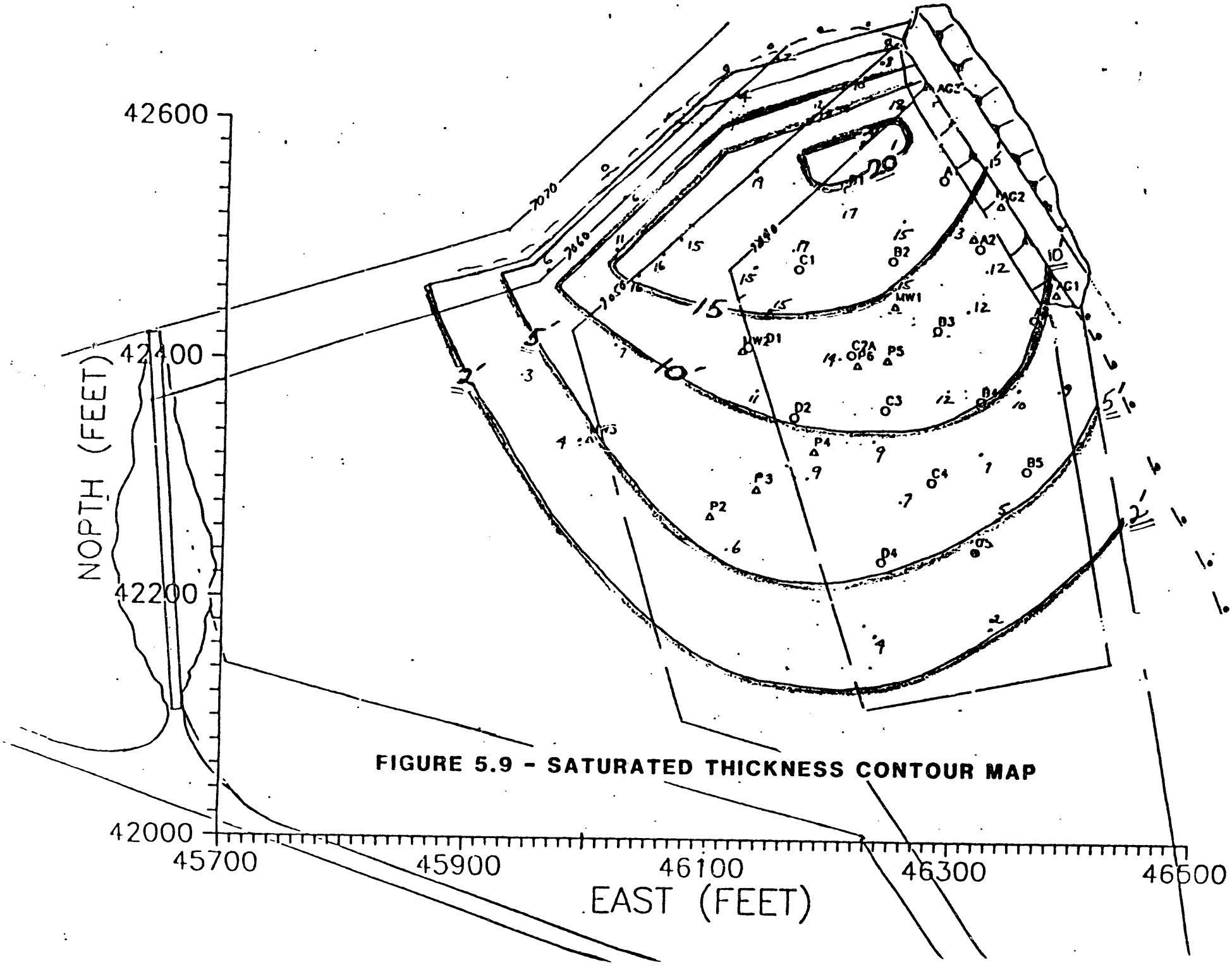


FIGURE 5.9 - SATURATED THICKNESS CONTOUR MAP

6.0 WORK IN PROGRESS

Three areas of investigation continue for the dewatering project at Durango. The first includes laboratory analysis of samples recently obtained; the second is a more complete characterization of the site; and the third is the laboratory drainage test. All studies are scheduled for completion in January 1990. Study results, as well as implications of the results relative to environmental impact and site closure, will be presented in subsequent reports.

6.1 Sample testing

Samples were taken during test pit and toe trench excavations. They include:

Test pit excavation:

Test Pit 1 --- 6 Tailings samples
2 Low permeability liner samples
2 samples from beneath the liner in the natural material

Test Pit 2 --- 2 Low permeability liner samples

Test Pit 3 --- 3 Tailings samples
2 Low permeability liner samples

Toe Trench excavation:

Dike --- 6 Low permeability liner samples

V.P. Layer --- 2 samples

These samples will be tested for dry density, water content, and specific gravity. Other tests include geochemical attenuation potential, strength characateristics of the vicinity property layer, and geotechnical parameters of the tailings directly above the low permeable liner.

6.2 Site Characterization

The TAC is currently analyzing data from their installation of monitor wells and from pumping tests performed in October 1989. In order to better characterize the hydrogeological conditions of the site and to evaluate groundwater compliance strategy, the TAC is also performing computer modeling of the embankment.

6.3 Laboratory Drainage Test

Work continues on the drainage test outlined in the September status report. Results will provide a better understanding of movement of water through unsaturated tailings and the hydrogeological properties of the material, such as the specific yield.

Appendix A

WELL POINT CONSTRUCTION

Prior to construction of the toe trench a line of approximately 87 vacuum operated well points were installed on the uphill side of the planned trench. The location of the well point line is shown on Figure A-1. The well points are on 4 foot centers except along the southernmost 100 foot section where they were installed on 8 foot centers. The well point line was constructed approximately 15 feet from the centerline of the planned toe trench and extends 4 feet deeper than the trench.

The well point holes were drilled 12 feet deep with an 8 inch hollow stem auger. A wash pipe was inserted to the bottom of the hole and water was circulated through the hole for several minutes until the return water was relatively clean. The well point, which consisted of a 1 1/2 inch diameter PVC pipe with 0.020 inch slotted openings along the bottom one foot, was then installed. To keep the hole from caving, water under low pressure was kept circulating while 10/40 silica sand was poured down the hole around the well point. When the hole was about half full of sand the wash pipe was removed. The hole was then filled with sand to within one foot of the surface. A bentonite clay backfill was used for the upper one foot of the hole.

Washing enlarged the holes from 8 inches to an average of about 14 inches as indicated by the quantity of sand required to fill the holes. In some holes, however, larger cavities were washed out as indicated by larger sand requirements. Usually 11 or 12 hundred pound bags of sand would fill a hole but on one occasion 33 bags were used. None took less than 9 bags. Communication of wash water occurred on several holes 4 feet apart indicating the extent of the cavities produced by caving and washing of the holes.

The well points were fitted with individual valves and water was piped to a common header. Valves were adjusted as the water levels fell to avoid vacuum drop. The average flow from all well points was about 2.0 gallons per minute (gpm).

The sequence of construction for the well point system is illustrated in the photographs of Plates A.1 and A.2.

WELL POINT GROUTING

At the conclusion of the dewatering trench construction the sand used in the well point system was pressure grouted along the bottom

4-6 feet of each hole. The inside of each well point was also grouted to the surface.

The well point holes averaged about 14 inch diameter as indicated from sand quantities required to backfill the holes during well point construction. To grout the lower 4 feet of hole, assuming a uniform sized hole with a 30% porosity of the sand backfill, approximately 10 gallons of grout was needed per hole. The grout used was a mixture of one bag of M-1 gel bentonite to 150 gallons of water which was injected from the top of the well point pipe under a pressure of about 12 psi. The bottom cap on each well point was knocked off by using a 15 foot long, 5/8 inch diameter reinforcing rod. The pipe was raised from 1 to 2 feet off the bottom before grouting. All well point holes took the required quantity of 10 gallons of grout using this method.

Some communication of grout occurred between both the 8 foot spaced holes and between the 4 foot spaced holes which indicated good grout travel through the sand backfill.

All of the well points will be abandoned and buried in the fill except for twelve of the well points that were left ungrouted for future use. Four are located north and eight are located south of well A-1. All are on 4 foot centers. An additional well point within 2 feet of well A-3 was also left ungrouted temporarily due to its close proximity to the well and potential communication between the two.

A temporary soil berm will be constructed around the 12 well points left ungrouted. The well casings of wells A-1, A-2 and A-3, and piezometer P-7 will be extended to the surface of the cell for future use. The single well point near A-3 will also be extended to facilitate grouting at a later time.

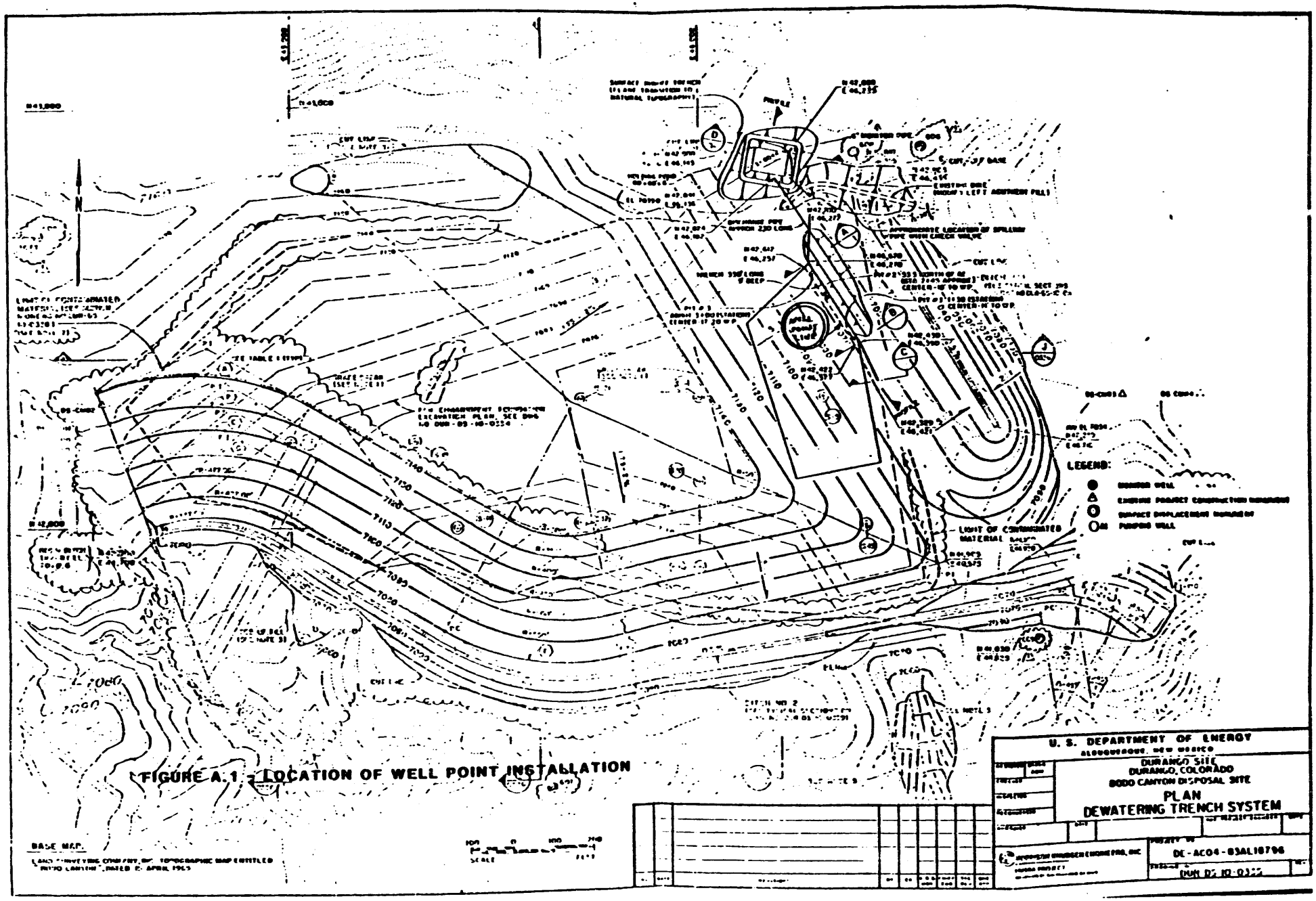
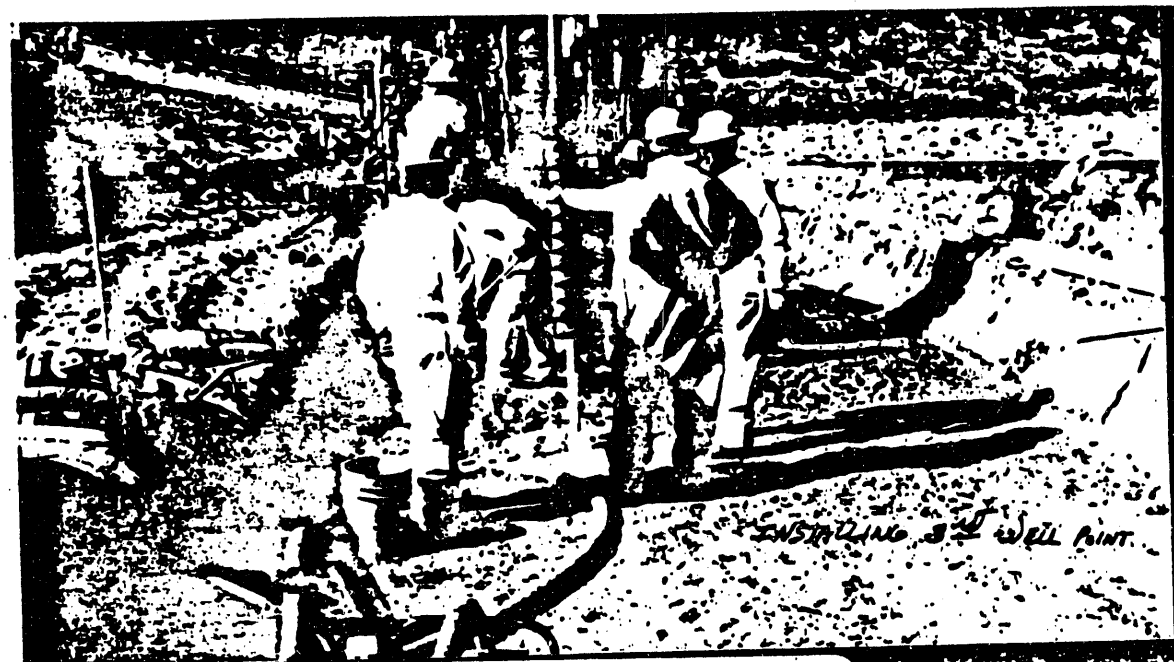


