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SOUTHERN ILLINOIS INVESTIGATIVE SERVICES
PALZO SITE; AML-GsWA-9600J
WILLIAMSON COUNTY, ILLINOIS
SITE STUDY AND RECOMMENDATIONS

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Prepared for:

Illinois Department of Natural Resources
Office of Mines and Minerals

Prepared by:

Indeco, Inc.

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I. INTRODUCTION.

1. This report provides a summary of our findings of the site investigation at the Palzo Site in Williamson County near Marion, Illinois. The purpose of this study was two-fold: (1) to identify and delineate the sources and causes of the Acid Mine Drainage (AMD) which is discharging from the Palzo site into Sugar Creek; and (2) to provide the Agency with conceptual remedial alternatives and budgetary cost estimates for preventing the continual contamination at Sugar Creek by AMD. In order to perform this study it was necessary to: (1) review previous/existing data; (2) develop a site investigation program; (3) evaluate and analyze the investigation results; (4) prepare a geotechnical engineering report; and (5) provide conceptual remedial alternatives. An aerial photographic history of the site from 1951 (premining) through 1980 is shown in Appendix A. Drawing 10 in Appendix C shows an aerial view of the 1995 site conditions with the disturbed and undisturbed areas of the Palzo site being identified. Drawing 20 shows the site conditions and topography after completion of the Phase III Remediation Study in 1985 with the areas of previous and current remediation treatments identified. Existing site conditions in December 1997 are shown by photographs in Appendix B.

2. An agreed upon scope of work was prepared and submitted to the Illinois Department of Natural Resources in the Indeco letter dated 10 November 1997. The notice to proceed was given to Indeco by the Office of Mines and Minerals in a letter dated 21 November 1997.

II. SITE HISTORY.

3. The Palzo site is an abandoned surface mine tract which has had multiple phases of reclamation. The 312-acre site is located in southeast Williamson County, Illinois (T10S, R4E, Sec 16), approximately 6.5 miles southeast of Marion and 3.5 miles northeast of Creal Springs, Illinois (reference Drawings 5 and 10 for exact location). Its northern boundary lies along the south bank of Sugar Creek with its eastern and southern boundaries defined by County Highway 12 and a gravel county road respectively. The former Will Scarlett mining operation is located immediately adjacent to the east of County Highway 12 along the northern two-thirds of the Palzo site. The western boundary abuts private property along its entire length.

4. Aerial photograph (Plate A-1 in Appendix A, dated 2 June 1951) indicates that the site was apparently utilized for row crop farming and pastureland prior to conducting mining operations. The site was surfaced mined to recover the shallow Dekoven and underlying Davis Coal seams by the Stonefort Mining Company in the late 1950's through the 1960's which left approximately 270 acres unreclaimed at the completion of

the mining operations. Initial mining operations at the site consisted of extracting the upper Dekoven coal from a 60-acre tract located within the central portion of the site as shown on Plate A-2. This area was left unreclaimed and naturally revegetated. It now supports a mature growth of trees upon windrowed spoil banks and has been generally accepted as being reclaimed (reference Drawing 10 for location).

5. Subsequent mining operations affecting approximately 192 acres of the site removed both the upper Dekoven and underlying Davis Coal seams, although not in a contiguous manner. These areas are identified on Drawing 10 and shown on Plates A-3 through A-6. Certain portions of the site were mined by first removing the upper Dekoven Coal and then returning at a later date to remove the underlying Davis Coal seam. A 10 to 12-foot bed of pyritic black shale separated the two coal seams. The upper Dekoven Coal was immediately overlain by a brown, medium grained, sandstone which in turn was covered by unconsolidated, loess-derived, clay materials. The mining sequence and equipment utilized, resulted with the spoil materials becoming in part intermixed and created a classification/distinction of five (5) spoil types which were identified in subsequent field investigations and reclamation efforts. The mining operations left the western portion of the site with spoil banks covered by acidic shales which readily attributed to the acid runoff into Sugar Creek. However, mining along the northern edge of the tract (adjacent to Sugar Creek) was characterized by a distinctive overburden handling sequence resulting in approximately one-half of these spoil banks (most occurring in the eastern half) being capped with the loess derived clay materials. Surface runoff from this area also resulted in acidic discharge to Sugar Creek.

6. In 1966, the United States Forest Service acquired the Palzo site from the Stonefort Mining Company and incorporated it into the Shawnee National Forest. At that time, the site contained approximately 192 acres of exposed acid spoil, 60 acres of naturally revegetated strip mined land and 60 acres which consisted of roads or undisturbed natural vegetation. Since becoming Forest Service land, the Palzo site has undergone a number of studies, field investigations and reclamation projects. A brief summary of the more significant projects is provided as follows.

- 1970. The Illinois Sanitary Water Board requested the Forest Service to end acid drainage from the Palzo site. In the fall of that year, test plots utilizing lime, commercial fertilizers and treated municipal waste (sludge) were established (reference Plate A-4).

- 1972. An environmental statement was filed proposing large scale treatment of the unreclaimed 192 acres with sludge obtained from the Metropolitan Sanitary District of Greater Chicago (MSDGC).

- 1972-1974. Site grading was performed as part of the U.S. Forest Service Job Corp Heavy Equipment Operators vocational training program (reference Plate A-5).

- 1975-1977. PHASE I RECLAMATION. Actual incorporation of sludge obtained from the Metropolitan Sanitary District of Greater Chicago (MSDGC) on a contractual basis occurs (reference Plates A-5 and A-6).

- 1980-1982. PHASE II RECLAMATION STUDY. Two test plots utilizing sewage solids (55 percent and 30 percent solids "Nu Earth") were established to evaluate application methods and vegetation success. A three-part feasibility study was initiated by the Abandoned Mine Lands Reclamation Council to aid in selecting an effective and economically acceptable reclamation alternative for Palzo – Phase II.

- 1985. PHASE II RECLAMATION - Contract AML-GWmE-8450. This work entailed clearing, trash and debris removal; 285,000 c.y. earth excavation; 43,300 c.y. rock removal; ditch excavation; riprap placement; excelsior blanket; surface and deep lime incorporation; fertilizing; seeding; mulching and other site incidentals.

- 1986. PHASE III RECLAMATION - Contract AML-GWmE-8454. This work entailed 960 c.y. earth excavation; trench treatment and backfill; riprap placement; earth dam construction; surface and deep lime incorporation; fertilizing; seeding; mulching and other site incidentals.

- 1987. PALZO SURFACE MINE REMEDIAL RECLAMATION - CONTRACT AML-GSwE-8725A. This work entailed limestone incorporation; excelsior blanket; fertilizer; seeding; mulching and other site incidentals.

III. SITE RECONNAISSANCE.

7. During the two-week subsurface investigation in December 1997, a thorough site reconnaissance was performed to identify all on-site impoundments, streams, creeks, seeps, etc. and identify surface conditions that may be contributing to the AMD. Appendix B – Project Photographs, provides a pictorial account of some of the potential "problem areas" for the AMD. The site reconnaissance indicated that the Palzo site is, in general, well vegetated. There are a few areas where no vegetation is present. In these areas, black shale, rock fragments, boulders and overburden materials have been exposed. For the most part, these areas are located where the site access roads

were present. The exceptions are some eroded slopes adjacent to the western drainageway along with some barren spoil piles through which the drainageway flows. It appears that these slopes will continue to erode and expose new material to surface water runoff. Acidic water was noted seeping into the drainageway which ultimately discharges into Sugar Creek. The acidic water was noted to be seeping in both August and December 1997. The pH of this water was measured with a portable pH meter and ranged from 2.8 to 3.4. Samples were also collected for laboratory analysis with the results presented in Section X of this report. There was also acidic water noted to be seeping into Sugar Creek along the northern perimeter of the site. The pH of the seeping water varied from 2.8 to 3.1 while the pH of Sugar Creek in this area ranged from 5.1 to 7.0 as measured with the portable pH meter.

IV. FIELD INVESTIGATION.

8. The proposed boring layout was finalized and staked in the field by Indeco with the boring locations selected in an effort to identify the sources and causes of the AMD and to develop a cross sectional profile to adequately delineate those areas creating and/or contributing to the site's AMD problem. The final boring locations and surface monitoring points are shown on Drawing 30. Indeco mobilized to the site and began the subsurface exploration on 1 December 1997.

9. A total of fifteen (15) borings were drilled for the site investigation using a CME 55/ATV track mounted drill rig. The borings were advanced in the soil with 4.25-inch I.D. hollow stem augers (HSA). Soil samples were taken with either a continuous sampler, a Shelby tube, or from the auger cuttings. The depth of the borings ranged from 19 to 64 feet deep, depending upon the depth to groundwater, mined depth and depth to bedrock. The locations of the borings, as determined by Indeco, are shown in reference to existing features, Drawing 30. Borings that were converted to monitoring wells are identified as MW-97-X, where (X) is the monitoring well number. For borings that were not converted, the boring number (X) is identified by the last numeric character in the boring identification (i.e. B-97-X). In Appendix F, Chemical Analyses, analyses on soil samples are referenced to the boring number before conversion to a monitoring well (i.e. B-3 for B-97-3) while water samples are referenced to the boring after conversion to a monitoring well (i.e. MW-3 for MW-97-3).

10. During drilling of the exploratory borings, samples of the subsurface soils were obtained by using 4.0-inch O.D. continuous samplers or by pushing 3.0-inch O.D. Shelby tubes. The continuous samplers were used in order to obtain a complete vertical profile of the boring, while the Shelby tubes were pushed at selected locations to obtain a relatively undisturbed sample to be used in a laboratory test to determine vertical permeabilities. In the field, calibrated hand penetrometer values were taken to

estimate the unconfined compressive strength of cohesive soil samples. Boring logs with descriptions of subsurface soils, field test results, and water level observations were recorded in the field, and are provided in Appendix D.

11. Fourteen (14) of the borings were converted to monitoring wells (MW-97-1 thru MW-97-14) consisting of 2-inch diameter schedule 40 PVC screen (0.010-inch slot size) 10 feet long with a sand filter, a bentonite pellet seal, and 2-inch diameter schedule 40 PVC riser to above ground surface with protective covers and locking caps. Upon completion of the well installation, each monitoring well was developed by surging and/or bailing the well. Monitoring well construction diagrams are shown on the logs in Appendix D.

12. A Total Station (transit/level) setup and a portable GPS instrument were utilized to determine the location and elevation of each monitoring well or boring. The results of this survey are indicated on the logs in Appendix D. The purpose of this was not only to determine the location of the monitoring wells and boring in reference to the existing map, but to also ensure accurate groundwater elevations and analytical data were obtained.

13. Stratification boundaries indicated on the boring logs and shown cross sections developed on Drawings 100 through 107 were based in part through prior research documents, on observation during drilling, an extrapolation of information obtained by inspecting samples from the borings, and comparisons of similar engineering characteristics.

V. FIELD AND LABORATORY TESTING.

14. After the monitoring wells had been developed and allowed to recharge, each well was sampled. At least 3 well volumes of water were removed from each monitoring well prior to sampling. Upon completion of the groundwater sampling operations, each well was slug tested to determine its in-situ horizontal permeability. This generally involved placing a slug of known dimension into the well, displacing the groundwater inside, and recording the time duration for the groundwater to achieve a state of equilibrium. Upon reaching equilibrium, the slug was removed from the well, displacing the groundwater in the opposite direction, and again, the time duration for the groundwater to achieve a state of equilibrium was recorded. For monitoring wells in which the groundwater table was not high enough within the well itself in order to perform this test, the groundwater in the well was removed by bailing the well and the time duration was recorded for the groundwater to return to equilibrium. The results of the horizontal permeability from slug tests are summarized in Appendix G.

15. Soil samples taken from the borings were examined in our laboratory and visually classified in accordance with the Unified Soil Classification System (ASTM D2488). Tests were run on selected samples in order to categorize the site stratigraphy, develop a geochemical profile, and to identify the vertical permeability of both the backfill material and the shale bedrock. Laboratory classification testing of soil samples from the borings included moisture content, Atterberg limits, particle size analysis (hydrometer), sieve analysis, specific gravity, percent passing the No. 200 sieve, and constant head vertical permeability. The results of the field and laboratory tests are shown in Appendices D, E, and G. All tests, both field and laboratory, were performed in general accordance with applicable ASTM Standards.

16. Groundwater samples from all fourteen (14) monitoring wells and selected surface water points (see Drawing 30) were sent to the AMLR Division Laboratory in Benton, Illinois for chemical analysis. The chemical analysis performed depended upon whether or not the sample was filtered or unfiltered, but generally consisted of Total Aluminum, pH, Total Iron, Total Suspended Solids, Total Alkalinity, Total Acidity, Total Sulfate and Total Manganese (unfiltered only). In addition to the water samples, selected soil samples were forwarded for chemical analysis as well. The soil samples sent for chemical analysis were chosen based upon their depth relative to that of the groundwater table and their depth relative to the anticipated success of the previous reclamation efforts to buffer the upper backfill materials. The chemical analysis performed on the soil samples generally consisted of pH, Buffer pH, Sum of Bases/Cation Ion Exchange Capacity, Pyritic Sulfur, Potential Acidity, Net Alkalinity or Acidity, Neutralization Potential, Manganese Macro Nutrient And Iron Macro Nutrient. The results of the chemical analysis for both the groundwater and soil samples are provided in Appendix F.

VI. STRATIGRAPHY.

17. The geologic description provided for the Palzo Tract was developed utilizing a combination of resources including information received from the IL DNR Abandoned Mined Lands Council, Illinois Geological Survey, Southern Illinois University Cooperative Wildlife Research Laboratory and conducting a drilling and sampling field investigation.

18. The geology of the Palzo site prior to commencement mining operations consisted of a thin mantle of loess derived soils immediately overlying Des Moines Series, Pennsylvanian Age sandstone bedrock. The uppermost bedrock encountered was a brown, medium grained sandstone of the Spoon Formation. Immediately underlying the sandstone was the Dekoven Coal Member followed by 10 to 12 feet of black shale, which overlaid the Davis Coal Member of the Spoon Formation, followed by a gray to

black shale of indeterminate thickness. The Dekoven and Davis Coal Members were mined for many years along their outcrop in small operations and subsequently have been extensively surfaced mined in operations such as Palzo in portions of southern Saline, eastern Williamson and Gallatin counties. Where mined, the Dekoven and Davis seams are commonly 10 to 25 feet apart and generally, both seams have been mined simultaneously. The upper coal, the Dekoven, has an average thickness of 3 to 3.5 feet. The lower coal, the Davis, has an average thickness of 3.5 to 4 feet. The Dekoven and Davis Coals have been correlated stratigraphically with the Seelyville Coal further north and east.

19. Much of the Palzo site geology was altered by mining operations, with apparently only two (2) small portions of the site being not mined (see Drawing 10). The first area unaffected (approximately 10 to 12 acres) was located near the southwest corner of the property. The other notable area was a narrow band (150 feet x 1,200 feet) aligned in a north-south direction in the northwest portion of the site that drained into Sugar Creek. This narrow band was not mined, but was partially disturbed by grading operations and subsequent utilization as the on-site sludge storage pond. After completing the application of sludge, much of this narrow band was further graded (filled in) with mine spoil with the exception being the northern 300 to 400 feet, which drains into Sugar Creek. Drawing 10 and Plates A-3 thru A-6 show the locations of these areas.

20. Approximately 60 acres of the site had coal extracted only down to the first coal seam (Dekoven Coal Member). The mined overburden materials from this area were left in windrowed spoil piles and naturally revegetated. This area is located within the central portion of the tract (see Drawing 10 and Plate A-2). The remainder of the site (with the exception of the aforementioned locations) was mined to extract both the Dekoven Coal Member and the deeper lying Davis Coal Member of the Spoon Formation, which also necessitated the removal of pyritic black shale (10 to 12 feet thick) separating the two coal members. Drawing 10 and Plate A-3 exhibit the extent of this deeper mined region.

21. In general, select material handling of the overburden materials was not practiced during the mining operations. As such, the present site geology for the most part can be typified as backfill material overlying shale bedrock in an overall geologic sense. A great deal of prior work performed by others has documented the delineation and classification of the near surface ("soils") unconsolidated materials. In areas from which both the Dekoven Coal Member and the Davis Coal Member were extracted, the unconsolidated materials consisting of silts, clays, sand and rock fragments (sandstone, gray and black shale) are intermixed and lie directly upon gray shale bedrock. This gray shale bedrock was encountered in borings MW-97-2, -4, -6, -7, -9,

and –11 thru –14, and B-97-15 and is presumed to be continuous throughout the site (reference Drawings 100 thru 107 for typical cross sections of this area and Appendix D for boring logs).

22. Several existing reports indicate that in the western one-third of the site (termed Phase I) where both coal seams were mined, ungraded spoils were covered by the acid shales which directly overlaid the Davis Coal Member. The mine cuts were oriented in a north-south direction in this area and are shown on Plate A-3. It can be seen on Plate A-3, that the spoilbanks are windrowed, with the appearance of dark areas on the spoilbanks being the presence of the acidic black shale. It can be inferred that the mining sequence resulted with the uppermost overburden materials encountered being deposited within the bottom of the adjacent mine cut, and since the black shale was the last to be extracted, it was placed near the top of the spoil bank. However, site grading was performed as part of the U. S. Forest Service Job Corp Heavy Equipment Operators Vocational Training Program and as a result, altered the overburden spoil pile "sequence" with the overburden being intermixed and characterized as "backfill". This is born out in the boring logs and supported by the soil analytical test results. When comparing the soil test results for samples 2, 3 and 4 in MW-97-12 for a vertical profile as well as comparing soil sample 3 in MW-97-12 (El. 472.8) and soil sample 2 in MW-97-7 (El. 473.3) in Appendix D, a wide variation is noted. Plate A-4 shows a portion of the Phase I area being graded.

23. As mining operations shifted east of the Phase I area into the northern and eastern portions of the site (termed Phase II), the orientation of the mining generally was performed in an east-west manner for the northern two-thirds and in a north-south orientation for the eastern one-third. This can be seen in Plates A-3 and A-4. Existing reports regarding this area indicate the Phase II mining operations generally followed the same sequence as that utilized in Phase I with the exception being approximately 50 percent of the spoilbanks located within the eastern half were capped with clay spoils originating from the uppermost overburden loess deposits. This is evidenced on Plates A-3 and A-4 by the natural vegetation growth that is seen on the spoilbanks in this area prior to any reclamation. However, as with the Phase I area, the U. S. Forest Service Job Corp Heavy Equipment Operators Vocational Training Program graded this area and altered the original patterns and locations of clay spoil cover, as well as, the acid producing shales and sandstones on lower and mid slopes on the spoilbanks. Plates A-5 and A-6 show the area with different stages of grading being completed. The grading lent itself to "intermixing" of the unconsolidated spoilbank materials (backfill). Our site investigation borings bear this out, as well as, the laboratory analytical soil test results (reference Appendices D and F for boring logs and chemical analyses test results).

24. In that portion of the site from which only the Dekoven Coal Member was extracted, the unconsolidated materials are presumed to be lying directly upon the pyritic black shale which separated the two coal seams. The area unaffected by mining operations in the southwest corner of the site has a thin mantle of loess derived soils overlying sandstone of the Spoon Formation followed by interbedded shale/sandstone lenses, which overlie the Dekoven Coal Member, black shale and underlying Davis Coal Member. The other portion (the narrow band in the northwest portion of the site) of the tract unaffected by mining operations has the same stratigraphic sequence with the exception of backfill materials (silts, clays, sand and rock fragments) which lie directly upon the in-situ unconsolidated material.

VII. PERMEABILITY.

25. **General.** Field permeability tests to determine horizontal permeability were performed on each of the monitoring wells with the results contained in Appendix G. In addition, laboratory permeability testing was performed on selected soil samples to determine the vertical permeability with the results also shown in Appendix G.

26. **Vertical Permeability.** The vertical constant head permeability testing was performed on three (3) Shelby tube samples, two (2) of which were representative of the backfill material and the other was a shale representing the bedrock encountered below the Davis Coal Member. The vertical permeabilities of the backfill material had nearly identical values of 2.18E-05 cm/sec and 2.34E-05 cm/sec for samples that were obtained approximately 10 feet and 5 feet below ground surface in borings MW-97-5 and MW-97-13, respectively. The vertical permeability of the shale bedrock had a value of 1.32E-07 cm/sec. This sample was obtained from a depth of 39.5 feet from MW-97-14.

27. **Horizontal Permeability – Backfill.** The average horizontal permeability values of the monitoring wells drilled into and screened within the backfill material (MW-97-1 thru MW-97-10 and MW-97-13) ranged from 2.48E-02 cm/sec to 2.56E-05 cm/sec with an overall average of 3.64E-03 cm/sec. Both slug-in and slug-out test results were utilized to determine the average permeability value with the exception of monitoring wells MW-97-1, MW-97-2 and MW-97-6 where only slug-out values were utilized. Monitoring well MW-97-1 only had 2 data points for the slug-in test, which was not felt to be an adequate data set, while only slug-out tests could be performed on wells MW-97-2 and MW-97-6, due to the extremely low water levels existing within the wells. The test values are presented in Appendix G according to increasing monitoring well/screen depth in order to determine if there was any correlation of depth and permeability. No correlation was apparent.

28. When comparing the horizontal permeability values to vertical permeability values, it can be seen that the average horizontal permeability value of monitoring well MW-97-13 (2.48E-04 cm/sec) reasonably compared (factor of 10) to the vertical permeability value (2.34E-05) on this well. The vertical permeability test was performed on a soil sample obtained from approximately 5 feet below ground surface (approximately 4 feet above the screen) while the horizontal permeability was performed within the screened interval, which extended from 9 to 19 feet. However, the average horizontal permeability value of monitoring well MW-97-5 (2.48E-02 cm/sec) was much greater (by a factor of 1,000) than its vertical permeability value (2.18E-05 cm/sec). The vertical permeability test was performed on a soil sample obtained from approximately 10 feet below ground surface (within the screened interval) and the horizontal permeability was performed within the screened interval, which extended from 9 to 19 feet. This fact, coupled with the wide variation seen in horizontal permeability test values, depicts the extremely variable nature of the backfill in-place at the site. This was also evidenced and supported during the exploratory field drilling where sand, clay, sandstone boulders and shale rock fragments were randomly encountered.

29. Monitoring wells MW-97-1 through MW-97-10 and MW-97-13 are considered shallow monitoring wells, which were installed within unconsolidated materials. Monitoring wells MW-97-4, MW-97-6, MW-97-7 and MW-97-9 had well/screens installed partially within the bedrock and partially within the unconsolidated materials. Their screens were partially installed within the bedrock to a depth of 2, 5, 3.5 and 5 feet, respectively. Although the installation into the bedrock would not be expected to affect the measurement of groundwater within the unconsolidated materials, it does apparently affect the horizontal permeability, as can be seen in Appendix E. The horizontal permeabilities of monitoring wells MW-97-6 and MW-97-9 were 2.56E-05 and 4.48E-05, respectively. These values were higher than those monitoring wells screened entirely within the bedrock (except MW-97-11) but lower than the monitoring wells that were screened entirely within the unconsolidated materials. It appears that the 5-foot embedment of wellscreen into the bedrock was sufficient to affect horizontal permeability.

30. The existing data would indicate that the vertical permeabilities are lower than the horizontal permeabilities for like materials, and this is what would generally be expected. However, it should be pointed out that due to random nature (clay to boulders) of the backfill existing at the site, there may well be areas/pockets where the horizontal permeability value is less than the vertical permeability. The higher average horizontal permeability value indicates that the groundwater moves through the site fairly quickly (~12 feet/day) with the lower vertical permeability rates lending itself to less surface infiltration and more surface runoff. This (greater surface runoff) is also enhanced by the overall good vegetation growth present at the site.