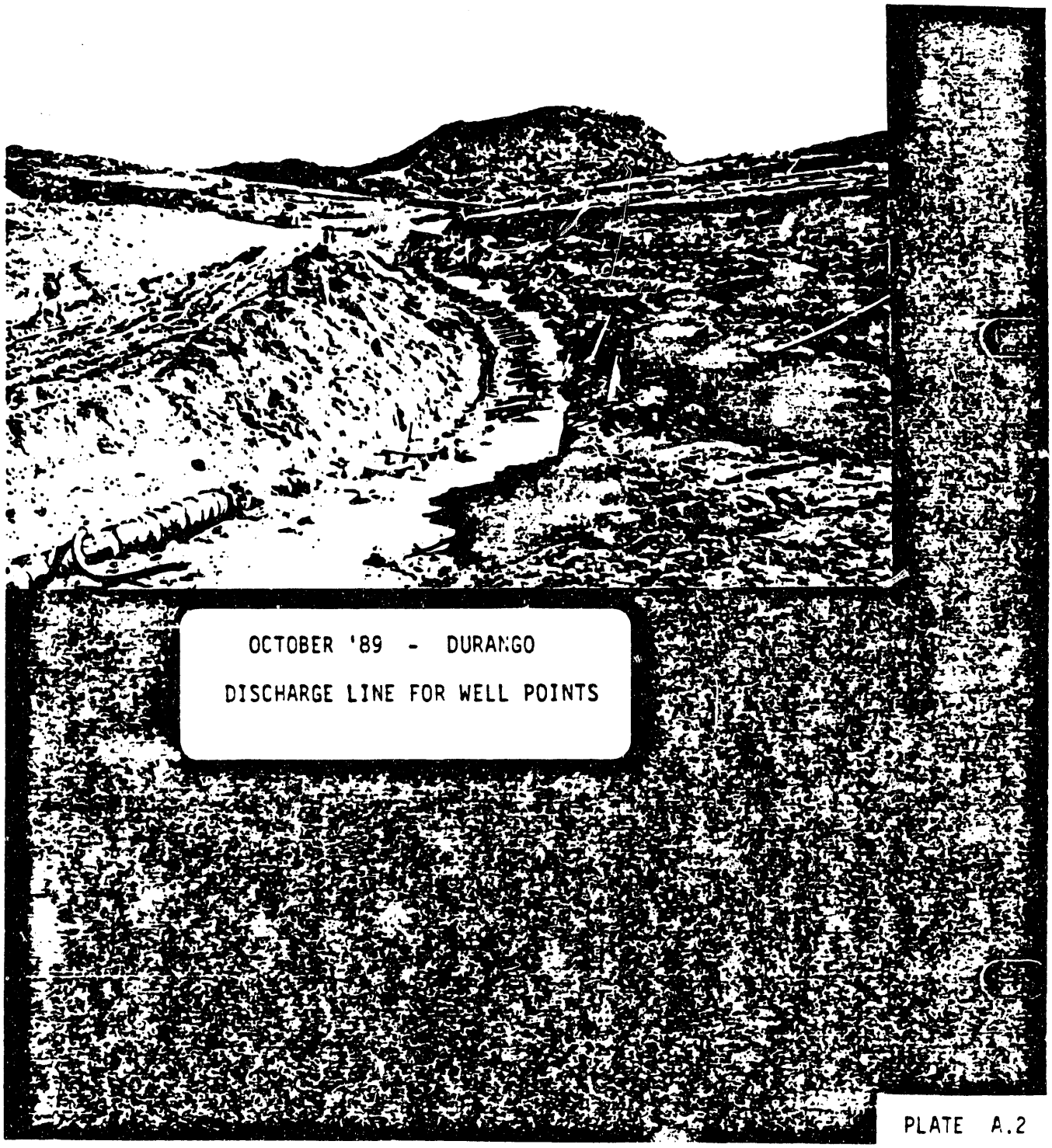
FIGURE A.1 - LOCATION OF WELL POINT INSTALLATION



10/11/89 - DURANGO

INSTALLING WELL POINTS

PLATE A.1



OCTOBER '89 - DURANGO

DISCHARGE LINE FOR WELL POINTS

PLATE A.2

APPENDIX B

TOE TRENCH AND HOLDING POND CONSTRUCTION

The toe trench is designed to permanently lower the indicated phreatic surface (IPS) a minimum of three feet below the impervious radon barrier to prevent hydrostatic uplift pressures on the barrier and seepage over the containment dike. It is not designed to completely drain the cell since at its deepest point it is 5 feet higher than the cell bottom.

The toe trench is located along the northeast toe of the tailings embankment (See Figure B.1). It is 330 feet long within the cell and connects to a 236 foot long discharge trench. The toe trench terminates at a 60 foot x 80 foot holding pond located north of the embankment. Flow from the cell to the holding pond is by gravity.

The toe trench contains a 20 ml. impermeable plastic lining along its bottom and a 6 inch diameter, perforated drain pipe encapsulated in coarse gravel and wrapped in a geotextile fabric (Figure B.2). The trench is backfilled with compacted concrete sand, covered with tailings and one foot of clay spoil, and ultimately will be covered with a radon barrier and erosion protection. The toe trench discharges into a 6 inch diameter solid drain pipe extending through the embankment lining near the end of the low containment dike (Figure B.1,B.3 and B.4). The discharge trench is backfilled with compacted clay similar in composition to the liner material and has a concrete waterstop constructed around the pile where it exits the disposal embankment. The drain pipe is buried for its full length until it reaches the berm surrounding the holding pond. At this point a vent pipe and shutoff valve were installed.

The holding pond is 7 feet deep (one foot freeboard) and constructed on a natural slope between the disposal cell and a drainage channel. Most of the excavation was in cut but some fill was necessary along the northeastern corner. The pond as constructed is above the 10-year flood level of the drainage channel. To ensure watertightness, the pond was lined with 2 feet of clay and covered with a double layer of 40 ml. HDPE liner which has a drainage net between the two plastic sheets. At the northeastern corner of the holding pond, in between the plastic "sandwich" is a monitoring pipe to detect leakage. An overflow pipe leading to a temporary treatment pond was also installed to prevent accidental overtopping.

As constructed the pond will hold approximately 300,000 gallons of water and at maximum capacity has a water surface area of 8700

square feet. After one week of operation the flow from the trench into the pond averaged about 1 gallon per minute (gpm).

Construction of the trench and holding pond are shown in Plates B.1 through B.12.

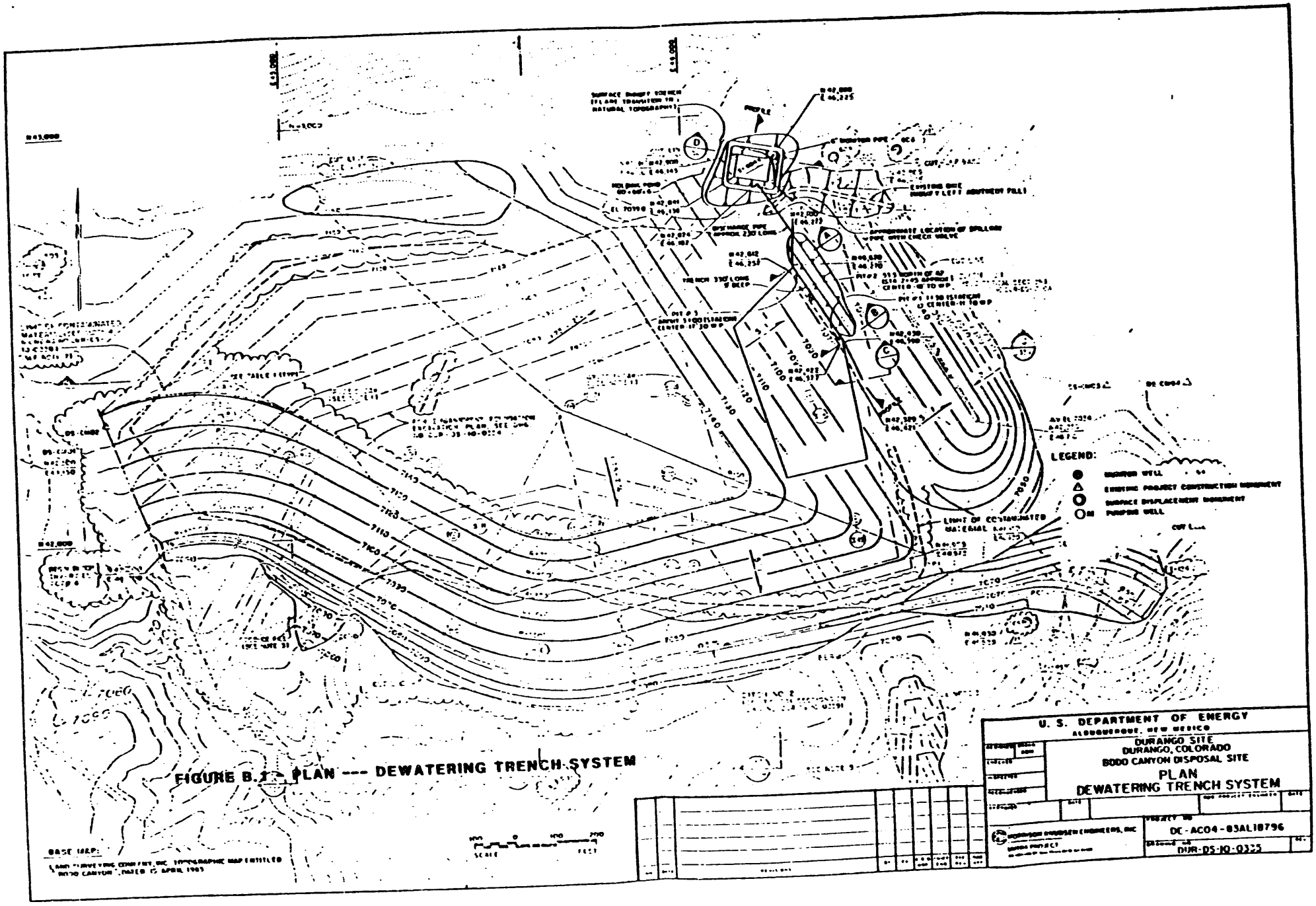


FIGURE B.1 — PLAN --- DEWATERING TRENCH SYSTEM

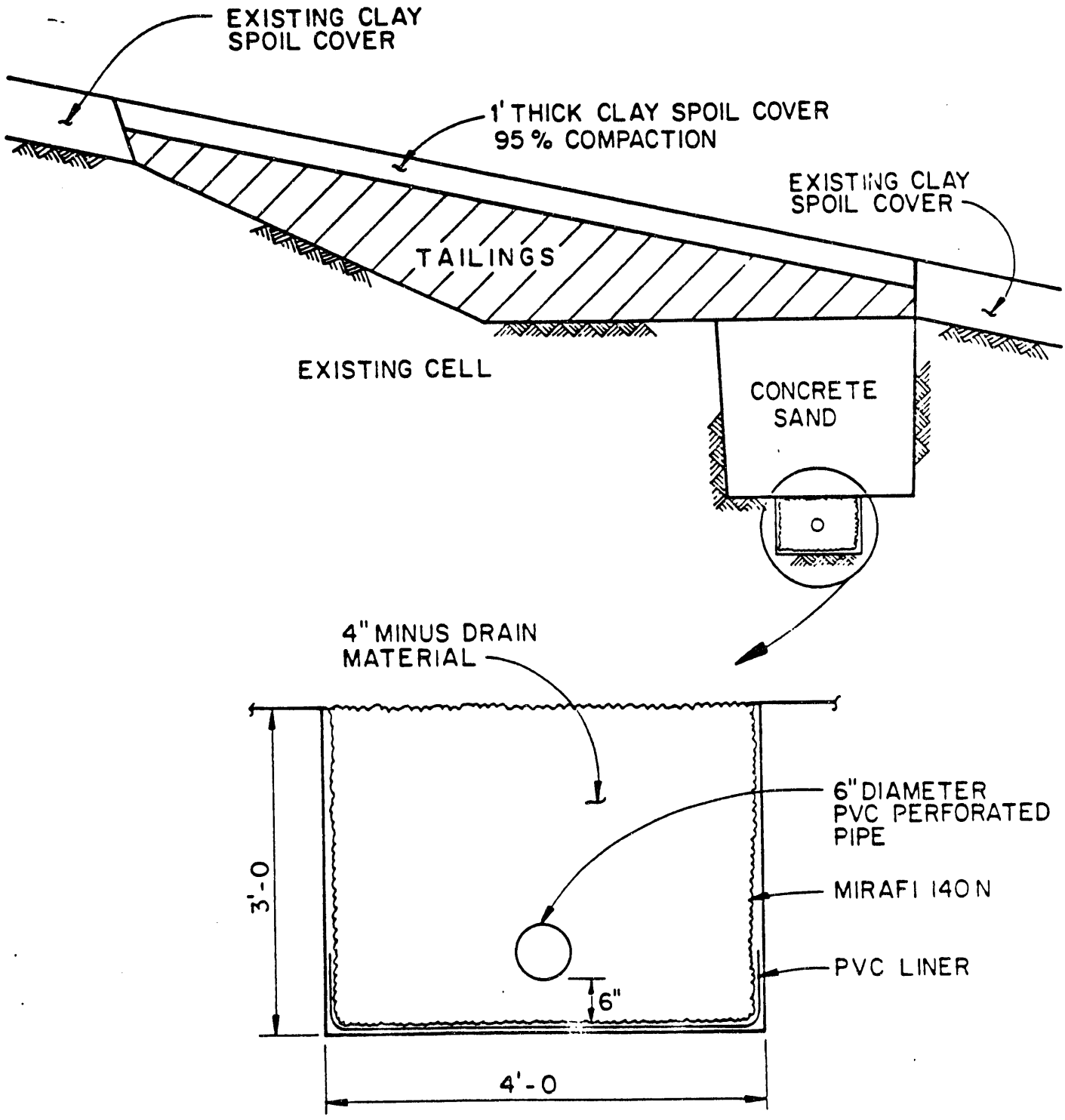


FIGURE B.2

AS-BUILT CROSS-SECTION OF TOE TRENCH

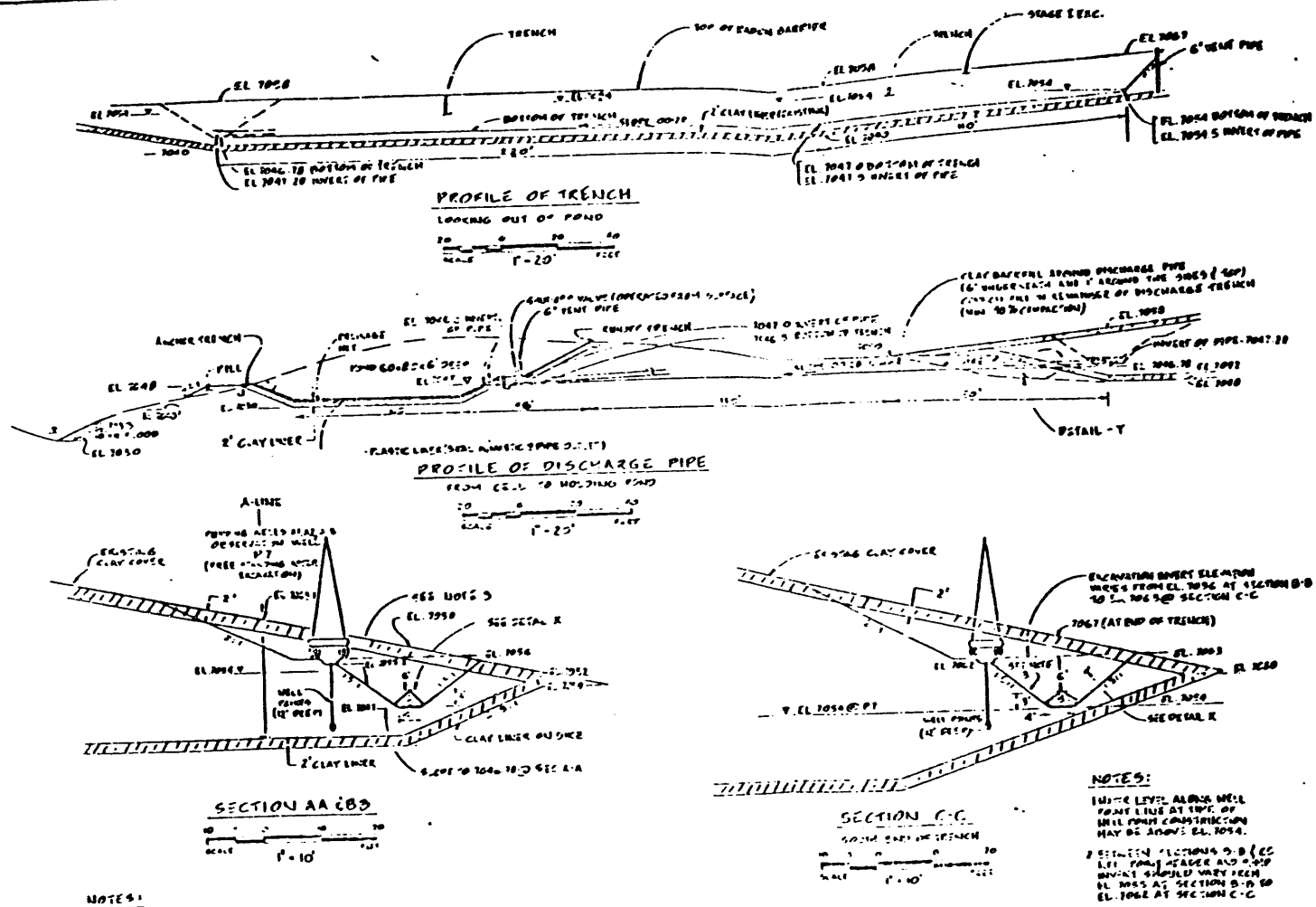


FIGURE B.3 – PROFILE AND SECTIONS DEWATERING TRENCH SYSTEM

U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

PROFILE AND SECTIONS
DEWATERING TRENCH SYSTEM

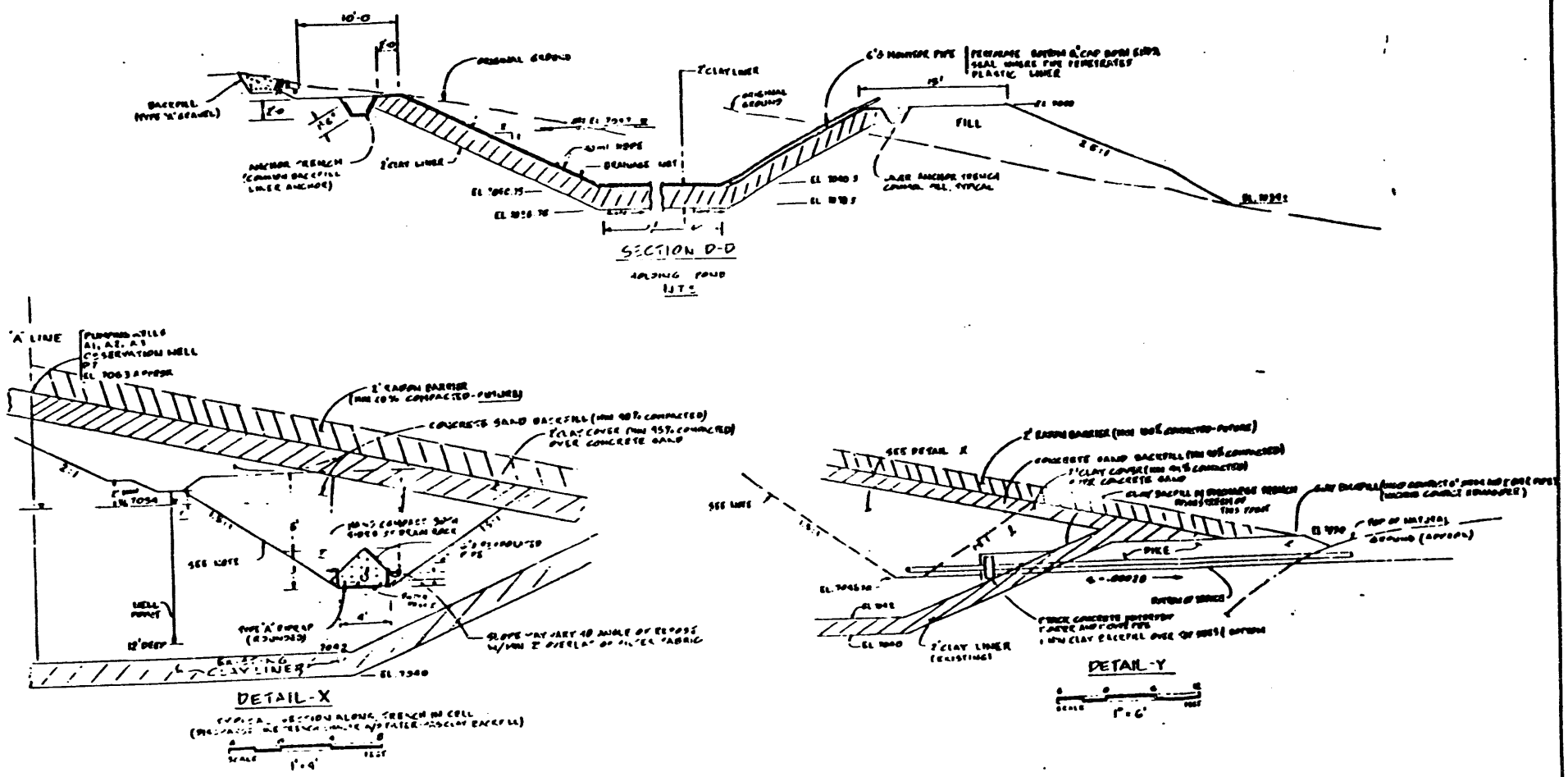


FIGURE B.4 - DETAIL AND SECTIONS OF DEWATERING TRENCH SYSTEM

NOTE: [illegible]