31. **Horizontal Permeability – Bedrock.** The horizontal permeability testing was performed on each monitoring well installed, twelve (12) of which were drilled down into and screened within the backfill material and two (2) which were drilled and screened within the shale bedrock. The horizontal permeability testing consisted of both a slug-in (falling head) test and a slug-out (rising head) for each well, where possible. For those monitoring wells which did not have a sufficient quantity of water initially, (MW-97-2 and MW-97-6) a slug-out (rising head) test was the only field permeability test performed. The average (slug-in and slug-out) horizontal permeability values of the three (3) monitoring wells within the bedrock was 3.59E-03 cm/sec for monitoring wells MW-97-11, MW-97-12 and MW-97-14. This was a rather unexpected high value for the bedrock wells. However upon closer examination, it can be seen that MW-97-11 had an extremely high value, which greatly increased the average permeability value for all three wells. It should be pointed out that the wellscreen for MW-97-11, although located within the bedrock, was close to the surface of the previous mining operations. When exposed, this shale surface could have been weathered and fractured thus providing avenues for water movement and increased permeability values. It could also have been fractured by drilling and blasting from mining operations. Another plausible explanation is that the wellscreen spans a thin sand seam and/or coal seam which was not noted during the drilling from 24 to 34 feet in depth where no sampler was utilized due to plugging of the drill tools. This seems likely when given the low pH and extremely high concentrate levels of acidity and iron present in MW-97-11. Any one of these explanations or a combination thereof would readily explain the high horizontal permeability measured in monitoring well MW-97-11. It was evident at the site that the groundwater readily moves through the sandstone as evidenced by the groundwater seeps present at the northern perimeter. Past experience with coal seams has shown them to be blocky and fractured, oftentimes having high permeability values.

32. When examining monitoring well MW-97-12 and MW-97-14 separately, their values are 7.62E-06 cm/sec and 2.28E-06 cm/sec. These wells exhibit what is considered to be a low horizontal permeability. The horizontal permeabilities reasonably compared (factor of 10) to the vertical permeability of MW-97-14 (1.32E-07 cm/sec), thus indicating that the shale bedrock at the site which is not located close to the prior surface of mining operations, is fairly "tight" and of low permeability.

VIII. SOIL GEOCHEMISTRY.

33. Analytical laboratory testing was performed upon thirty (30) selected soil samples in order to evaluate the geochemical conditions of the site. Multiple samples were selected from each boring with the exception of boring MW-97-13 which is located within ~ 5 feet of boring MW-97-12. The results obtained from boring MW-97-12 can be extrapolated to represent the in-situ conditions existing at boring MW-97-13. The

test results are shown in Appendix F, Worksheets 5 thru 10. The analytes tested for included pH, Buffer pH, Neutralization Potential, Percent Pyritic Sulfur, Maximum Potential Acidity, Net Alkalinity/Acidity and CEC (Cation Exchange Capacity).

34. The soil pH values ranged from 2.66 to 6.51 with an average value of 3.71. This is considered to be acid-toxic (as defined by Sobek and Skouser, et al., 1987) since it is less than 4.0. The wide variation of pH values was observed to occur regardless of sample depth as seen on Worksheet 10 in Appendix F. The buffer pH values ranged from 3.80 to 7.44 with the average value being 5.21. By measuring the change in pH of a buffer caused by the acids in a soil, Shoemaker, McLean and Pratt (1962) determined the lime requirement of a soil. The lime requirement is obtained by reading directly from a table based upon the pH of a soil after the S.M.P. buffer has been added. It was interesting to note that the average buffer pH value steadily increased (5.05-5.60) as the depth increased for the test samples obtained from 0 to 19 feet. From 19 to 29 feet in depth, the average buffer pH value decreased (4.42 and 4.70), then continued its trend of increasing average values (5.71 and 6.82) as the depth increased from 30 to 44 feet, as shown on Worksheet 10 in Appendix F. It was also noted that the average pH value of the groundwater was approximately 1 pH unit greater (4.72 vs. 3.71) than the average soils pH value and 0.5 pH unit less than the average buffer pH value as shown on Worksheet 6 in Appendix F.

35. Neutralization potential values ranged from a deficiency of –16.50 tons to an excess of 26.40 tons of CCE (calcium carbonate equivalent), the average value being a deficiency of -0.53 tons of CCE. The excess average neutralization potentials values seen on Worksheet 10 in Appendix F, are at depths of 14 to 19 feet, 30 to 39 feet and 39 to 44 feet and for the most part exhibit the alkaline characteristic of the gray shales and bedrock. Sample #3 from boring MW-97-12 taken from the 14 to 19-foot depth readily shows this effect.

36. In general, the pyritic sulfur content was shown to be high with an overall average value of 1.46 percent. The test values ranged from 0.00 to 5.22 percent with a random scatter of values as would be expected within the backfill material with no readily apparent correlation. However, it can be seen that the black shale contains high concentrations of pyritic sulfur as shown from the values (3.84 percent and 3.98 percent) exhibited from samples obtained from the black shale from borings MW-97-1, sample 6 and MW-97-11, sample 5. This has also been documented in other studies. The percent pyritic sulfur values of the soil samples tested translated into maximum potential acidity values that ranged from 0.0 to 163.1 tons of CCE, the average value being 45.62 tons CCE (reference Appendix F, Worksheets 5 thru 10).

37. The acid-base accounting reveals an overall net acidity (-) value of –46.15 tons of CCE as shown on Worksheets 5 thru 7 in Appendix F. Based upon the overall net acidity (-) or alkaline value, a recommendation of lime application was determined by the Benton Laboratory and is shown on Worksheet 7 in Appendix F. Worksheet 10 depicts the acid-base accounting results with respect to increasing depths.

IX. GROUNDWATER GEOCHEMISTRY.

38. Groundwater and surface water samples were obtained from each monitoring well and at various surface water locations as shown on Drawing 30 in order to evaluate the geochemical conditions. The analytes tested for included pH, Acidity, Total Alkalinity, Total Suspended Solids (TSS), Sulfate, Total Iron, Total Manganese and Total Aluminum. A single round of groundwater sampling and testing was performed in December 1997. Monitoring well MW-97-14 was sampled and tested a second time in March 1998 due to values reported from the December 1997 sampling event. Two (2) separate rounds of surface water sampling were performed in December 1997 and again in March 1998. The sampling performed in December 1997 was conducted during wet, rainy, inclement weather with high flows present in drainageways and in Sugar Creek. The sampling performed in March 1998 was conducted in dry weather with significantly lower flows occurring within both the drainageways and Sugar Creek. Laboratory test results of the groundwater and surface samples are contained in Appendix F, Worksheets 1 thru 4, 8 and 9.

39. The groundwater laboratory test results are presented in their entirety on Worksheet 1 in Appendix F and are summarized in plan view on Drawing 301. Worksheets 2 and 4 in Appendix F present the groundwater data from those wells that are located within the western portion of the site. Worksheet 4 includes monitoring wells MW-97-4 and MW-97-10 which are not immediately adjacent to the western drainageway, but do reflect overall groundwater conditions present within the western portion of the site. The values reported for the western drainageway in this report reflect test values shown on Worksheet 4 unless otherwise noted. Worksheet 3 presents the groundwater data from those wells located along the northern perimeter of the site since these have been areas where seeps have been noted and where surface water is discharged into Sugar Creek which borders the northern perimeter of the site.

40. The laboratory test results for the groundwater yielded an average pH value of 4.56, with a range of 3.80 to 7.16 as seen on Worksheet 1. The western wells yielded an average pH value of 4.94 with a range of 3.96 to 7.16 as seen on Worksheets 4 and 8. The northern perimeter wells had an average pH value of 4.36 ranging from 4.06 to 4.78 as seen on Worksheets 3 and 9. The groundwater from those wells located in the western portion of the site had a 0.58 greater pH value than that groundwater tested

.from the northern perimeter monitoring wells. It is interesting to note that the average groundwater pH value for the western monitoring wells was 2.25 pH units greater than the surface water tested in the western drainageway as seen on Worksheets 4 and 8. The average groundwater pH value from the monitoring wells located along the northern perimeter of the site was 1.44 pH units greater than the surface water average pH values as seen on Worksheets 3 and 9.

41. The average groundwater acidity value was 1,329.29-mg/L $CaCO_3$ and ranged from –150.00 to 2,790.00-mg/L $CaCO_3$ as shown on Worksheet 1. The average groundwater acidity value for the western portion of the site was 885.71 and ranged from –150.00 to 1,670.00-mg/L $CaCO_3$, with the northern perimeter wells averaging slightly higher at 1,265.00 with a range of 1,010.00 to 1,535.00-mg/L $CaCO_3$ (reference Appendix F, Worksheets 1, 3, 4, 8 and 9).

42. The average total alkalinity value of the groundwater was reported as 60.04-mg/L $CaCO_3$ and ranged from 0 to 1,570-mg/L $CaCO_3$ as shown Worksheet 1. The western perimeter average groundwater value was 105.83 with a range of 0 to 615.0-mg/L $CaCO_3$. The northern perimeter groundwater value was 1.50-mg/L $CaCO_3$ with a range of 0 to 4.50-mg/L$CaCO_3$ (reference Appendix F, Worksheets 1, 3, 4, 8 and 9).

43. Total suspended solids (TSS) in the groundwater were sampled and tested with an overall average value of 43.93-mg TSS/L and a range of 1.00 to 158.00-mg TSS/L being reported and shown on Worksheet 1. The western perimeter groundwater wells had an overall average of 42.93-mg TSS/L with a range of 6.0 to 158.00-mg TSS/L as shown on Worksheets 4 and 8. The northern perimeter groundwater wells showed an average value of 33.83-mg TSS/L with a range of 11.50 to 53.00-mg TSS/L as seen on Worksheets 3 and 9. The test results received from the testing laboratory indicated that the tests for TSS were performed on filtered samples for monitoring wells MW-97-1 thru MW-97-13, and performed on both filtered and unfiltered samples for monitoring well MW-97-14 during the December 1997 sampling session. The filtered TSS value for MW-97-14 was reported as 82.0-mg TSS/L as compared to the unfiltered value of 130.00-mg TSS/L for the December 1997 water sample. When monitoring well MW-97-14 was sampled in March 1998, TSS values were calculated for only an unfiltered sample as is normal. It is interesting to note that the reported TSS value in March was 696.00-mg TSS/L.

44. The average sulfate value of the groundwater was reported to be 278.56-mg/LSO_4^2, which is slightly higher of the drinking water standard of 250-mg/LSO_4^2, and had a range of 1,857.00 to 140.80-mg/LSO_4^2. Only monitoring well MW-97-14 had a value reported to be above the drinking water standard. Its values were reported as 1,857 and 2,197-mg TSS/L for the December and March sampling events. The rest of

the monitoring wells all had reported values of less than 200-mg TSS/L. The average sulfate value of the western perimeter groundwater wells exhibited a value of 152.86-mg/LSO_4^2, which is well below the drinking water standard and had a narrow range of 140.8 to 166.4-mg/LSO_4^2. The average sulfate value of the northern perimeter groundwater wells showed a similarly low value of 149.33-mg/LSO_4^2, with a narrow range of 140.80 to 153.60-mg/LSO_4^2. What is interesting to note is the consistent narrow sulfate value ranging from 140 to 153 seen in ten (10) of the monitoring wells. The remaining four (4) monitoring wells (MW-97-1, MW-97-6, MW-97-8 and MW-97-13) had values close to this range, only slightly higher, but all well below the drinking water standard (reference Worksheets 1, 3, 4, 8 and 9).

45. The average iron value of the groundwater was reported to be 417.12-mg Fe/L with a range of 30.00 to 1,270.00-mg Fe/L as seen on Worksheet 1. All values are above the drinking water standard. The values seen are consistent with the low pH values recorded. At pH values less than 6, oxidation processes are not rapid. The average iron value of the western perimeter groundwater wells exhibited an average value of 310.10-mg Fe/L with a range of 14.5 to 877.5-mg Fe/L as shown on Worksheets 4 and 8. The northern perimeter groundwater wells had a similar average value of 294.30-mg Fe/L with a narrow range of 243.60 to 334.60-mg Fe/L as seen on Worksheets 3 and 9.

46. The average manganese value of the groundwater was reported to be 46.60-mg Mn/L with a range of 1.1 to 78.8-mg Mn/L, all well above the drinking water standard. This is consistent with the low pH values recorded within the groundwater. Manganese precipitates out at higher pH levels, somewhere around a pH of 8 is not uncommon. The manganese adds to the turbidity of the water. The average manganese value of the western perimeter groundwater wells displayed an average value of 34.74-mg Mn/L with a range of 1.1 to 63.5-mg Mn/L. The average manganese value of the northern perimeter groundwater wells had a value of 49.83-mg Mn/L and ranged from 25.60 to 78.80-mg Mn/L (reference Worksheets 1, 3, 4, 8 and 9).

47. The average aluminum value for the groundwater was reported to be 125.61-mg Al/L with a range of 1.5 to 392.6-mg Al/L as seen on Worksheet 1. The values were consistent with the recorded pH values. Aluminum will not generally precipitate until a pH value of 4.5 or greater is attained. The higher aluminum values were seen with the lower pH values and decreased in value as the pH value increased. The exception to this was in monitoring well MW-97-12, which was screened within the gray shale bedrock and is not exposed to the unconsolidated backfill materials. The average aluminum value of the western perimeter groundwater wells is 87.87-mg Al/L with a range of 1.5 to 311.0-mg Al/L as seen on Worksheets 4 and 8. The average value of

the northern perimeter groundwater wells is 79.97-mg Al/L with a range of 43.80 to 130.00-mg Al/L shown on Worksheets 3 and 9.

X. SURFACE WATER GEOCHEMISTRY.

48. As explained earlier, surface water samples were obtained from various locations (12 sites), as shown on Drawing 30, in order to evaluate the geochemical conditions. Sample locations S-1 thru S-4 are located within the western drainage way proper and represent both groundwater seeps and surface water runoff which is transported over reclaimed vegetated lands as well as barren toxic spoil areas. Location S-5 represents water obtained from the pond in the western portion of the site and represents the quality of surface water runoff over reclaimed and well vegetated surface areas. The location of the tributary is within the western drainageway approximately 50 to 70 feet before it empties into Sugar Creek. This location was selected to see what, if any, impact the limestone gabion baskets have upon the surface water draining within the western drainageway. The upstream and downstream locations are approximately 50 feet above and below where the western drainageway empties into Sugar Creek to try and ascertain what impact the western drainageway has upon Sugar Creek. Location S-6 represents surface water obtained from the pond located within the eastern portion of the site near the northern perimeter with location S-7 (northern drainageway) representing surface water exiting the aforementioned pond into a drainageway and sampled prior to being discharged into Sugar Creek. Location S-8 is water sampled directly from Sugar Creek downstream of where water is being discharged from the northern drainageway. Location S-9 is water sampled from Sugar Creek directly upstream (within 60 feet) of the northern drainageway in an effort to ascertain what impact the northern drainageway and seeping groundwater along the northern perimeter downstream of location S-7 has upon Sugar Creek.

49. The analytes tested for included pH, Acidity, Total Alkalinity, Total Suspended Solids (TSS), Sulfate, Total Iron, Total Manganese and Total Aluminum. A single sampling event performed on two (2) separate dates (12/11/97 and 12/16/97) was conducted to ensure sufficient data of surface water conditions was obtained. A second sampling event of the same sample points plus one (1) additional location (S-9) was performed on 12 March 1998. It was felt that a second sampling event was necessary within the window of time allowed for this report, in order to try and evaluate the impact climatic conditions have upon surface water. The sampling performed in December 1997 was conducted during wet, rainy, inclement weather with high flows present in drainageways and in Sugar Creek. The sampling performed in March 1998 was conducted in dry weather with significantly lower flows occurring within both the drainageways and Sugar Creek. Laboratory test results of the groundwater and

surface samples are contained in Appendix F, Worksheets 1 thru 4, 8 and 9 and summarized in plan view on Drawings 200 thru 204.

50. The surface water laboratory test results are contained in their entirety on Worksheet 1 in Appendix F. Worksheets 2 and 4 in Appendix F present the surface water data from those locations within the western portion of the site. As explained earlier, Worksheet 4 includes monitoring wells MW-97-4 and MW-97-10 which are not immediately adjacent to the western drainageway, but do reflect overall groundwater conditions present within the western portion of the site. The surface water values reported on Worksheets 2 and 4 are identical. Worksheet 3 presents the surface water data from those locations along the northern perimeter of the site since these have been areas where seeps have been noted and where surface water is discharged into Sugar Creek which borders the northern perimeter of the site. As can be seen, the data on Worksheets 1 thru 4 is presented so average values can be evaluated as well as individual values for both of the sampling events (December 1997 and March 1998). Worksheets 8 and 9 in Appendix F also present surface water values, however, the reported individual values reflect an averaging of the December 1997and March 1998 sampling events. In Appendix C, Drawing 200 shows surface water pH concentration values. Drawing 201 shows surface water iron concentration values. Drawing 202 shows surface water sulfate values. Drawing 203 shows surface water acidity values and Drawing 204 shows surface water alkalinity values.

51. The laboratory test results as reported on Worksheet 1 indicate that the overall surface water collected on-site (locations S-1 thru S-7 and tributary) is extremely acidic with an average pH value of 3.15/3.48 (December/March). The average pH values of water obtained from Sugar Creek were 5.38/6.35 indicating that the creek is slightly acidic. The laboratory test results as reported on Worksheets 2 and 4 in Appendix F indicated a pH value of 2.69/2.78 (December/March) for the western drainageway and an average value of 2.74 as shown on Worksheet 8. These values do not vary significantly and represent extremely acidic water. Drawing 200 in Appendix C also portrays the December and March pH concentration values at their sampled locations. It is interesting to note that the surface water pH values from the western drainageway are significantly lower than the groundwater pH values within this portion of the site. It was noted that the much of the ground slope immediately adjacent to the drainageway along much of its length was barren and being eroded. This condition is shown on the photographs contained in Appendix B. It is felt that the continued slope erosion is resulting in constant new exposure of toxic materials which are reacting with the seeping groundwater and surface water, and are contributing in large part to the extremely acidic conditions present within the western drainageway. It is also noted the pH values for location S-5 (western pond) were 5.90 and 7.32 respectively, which vary from being slightly acidic to neutral.

52. The average pH value of the western drainageway surface water just prior to being discharged into Sugar Creek (location - Tributary) is reported as 2.78 pH units as seen on Worksheet 8. This low pH value is indicative that the limestone filled gabion baskets constructed at five (5) locations within the western drainageway are no longer effective for buffering the water. In fact, most of the gabions are silted in and the water is flowing over the tops. In one instance, the surface water has eroded a channel into the bank and is bypassing the gabion altogether. The present condition of some of these gabions is depicted in Appendix B. The average pH values of Sugar Creek immediately upstream and downstream of where the western drainageway enters are nearly identical and are reported as 6.55 vs. 6.59 as shown on Worksheet 8. This indicates that even though the water being discharged into Sugar Creek from the western drainageway is extremely acidic, it apparently has little deleterious effect due to the small volume of water entering Sugar Creek. This was also evidenced and supported with use of a portable microprocessor pH meter with which numerous readings were taken along Sugar Creek as well as at each sampling location.

53. The average pH value of the surface water present in the northern pond (location S-6) and northern drainageway (location S-7) is reported as 3.10 pH units as seen on Worksheet 9. Worksheet 3 shows average pH values of 2.92/3.28 (December/March) for the individual sampling events. These pH values indicate the presence of acidic surface water that is comparable to the quality of surface water seen in the western drainageway. As with the surface water within the western drainageway, it is felt that the main factor contributing to the low pH values within the pond, is a result of surface water coming in contact with toxic materials which have been eroded and exposed and/or have been deposited within the pond. The pH values seen at location S-7 represent surface water exiting from the pond as well as seeping groundwater. This seeping groundwater was noted to be occurring along the northern perimeter immediately adjacent to Sugar Creek from an outcrop of sandstone bedrock. The bedrock outcrop extends from the northern drainageway and stretches eastward for approximately 60 yards. Appendix B contains photographs depicting this condition. The laboratory test results indicate that the surface water draining into Sugar Creek from the northern drainageway in conjunction with the seeping groundwater is the major contributing factor to the degradation to Sugar Creek. This is supported by pH values seen at location S-8 and S-9, both of which are water samples obtained from Sugar Creek. Sample location S-8 is downstream of the northern drainageway and seeping groundwater from the bedrock outcrop and had pH values of 3.16 and 5.70 (December/March) as seen on Worksheet 3. The December value (3.16) represents a sample obtained very close to the creek bank, whereas the March value (5.70) represents a sample obtained from the middle of the creek channel. This is interesting in that the volume of water within the creek in December was significantly greater, and due to dilution it would have been expected to see a pH value equal to or greater than

the March pH value. Sample location S-9 is located approximately 50 feet upstream of where the northern drainageway enters Sugar Creek and had a pH value of 6.38 as seen on Worksheet 3. The pH value of 6.38 closely corresponds to the 6.51-pH value recorded downstream of the western drainageway as seen on Worksheet 3. This fact was also evidenced by use of the portable pH meter where numerous (9) readings were taken along Sugar Creek. No discernable change in pH value was noted in Sugar Creek until surface water received from the northern drainageway and seeping groundwater was checked with the portable pH meter.

54. The average on-site surface water acidity values (locations S-1 thru S-7 and tributary) were 1,789/1,480-mg/L $CaCO_3$ (December/March) and ranged from –20 to 2,520-mg/L $CaCO_3$ as shown on Worksheet 1. The average acidity values for Sugar Creek were reported as 143.33-mg/L $CaCO_3$ and ranged from –30 to 210 -mg/L $CaCO_3$ as seen on Worksheet 1. Drawing 203 in Appendix C also portrays the December and March acidity concentration values at their sampled locations. The average on-site surface water value is approximately 25 percent greater than the groundwater value and over 10 times higher than the average acidity reported in Sugar Creek. The average acidity value for the western portion of the site was reported as 2,239-mg/L $CaCO_3$ as seen on Worksheet 8. The average December/March acidity values as shown on Worksheet 2 were 2,408 and 2,070-mg/L $CaCO_3$, with a 14 percent decrease in value during drier and lower flow conditions in this area. The average acidity value for the northern portion of the site was reported as 912-mg/L $CaCO_3$ shown on Worksheet 9. The average December/March acidity values as shown on Worksheet 3 were 1,070 and 755-mg/L $CaCO_3$, a 29 percent decrease in acidity occurring during March. The acidity value of the western portion of the site was more than double than that of the northern portion of the site.

55. The average total alkalinity value of the on-site surface water is represented by one (1) data point, the western pond (location S-5), and is shown as a value of 22.4/35.0 (December/March) on Worksheets 1, 4 and 8. This would be expected, given the acidity values reported for the on-site surface water at location S-5. It can be seen that the groundwater has a greater buffering capacity than the on-site surface water that is draining into the western and northern drainageways and northern pond. The average total alkalinity values reported for Sugar Creek as seen on Worksheet 1 are 52.00/32.63-mg/L $CaCO_3$ (December/March) indicating that there is buffering capacity. Note that the greater concentration value occurred during the wetter sampling event (December). The average total alkalinity values in Sugar Creek by the western drainageway (locations – upstream and downstream) were reported as 52/44-mg/L $CaCO_3$ (December/March) on Worksheet 2 with a combined average value of 48-mg/L $CaCO_3$ as shown on Worksheet 8. The average total alkalinity values of Sugar Creek as it approaches the northern drainageway region are reported as 34.63-mg/L $CaCO_3$

as shown on Worksheet 9. In fact, the value decreases from 30-mg/L $CaCO_3$ immediately above the northern drainageway (location S-9) to 12.5-mg/L $CaCO_3$ at location S-8 downstream of where the northern drainageway enters Sugar Creek as seen on Worksheet 9 (reference Drawing 204 in Appendix C for the December and March total alkalinity values at their sampled locations).