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DETAIL AND SECTIONS
DEWATERING TRENCH SYSTEM

NOV. 1989 - DURANGO

BACKHOE & TRENCH BOX USED
FOR TOE TRENCH INSTALLATION

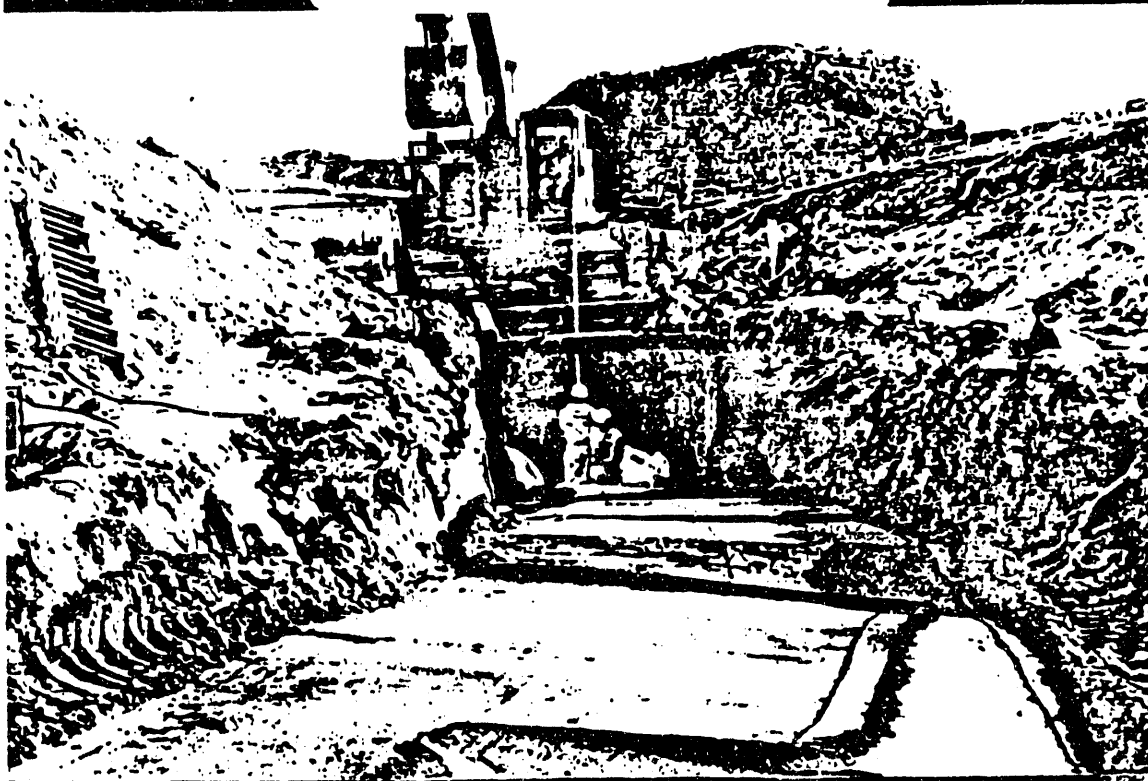
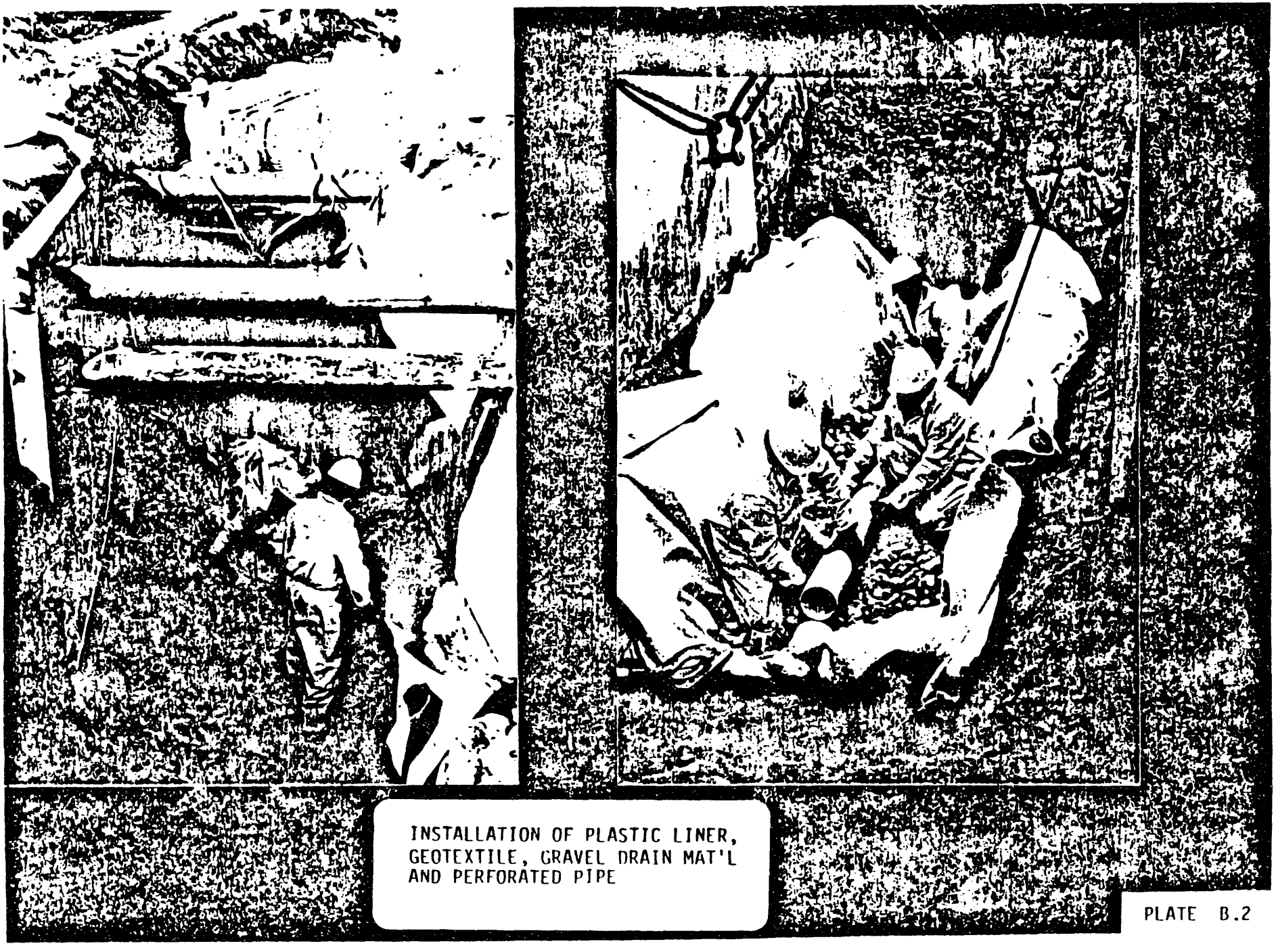


PLATE B.1



INSTALLATION OF PLASTIC LINER, GEOTEXTILE, GRAVEL DRAIN MAT'L AND PERFORATED PIPE

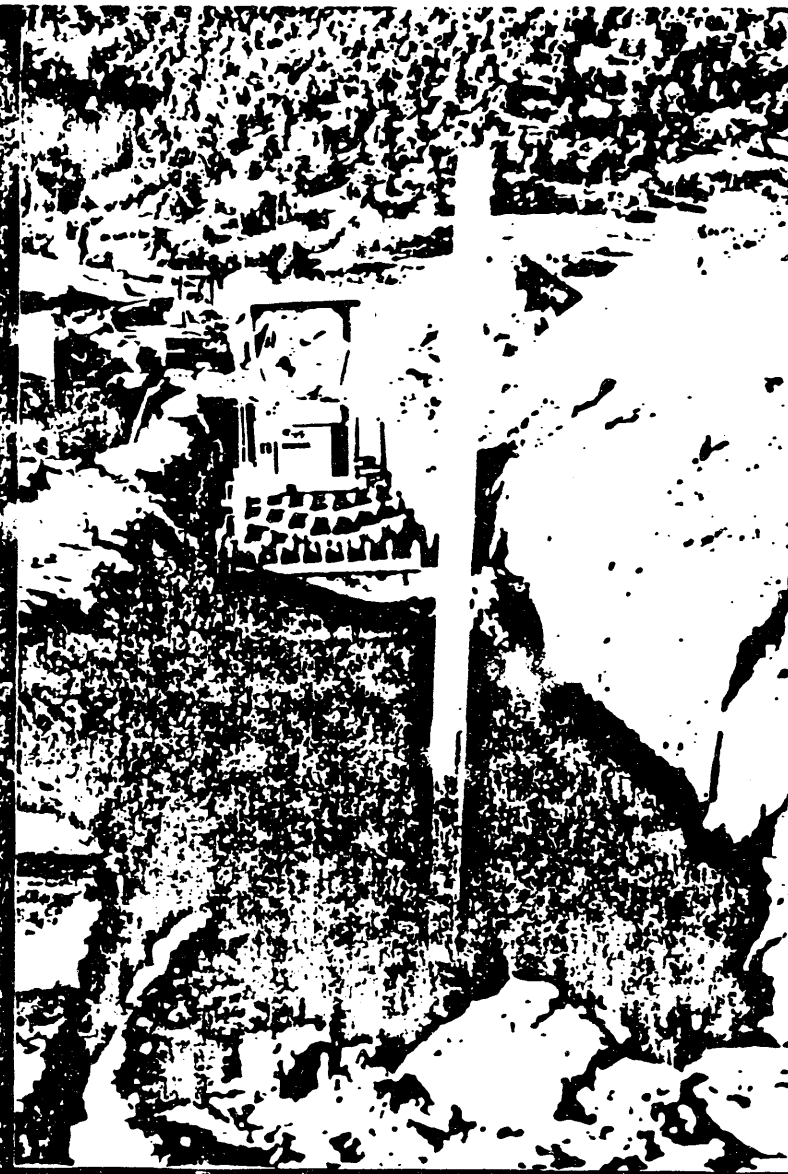
PLATE B.2

DRAIN GRAVEL PLACED ON TOP
OF PERFORATED PIPE

NOV. '89 - DURANGO

SOUTHERN END OF THE TRENCH
SHOWING VENT PIPE

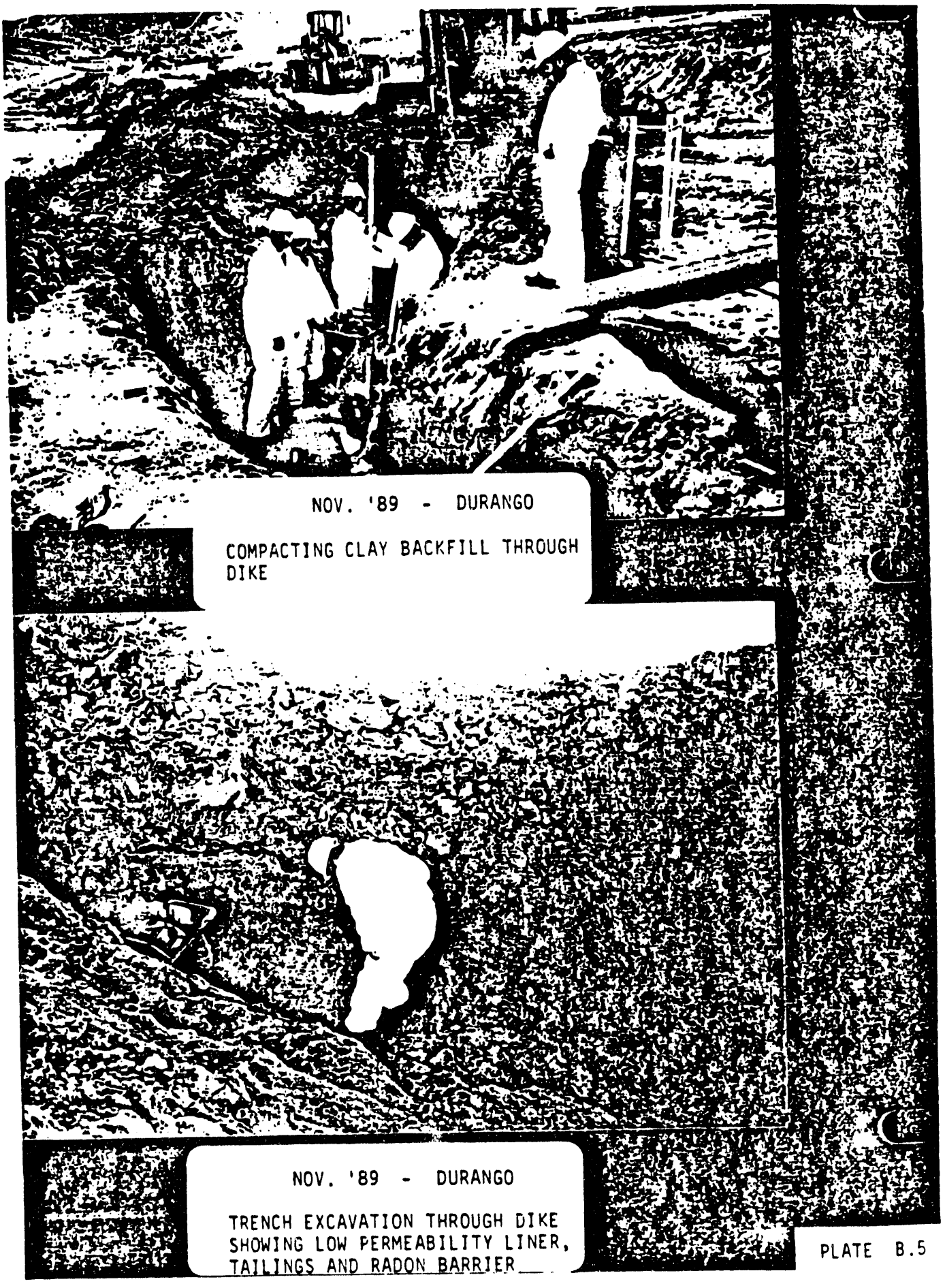
PLATE B.3



NOV. '89 - DURANGO

SOUTHERN END OF TOE TRENCH SHOWING
VENT PIPE AND COMPACTION OF
BACKFILL

PLATE B.4



NOV. '89 - DURANGO

COMPACTING CLAY BACKFILL THROUGH DIKE

NOV. '89 - DURANGO

TRENCH EXCAVATION THROUGH DIKE SHOWING LOW PERMEABILITY LINER, TAILINGS AND RADON BARRIER

PLATE B.5

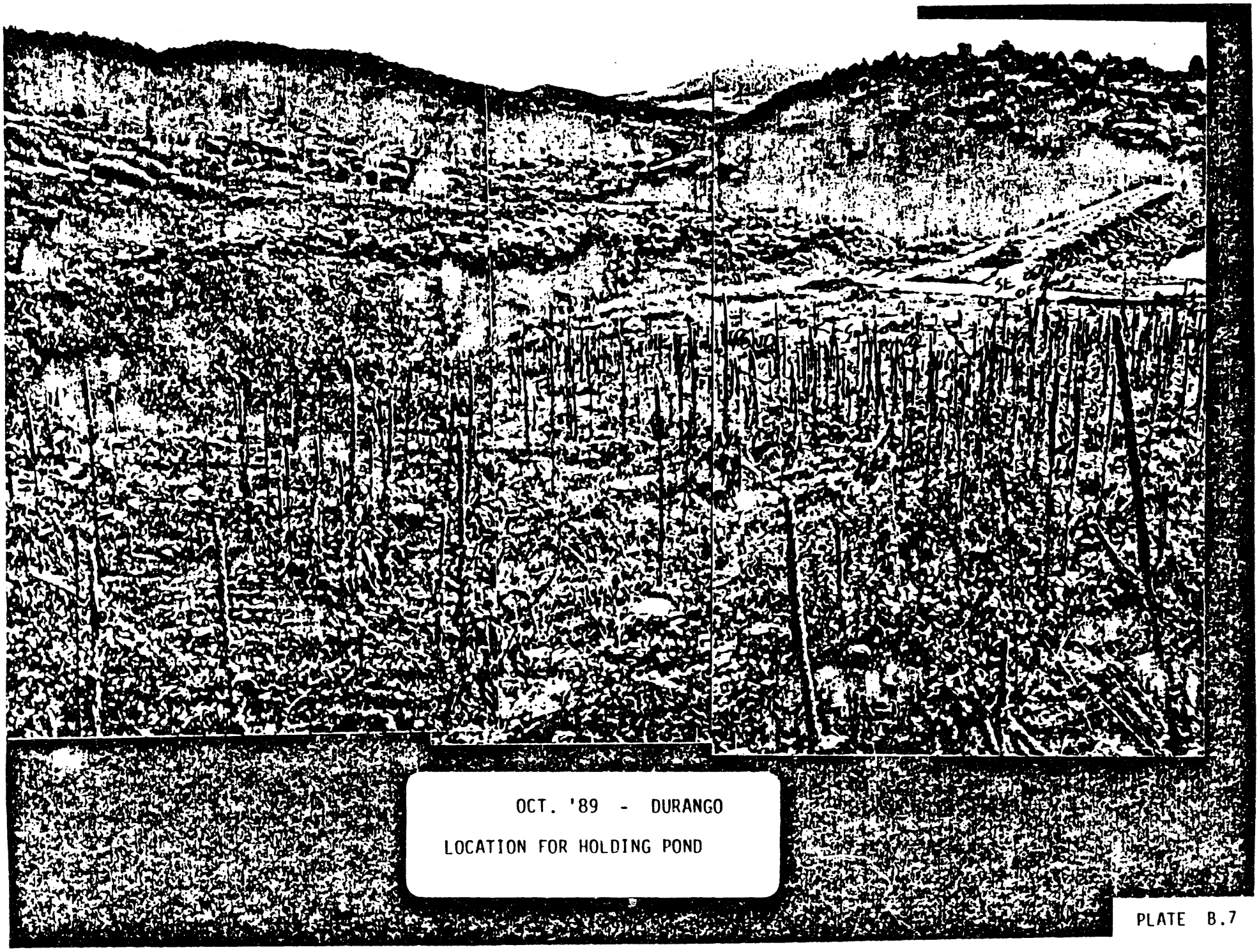
NOV. '89 - DURANGO

SETTING INVERT OF TOE DRAIN
USING LASER LEVEL

NOV. '89 - DURANGO

DENSITY TEST OF SUBGRADE

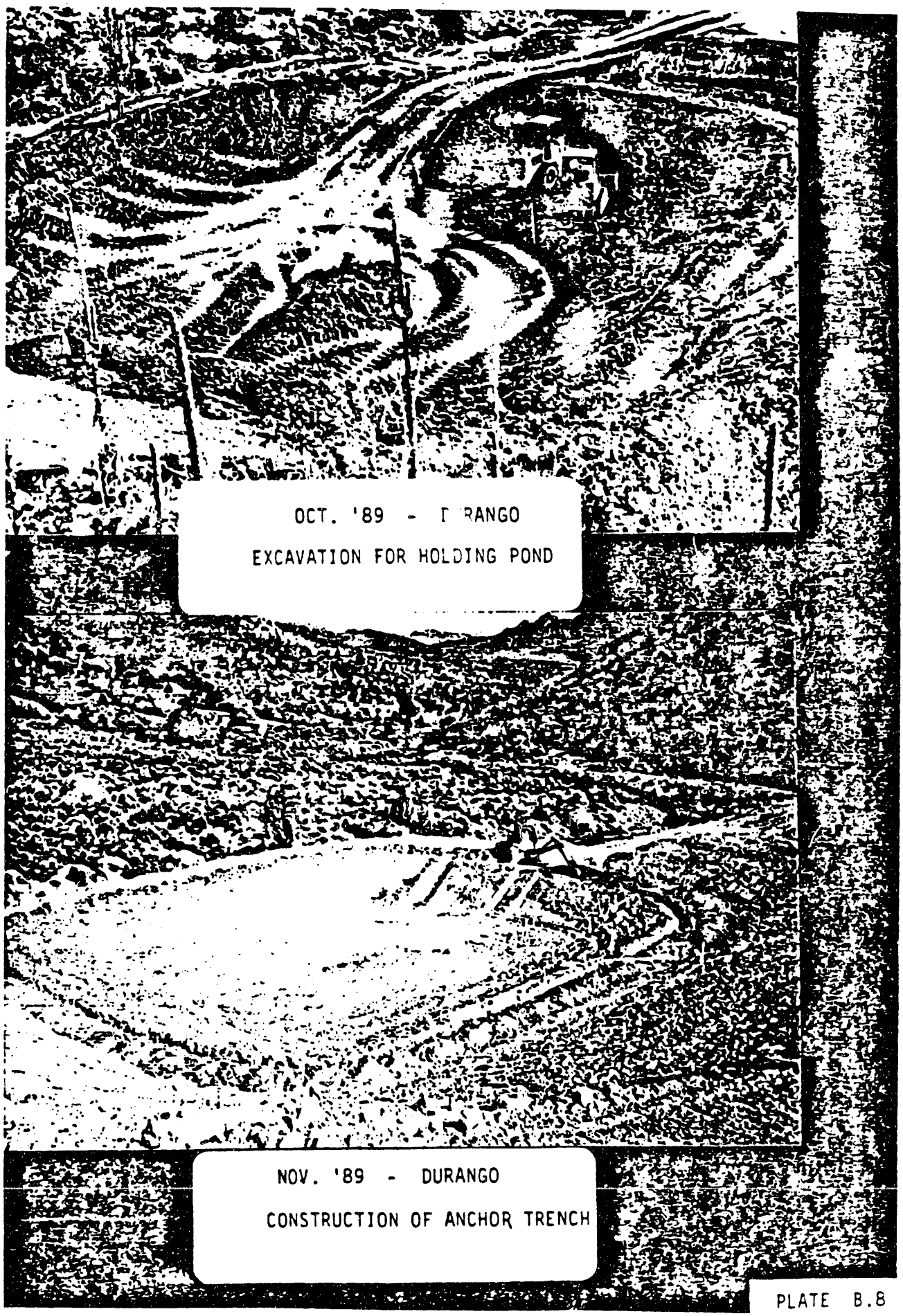
PLATE B.6



OCT. '89 - DURANGO

LOCATION FOR HOLDING POND

PLATE B.7



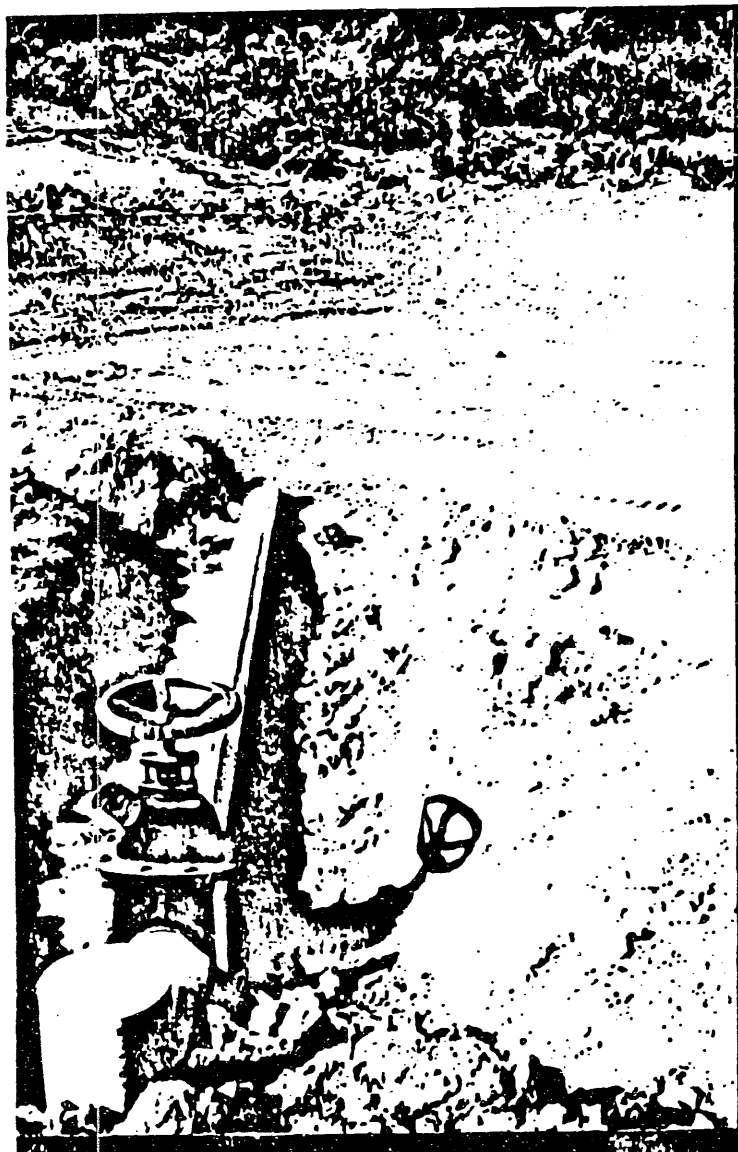
OCT. '89 - DURANGO

EXCAVATION FOR HOLDING POND

NOV. '89 - DURANGO

CONSTRUCTION OF ANCHOR TRENCH

PLATE B.8



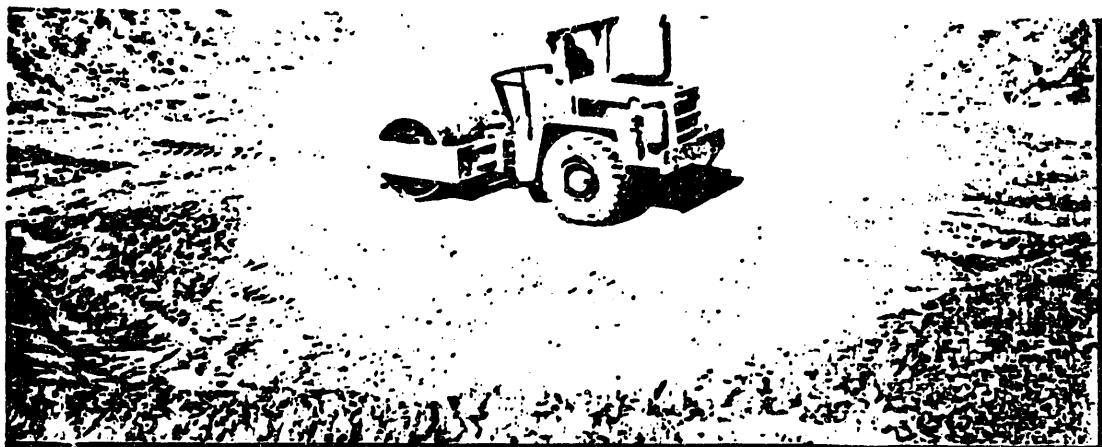
NOV. '89 - DURANGO

OUTLET OF DRAINAGE PIPE,
SHUTOFF VALVE AND VENT PIPE

NOV.'89 - DURANGO

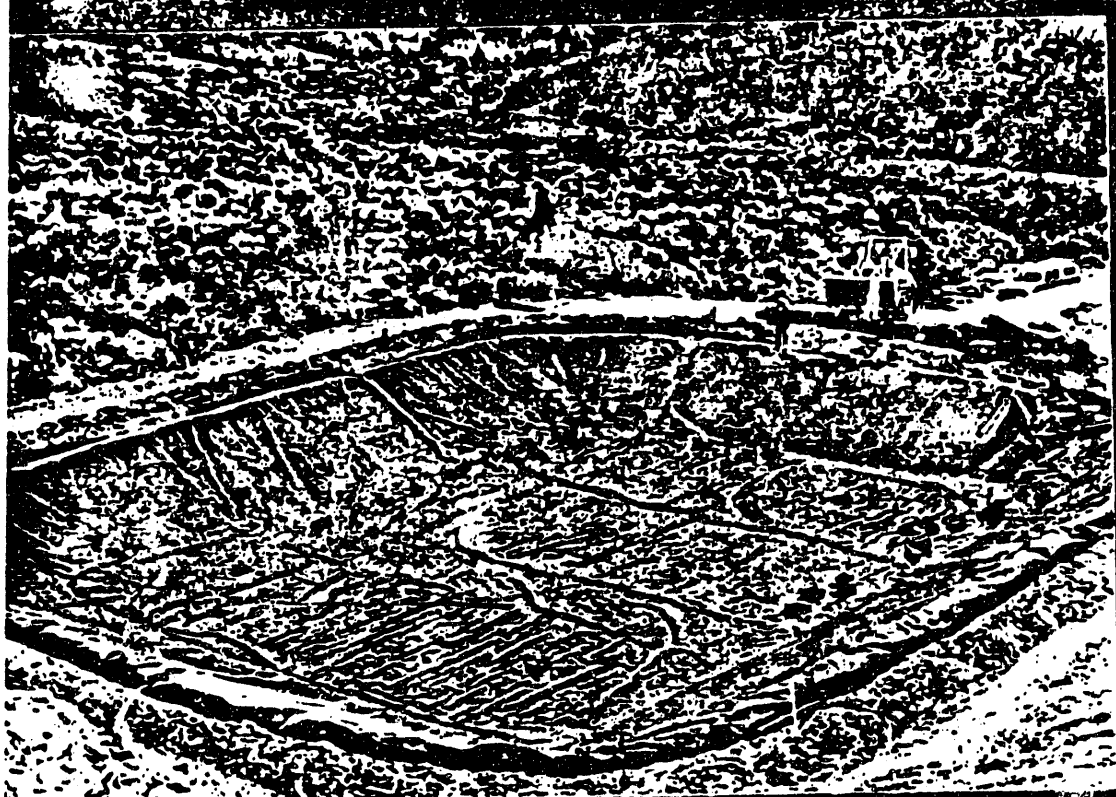
DISCHARGE PIPE THROUGH DIKE

PLATE B.9



OCT. '89 - DURANGO

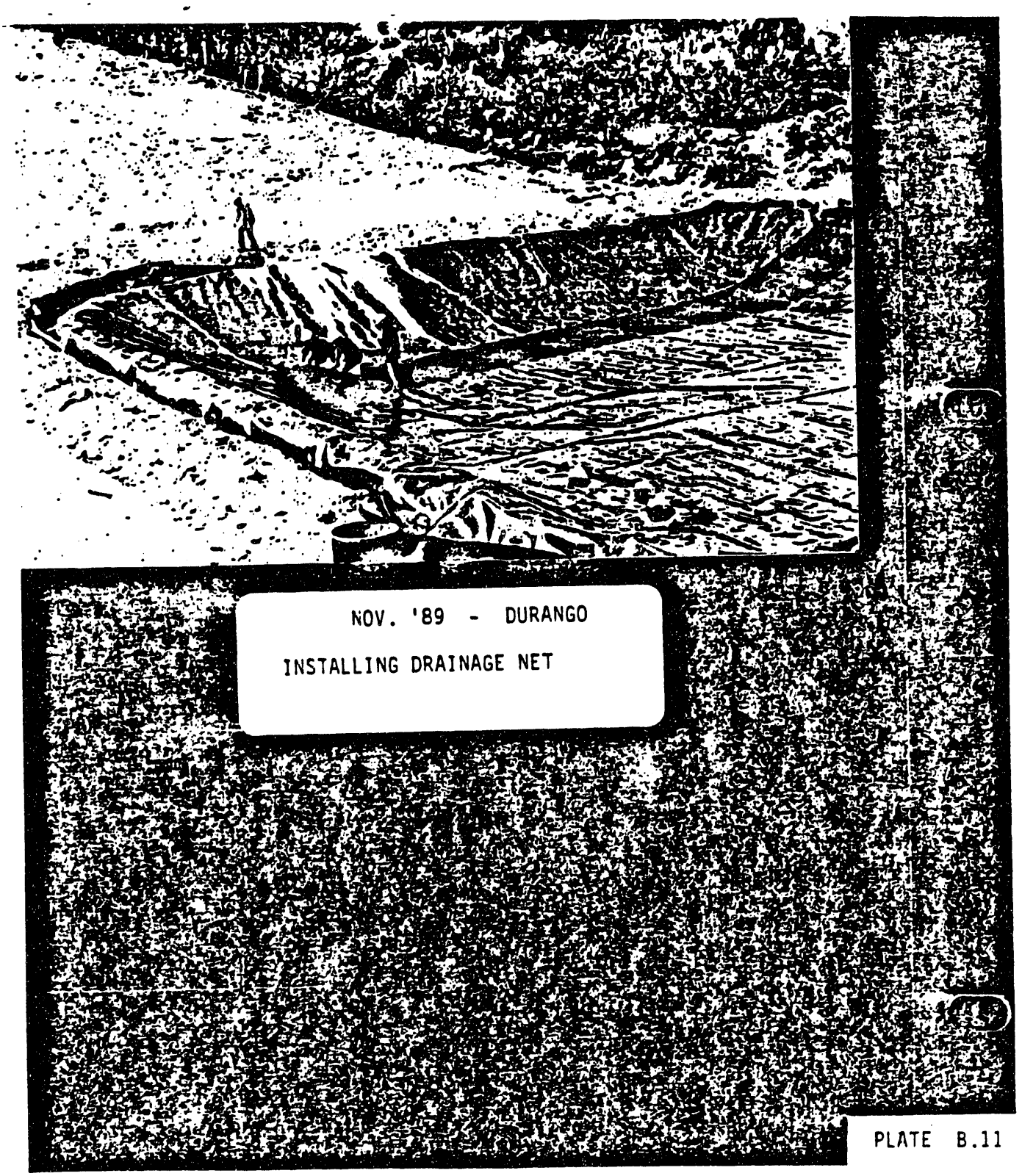
COMPACTING CLAY LINER IN HOLDING POND



NOV. '89 - DURANGO

INSTALLING 40 ml. HDPE BOTTOM LINER

PLATE B.10



NOV. '89 - DURANGO

INSTALLING DRAINAGE NET

PLATE B.11

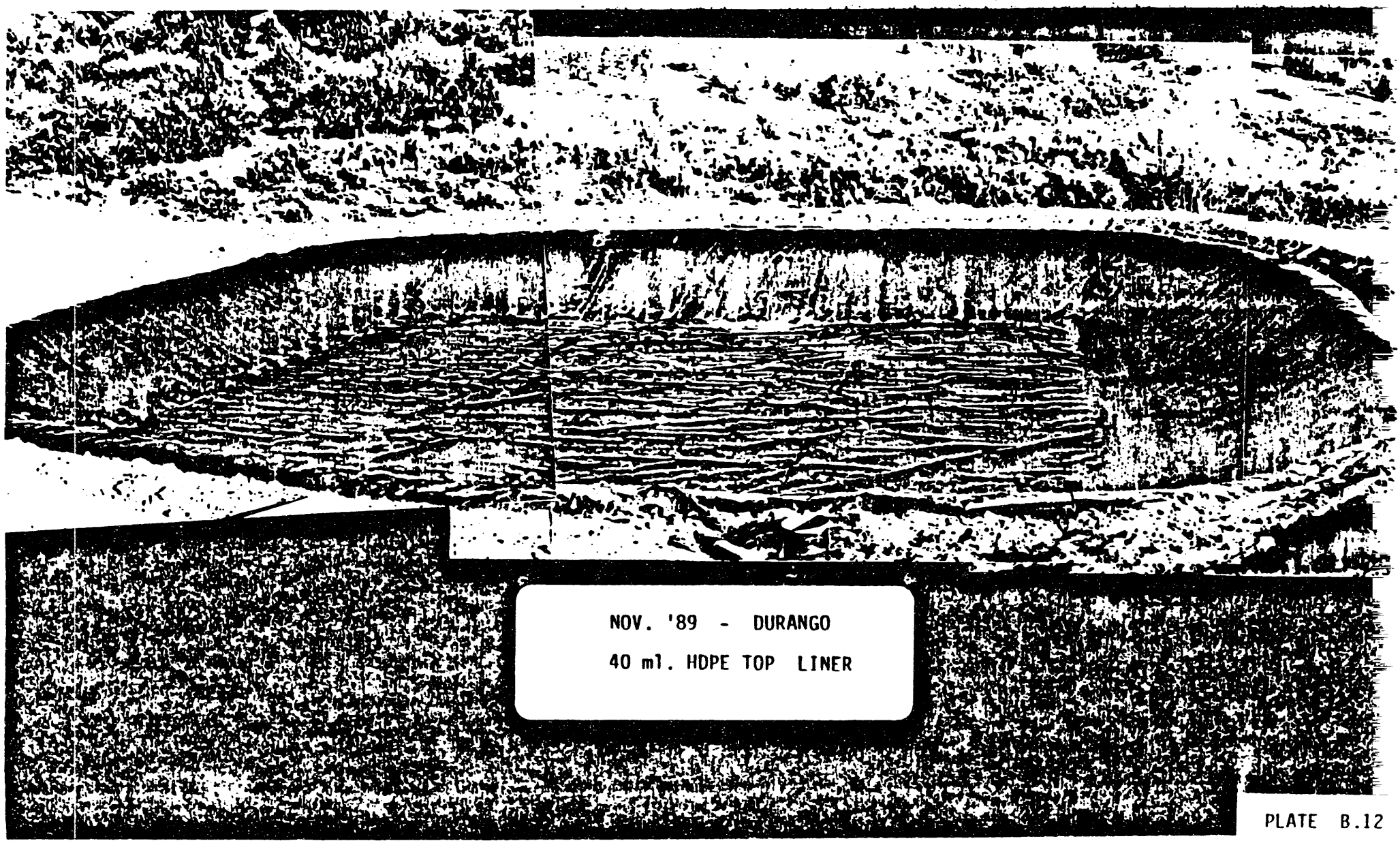


PLATE B.12

APPENDIX C

STATUS OF THE 17 WELL DEWATERING SYSTEM

The 17 well dewatering system was shutdown as construction of the toe trench proceeded. The A-line was shutdown on October 6, 1989, because the location of the A-line wells interferred with the well point construction.

The C and D lines were turned off on October 26, 1989 in order to prepare those lines for winter and facilitate the placement of the winter cover around the wells. To help dewater the toe trench alignment, the B-line of wells continued to operate until November 2, 1989 at which time it was also decommisioned.