56. Average values of total suspended solids (TSS) for the on-site surface water were reported as 23.25/17.63-mg TSS/L (December/March) as shown on Worksheet 1. Due to the fact that TSS values of Sugar Creek for the upstream and downstream locations in December 1997 represent values of filtered samples, only March 1998 TSS values will be discussed for Sugar Creek in this report. However, the December 1997 TSS values are shown on the appropriate Worksheets in Appendix F for review. The average TSS values for Sugar Creek were reported as 25.25-mg TSS/L as shown on Worksheet 1. The average TSS values for the western drainageway surface water are reported on Worksheet 8 as 13.0-mg TSS/L as compared to 22.5-mg TSS/L for Sugar Creek in this area. TSS values of surface water along the northern perimeter were elevated as compared to Sugar Creek TSS values in this area, 50.25 vs 31.25-mg TSS/L, as seen on Worksheet 9.

57. The average sulfate values of the on-site surface water were reported on Worksheet 1 to be 1,254/1,182-mg/LSO_4^2 (December/March) which exceeds the drinking water standard of 250-mg/LSO_4^2, and had a range of 0.20 to 2,326.00-mg/LSO_4^2. Drawing 202 in Appendix C portrays the December and March sulfate concentration values at their sampled locations. The average sulfate values of Sugar Creek were reported on Worksheet 1 to be 378.47/327.75-mg/LSO_4^2 (December/March) which are slightly higher than the drinking water standard. The western drainageway sulfate values reported on Worksheet 4 are 1,433/1,203-mg/LSO_4^2 (December/March) with the average sulfate values reported on Worksheet 8 as 1,318-mg/LSO_4^2. All of which are significantly greater than the drinking water standard and those values seen within Sugar Creek. The sulfate values for the upstream and downstream locations seen in Sugar Creek near where the western drainageway empties into the creek do not vary appreciably (40 vs. 38 and 259 vs. 276-mg/LSO_4^2) as seen on Worksheet 2. The sulfate concentration continues to gradually increase downstream on Sugar Creek until the northern drainageway is encountered, as is clearly shown on Worksheets 1 and 3. The March 1998 sulfate levels for the following locations (upstream, downstream, S-9 and S-8) are as follows: 259, 276, 405 and 2,326-mg/LSO_4^2. It is interesting to note that there is only a slight increase of sulfate from where the western drainageway enters Sugar Creek, as compared to the large increase seen after the northern drainageway and groundwater seeps enter Sugar Creek. As mentioned earlier, this may lead one to conclude that the volume of water received by Sugar Creek from the western drainageway is not sufficient in quantity to adversely affect it.

The average sulfate value for the northern drainageway as reported on Worksheet 9 was 1,492-mg/LSO_4^2 which is very comparable to those levels seen in the western drainageway. The surface water sulfate levels are approximately 4.5 to 10 times greater than those seen in the groundwater depending which areas of the site are being evaluated (i.e. whole site vs. western or northern drainageways). This is attributed in large part to the chemical reactions, which occur when toxic materials are exposed by erosion and come into contact with the surface water and atmosphere.

58. The average iron values of the on-site surface water were reported on Worksheet 1 as 147.90/153.16-mg Fe/L (December/March) which exceeds the drinking water standard of 0.3-mg Fe/L, and had a range of 0.2 to 279.80-mg Fe/L. Drawing 201 in Appendix C portrays the December and March iron concentration values at their sampled locations. The average iron values of Sugar Creek were reported on Worksheet 1 to be 14.37/5.35-mg Fe/L (December/March) which are higher than the drinking water standard. The average iron values of Sugar Creek are approximately 10 times lower than those levels seen on the on-site surface water as shown on Worksheet 1. The surface water iron levels are approximately 2 to 3 times greater than the groundwater levels as seen on Worksheet 1. The western drainageway iron values reported on Worksheet 4 are 201.82/196.98-mg Fe/L (December/March) with the average iron value reported on Worksheet 8 as 199.4-mg Fe/L. All of these values are significantly greater than the drinking water standard and those iron values seen within Sugar Creek. The iron values for the upstream and downstream locations seen in Sugar Creek near where the western drainageway empties into the creek do not increase appreciably (5.3 vs. 3.8 and 2.17 vs. 2.77-mg Fe/L as seen on Worksheet 2. As with the sulfate values in Sugar Creek, the iron concentration continues to gradually increase downstream on Sugar Creek until the northern drainageway is encountered, as is clearly shown on Worksheets 1 and 3. The March 1998 iron levels for the following locations (upstream, downstream, S-9 and S-8) are as follows: 2.17, 2.77, 5.25, 11.22-mg Fe/L. It is noted that there is only a slight increase of iron from where the western drainageway enters Sugar Creek, as compared to the large increase seen after the northern drainageway and groundwater seeps enter Sugar Creek. The average iron value for the northern drainageway as reported on Worksheet 9 was 103.46-mg Fe/L which is appreciably less than those levels seen in the western drainageway (199 vs. 103-mg Fe/L).

59. The average manganese values of the on-site surface water were reported on Worksheet 1 as 12.64/10.00-mg Mn/L (December/March) with a range of 0.1 to 23.2-mg Mn/L, all well above the public health drinking water standard of 0.05-mg Mn/L. This is consistent with the low pH values recorded for these locations. Manganese precipitates out at higher pH levels, somewhere around a pH level of 8 is not uncommon. The manganese adds to the turbidity of the water. The manganese levels

of on-site surface water was approximately 10 times higher than the average value of 1.10-mg Mn/L recorded for Sugar Creek as seen on Worksheet 9. Manganese values of Sugar Creek varied from 0.39 to 3.8-mg Mn/L as shown on Worksheet 3. As with the other analytes tested, no discernable impact to Sugar Creek manganese values were noted by the influx of the western drainageway flow, but there was some impact noted (increase) after the northern drainageway and seeping groundwater enters Sugar Creek. The average manganese value of the western perimeter surface water displayed an average value of 12.8-mg Mn/L as shown on Worksheet 8 and with a range of 1.06 to 15.5-mg Mn/L as seen on Worksheet 4. The average manganese value of the northern perimeter surface water exhibited an average value of 13.19-mg Mn/L as seen on Worksheet 9 with a range of 1.06 to 23.2-mg Mn/L shown on Worksheet 3. These values are very similar to those recorded at the western drainageway.

60. The average aluminum value for the on-site surface water was reported to be 141.48-mg Al/L (March) with a range of 0.08 to 209.00-mg Al/L as shown on Worksheet 1. Only a single data point (Tributary) for the on-site surface water was tested in December. As such, only March 1998 test data is discussed in this report. The December data point test value is shown on the appropriate Worksheets for the reader's review. The average aluminum values for Sugar Creek were reported as 2.94-mg Al/L (March-98) as seen on Worksheet 1. These values were consistent with the recorded pH values. Aluminum will not generally precipitate until a pH value of 4.5 or greater is attained. The higher aluminum values were seen with the lower pH values and decreased in value as the pH value increased. The exception to this was the aluminum value for location S-6 (the north pond) which had a low pH value but a low aluminum value (8.85-mg Al/L) that was close to the values seen in Sugar Creek at locations S-8 and S-9. The average aluminum value for the western drainageway was reported as 198.3-mg Al/L with a range of 174 to 209-mg Al/L as seen on Worksheets 8 and 4. The average aluminum value for the northern drainageway was reported as 77.93-mg Al/L with a range of 8.85 to 147-mg Al/L as seen on Worksheets 9 and 4.

XI. GROUNDWATER HYDROGEOLOGY.

61. A total of fourteen (14) groundwater monitoring wells were installed for use in developing the site groundwater profile. The monitoring well locations are shown on Drawings 30 and 300. Monitoring well construction details are contained in Appendix D. Groundwater levels were measured on two (2) occasions using a portable electronic water level meter. The measurements were obtained on 11 and 17 December 1997 after the wells had been developed and allowed some time to reach a state of equilibrium. For the most part, the readings taken on the 11th and 17th were fairly close to each other, the exception being MW-97-12. MW-97-12 was installed on 9 December

1997 and developed the following day by repeatedly bailing the well dry. The wellscreen was installed within the shale bedrock with the bentonite plug also beginning within the shale bedrock. It is felt that the readings obtained on the 11th represent the monitoring well still recharging with equilibrium not having been reached yet. As such, the groundwater gradient map was developed using the groundwater measurements obtained on 17 December 1997 since it is felt that these values represent the wells after they had reached equilibrium. The measurements obtained for each of the wells are provided on the table below.

Well Number.	Riser Elevation	Dec.12 Level (Feet)	Dec.12 Elevation	Dec. 17 Level (Feet)	Dec 17 Elevation
MW-97-1	446.11	26.4	419.71	27.19	418.92
MW-97-2	437.36	24.9	412.46	24.78	412.58
MW-97-3	435.30	15.4	419.90	15.81	419.49
MW-97-4	458.78	29.8	428.98	29.71	429.07
MW-97-5	445.21	10.8	434.41	10.69	434.52
MW-97-6	478.35	39.4	438.95	36.90	441.45
MW-97-7	482.16	25.2	456.96	24.96	457.20
MW-97-8	436.58	10.6	425.98	10.58	426.00
MW-97-9	455.35	20.8	434.55	20.35	435.00
MW-97-10	523.73	19.5	504.23	19.48	504.25
MW-97-11	461.52	32.3	429.22	32.28	429.24
MW-97-12	486.62	34.3	452.32	13.35	473.27
MW-97-13	486.51	14.1	472.41	14.15	472.36
MW-97-14	447.28	N/A	N/A	32.60	414.68

62. The groundwater contours shown on Drawing 300 indicate that the groundwater at the site moves primarily in a south to north direction, towards Sugar Creek, as would be expected. The groundwater is highest in elevation (mounded) near the middle of the site (MW-97-10) and as it migrates primarily in a northern direction, it also migrates somewhat radially where it can be seen exiting into the western drainageway in the form of groundwater seepage. The groundwater can also be seen exiting onto and from the sandstone bedrock outcrop located immediately adjacent to Sugar Creek between the northern drainageway and the bridge on County Highway 12 which borders the east side of the Palzo site.

63. Monitoring wells MW-97-1 thru MW-97-10 and MW-97-13 are considered shallow monitoring wells, which were installed within unconsolidated materials. Monitoring wells MW-97-4, MW-97-6, MW-97-7 and MW-97-9 had wellscreens installed partially within the bedrock and partially within the unconsolidated materials. Their screens

were partially installed within the bedrock to a depth of 2, 5, 3.5 and 5 feet, respectively. Although the installation into the bedrock would not be expected to affect the measurement of groundwater within the unconsolidated materials, it does apparently affect the horizontal permeability, as can be seen in Appendix G. The horizontal permeabilities of monitoring wells MW-97-6 and MW-97-9 were 4.45E-05 and 2.56E-05, respectively. These values were higher than those monitoring wells screened entirely within the bedrock (except MW-97-11) but lower than the monitoring wells that were screened entirely within the unconsolidated materials. The 5-foot embedment into the bedrock was sufficient to affect horizontal permeability.

64. Three (3) monitoring wells had wellscreens installed totally within the bedrock in an effort to determine whether there existed separated groundwater regimes at the site. The bedrock monitoring wells had 10-foot wellscreens and included MW-97-11, MW-97-12 and MW-97-14. Monitoring well MW-97-11 was installed within the area where only the upper coal seam (Dekoven Coal) had been mined. Underlying this mined coal seam is the pyritic black shale bedrock that was encountered and into which MW-97-11 was installed. The groundwater elevation in monitoring well MW-97-11 was found to exist within the black shale bedrock. No other monitoring wells were installed in this area to determine whether there is perched groundwater above the black shale bedrock, but based upon the groundwater levels present in bedrock monitoring wells MW-97-12 and MW-97-14 this would not appear to be the case.

65. Monitoring wells MW-97-12 and MW-97-14 were installed within areas where both coal seams (Dekoven Coal and Davis Coal) had been mined previously. As such, the pyritic black shale, which separated the two coal seams, had also been removed by mining operations. The groundwater elevation present in monitoring wells MW-97-12 and MW-97-14 existed above the bedrock within the unconsolidated materials. MW-97-12 was installed adjacent (within 5 feet) to MW-97-13 in near proximity to the western drainage way. MW-97-13 was installed only 20 feet below ground surface within the unconsolidated backfill, while MW-97-12 was installed 55 feet below ground surface, the last 36 feet being into shale bedrock. However, their groundwater elevations are within approximately 1 foot of each other indicating that the groundwater within the bedrock is connected to the groundwater present within the overlying unconsolidated backfill material. This was also the case with monitoring well MW-97-14 which is located at the eastern edge of the site in close proximity (within 125 feet) to monitoring well MW-97-1. Monitoring well MW-97-14 was installed approximately 64 feet below ground surface with the bottom 25 feet installed within shale bedrock, while monitoring well MW-97-1 was installed 34 feet below ground surface within the unconsolidated backfill. The groundwater elevation of MW-14-97 was 414.6 while the groundwater elevation of MW-97-1 was recorded as being slightly higher at 418.9.

This also demonstrates that the groundwater within the bedrock is connected to the groundwater existing within the backfill.

XII. SUMMARY/CAUSES OF AMD.

66. Based upon the information gathered during this investigation and review of previous project work and investigations, there are two (2) primary locations from which the acid mine drainage (AMD) is moving offsite and entering Sugar Creek. The first location is the surface water ultimately collected within the western drainageway and discharged into Sugar Creek at the northwest corner of the site (reference Drawing 30 for this location). The second location is along the northeast perimeter of the site where surface water is collected and transported within the northern drainageway to Sugar Creek. This area is also affected by seeping groundwater in close proximity to the northern drainageway locale from the sandstone bedrock outcrop and enters as surface water runoff into Sugar Creek (reference Drawings 30 and 300 for this location).

67. There are two (2) main factors which have been identified that are contributing to the cause of the acid mine drainage occurring at the Palzo site. The first factor is the contamination of surface water that migrates offsite; the other is the contamination of groundwater from the pyritic black shale material, through which the groundwater is migrating. The contaminated groundwater migrates until it appears as groundwater seepage along the western and northern drainageways as well as the sandstone bedrock outcrop adjacent to Sugar Creek near the northern drainageway discharge.

68. The surface water along the western drainageway is extremely acidic as characterized by its very low pH values (see Drawing 200). It was noted that the surface water in the western drainageway had pH values which were consistently lower in magnitude by approximately 2 pH units than the groundwater pH seen the western monitoring wells (i.e. compare Drawings 200 and 301). It is felt that the poor quality of the surface water present in the western drainageway is a result of surface water coming into contact with barren toxic materials. It was noted that there is severe erosion occurring along a great extent of the western drainageway. Photographs contained in Appendix B have depicted this condition. The erosion is continually exposing toxic materials previously covered by reclamation. The erosion allows surface water to come into contact with these toxic materials as it is transported over the ground surface. It also allows for the development and enhancement of AMD by eroding these toxic materials and depositing them within the drainageway through which the surface waters are directed and flow through. The continued erosion of the drainageway slopes also may allow for groundwater to begin seeping at new locations whereby it comes into contact with toxic materials which are now being exposed, and

allow for the chemical processes for the formation of AMD to accelerate. It is felt that the erosion and exposure of toxic materials is significantly contributing to AMD.

69. In contrast to the low quality surface waters present within the western drainageway, surface waters which are transported over the reclaimed ground surface and collected in the pond located within the western portion of the site (sampling location S-5) are of good quality as shown in Appendix F, Worksheet 1. It should be noted that surface waters draining into this western pond do not travel over barren and toxic materials or areas that have been eroded. Nor was there any evidence of eroded material being deposited within this pond.

70. It was also noted that none of the gabion basket structures previously installed within the western drainageway are helping to buffer the AMD as it is being transported towards Sugar Creek. They have apparently outlived their usefulness as evidenced by heavy iron staining, significant scaling and the continued poor water quality present along the entire length of the western drainageway. All of the gabions had been silted in and the water was either flowing over the top or in some cases around the gabions where the bank had been eroded. It should be pointed out that even though the surface water entering Sugar Creek from the western drainageway is of an extremely toxic nature, it apparently is not of sufficient quantity to have much of a deleterious impact upon Sugar Creek. This was evident when comparing the water quality at sampling locations Upstream, Downstream and Tributary on Worksheets 1, 4 and 8 in Appendix F, and as summarized on Drawing 200. This is significant when considering what remedial measures could be taken.

71. The groundwater within the western portion of the site, and at the site in general, is becoming contaminated from migration of groundwater through the pyritic black shale material. It is noted that the groundwater quality is vastly improved when compared to the earlier sampling events conducted prior to reclamation and immediately following the different reclamation phases. This is due to the success of the reclamation efforts done to date and the continued flushing of the groundwater from surface infiltration and groundwater migration. However, until the in-situ backfill materials on the site through which the groundwater is migrating have been neutralized/ameliorated sufficiently, the groundwater will continue to be contaminated.

72. The surface water, which is discharged directly into Sugar Creek from the northern drainageway, is similar in quality to that of the western drainageway. It is of poor quality as seen from the water quality results of sample location S-7 contained in Appendix F, Worksheets 1, 3 and 9. It is also felt the erosion of previously reclaimed toxic materials that the surface waters come into contact with is impacting the quality of the surface water in this area. The erosion and exposure of these toxic materials is

occurring throughout the site, and as a result, toxic materials are being deposited into the pond within the northern drainageway (sampling location S-6) which adversely impacts the ponded water. A main contributor is the presence of barren pyritic black shales which are present along the roadway through the center of the site leading toward monitoring well MW-97-8 as shown on Plate B-1 in Appendix B. Surface water that travels over these barren toxic materials drains into the northern drainageway pond and also carry eroded toxic materials to be deposited ultimately within this pond.

73. Similar to that seen within the western drainageway, the gabion baskets installed within the northern drainageway are of little, if any, benefit. They are heavily iron stained, clogged with silt and do not appear to have any buffering benefit to the surface waters for which they were constructed. Photographs depicting their condition are shown on Plates B-12 and B-14 in Appendix B. The surface water discharged directly into Sugar Creek has a significant derogatory impact to the water quality. This is easily seen when examining the water quality data for surface monitoring points S-6, S-7, S-8 and S-9 on Worksheets 1, 3 and 9 in Appendix F. Immediately upstream of the northern drainageway, the water quality appears to be satisfactory even after having received the western drainageway discharge. Immediately downstream of the northern drainageway, the water quality is degraded as seen from the water quality test results from surface monitoring location S-8. However, the impact appears to be significantly less than seen in prior studies. To exactly quantify what degree the reclamation efforts to date performed at Palzo have upon this fact is unknown at this time, but it can be safely stated that they have had a significant impact. A continued groundwater and surface water sampling program would make it possible to quantify this fact but it is not felt that it is warranted at this time.

74. There is also AMD which is being transported directly into Sugar Creek as a result of groundwater seepage occurring along the sandstone bedrock outcrop that is present adjacent to the creek. This seepage area extends from the northern drainageway approximately 150 feet eastward along Sugar Creek. Photographs depicting this condition are contained in Appendix B, Plates B-12 and B-13. It was noted that depending upon where the water samples were obtained from the creek in this area, a variation in the concentration values was obtained. During the first surface water sampling event of Sugar Creek in December 1997, surface water samples were obtained close to the creek bank. It should be noted that the volume of water flowing within the creek was much greater at this time than during the second sampling event in March 1998. Water samples were obtained closer to the center of Sugar Creek during the second sampling event in March. Concentration values were noted to be much lower in March even though the flow within Sugar Creek was greatly reduced in quantity. It is felt that there is a strong likelihood that water samples obtained close to

the creek banks may be skewed from the seeping groundwater that enters as surface water along this area.

75. As was seen in the western portion of the site, the groundwater within the northern and eastern portions of the site, and at the site in general, is becoming contaminated from migration of groundwater through the pyritic black shale material. As with the groundwater analyzed from the western portion of the site, it is noted the groundwater quality is vastly improved when compared to the earlier sampling events conducted prior to reclamation and immediately following the different reclamation phases. This is due to the reclamation efforts done to date and the continued flushing of the groundwater from surface infiltration and groundwater migration. However, until the in-situ backfill materials on the site through which the groundwater is migrating have been neutralized/ameliorated sufficiently, the groundwater will continue to be contaminated. This will result in the formation of AMD which will continue to migrate toward Sugar Creek and enter the creek as surface water seeping from the outcrop of sandstone bedrock which forms the creek banks of Sugar Creek from the northern drainageway eastward.

XIII. RECOMMENDATIONS/COST ESTIMATES.

76. Although, as seen in this study that the water draining into Sugar Creek from the western drainageway had little deleterious impact, it is felt that if left unattended, this will become a problem with significant negative impact to Sugar Creek. Attention should be given to the existing surface areas that are barren and void of vegetation. This would entail providing soil nutrients and seeding to establish vegetation. This would help eliminate surface water from becoming contaminated, as well as, prevent the possible erosion and exposure of toxic materials that have already been reclaimed.

77. The continued erosion of the western drainageway banks needs to be addressed. The slopes need to be graded, nutrients added and seeded. Placing erosional armor (limestone riprap) and use of geotextile filter fabric should also protect several areas that have steeper slopes. It is felt that much of the AMD problem in the western portion of the site is due to surface water contamination, therefore consideration should be given to removing the silted in gabion structures and replacing them. Since this area and the site in general has a well established growth of vegetation, new gabion baskets will not be as prone to becoming silted in and they will also provide buffering for the groundwater which seeps into the drainageway. By the time their usefulness has expired, the groundwater that is seeping into the drainageway will also have slowly improved, having been flushed by surface water infiltration and groundwater migration. Removal and treatment of deposited eroded toxic materials from the drainageway would also reduce the negative impact to surface waters transported within the western

drainageway. Based upon the findings of this study that the western drainageway is not significantly impacting Sugar Creek, it is felt that these corrective measures will adequately address the AMD occurring within the western region of the site. An estimate of construction costs for conducting these remedial measures within the western portion of the site ranged from $50,000.00 to $60,000.00. The most significant item in terms of cost is the amount of erosional armor (riprap) that would be utilized. This item accounts for approximately 50 percent of the remedial costs.

78. The most significant factor that is adversely impacting Sugar Creek is the AMD surface water entering the creek from the northern drainageway and AMD (seeping groundwater) that is exiting from the sandstone bedrock outcrop immediately adjacent to Sugar Creek. Several options are available for consideration and are presented in subsequent paragraphs 79 and 80. Before these options are discussed it needs to be pointed out that as with the western portion of the site, surface water is being contaminated from contact with toxic materials. Attention should be given to the existing surface areas that are barren and void of vegetation. These areas need to have soil nutrients added and vegetation established. This would help eliminate the surface water from becoming contaminated as well as prevent possible erosion and exposure of toxic materials that have already been reclaimed. It is estimated that this work could be completed for approximately $10,000.00. This includes the treating of eroded toxic materials that have silted in drainageways, the pond and gabion baskets.

79. There are two (2) existing gabion basket structures that are associated with the pond in the northern portion of the site. One is located immediately adjacent to the north edge of the pond as seen in Appendix B, Plate B-14 and Drawing 20. The other is located west of the northern pond through which much of the surface water draining into this pond from the west is directed. Both of these have been silted in, are heavily iron stained, and have outlived their usefulness. Consideration should be given to their replacement. In addition, the silt present within the pond should be removed and treated. Possible disposal locations could include the central portion of the site that has windrowed spoil piles as a result of the previous mining operations. This area has never been reclaimed and has naturally revegetated. It is felt that excess spoil material could be placed here with a minimal amount of disturbance. Removal of the silted material would increase the available pond storage capacity. Consideration could also be given to removing additional material to enlarging the pond by deepening it so as to allow groundwater to emerge. The pond could then be made into wetlands, utilizing shallow water wetland plant materials, to aid in metal precipitation. The drainageway which extends from the pond to Sugar Creek should be dressed up with limestone riprap being placed upon geotextile filter fabric to prevent erosion and to help buffer water exiting from the pond. These items would greatly reduce the degradation to the surface water being discharged into Sugar Creek. Construction costs are projected to

be approximately $15,000.00 without any shallow water wetland plant materials. The wetland plant materials are estimated to be approximately $10,000.00 per acre planted.

80. Construction of a slurry wall to prevent the groundwater from entering Sugar Creek along the northern perimeter is a distinct possibility. Slurry walls have been used with great success to contain groundwater and/or alter its migration. Since the groundwater at the Palzo site migrates from south to north (see Drawing 300), a slurry wall extending from west of the northern drainageway to the northeast corner of the site and also extending partially along the east perimeter of the site would conceivably alter the groundwater flow. However, the purpose of the slurry wall would be to stop the AMD from entering Sugar Creek along the northern perimeter and not allow it to enter the creek at a location further downstream. Once the slurry wall was in place, and dependent upon its location, it would be expected that the groundwater table would rise in elevation. This is one reason for deepening the pond located along the northern drainageway. It would allow the groundwater to be stored and "treated" prior to its discharge into Sugar Creek. The slurry trench concept could also be modified by excavating for a conventional slurry trench, lining the downgradient side of the trench with an impermeable hypalon geomembrane and backfill the trench with aggregate limestone with a leachate collection pipe. The drainage pipe could be a gravity drain into the northern pond prior to its discharge into Sugar Creek.

81. Another alternative would be to construct a pond/wetlands in the area where monitoring well MW-97-2 and boring B-97-15 are located. As the groundwater table rose in elevation, it would fill the pond. In conjunction with this pond, a limestone drainageway (anoxic limestone drain) could be constructed to allow for the flow of water into the existing pond located near monitoring well MW-97-3 or possibly routed into Sugar Creek. Should a slurry wall be considered, it is recommended that groundwater elevations and testing be conducted to determine how the groundwater fluctuations could possibly impact the slurry wall. The construction costs for the slurry wall concept(s) range from approximately $110,000.00 to $300,000.00 depending upon what slurry trench approach is used and what combinations of drainage and treatment are selected.

82. Another option would be to consider the possibility of constructing an additional pond within the central portion of the site that has never been reclaimed and has naturally revegetated. The purpose of this would be to enhance the groundwater that is up gradient and have this groundwater provide a flushing effect to the site that is down gradient. However, we would recommend that 2 to 4 additional monitoring wells be installed within the central portion of the site to better characterize the groundwater table. With this additional data, it could be determined what depth the pond would need to be constructed to as well as storage capacity and help determine the feasibility

of this option. It is recognized that this would entail disturbing an area that was left unreclaimed but does have a well-established growth of vegetation present. It is felt that construction of this pond could certainly aid in improving groundwater quality, but would not be practical as a solo alternative to improving groundwater quality. Construction of this pond could be completed for $25,000.00 to $60,000.00 depending on size and whether shallow water wetland plants would be part of the pond construction.

XIV. REMARKS.

83. The analyses, conclusions and recommendations in this report were based on site conditions existing at the time of the investigation and on the assumption that the information obtained from the limited number of borings and monitoring wells is representative of subsurface conditions throughout the site. We make no warranty for the contents of this report, neither expressed nor implied, except that our professional services were performed in accordance with engineering principles and practices generally accepted at this time and location.

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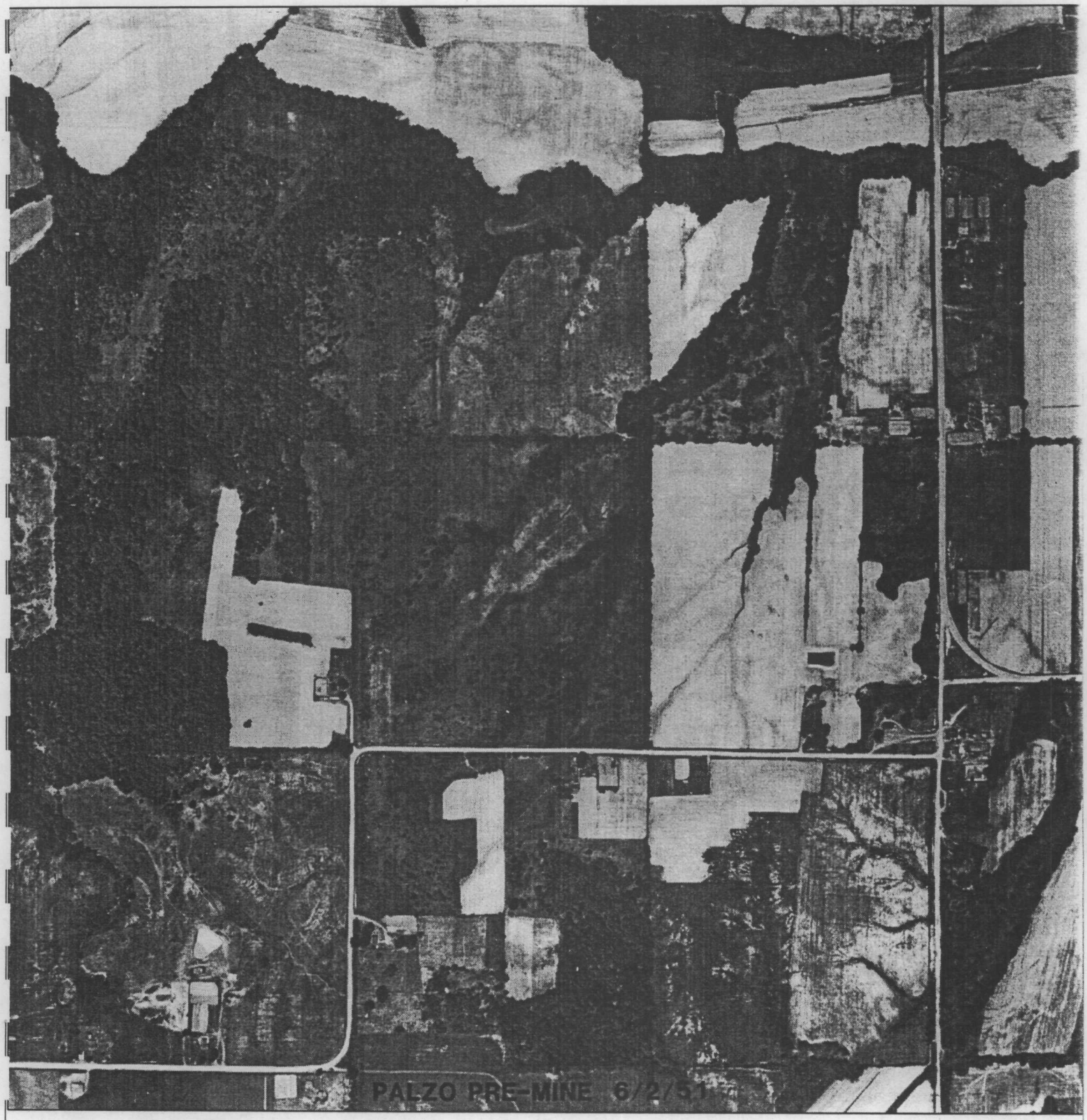
SOUTHERN ILLINOIS INVESTIGATIVE SERVICES
PALZO SITE; AML-GsWA-9600J
WILLIAMSON COUNTY, ILLINOIS
SITE STUDY AND RECOMMENDATIONS

APPENDIX A

AERIAL PHOTOGRAPHIC HISTORY

indeco

P.O. Box 1148 • 630 River Drive, Bettendorf, IA 52722 • Tel (319) 359-5451 • Fax (319) 359-4318



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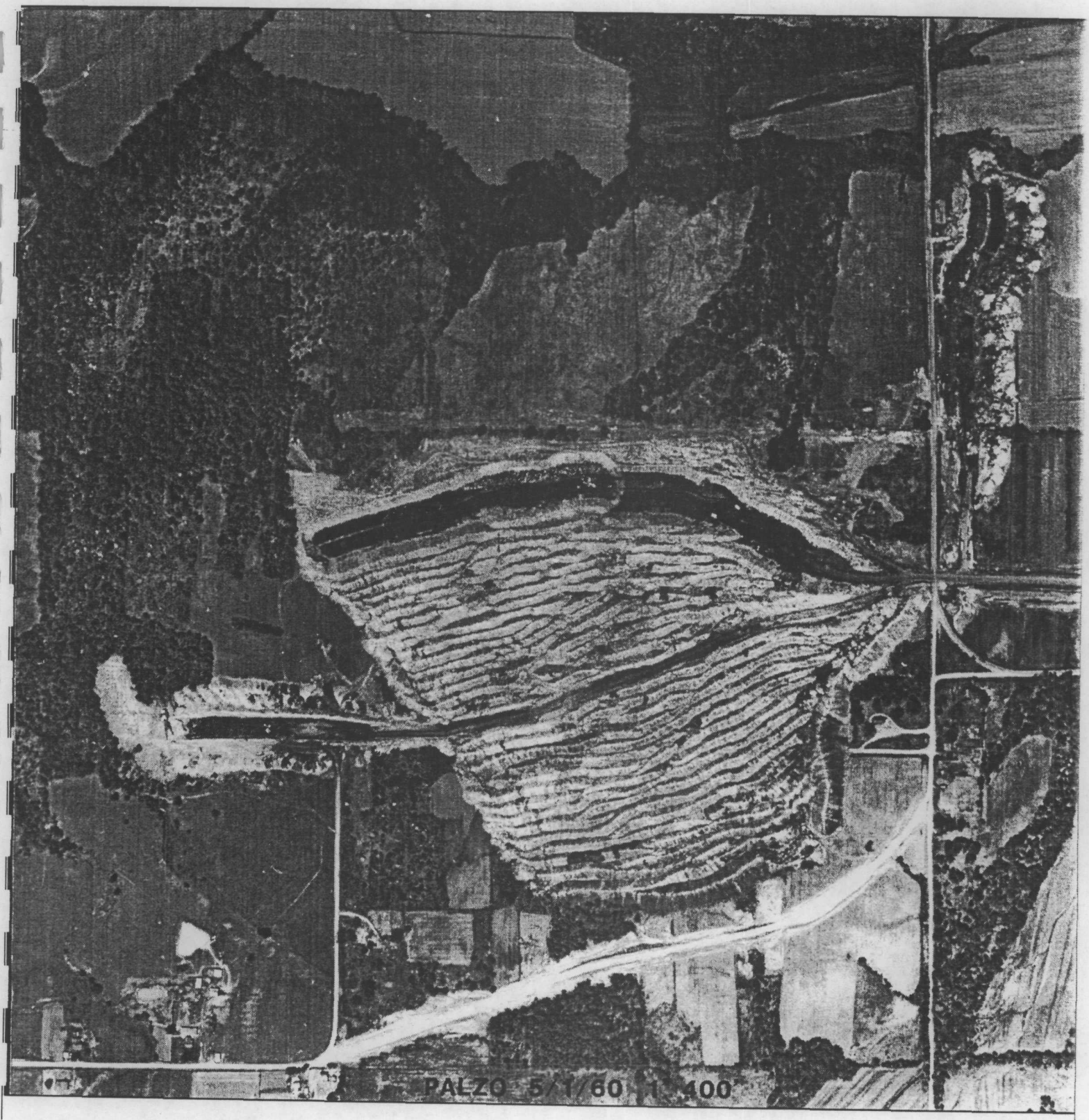
1710 RIVER DRIVE
MOLINE, ILLINOIS 61265 (309)762-8863
A SUBSIDIARY OF JOHNSON BROS. CORPORATION

PALZO SITE
AERIAL PHOTO
PRE-MINING CONDITIONS
6/2/51

PLATE A-1



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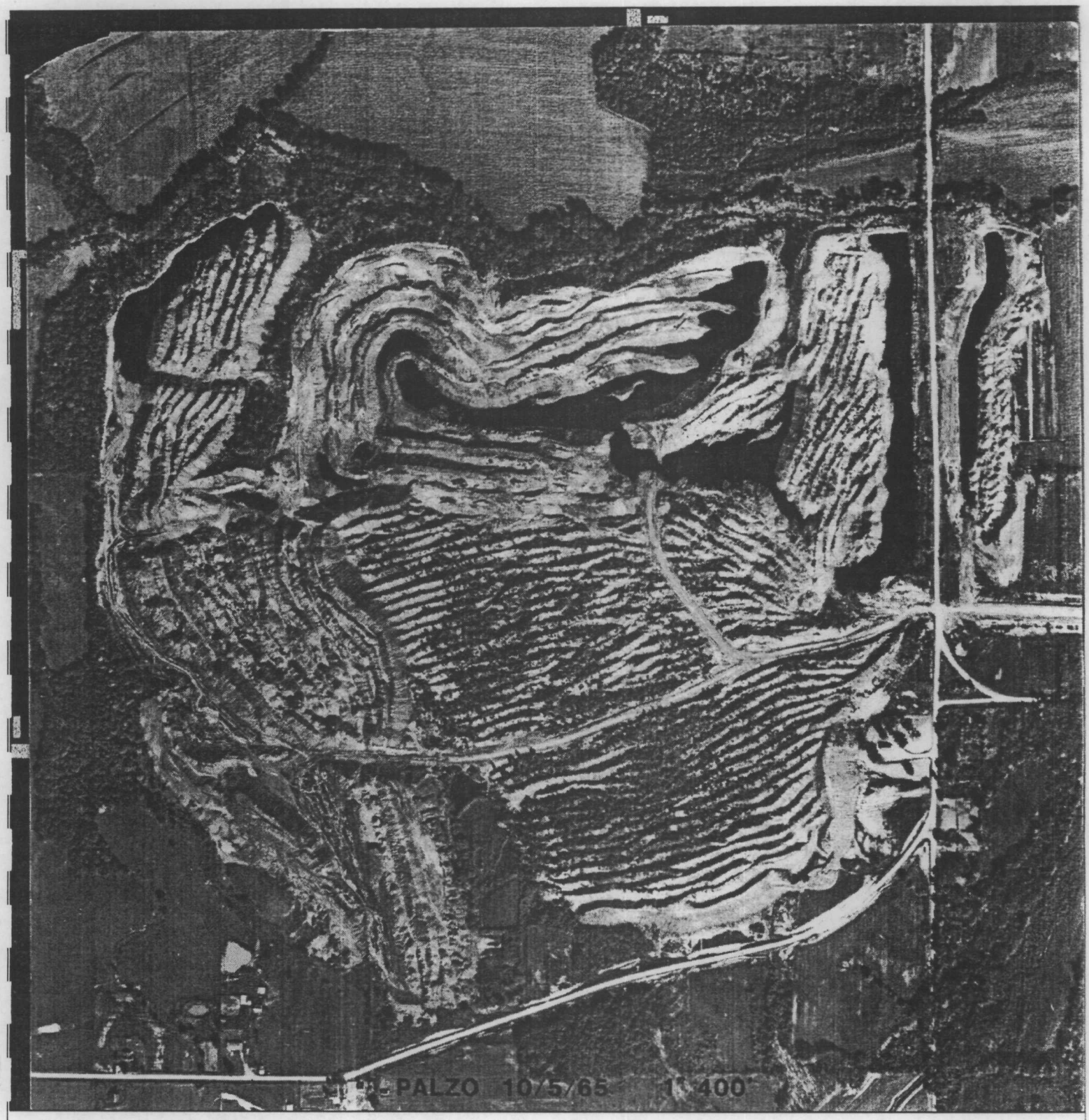
PALZO SITE
AERIAL PHOTO
MINE SITE CONDITIONS
5/1/60

PLATE A-2



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PALZO SITE
AERIAL PHOTO
MINE SITE CONDITIONS
10/5/65

PLATE A-3

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PALZO SITE
AERIAL PHOTO
MINE SITE CONDITIONS
1971

PLATE A-4

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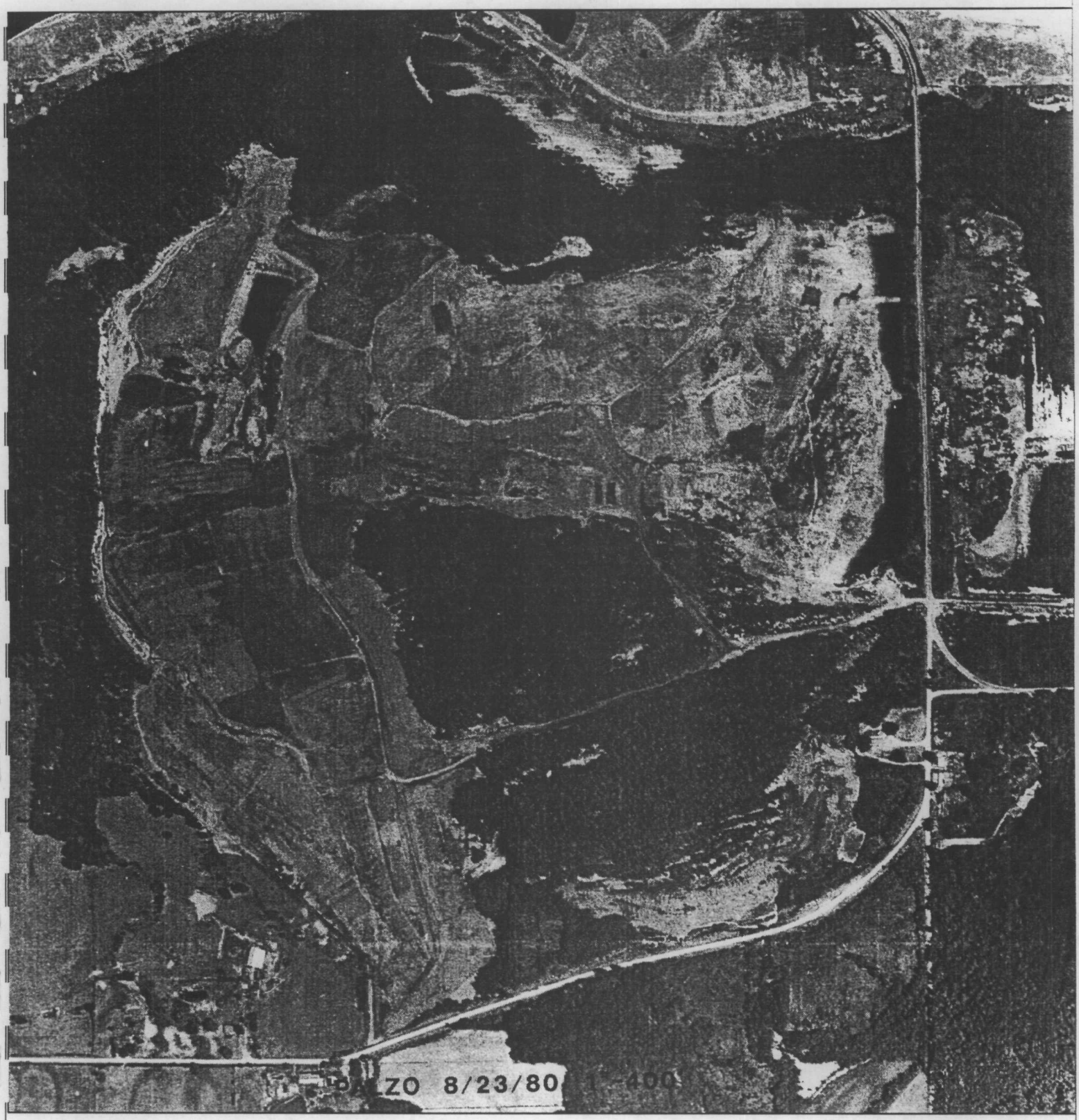
PALZO SITE
AERIAL PHOTO
MINE SITE CONDITIONS
3/14/79

PLATE A-5



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PALZO SITE
AERIAL PHOTO
MINE SITE CONDITIONS
8/23/80

PLATE A-6

SOUTHERN ILLINOIS INVESTIGATIVE SERVICES
PALZO SITE; AML-GsWA-9600J
WILLIAMSON COUNTY, ILLINOIS
SITE STUDY AND RECOMMENDATIONS

APPENDIX B

PROJECT PHOTOGRAPHS

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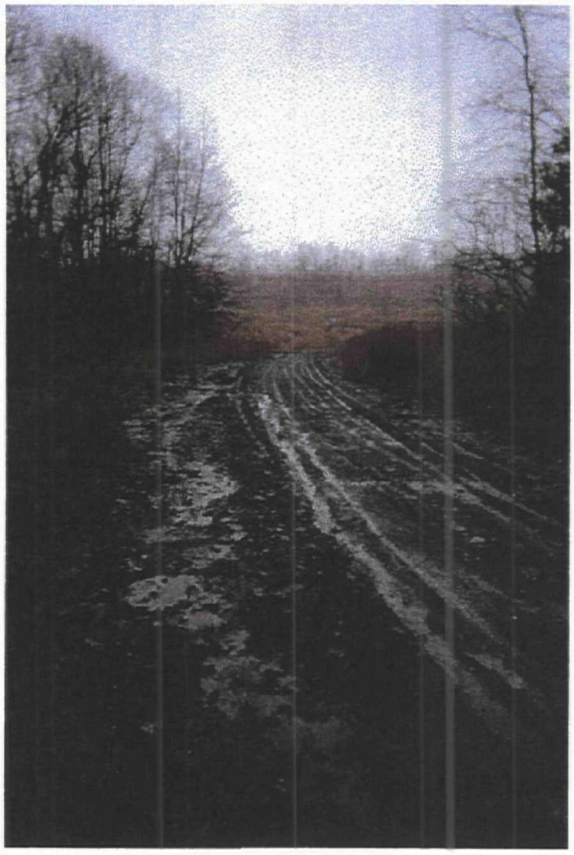
PALZO SITE

Pictured is a view of naturally revegetated windrowed spoil piles located in the central portion of the site near MW-97-11. This area was mined down only to the shallower Dekoven Coal.

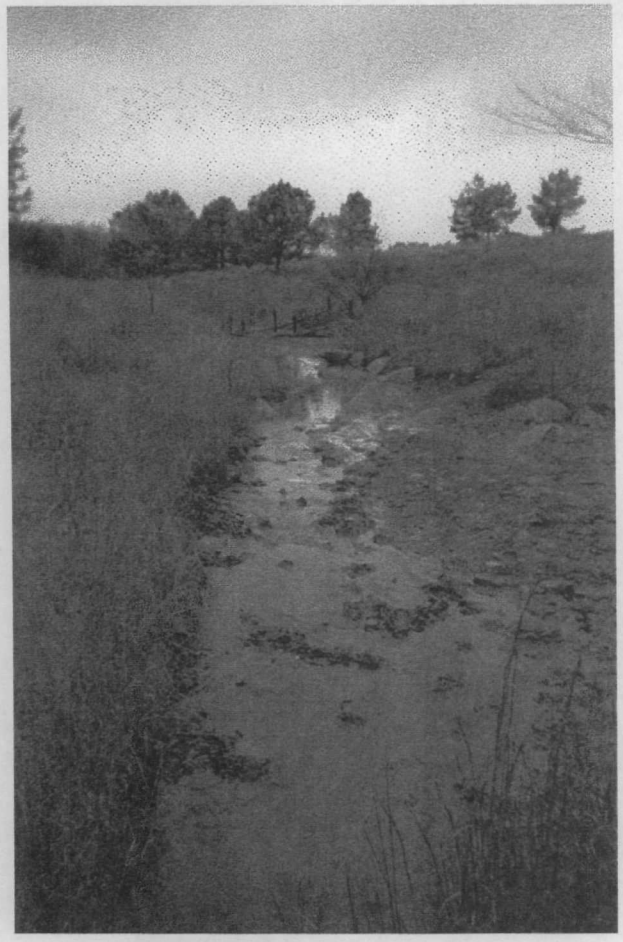


This photo was taken along the access road in a naturally revegetated area. The view is to the north towards MW-97-8. The photo depicts the presence of exposed overburden materials, particularly black shales. Surface water which flows over this area drains into the retention pond by gabion structure #1 and ultimately into Sugar Creek.