A summary of the performance of the 17 wells is presented in Table C.1. The table shows the volume of water pumped for each well, the highest flow rate, and the final flow rate as of October 24, 1989. Approximately 50% of the water was pumped by 5 of the 17 wells (A1,B1,C1,C2-A, and D1). Final flow rate ranged from 16% to 56% of the highest flow rate for each well.

Drawdowns for the 10 monitoring wells through November 16, 1989 are presented on Figures C.1 and C.2. No drawdown was noted in MW 7. Increases in water levels in the monitoring wells can be observed after Oct. 26 when the C and D lines were turned off. The sharp decline in the water level in piezometer P7 reflects the start-up of the well point system on October 18, 1989.

Figure C.3 is a contour map of drawdowns on November 9, 1989, and Figure C.4 depicts the IPS contours as of Nov. 9. These two figures represent the long term drawdown produced in the embankment by the dewatering system. Figure C.5 is a cross section in the vicinity of the monitoring wells. The figure shows the ground surface of the tailings pile, the inital IPS, the IPS on Nov. 9, 1989, and the surface of the v.p. layer.

Table C.1

Comparison of Seventeen Pumping Wells
As of 10/24/89

Well #	Total Gallons Pumped (10/24/89)	Highest Flow Rate (gpm)	Final Flow Rate (gpm)
A-1*	60523	0.99	0.58 (10/6/89)
A-2*	22836	0.58	0.21 "
A-3*	20108	0.51	0.19 "
B-1	53166	0.79	0.37 (10/24/89
B-2	41352	1.1	0.2 "
B-3	33650	0.81	0.18 "
B-4	25489	0.69	0.11 "
B-5	16890	0.32	0.08 "
C-1	56087	1.12	0.29 "
C-2	65039	1.33	0.32 "
C-3	43304	0.97	0.18 "
C-4	18746	0.5	0.08 "
C-5	21186	0.47	0.11 "
D-1	53904	1.04	0.22 "
D-2	35589	0.45	0.22 "
D-3	22116	0.67	0.11 "
D-4	10461	0.3	0.06 "
Total as of 10/24/89	600446		

* The A-line of wells was shutdown for the well point installation on Oct. 6, 1989.