AML-GsWA-9600J
PALZO SITE

Pictured is a view looking north along the N-S access road located adjacent to the western edge of naturally revegetated windrowed spoil banks (near MW-97-10). The photo depicts severe erosion (gullies up to 3' deep) that has occurred, exposing overburden materials with acid producing potential. Surface water that flows over this area eventually drains towards the center of the site to the northern drainageway in the vicinity of MW-97-9 and gabion structure #2.

AML-GsWA-9600J
PALZO SITE



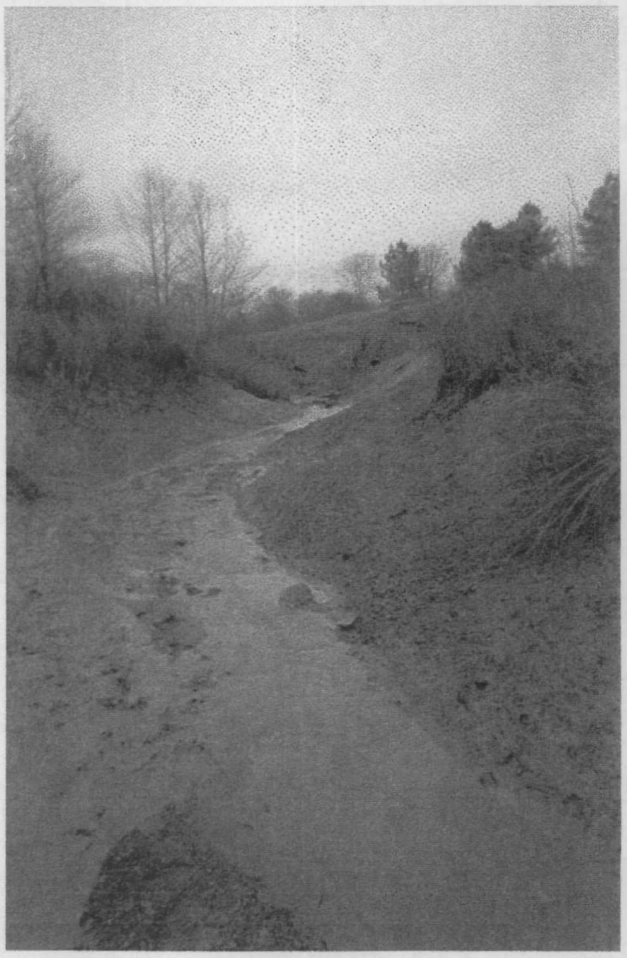
Pictured at left is a view to the north (downstream) of the western drainageway above gabion structure #3 near a seep area which received a treatment trench. The photo shows the presence of eroded material over which surface water runoff and groundwater seepage flows. Bank erosion is minimal in this stretch of drainageway.

Pictured above is a view looking northwest (downstream) along the western drainageway immediately above gabion structure #3. This photo depicts the considerable silting in of the structure that has occurred to such extent that silted material is almost even with the top of the gabion structure.

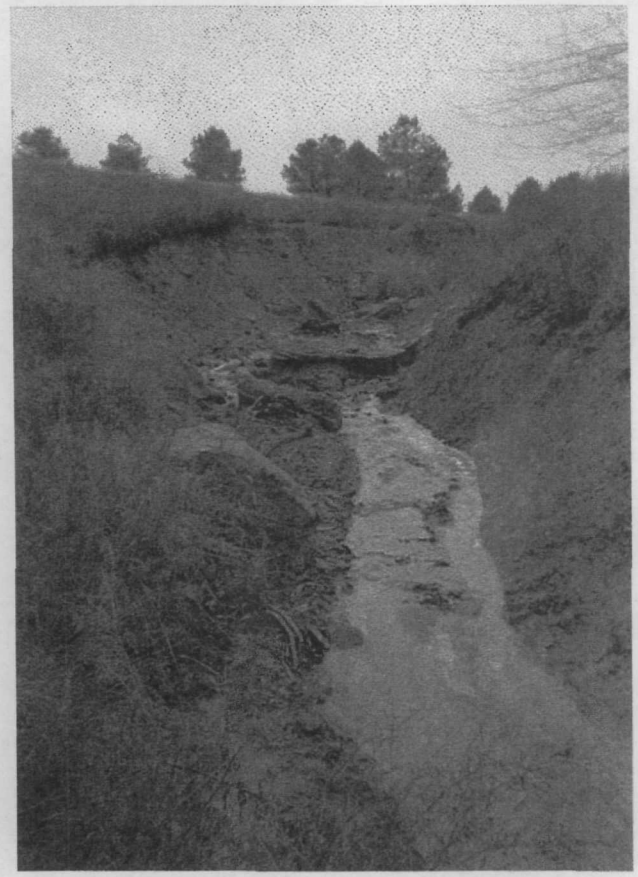
AML-GsWA-9600J
PALZO SITE

The view shown above looks northwest (downstream) along the western drainageway below gabion structure #3. The drainageway is wider (30'-50') in this area and has a considerable amount of eroded material which has silted in the drainageway. Some bank erosion has occurred in this area but is not as severe as other locations due in part to gentler slopes. Laboratory test results indicated a pH level of ~ 2.8.

Pictured at right is a view to the north immediately downstream of gabion structure #4. The gabion structure has been silted in and the water flows around the gabion, having eroded a channel into the west bank. Note the erosion of bank slopes and exposure of overburden material which both surface water and groundwater seepage flows over.



AML-GsWA-9600J
PALZO SITE

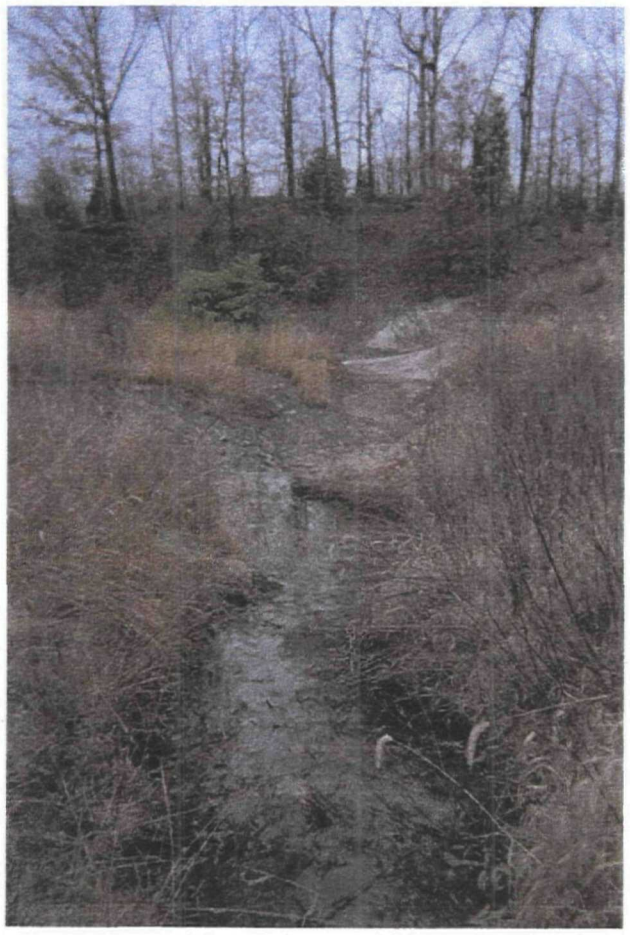


The view shown here looks to the south (upstream) along the western drainageway below gabion structure #4. The photo depicts erosion of bank slopes and exposure of overburden materials including black shales and sandstone. Note iron-stained sandstone in the center of the drainageway. Surface water runoff and groundwater seepage flows over these exposed materials. Erosion of banks contributes greatly to silting in of the drainageway.

The view above is to the north along the western drainageway between gabion structures #4 and #5. This photo depicts silting in of the drainageway, erosion of bank slopes and exposure of black shales, weathered sandstone and lack of vegetation. Surface water runoff and groundwater seepage flows over these exposed materials. Field measurements indicated pH levels of 3.8 - 4.0.

AML-GsWA-9600J
PALZO SITE

The view shown is of reclaimed slopes along the north side of the western drainageway near MW-97-6. Note the presence of barren surface areas which have been eroded and expose potential acid producing materials.



Pictured at left is a view to the west of the E-W drainageway located between MW-97-6 and MW-97-7. This photo was taken ~ 100' upstream of where this drainageway empties into the main western drainageway and shows partial erosion of bank slopes and exposure of acid producing materials. Laboratory test results indicated a pH level of ~ 2.7.

AML-GsWA-9600J
PALZO SITE

Pictured above is a north view of the western drainageway, upstream of gabion structure #6, near MW-97-6. This photo shows the silted in condition of the drainageway and presence of black shale material. Slopes on the right side were reclaimed with the left side being untouched after mining operations ceased. Laboratory test results indicated a pH level of ~ 2.7.

AML-GsWA-9600J
PALZO SITE

The photo shown above is a downstream view of gabion structure # 6 showing surface runoff flowing over, not through, the structure. The bottom of the gabion has been damaged, allowing gabion material to wash away.

Gabion structure # 6 is shown above with sediment to the top of the upstream side and trees growing within the structure itself. Note exposure of black shale outcrop. It was noted that due to siltation, runoff is beginning to go around the end of the gabion. Bank erosion will accelerate when a channel around the gabion is better incised into bank materials here.

The view shown above looks northwest (downstream) of the western drainageway halfway between gabion structures #6 and #7. Note that the channel width increases and contains a large amount of eroded sediments. Bank erosion is not too severe in this stretch due in part to gentler back slopes.

This view looks to the west of the western drainageway ~ 100 yards south of gabion structure #7. The low spot on the far bank in the center of the photo is an earthen embankment constructed in Phase III to contain drainage. Due to the amount of siltation that has occurred, this area could be overtopped after heavy rains, spilling water and materials into Sugar Creek.

The view shown above is to the north (downstream) of gabion structure #7 in the western drainageway. After rainfall, surface waters are retained by the gabion, thus creating a small pond. Waters flow over rather than through the structure due to siltation that has taken place. Field measurements indicated a pH level of ~ 4 - 4.3.

The view above looks to the south (upstream) of the downstream face of gabion structure #7 in the western drainageway. The structure has been silted in with portions of the bottom eroded away, thus allowing rock material to be washed away. Note the water flowing over the top of the structure.

Pictured is a view to the north (downstream) of gabion structure #7 ~ 100 yards from where it discharges into Sugar Creek. Note the presence of exposed overburden materials in the lower right-hand corner of the photo and the large amount of iron staining that has occurred.

A discharge area into Sugar Creek along the northern border through unmined areas is pictured above. This area is located within the narrow band of undisturbed mine land at the northwest quadrant of the site. This area now receives, in part, eroded materials from reclaimed slopes.

AML-GsWA-9600J
PALZO SITE

This picture shows a weather monitoring station in the upper right corner. Surface water runoff is discharging into Sugar Creek along the northern boundary of the site after flowing through the retention pond and gabion structure #1. Laboratory test results indicated a pH level of ~ 2.7.

Pictured above is a view to the east along the northern boundary of the site adjacent to Sugar Creek. This photo depicts an area where groundwater seepage occurs and flows directly into Sugar Creek. The area is devoid of vegetation due to bedrock outcropping.

The view above is of groundwater seepage occurring along the northern boundary adjacent to Sugar Creek. Note the amount of iron staining that has occurred.

Pictured above is gabion structure #1 with sediment almost to the top of the upstream side, allowing runoff to pass directly over the top of the structure before being discharged through the weir in the northeast quadrant. This gabion structure is in poor shape and the retention pond has received considerable eroded materials.

This view is to the south of gabion structure #1, which was built for the retention pond located in the northeast portion of the site. Water in the drainageway was flowing both over and through the gabion when the photograph was taken. Field measurements of pH indicated a level of ~ 4.4. The drainageway has been silted in to some extent.

SOUTHERN ILLINOIS INVESTIGATIVE SERVICES
PALZO SITE; AML-GsWA-9600J
WILLIAMSON COUNTY, ILLINOIS
SITE STUDY AND RECOMMENDATIONS

APPENDIX C

DRAWINGS

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ILLINOIS DEPARTMENT OF NATURAL RESOURCES
OFFICE OF MINES AND MINERALS
DIVISION OF ABANDONED MINED LAND RECLAMATION
PALZO SITE; AML-GsWA-9600J
WILLIAMSON COUNTY, ILLINOIS
SITE STUDY AND RECOMMENDATIONS

NOT FOR CONSTRUCTION

	DRAWING INDEX			DRAWING INDEX			DRAWING INDEX	
DWG. NO.	TITLE	REV. NO.	DWG. NO.	TITLE	REV. NO.	DWG. NO.	TITLE	REV. NO.
	GENERAL	0		CROSS SECTIONS	0		SURFACE WATER - CHEMICAL ANALYTES	0
0	COVER SHEET	0	100	CROSS SECTION LOCATIONS	0	200	CONCENTRATION VALUE - pH	0
5	LOCATION MAP AND GENERAL LEGEND	0	101	EAST-WEST SECTION A - A	0	201	CONCENTRATION VALUE - IRON	0
10	VICINITY MAP - 1995 AERIAL PHOTO WITH MINING HISTORY	0	102	EAST-WEST SECTION B - B	0	202	CONCENTRATION VALUE - SULFATE	0
20	SITE MAP WITH EXISTING TREATMENT	0	103	EAST-WEST SECTION C - C	0	203	CONCENTRATION VALUE - ACIDITY	0
30	BORING/MONITORING WELL AND SURFACE MONITORING POINTS	0	104	NORTH-SOUTH SECTION D - D	0	204	CONCENTRATION VALUE - ALKALINITY	0
			105	NORTH-SOUTH SECTION E - E	0		GROUNDWATER	0
			106	NORTH-SOUTH SECTION F - F	0	300	CONTOUR MAP	0
			107	NORTH-SOUTH SECTION G - G	0	301	CHEMICAL ANALYTES (pH, Iron, Sulfate, Acidity, & Alkalinity)	0

NO.	DESCRIPTION	DATE	APPROVED

DRAWN LDB
CHECKED PHS
APPROVED ---
SCALE NONE
DATE 05/08/98

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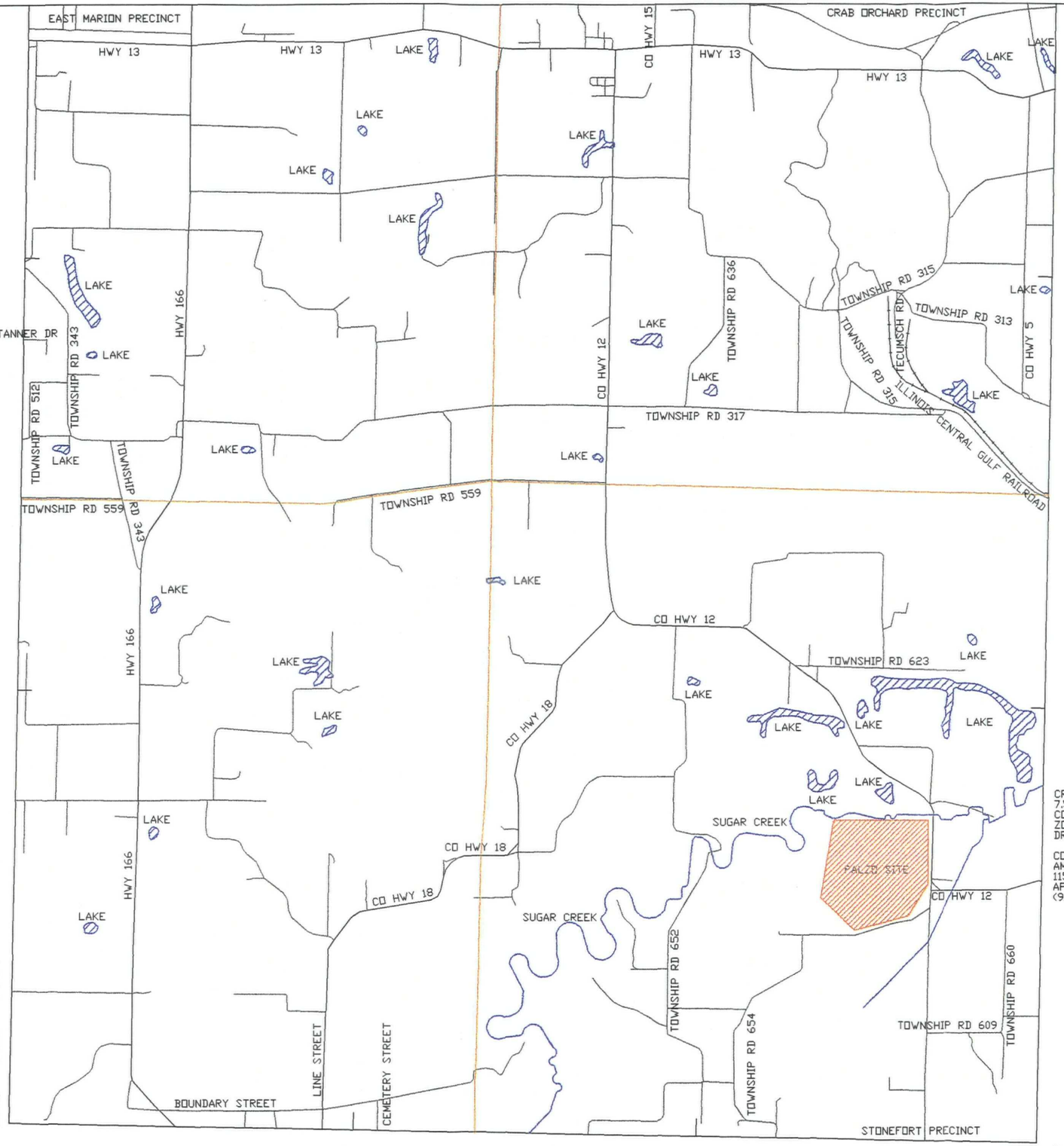
PALZO SITE; AML-GsWA-9600J

TITLE GENERAL
COVER SHEET

PROJECT NO. 88-19-202.00

DRAWING NO. 0



PROJECT LOCATION MAP

GENERAL LEGEND

- BRIDGE
- COUNTY ROAD (HARD SURFACE)
- COUNTY ROAD (GRAVEL)
- SITE ACCESS ROAD (DIRT/GRAVEL)
- BUILDINGS
- TEMPORARY BENCH MARK
- UTILITY POLE
- ROAD CULVERT
- FENCE LINE
- CONTOUR
- DEPRESSIONAL AREA
- DRAINAGEWAY
- SUGAR CREEK
- POND
- ACIDIC IMPOUNDMENT
- TREE LINE
- SWAMPY/MUDDY CONDITIONS
- LIMESTONE TREATMENT TRENCH
- RIPRAP DOWN DRAIN
- GABION/ROCK CHECK DAM (NUMBERED)
- CONSTRUCTION/SEEDING LIMITS
- GRADING/MULCHING LIMITS
- GREEN MANURING LIMITS
- FINE GROUND LIMESTONE APPLICATION LIMITS
- LIMESTONE TREATMENT TRENCH
- EARTH DAM
- RIPRAP DOWN DRAIN
- BREACH (RECEIVED EARTH DAM)
- SEEP AREA (COVERED WITH SOIL)

CRAB ORCHARD, IL 37088F7
7.5 MINUTE SERIES MAP
COORDINATE SYSTEM: NAD27 UNIVERSAL TRANSVERSE MERCATOR FEET
ZONE: UTM-16
DRAWING UNIT: FOOT

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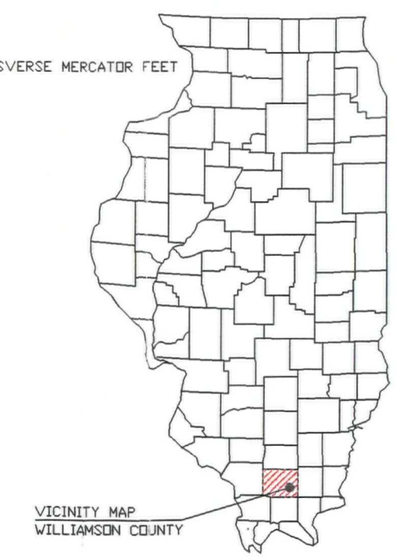
0 1000 2000 3000 4000 5000 6000 7000
SCALE IN FEET



VICINITY MAP
WILLIAMSON COUNTY

NO.	DESCRIPTION	DATE	APPROVED

DRAWN LDB | CHECKED PHS | APPROVED ---
SCALE AS SHOWN | DATE 05/08/98

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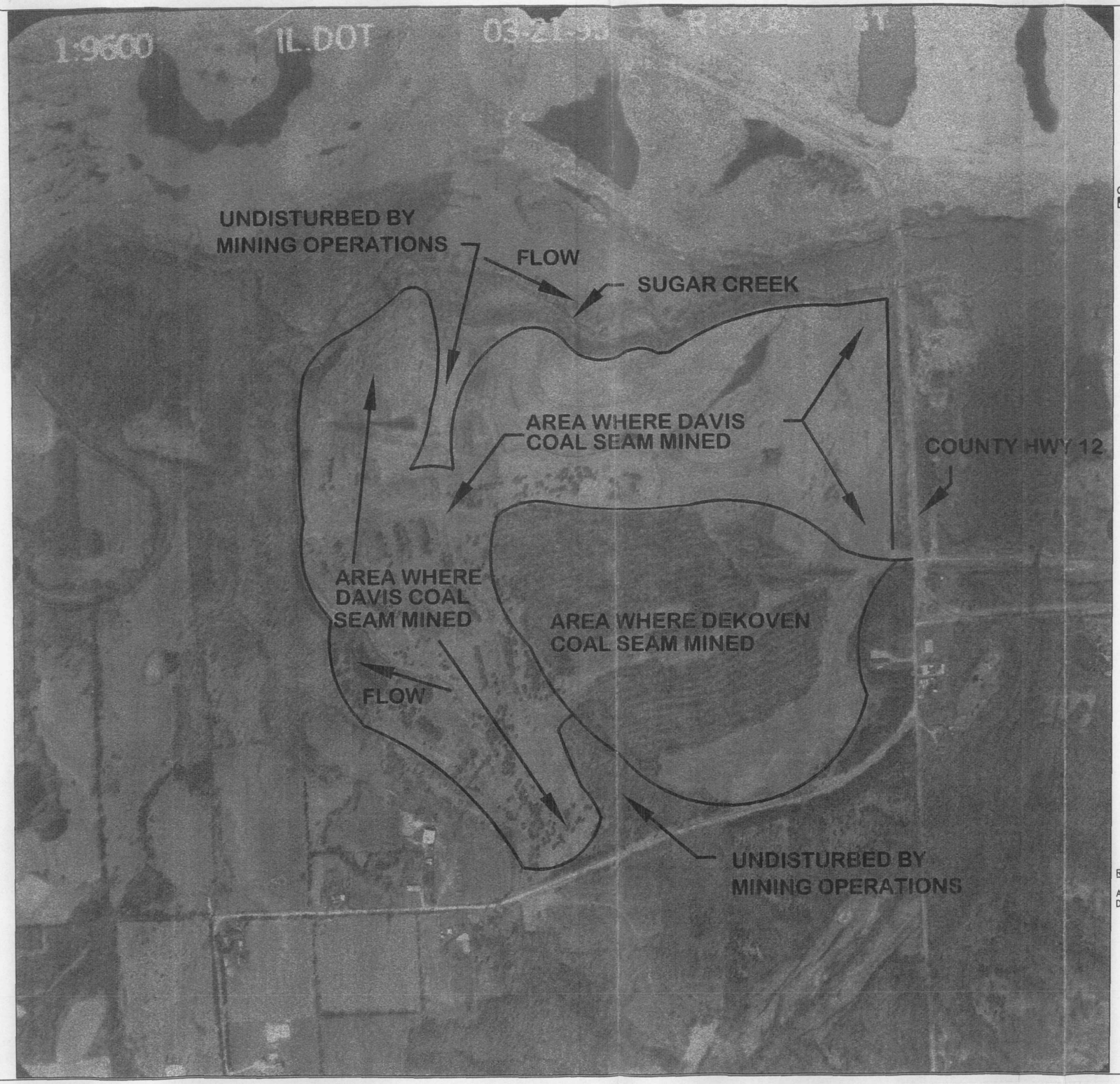
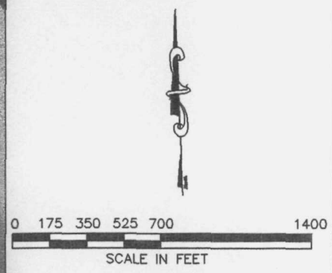
OFFICE OF MINES AND MINERALS
DIVISION OF ABANDONED MINED LAND RECLAMATION
PALZO SITE, AML-GSVA-9600J

TITLE GENERAL LOCATION MAP AND GENERAL LEGEND

PROJECT NO. 88-19-202.00

DRAWING NO. 5





REFERENCES:

AERIAL PHOTOGRAPH PROVIDED BY ILLINOIS DEPARTMENT OF NATURAL RESOURCES.

NO.	DESCRIPTION	DATE	APPROVED

DRAWN LDB | SCALE AS SHOWN
CHECKED PHS | DATE 05/08/98
APPROVED ---

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PALZO SITE; AML-GsWA-9600J

TITLE
GENERAL - VICINITY MAP
1995 AERIAL PHOTO WITH MINING HISTORY

PROJECT NO.
88-19-202.00

DRAWING NO.
10

GENERAL NOTES:

1. FOR EXISTING TREATMENT LEGEND, SEE DRAWING 5.

REFERENCES:

TOPOGRAPHY AND EXISTING TREATMENT FROM PALZO SURFACE MINE, PHASE III, AML-GWmE-8454, DRAWINGS DATED 22 MAY 1986.

NO.	DESCRIPTION	DATE	APPROVED
1.	ADDED NOTES, LABELS, LEGEND - BM	5/2/98	

DRAWN LDB | SCALE AS SHOWN
CHECKED PHS | DATE 05/08/98
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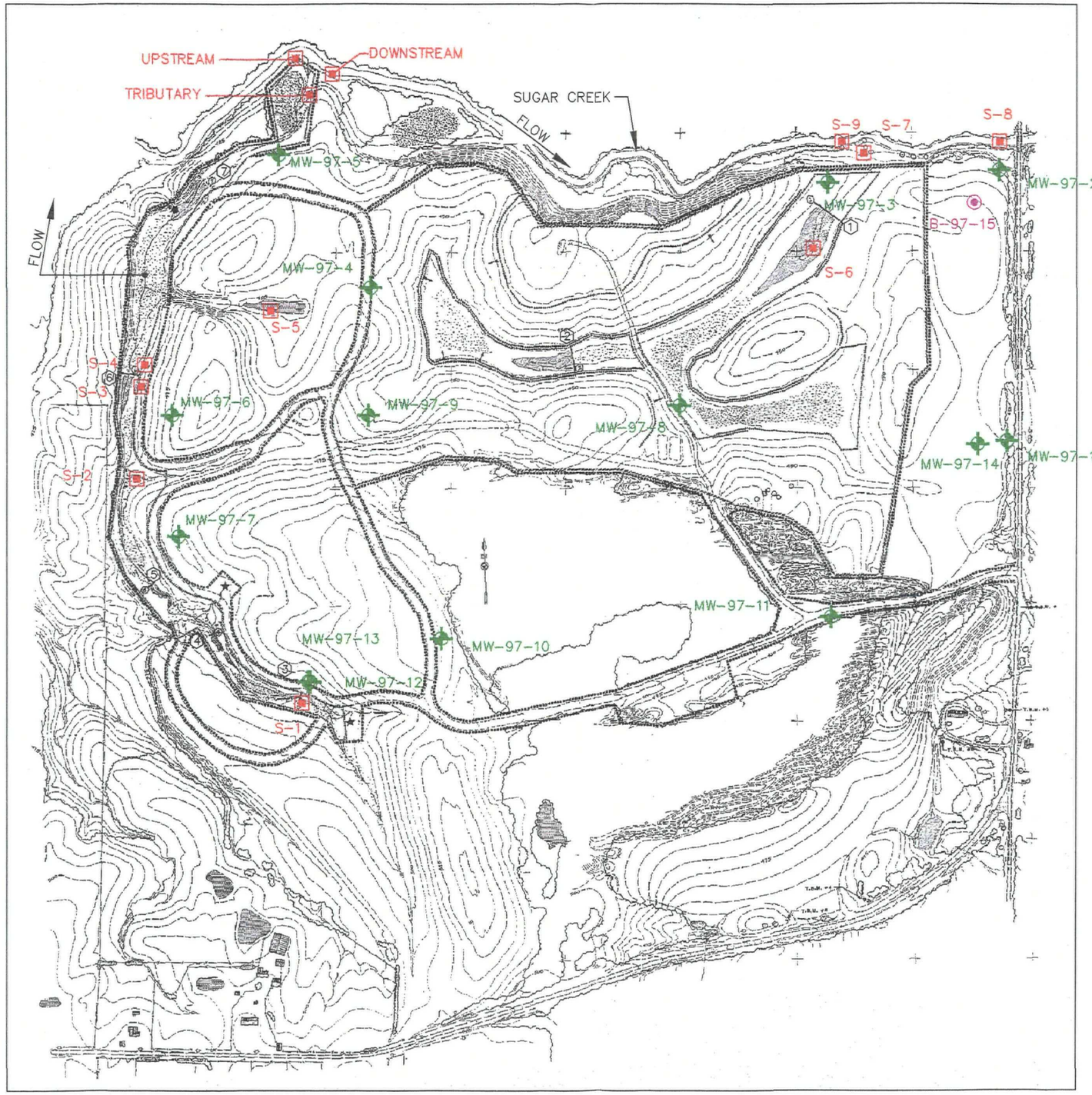
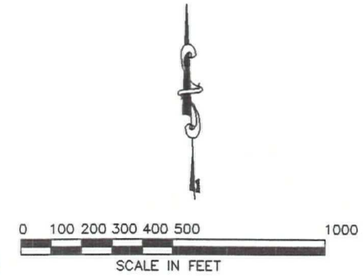
PALZO SITE; AML-GsWA-9600J

TITLE
GENERAL
SITE PLAN WITH EXISTING TREATMENT

PROJECT NO.
88-19-202.00

DRAWING NO.
20





MW-97-13 — MONITORING WELL LOCATION

B-97-15 — BORING LOCATION

S-1 — SURFACE WATER MONITORING POINT

GENERAL NOTES:

1. FOR EXISTING TREATMENT LEGEND, SEE DRAWING 5.

2. FOR GEOLOGIC CROSS SECTIONS, SEE DRAWINGS 100 THRU 107.

3. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

REFERENCES:

TOPOGRAPHY AND EXISTING TREATMENT FROM PALZO SURFACE MINE, PHASE III, AML-GWmE-8454, DRAWINGS DATED 22 MAY 1986.

NO.	DESCRIPTION	DATE	APPROVED
1.	ADDED NOTES, LABELS, LEGEND - BM	5/2/98	

DRAWN LDB | SCALE AS SHOWN
CHECKED PHS | DATE 05/08/98
APPROVED --- |

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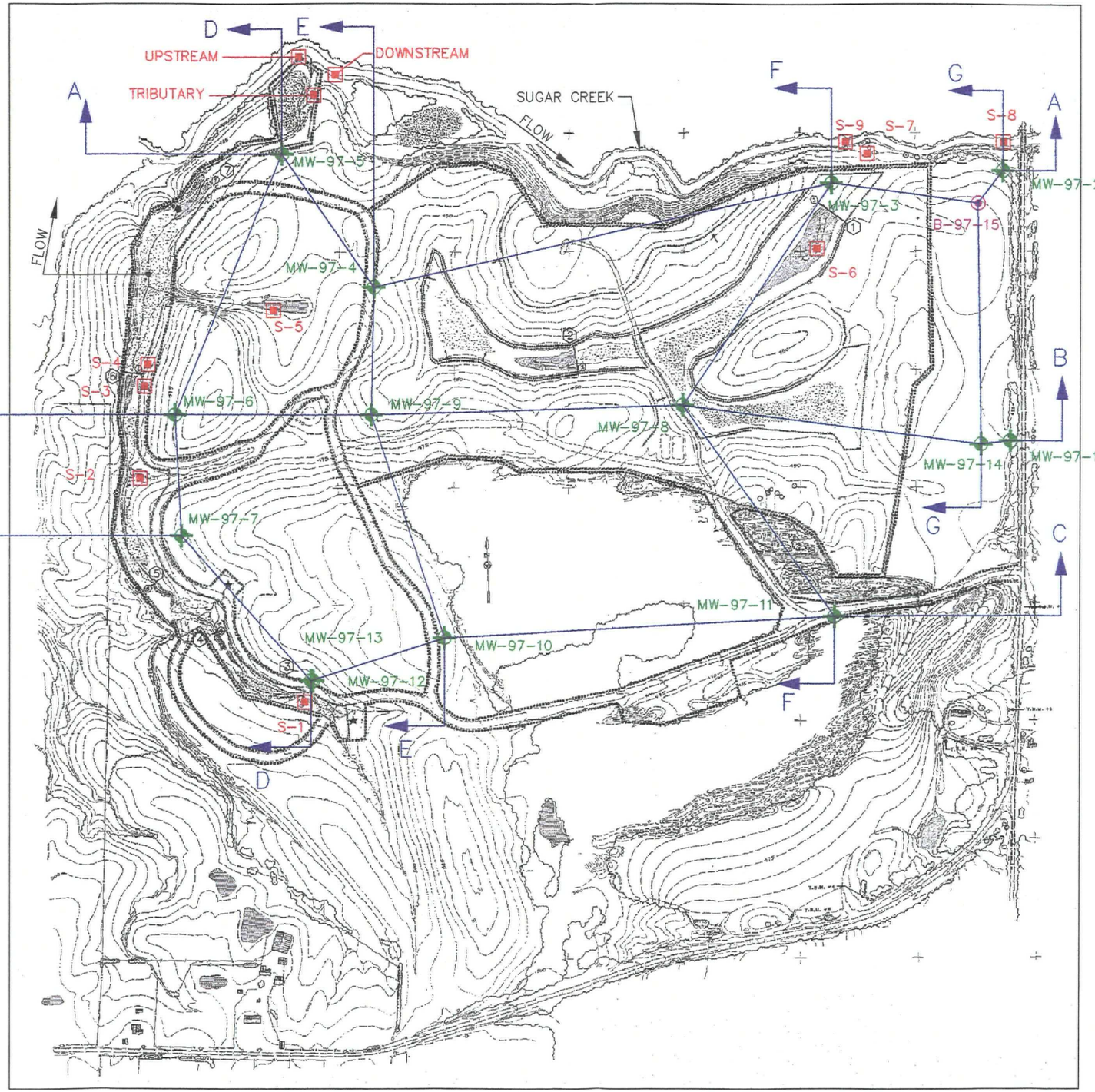
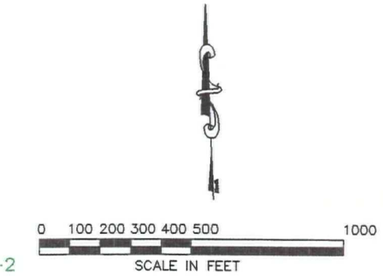
PALZO SITE, AML-GsWA-9600J

TITLE GENERAL
BORING/MONITORING WELL AND SURFACE POINT LOCATIONS

PROJECT NO. 88-19-202.00

DRAWING NO. 30





MW-97-13 MONITORING WELL LOCATION

B-97-15 BORING LOCATION

S-1 SURFACE WATER MONITORING POINT

A CROSS SECTION REFERENCE

GENERAL NOTES:

1. FOR EXISTING TREATMENT LEGEND, SEE DRAWING 5.

2. FOR GEOLOGIC CROSS SECTIONS, SEE DRAWINGS 100 THRU 107.

3. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

REFERENCES:

TOPOGRAPHY AND EXISTING TREATMENT FROM PALZO SURFACE MINE, PHASE III, AML-GWmE-8454, DRAWINGS DATED 22 MAY 1986.

NO.	DESCRIPTION	DATE	APPROVED
1.	ADDED NOTES, LABELS, LEGEND - BM	5/2/98	

DRAWN LDB | SCALE AS SHOWN
CHECKED PHS | DATE 05/08/98
APPROVED ---

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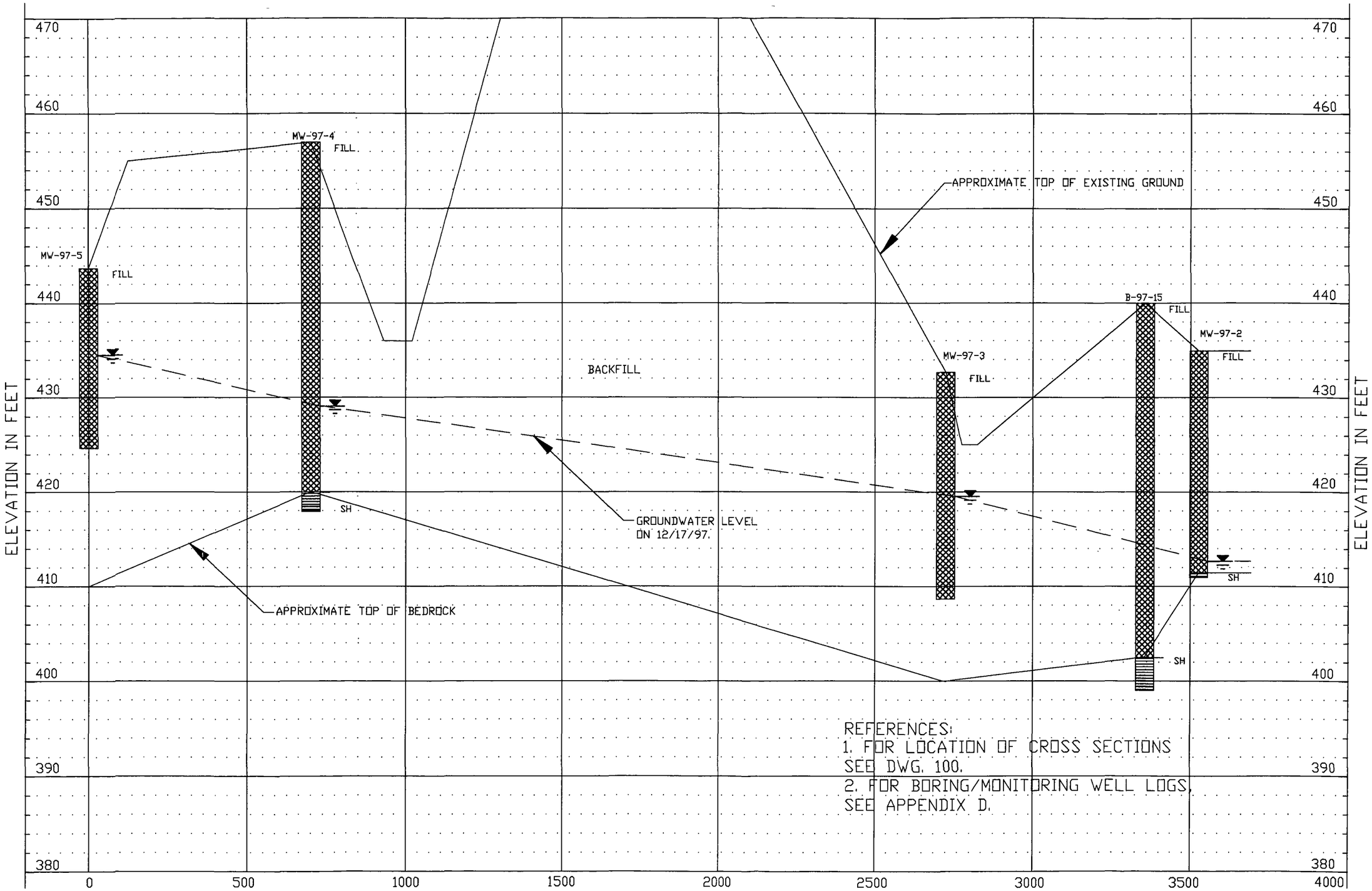
PALZO SITE; AML-GsWA-9600J

TITLE
CROSS SECTIONS
CROSS SECTION LOCATIONS

PROJECT NO. 88-19-202.00

DRAWING NO. 100



REFERENCES:
1. FOR LOCATION OF CROSS SECTIONS SEE DWG. 100.
2. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

SECTION A - A

NO.	DESCRIPTION	DATE	APPROVED

SCALE: AS SHOWN
DATE: 05/11/98
DRAWN: VAC
CHECKED: PHS
APPROVED: ---

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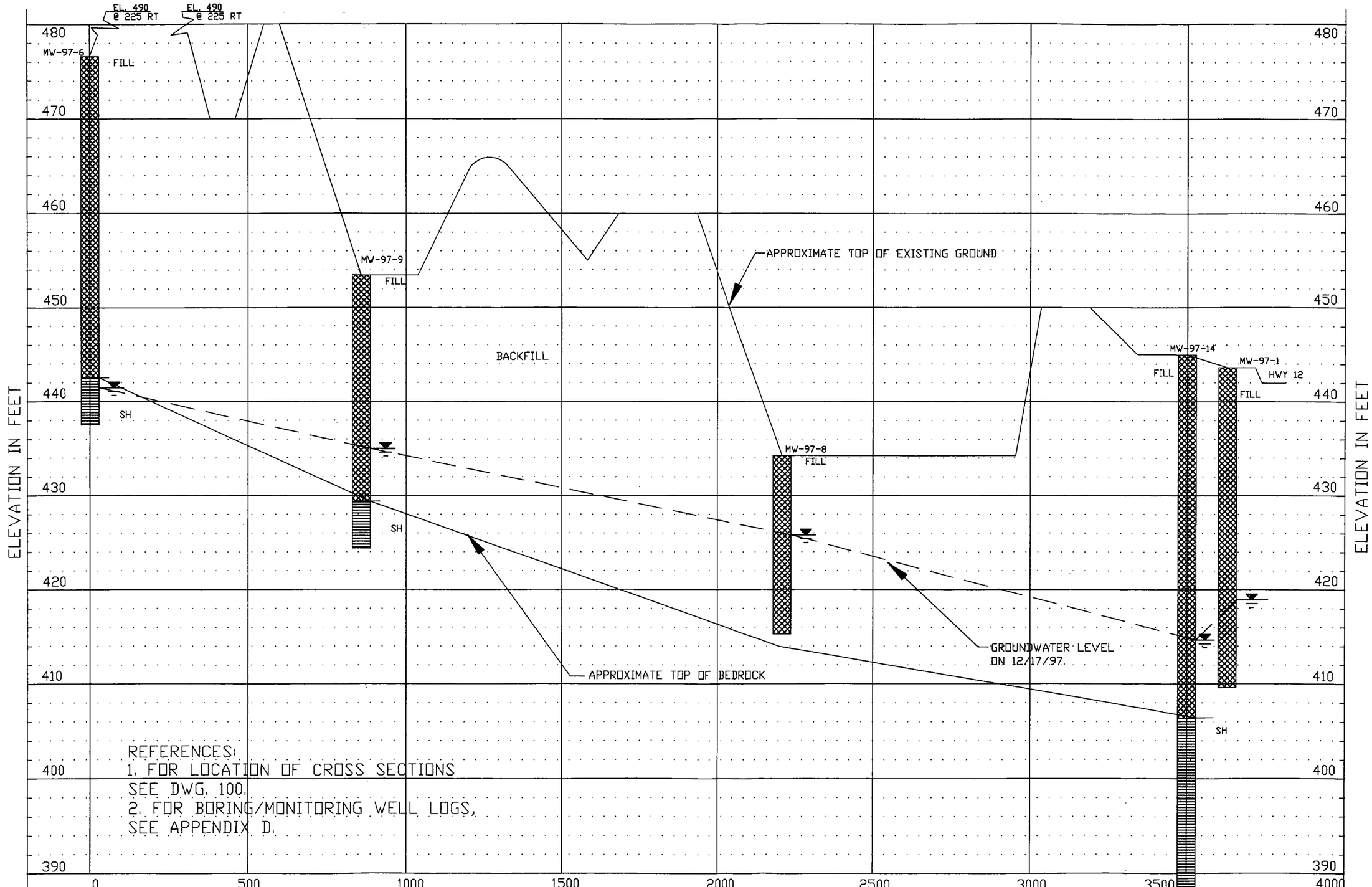
TITLE: CROSS SECTIONS
EAST - WEST SECTION A - A

PROJECT NO. 88-19-202.00

DRAWING NO. 101



Strata symbols

Fill

Shale

Misc. Symbols

Water table on 12/17/97

OFFSET ALONG CROSS SECTION IN FEET

SECTION B - B

SCALE: VERTICAL 10 5 0 10

HORIZONTAL 300 150 0 300

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN

DATE 05/11/98

DRAWN VAC

CHECKED PHS

APPROVED ---

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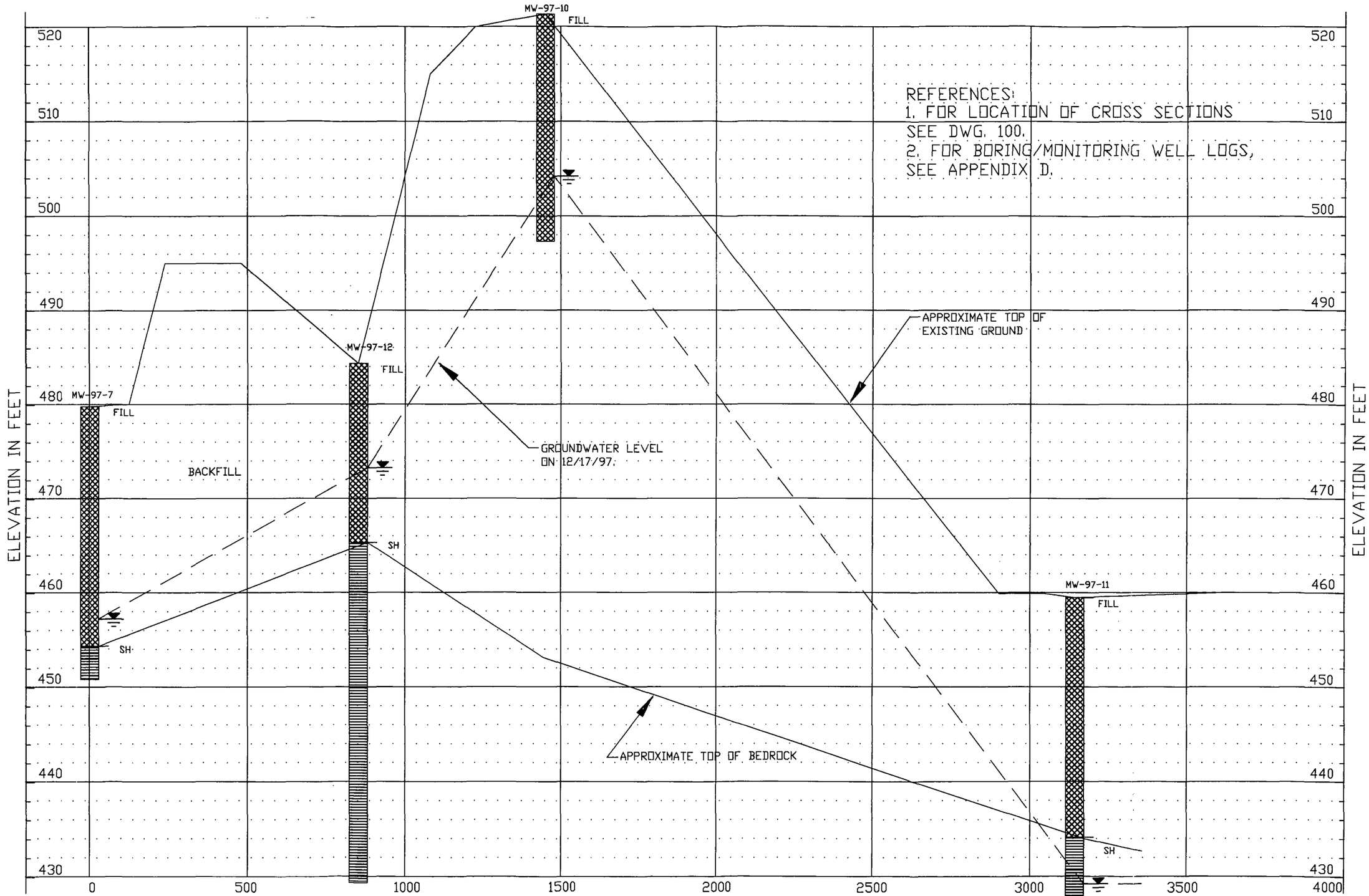
PALZO SITE; AML-GSVA-9600J