FIGURE C.1 - MONITOR WELL DRAWDOWNS

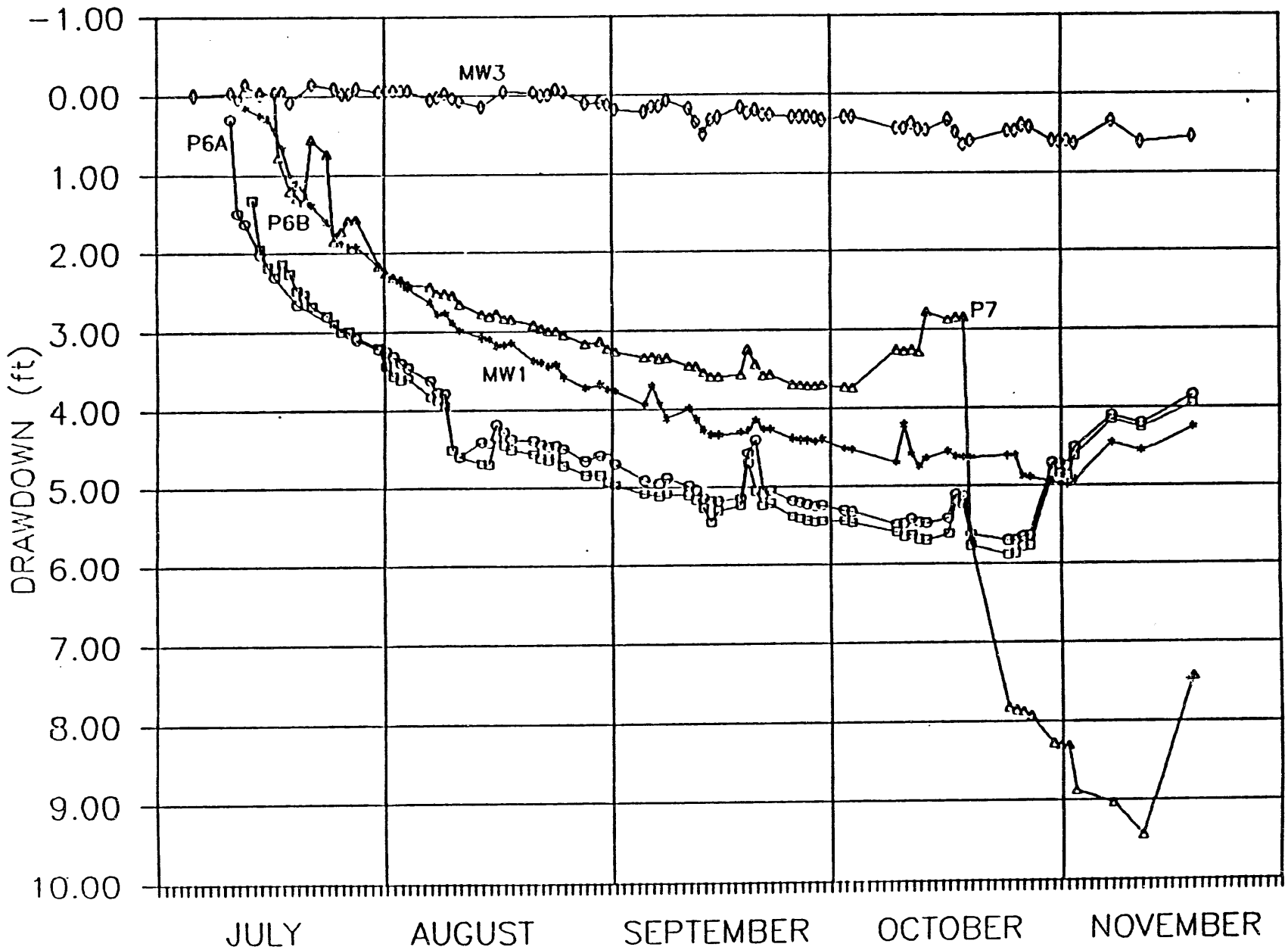


FIGURE C.2 - MONITOR WELL DRAWDOWNS

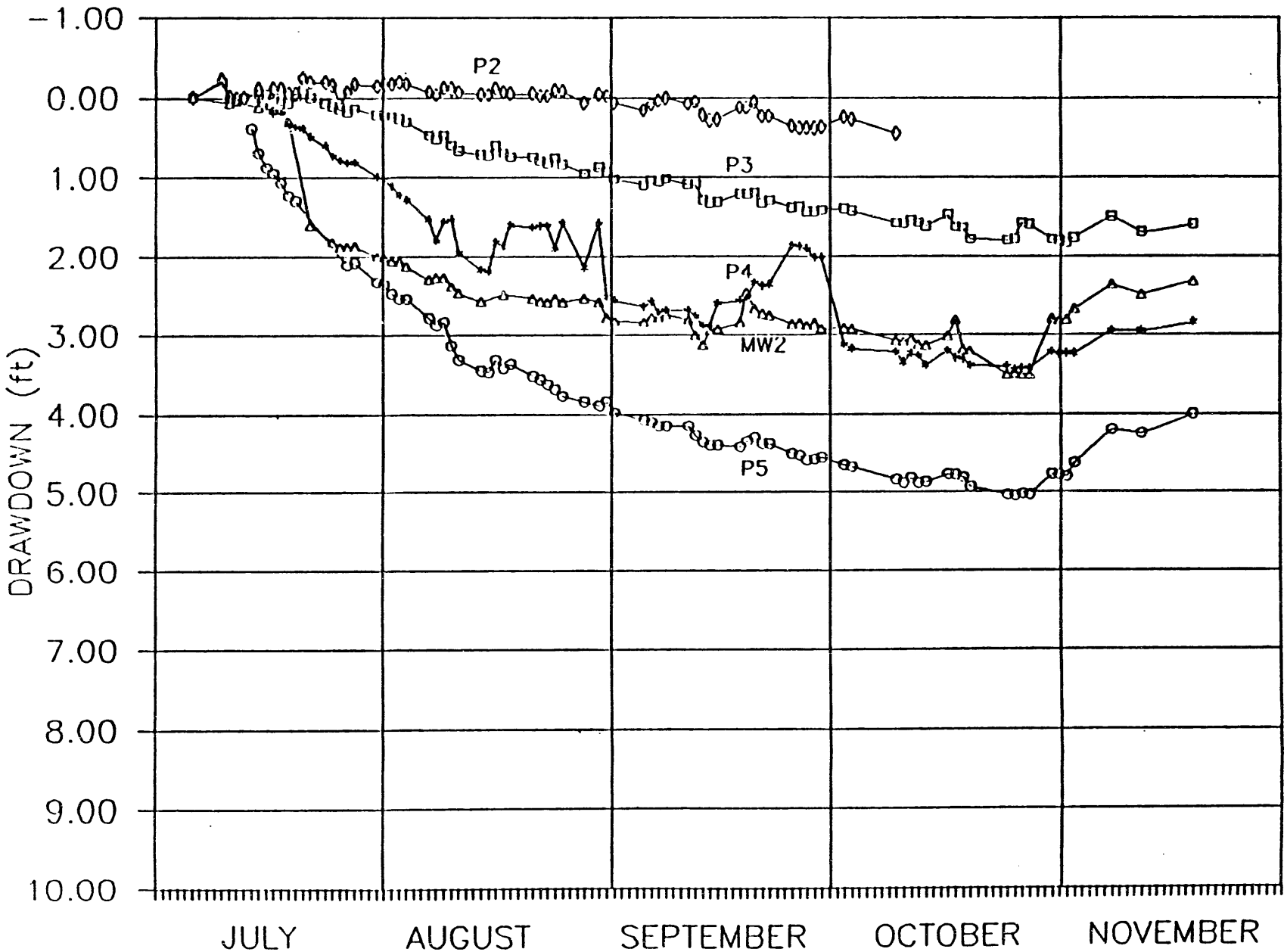


FIGURE C.3 - DRAWDOWN CONTOURS AS OF NOVEMBER 9, 1989

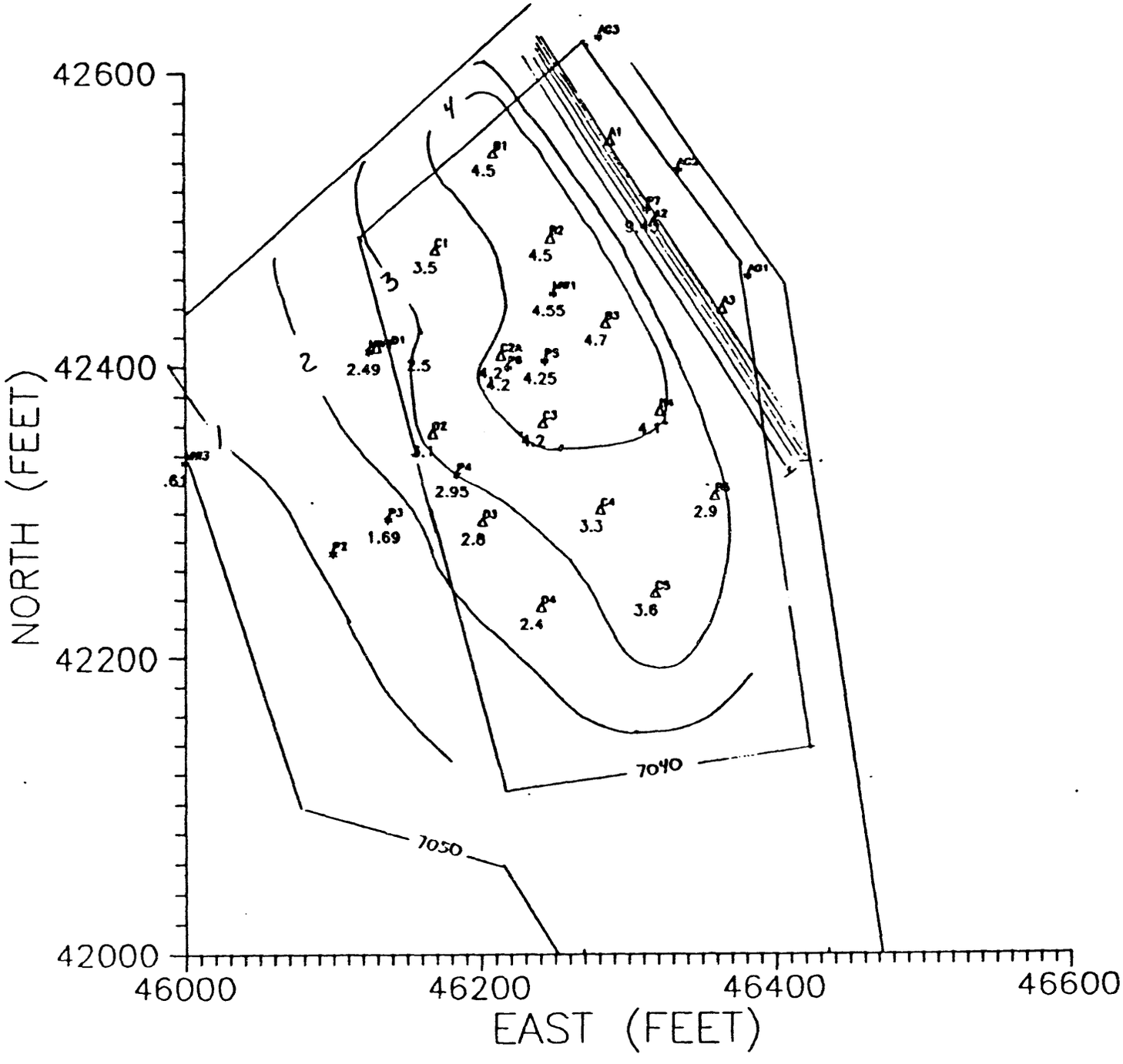


FIGURE C.4 - INDICATED PHREATIC SURFACE (IPS), NOVEMBER 9, 1989

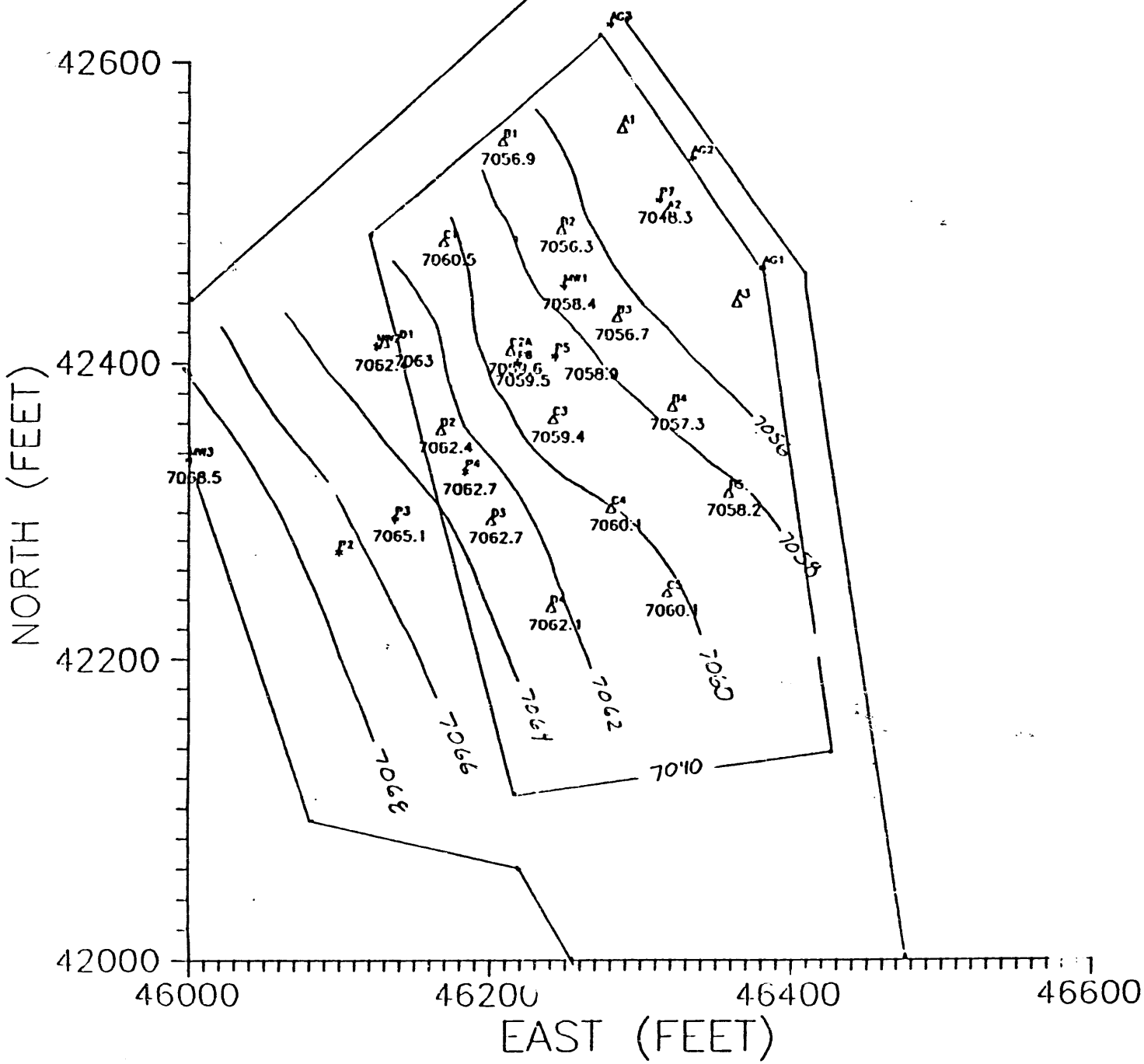
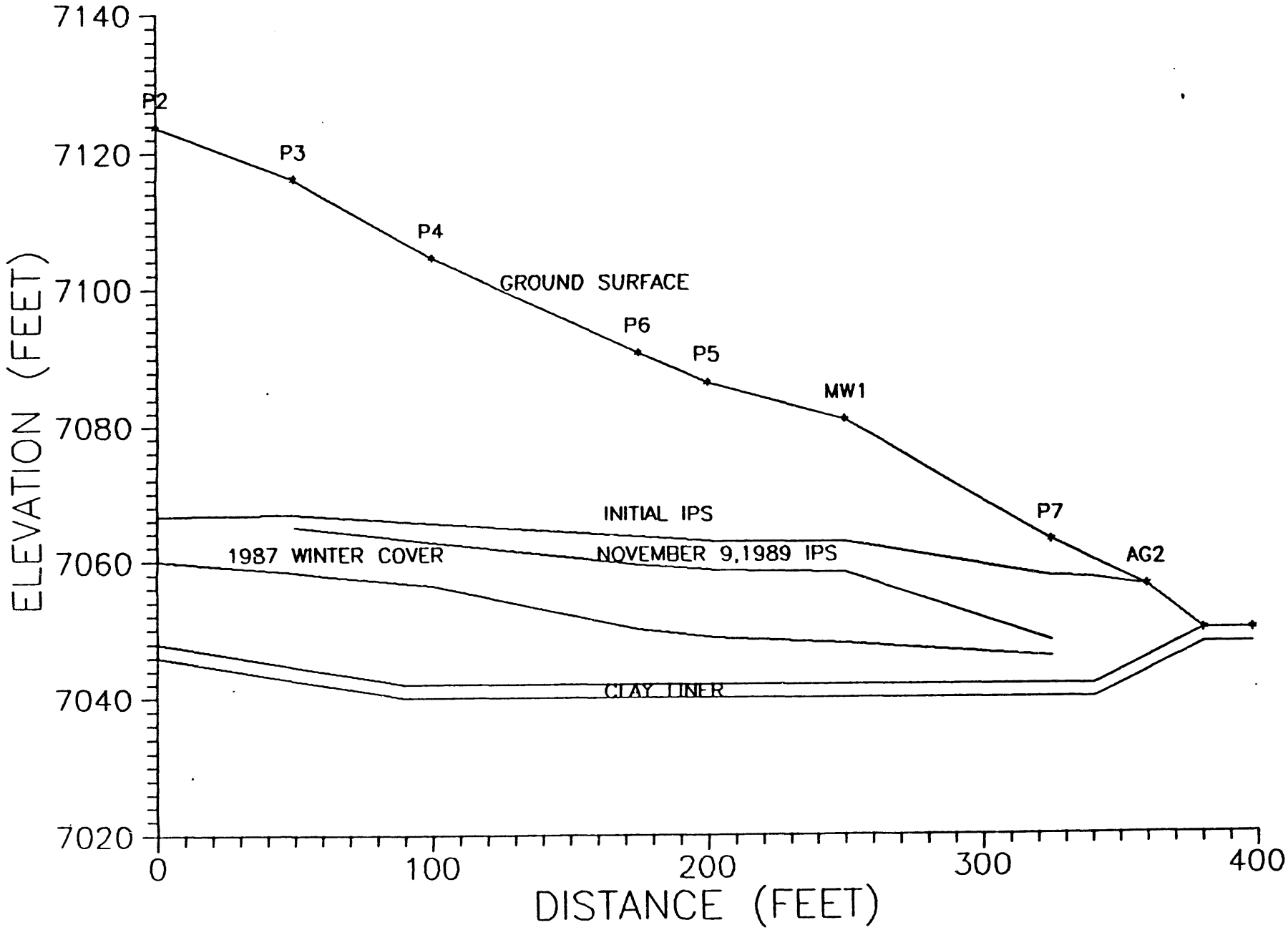


FIGURE C.5 - CROSS-SECTION OF OBSERVATION HOLES' DRAWDOWNS



APPENDIX D

CHRONOLOGY OF THE DEWATERING EFFORT AT DURANGO DISPOSAL EMBANKMENT

September 30, 1988 - Seep observed along eastern side of Durango disposal cell.

October 6, 1988 - MKE requested to evaluate seep.

October 10, 1988 - Site visit by MKE.

Determine the source of the seep and propose a plan of action. The water observed in the cell was thought to have originated from water used for dust control (approximately 80,000 gallons per day) and water used for compaction. The line of seepage was coincident with the edge of the low permeability liner on the east side of the embankment. The conclusion was that the lower regions of the cell were filling with water and the water was seeping out along the top of the low permeability liner. Five shallow exploration holes were augered immediately upslope of the seep to evaluate the piezometric surface.

October 28, 1988 - Specifications prepared for the installation of four monitoring wells for collection of water level and water quality data.

November 7, 1988 - Specifications changed to include seven monitoring wells.

November 21-29,1988 - Six groundwater monitoring wells (MW) installed. A seventh well was abandoned during installation due to obstructions.

January 12,1989 - Meeting in Albuquerque. (DOE, TAC, MK-F, MKE)

Assuming 30% porosity TAC estimated 19,000,000 gallons of water in the pile. Flow through low permeability liner out bottom of pile estimated at 7.4 gpm. Sampled water from monitoring wells have concentrations of molybdenum, uranium, selenium, and thorium above MCLs. TAC recommends horizontal wells to dewater pile so as not to

interfere with construction. Pumping test proposed in existing monitoring wells to evaluate transmissivity and storage coefficient of the tailings.

January 1989 - Meeting in Albuquerque.(NRC, CDH, DOE, MKF, TAC)

Meeting held to discuss groundwater issues. NRC wants to see documentation that confirms that the seep is not groundwater. MK-F indicates information would be presented to NRC using groundwater measurements. NRC informed that the RAC was evaluating horizontal drains and vertical pumping for dewatering.

February 6-10, 1989 - Pumping test in monitoring wells MW1 and MW2.

February 24, 1989 - Meeting in San Francisco. (DOE, CDH, MKF, MKE, TAC)

Five alternatives for removing water presented by MKE: 1) ejector system, 2) deep wells, 3) horizontal drains, 4) toe drain, and 5) ejector system plus toe drain. Of the five dewatering schemes presented only the ejector system or deep wells could dewater the cell in a relatively short period, approximately 3 to 4 months estimated after installation. These two methods would seriously impact the construction schedule however and additional water would infiltrate through the cell during subsequent construction.The following preliminary estimates were presented:

- 15 million gallons of drainable water in tailings.
- vertical leakage approximately 10000 gallons per day.
- no stability or settlement problems if the water were not removed.

Consensus was reached on the following items:

- cover to be placed during 1989 season.
- seepage area to be drained before placement of radon barrier via a toe drain.
- funds could be more effectively used for downgradient removal of water than dewatering pile.

March 24, 1989 - Meeting in Albuquerque. (DOE, NRC, CDH, MKF, MKE, TAC)

The five dewatering options were presented to the NRC. Comments from the NRC included the following:

- Deep wells and ejector systems not mandated due to impact on construction.

- o Cover to be placed in 1989.
- o If groundwater compliance downgradient became a problem, a system to intercept and pump back the contaminated water would be required.

The two options considered for dewatering included horizontal drains and toe trench.

March 1989 - MKE continues study.

Assumptions used previously for evaluating behavior of the water in the cell included that the tailings were saturated free draining sand with a moderate to low permeability. The data however may indicate that large portions of the tailings may not be free draining and may have permeability much lower than assumed. Originally estimated quantities may be substantially overstated. The ultimate vertical leakage will probably be much less than the 15 million gallons originally estimated, possibly on the order of 1/3. Construction of toe trench recommended in order to facilitate placement of the clay cover in area of the seep and prevent hydrostatic pressure buildup in the cover.