TITLE CROSS SECTIONS
EAST - WEST SECTION B - B

PROJECT NO. 88-19-202.00

DRAWING NO. 102



REFERENCES:
1. FOR LOCATION OF CROSS SECTIONS SEE DWG. 100.
2. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

SECTION C - C

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 05/11/98
DRAWN VAC
CHECKED PHS
APPROVED ---

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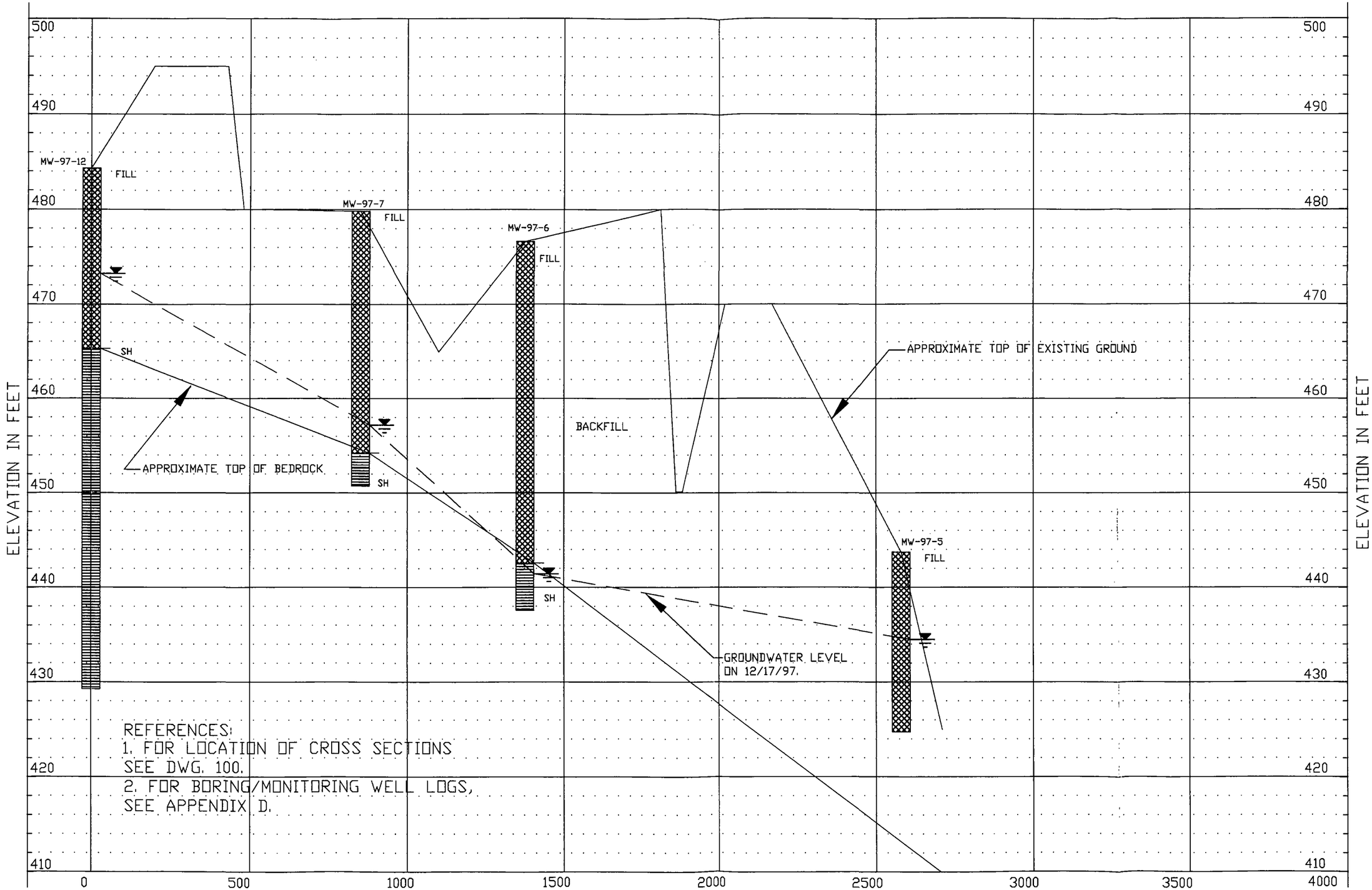
PALZO SITE, AML-GSVA-960DJ

TITLE CROSS SECTIONS
EAST - WEST SECTION C - C

PROJECT NO. 88-19-202.00

DRAWING NO. 103



REFERENCES:
1. FOR LOCATION OF CROSS SECTIONS SEE DWG. 100.
2. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

Strata symbols
- Fill
- Shale

Misc. Symbols
- Water table on 12/17/97

SECTION D - D

SCALE: VERTICAL 10 5 0 10
HORIZONTAL 300 150 0 300

NO.	DESCRIPTION	DATE	APPROVED

SCALE AS SHOWN
DATE 05/11/98
DRAWN VAC
CHECKED PHS
APPROVED ---

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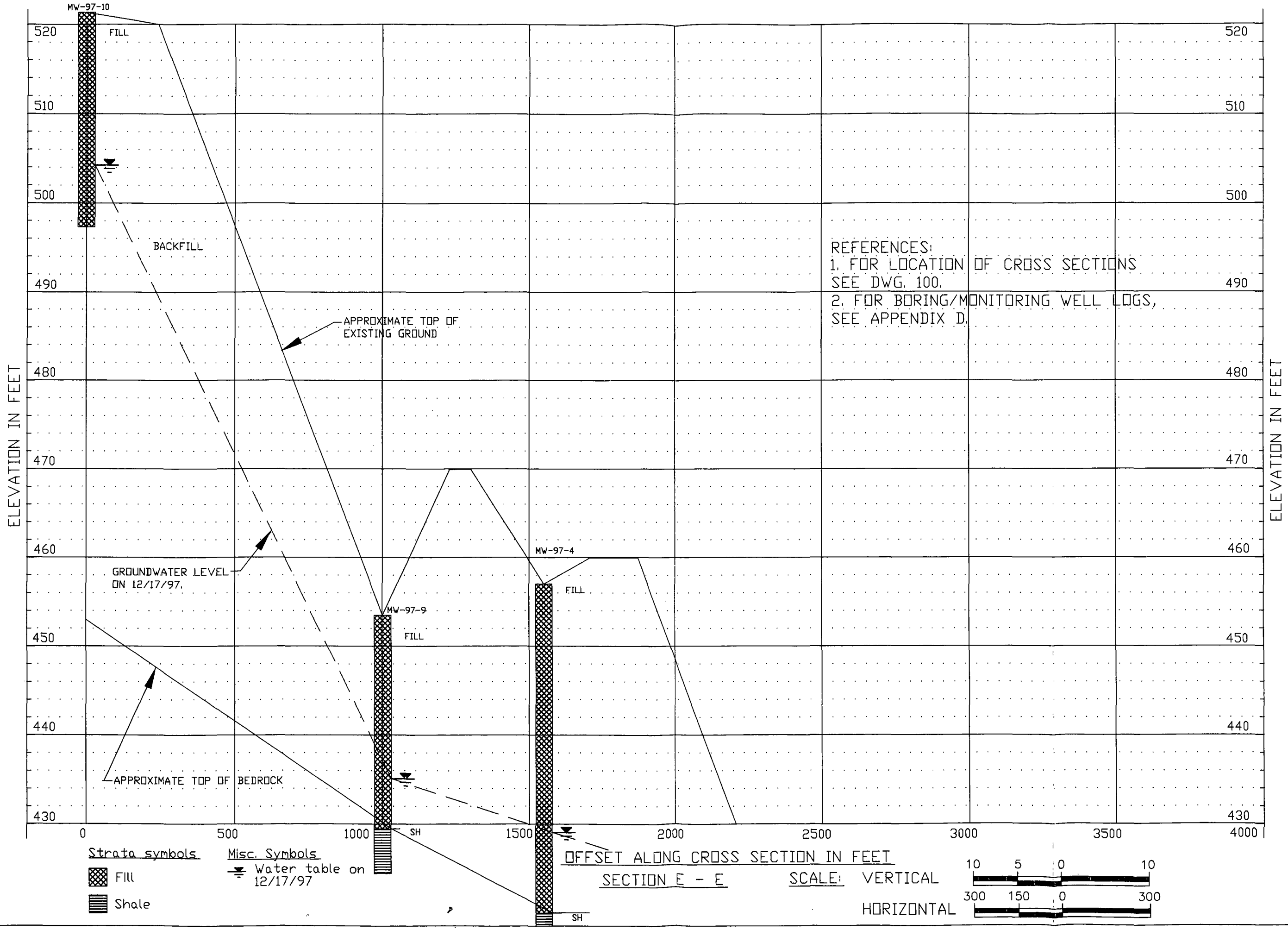
PALZO SITE; AML-GsVA-9600J

TITLE CROSS SECTIONS NORTH - SOUTH SECTION D - D

PROJECT NO. 88-19-202.00

DRAWING NO. 104



REFERENCES:
1. FOR LOCATION OF CROSS SECTIONS SEE DWG. 100.
2. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

NO.	DESCRIPTION	DATE	APPROVED

DRAWN VAC
CHECKED PHS
APPROVED ---
SCALE AS SHOWN
DATE 05/11/98

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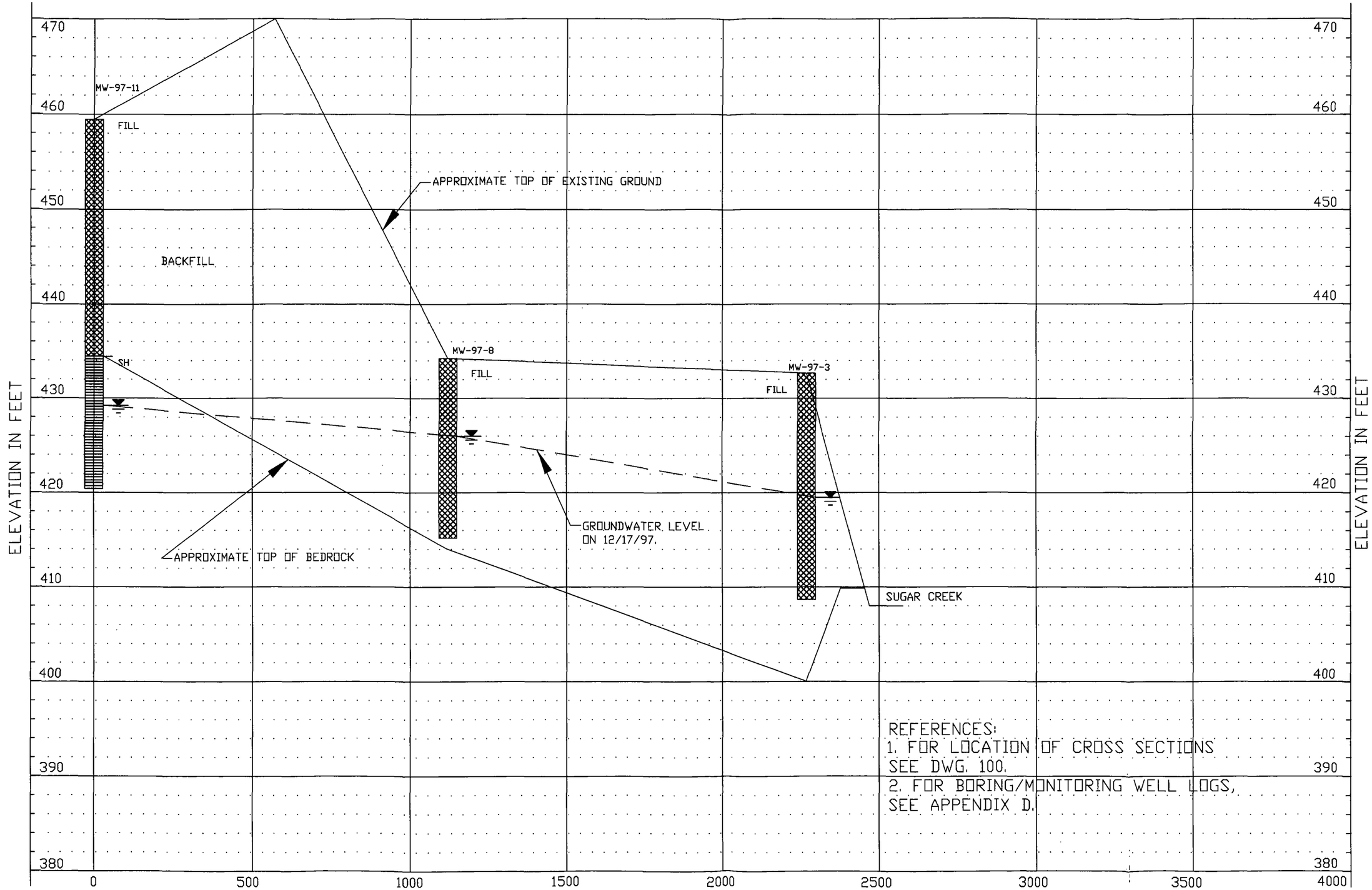
PALZO SITE, AML-GsVA-960DJ

TITLE CROSS SECTIONS
NORTH - SOUTH SECTION E - E

PROJECT NO. 88-19-202.00

DRAWING NO. 105



REFERENCES:
1. FOR LOCATION OF CROSS SECTIONS SEE DWG. 100.
2. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

Strata symbols
- Fill
- Shale

Misc. Symbols
- Water table on 12/17/97

SECTION F - F

SCALE: VERTICAL 10 5 0 10
HORIZONTAL 300 150 0 300

NO.	DESCRIPTION	DATE	APPROVED

DRAWN VAC
CHECKED PHS
DATE 05/11/98
SCALE AS SHOWN
APPROVED ---

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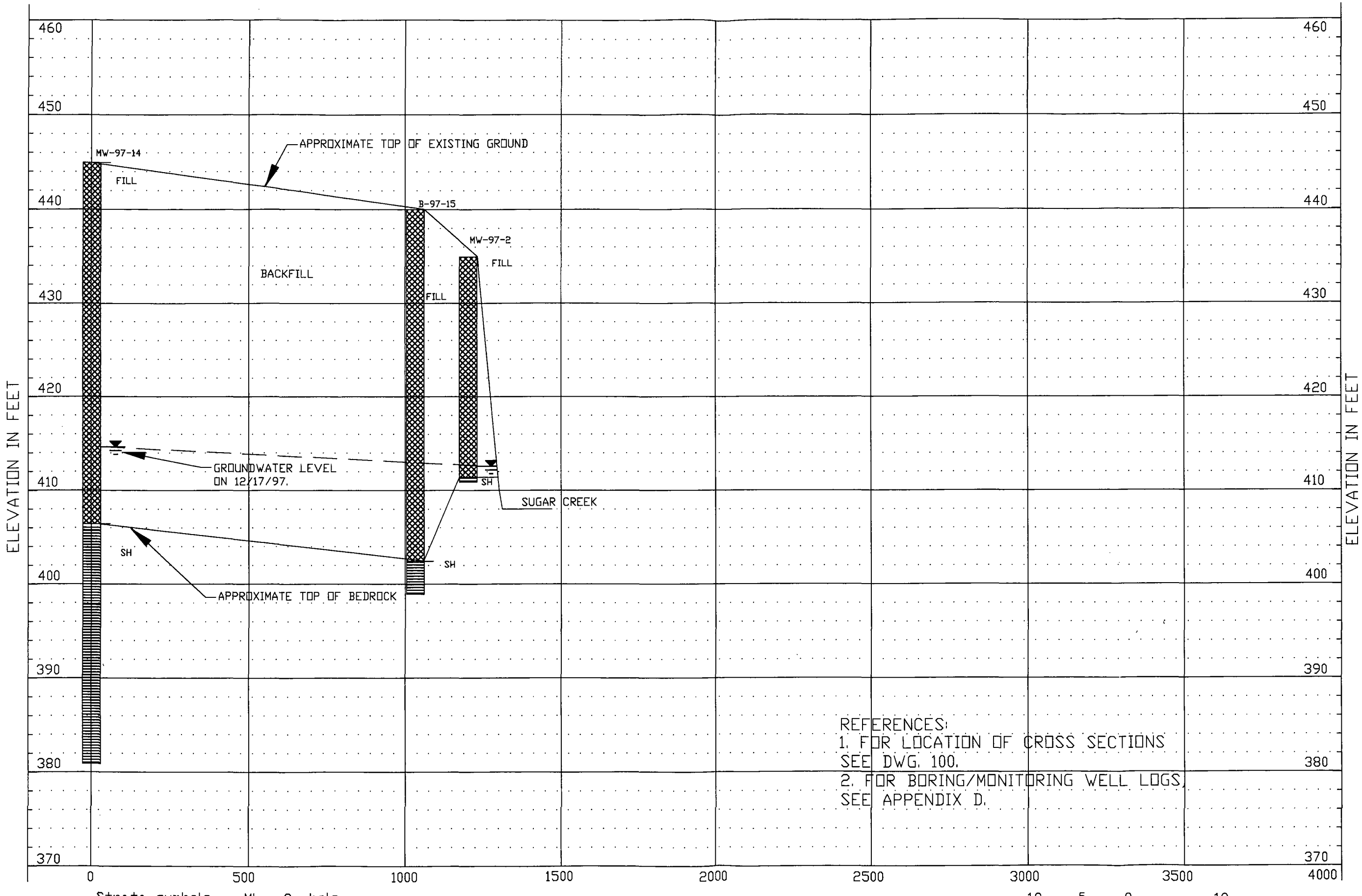
PALZO SITE; AML-GSWA-9600J

TITLE CROSS SECTIONS
NORTH - SOUTH SECTION F - F

PROJECT NO. 88-19-202.00

DRAWING NO. 106



REFERENCES:
1. FOR LOCATION OF CROSS SECTIONS SEE DWG. 100.
2. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

SECTION G - G

NO.	DESCRIPTION	DATE	APPROVED

DRAWN VAC | SCALE AS SHOWN
CHECKED PHS | DATE 05/11/98
APPROVED ---

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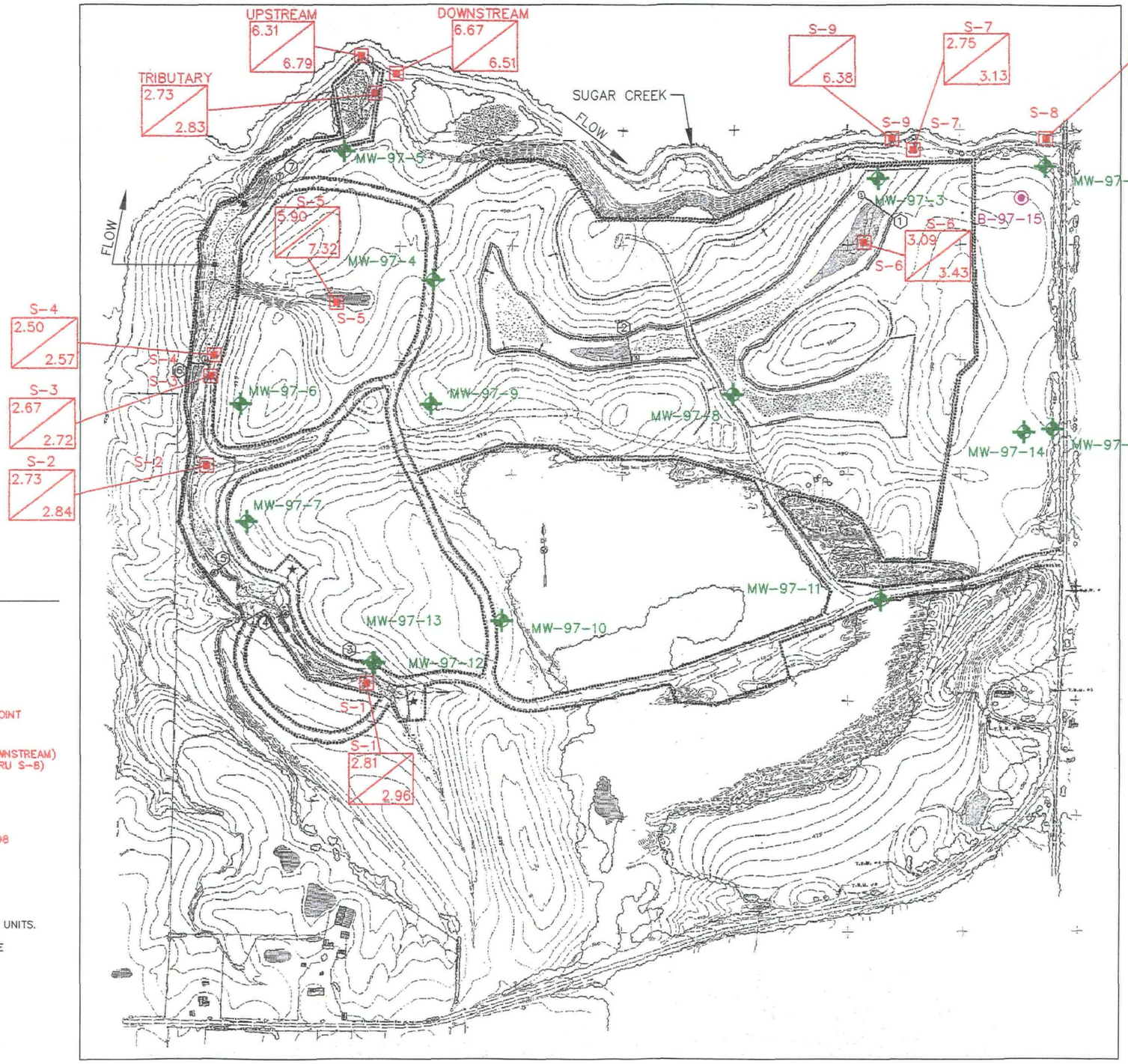
PALZO SITE, AML-GS-VA-9600J

TITLE CROSS SECTIONS
NORTH - SOUTH SECTION G - G

PROJECT NO. 88-19-202.00

DRAWING NO. 107



LEGEND

MW-97-13 — MONITORING WELL LOCATION

B-97-15 — BORING LOCATION

S-1 — SURFACE WATER MONITORING POINT

S-1 2.81 / 2.96 — pH SAMPLED ON 11 DEC 1997 (TRIBUTARY, UPSTREAM & DOWNSTREAM) AND ON 16 DEC 1997 (S-1 THRU S-8); pH SAMPLED ON 12 MARCH 1998

NOTES:

1. S-9 SAMPLED ONLY ON 12 MARCH 1998.
2. ALL VALUES EXPRESSED IN TERMS OF pH UNITS.
3. FOR ANALYTE TEST DATA SUMMARIES, SEE APPENDIX F.