April 12,1989 - Suggested attempt to dewater pile and further evaluate hydrological parameters of the tailings by pumping 18 of the originally proposed 54 vertical well system. Wells proposed to be installed in the sump area of the pile where the bottom contour is 7040', a natural low drainage point where most of the water accumulates. Assuming K=6 gpd/ft^2 and storage coefficient = 20% it was estimated that 1.8 million gallons of water could be removed before the 1990 construction season. MKE also suggested an appropriate program for instrumentation, field observation, and laboratory testing to be coordinated with installation and operation of the pumping wells. These actions were proposed to assist in obtaining information for future decision making concerning dewatering of the pile.

April 17, 1989 - Meeting at Durango. (DOE, CDH, MKF, MKE, TAC, Nielsons)

CDH wants to get underway with dewatering as soon as possible. The dewatering system is to include 17 pumping wells and 6 monitoring wells. Benefits of the system include:

- o Minimal delay of construction.
- o Dry up seep at toe.
- o Begin to dewater pile.
- o Accumulate data for design of more extensive or alternate dewatering system if required.
- o Obtain additional information on hydrological

properties and conditions in the tailings.

April 18, 1989 - Meeting at Durango. (MKE, MKF, Nielson)

System reduced to 17 wells. Prediction that in 2 to 3 months of pumping a high percentage of recoverable water will be removed from the pile.

April,1989 - Studies MKE (Review evaluation of data)

Water levels in monitoring wells from November 29 to December 14 were compared to estimated drawdown in wells that would have resulted from vertical leakage through the low permeability liner. Theoretical drawdowns should have been .9 to 1.8 feet. Actual drawdowns were 0 to 1 foot. Conclusion is that vertical leakage is significantly less than estimated.

May,1989 - Studies MKE (Review and evaluation of data)

Water levels do not necessarily indicate that materials below the indicated water surface are saturated. Questions put forth whether some parts of the tailings are not saturated. Air entrapment in the tailings is hypothesized as a possible mechanism for preventing downward migration of percolating water.

May 30, 1989 - Letter to DOE from MKF

Attached report which outlines recommended instrumentation for the 17 well dewatering test and data collection procedures. Included in this letter is a suggestion to perform a laboratory drainage test to try to directly observe water flow through the tailings.

June 8, 1989 - Meeting at Durango, DOE MKF MKE TAC Nielson

Preconstruction meeting for 17 well dewatering program. Pumping test proposed as soon as monitoring wells constructed.

June 14-29, 1989 - Six piezometer wells installed. (P2-P7)

June 22 to July 14,1989 - Seventeen pumping wells installed.

June 29, 1989 - 8-hr pumping test at well C2-A
(monitoring in piezometers P5 and P6)

July 14, 1989 - Two day pumping test at wells C1 through C5 (monitoring in Piezometers P5 and P6-B)

July 14, 1989 - Started continuous pumping on wells C1-C5.

July 18, 1989 - Started pumping on wells A1-A3 and B1-B5.

July 19, 1989 - Started pumping on wells D1, D3 and D4.

August 1, 1989 - Started pumping on well D2.

August 9-14, 1989 - Vacuum test on C2-A through C5.

August 31, 1989 - Recovery test at pumping well C5.

September 5, 1989 - Meeting in Durango. (DOE, CDH, MKF, MKES, TAC) Discussed progress of dewatering effort.

September 6, 1989 - Recovery test at piezometer P6-B.

September 14, 1989 - Recovery test at pumping wells C1 and C4.

September 18, 1989 - Thirty hour recovery test on entire well field.

October 5, 1989 - Meeting in Durango. (DOE, CDH, MKF, MKES, TAC) Update on dewatering tests in Sept. and discussion of future work.

October 6, 1989 - Installation of well point system, shutdown of wells A1-A3.

October 19, 1989 - Well point system in operation.

October 26-27,1989 - Excavation of three test pits. Holding pond lined with clay.

October 26, 1989 - Wells on C and D lines shutdown for winter.

November 1, 1989 - Installation of toe trench begins in tailings embankment.

November 2, 1989 - Well line B shutdown for winter.

November 9, 1989 - Toe trench operational, well points shut off, and valve opened to holding pond.

November 16-17, 1989 - Well points grouted.

END

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