GENERAL NOTES:

1. FOR EXISTING TREATMENT LEGEND, SEE DRAWING 5.
2. FOR GEOLOGIC CROSS SECTIONS, SEE DRAWINGS 100 THRU 107.
3. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

REFERENCES:

TOPOGRAPHY AND EXISTING TREATMENT FROM PALZO SURFACE MINE, PHASE III, AML-GWmE-8454, DRAWINGS DATED 22 MAY 1986.

NO.	DESCRIPTION	DATE	APPROVED
1.	ADDED NOTES, LABELS, LEGEND - BM	5/2/98	

DRAWN LDB | SCALE AS SHOWN
CHECKED PHS | DATE 05/08/98
APPROVED ---

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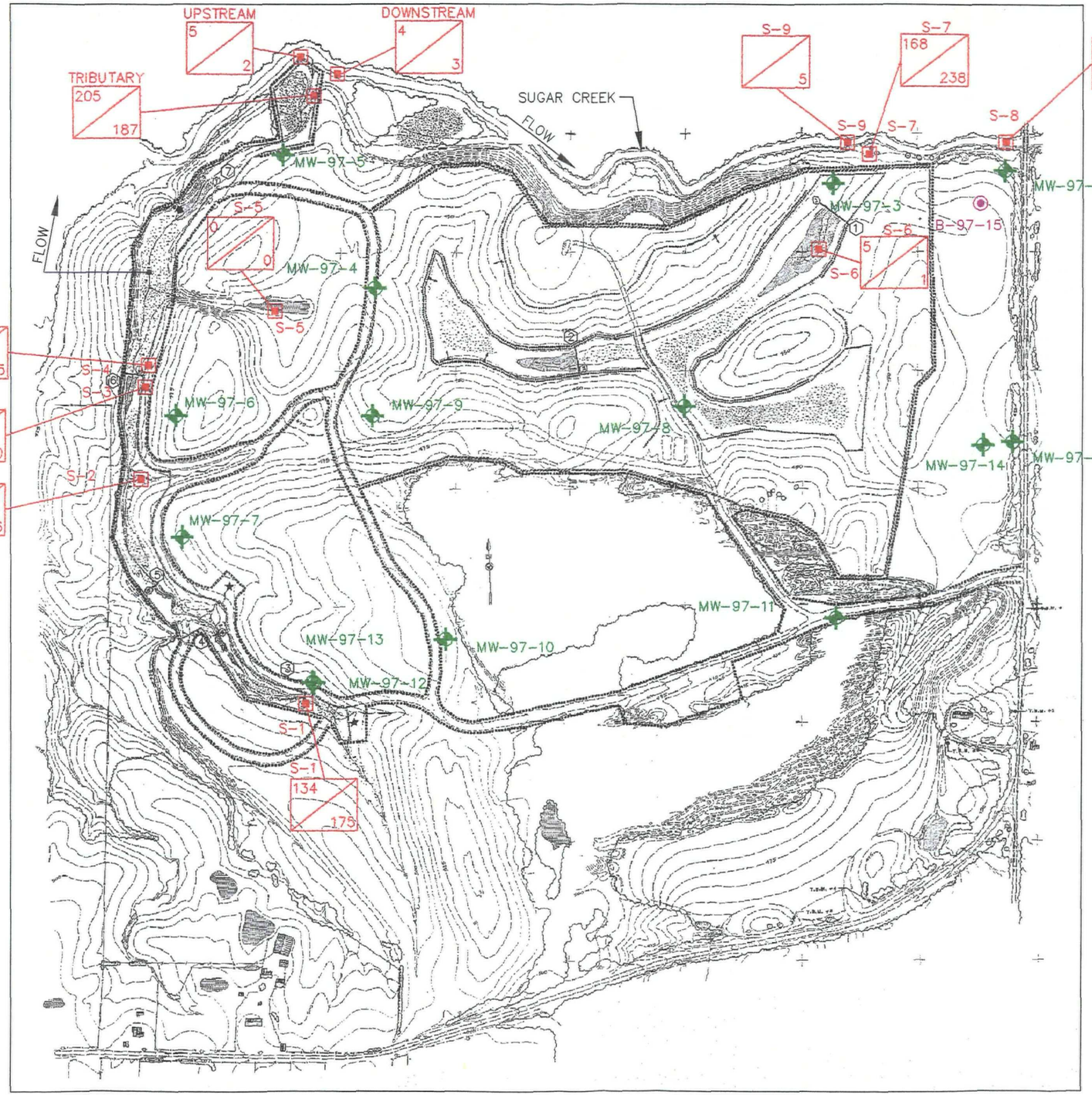
PALZO SITE; AML-GsWA-9600J

TITLE: SURFACE WATER - CHEMICAL ANALYTES CONCENTRATION VALUE - pH

PROJECT NO. 88-19-202.00

DRAWING NO. 200



0 100 200 300 400 500 1000
SCALE IN FEET

LEGEND

MW-97-13 — MONITORING WELL LOCATION

B-97-15 — BORING LOCATION

S-1 — SURFACE WATER MONITORING POINT

S-1 134/175 — IRON SAMPLED ON 11 DEC 1997 (TRIBUTARY, UPSTREAM & DOWNSTREAM) AND ON 16 DEC 1997 (S-1 THRU S-8); IRON SAMPLED ON 12 MARCH 1998

NOTES:

1. S-9 SAMPLED ONLY ON 12 MARCH 1998.
2. ALL VALUES EXPRESSED IN TERMS OF mg/L Fe.
3. FOR ANALYTE TEST DATA SUMMARIES, SEE APPENDIX F.

GENERAL NOTES:

1. FOR EXISTING TREATMENT LEGEND, SEE DRAWING 5.
2. FOR GEOLOGIC CROSS SECTIONS, SEE DRAWINGS 100 THRU 107.
3. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

REFERENCES:

TOPOGRAPHY AND EXISTING TREATMENT FROM PALZO SURFACE MINE, PHASE III, AML-GWmE-8454, DRAWINGS DATED 22 MAY 1986.

NO.	DESCRIPTION	DATE	APPROVED
1.	ADDED NOTES, LABELS, LEGEND - BM	5/2/98	

DRAWN LDB | CHECKED PHS | APPROVED --- | SCALE AS SHOWN | DATE 05/08/98

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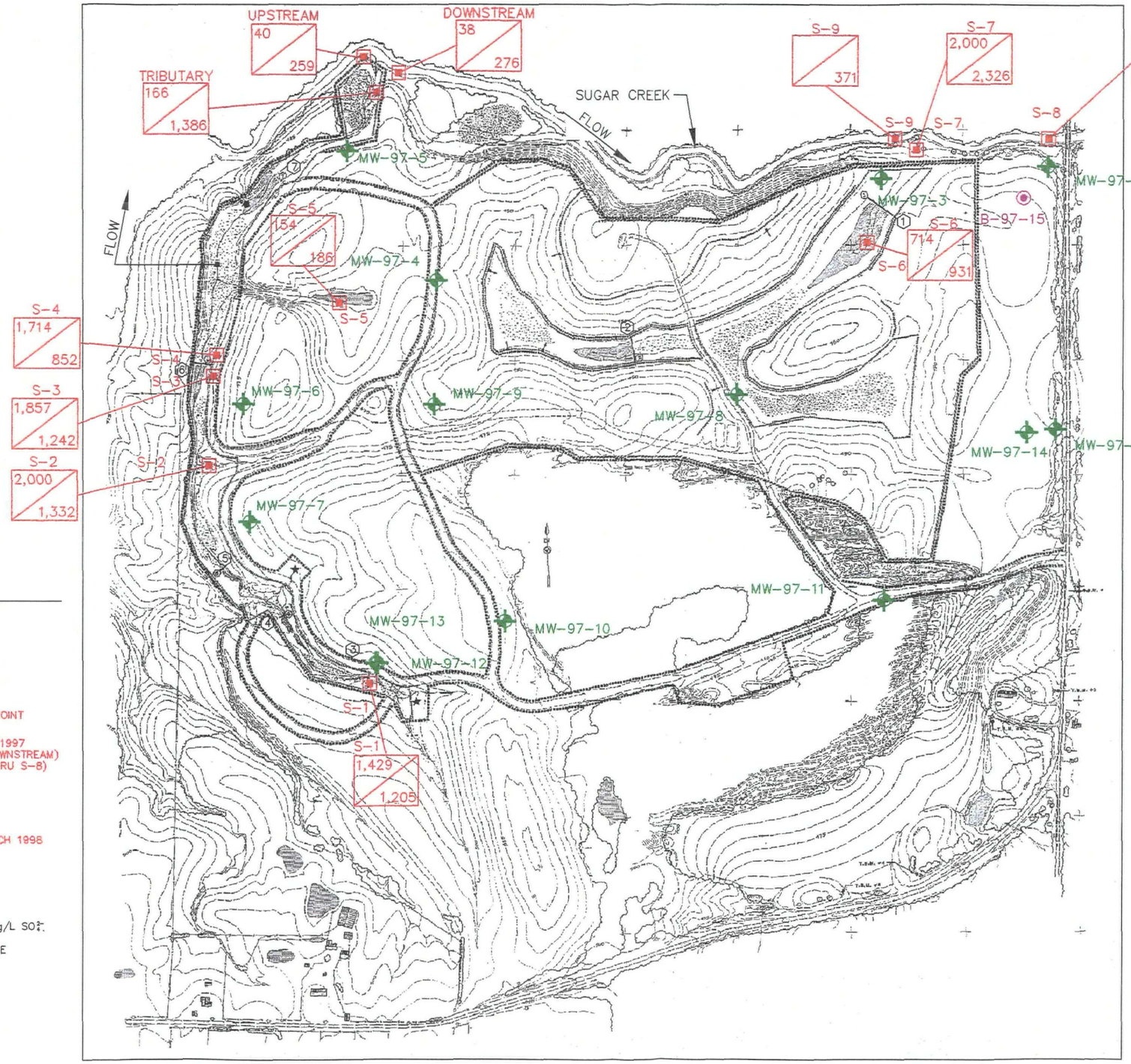
ILLINOIS DEPARTMENT OF NATURAL RESOURCES
OFFICE OF MINES AND MINERALS
DIVISION OF ABANDONED MINED LAND RECLAMATION
PALZO SITE: AML-GsWA-9600J

TITLE: SURFACE WATER - CHEMICAL ANALYTES CONCENTRATION VALUE - IRON

PROJECT NO. 88-19-202.00

DRAWING NO. 201



0 100 200 300 400 500 1000
SCALE IN FEET

LEGEND

MW-97-13 — MONITORING WELL LOCATION

B-97-15 — BORING LOCATION

S-1 — SURFACE WATER MONITORING POINT

S-1 1,429 / 1,205

SULFATE SAMPLED ON 11 DEC 1997 (TRIBUTARY, UPSTREAM & DOWNSTREAM) AND ON 16 DEC 1997 (S-1 THRU S-8)

SULFATE SAMPLED ON 12 MARCH 1998

NOTES:

1. S-9 SAMPLED ONLY ON 12 MARCH 1998.
2. ALL VALUES EXPRESSED IN TERMS OF mg/L SO_4^{2-}.
3. FOR ANALYTE TEST DATA SUMMARIES, SEE APPENDIX F.

GENERAL NOTES:

1. FOR EXISTING TREATMENT LEGEND, SEE DRAWING 5.
2. FOR GEOLOGIC CROSS SECTIONS, SEE DRAWINGS 100 THRU 107.
3. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

REFERENCES:

TOPOGRAPHY AND EXISTING TREATMENT FROM PALZO SURFACE MINE, PHASE III, AML-GWmE-8454, DRAWINGS DATED 22 MAY 1986.

NO.	DESCRIPTION	DATE	APPROVED
1.	ADDED NOTES, LABELS, LEGEND - BM	5/2/98	

DRAWN LDB
CHECKED PHS
APPROVED ---
SCALE AS SHOWN
DATE 05/08/98

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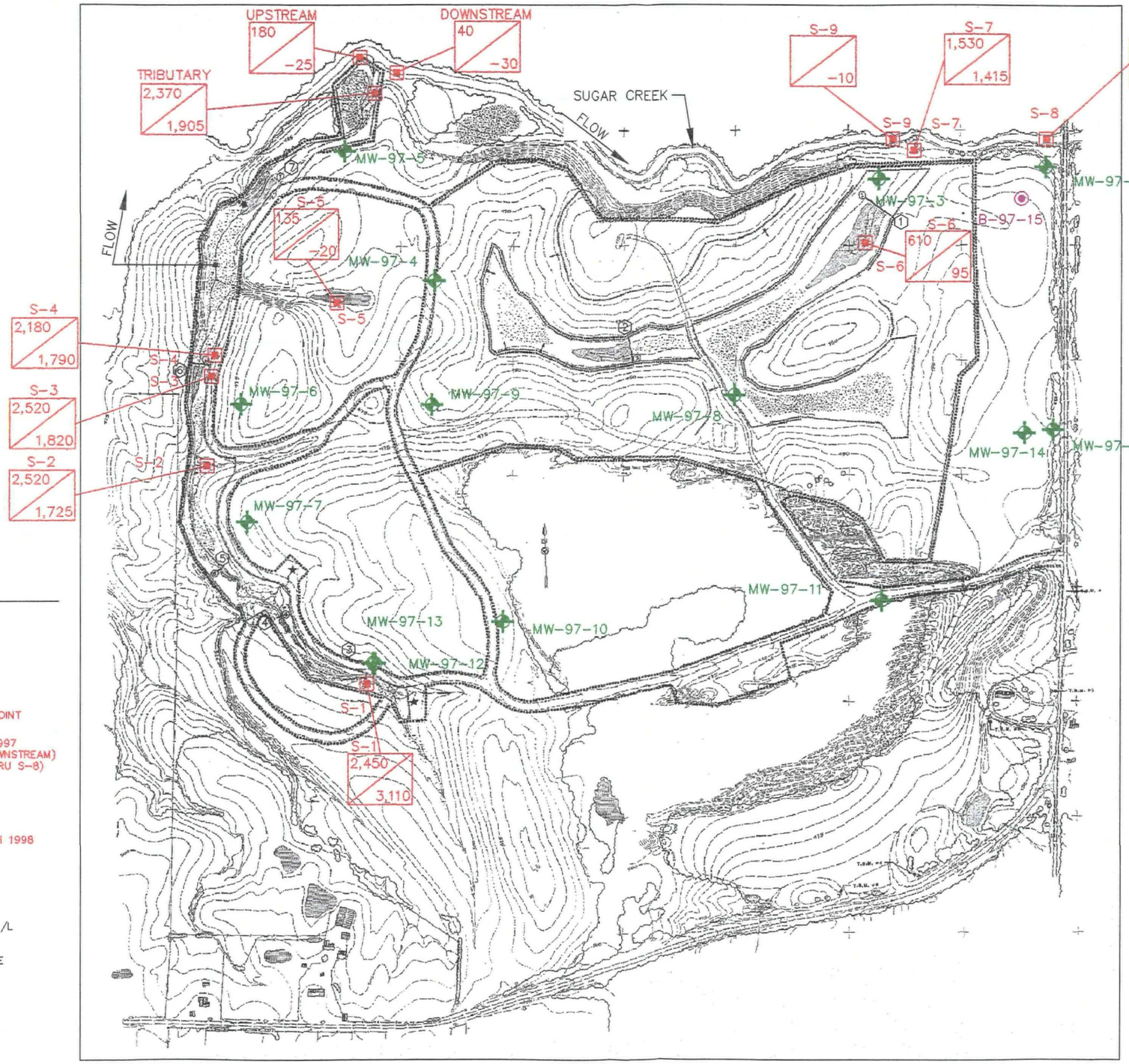
TITLE
ILLINOIS DEPARTMENT OF NATURAL RESOURCES
OFFICE OF MINES AND MINERALS
DIVISION OF ABANDONED MINED LAND RECLAMATION
PALZO SITE; AML-GsWA-9600J

SURFACE WATER - CHEMICAL ANALYTES
CONCENTRATION VALUE - SULFATE

PROJECT NO.
88-19-202.00

DRAWING NO.
202



LEGEND

MW-97-13 — MONITORING WELL LOCATION

B-97-15 — BORING LOCATION

S-1 — SURFACE WATER MONITORING POINT

S-1 2,450 / 3,110 — ACIDITY SAMPLED ON 11 DEC 1997 (TRIBUTARY, UPSTREAM & DOWNSTREAM) AND ON 16 DEC 1997 (S-1 THRU S-8); ACIDITY SAMPLED ON 12 MARCH 1998

NOTES:

1. S-9 SAMPLED ONLY ON 12 MARCH 1998.
2. ALL VALUES EXPRESSED IN TERMS OF mg/L $CaCO_3$.
3. FOR ANALYTE TEST DATA SUMMARIES, SEE APPENDIX F.

GENERAL NOTES:

1. FOR EXISTING TREATMENT LEGEND, SEE DRAWING 5.
2. FOR GEOLOGIC CROSS SECTIONS, SEE DRAWINGS 100 THRU 107.
3. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

REFERENCES:

TOPOGRAPHY AND EXISTING TREATMENT FROM PALZO SURFACE MINE, PHASE III, AML-GWmE-8454, DRAWINGS DATED 22 MAY 1986.

NO.	DESCRIPTION	DATE	APPROVED
1.	ADDED NOTES, LABELS, LEGEND - BM	5/2/98	

DRAWN LDB | SCALE AS SHOWN
CHECKED PHS | DATE 05/08/98
APPROVED ---

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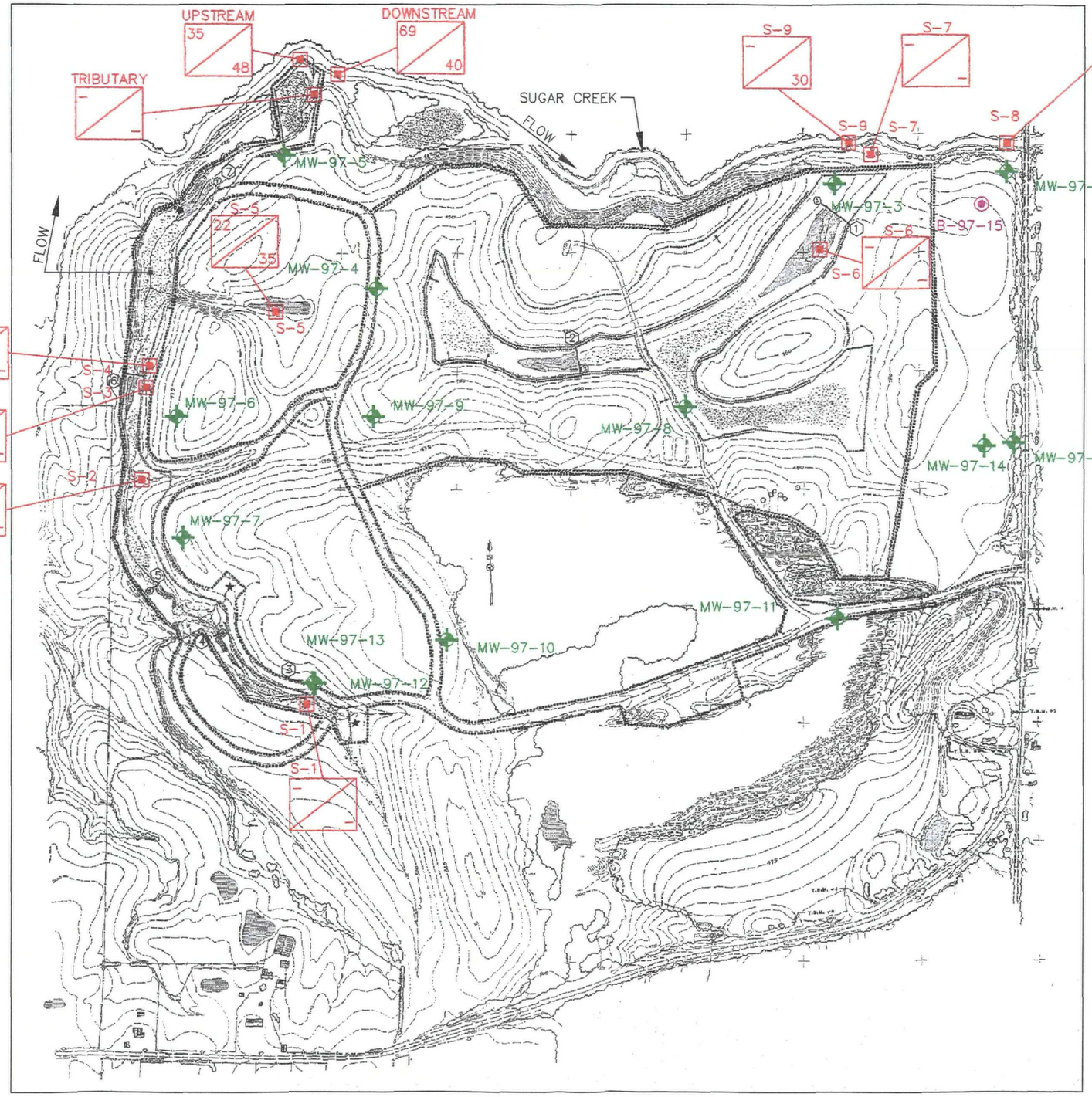
PALZO SITE; AML-GsWA-9600J

TITLE: SURFACE WATER - CHEMICAL ANALYTES CONCENTRATION VALUE - ACIDITY

PROJECT NO. 88-19-202.00

DRAWING NO. 203



0 100 200 300 400 500 1000
SCALE IN FEET

LEGEND

MW-97-13 — MONITORING WELL LOCATION

B-97-15 — BORING LOCATION

S-1 — SURFACE WATER MONITORING POINT

S-1 — ALKALINITY SAMPLED ON 11 DEC 1997 (TRIBUTARY, UPSTREAM & DOWNSTREAM) AND ON 16 DEC 1997 (S-1 THRU S-8)

S-1 — ALKALINITY SAMPLED ON 12 MARCH 1998

NOTES:

1. S-9 SAMPLED ONLY ON 12 MARCH 1998.
2. ALL VALUES EXPRESSED IN TERMS OF mg/L $CaCO_3$.
3. FOR ANALYTE TEST DATA SUMMARIES, SEE APPENDIX F.

GENERAL NOTES:

1. FOR EXISTING TREATMENT LEGEND, SEE DRAWING 5.
2. FOR GEOLOGIC CROSS SECTIONS, SEE DRAWINGS 100 THRU 107.
3. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

REFERENCES:

TOPOGRAPHY AND EXISTING TREATMENT FROM PALZO SURFACE MINE, PHASE III, AML-GWmE-8454, DRAWINGS DATED 22 MAY 1986.

NO.	DESCRIPTION	DATE	APPROVED
1.	ADDED NOTES, LABELS, LEGEND - BM	5/2/98	

DRAWN LDB | CHECKED PHS | APPROVED --- | SCALE AS SHOWN | DATE 05/08/98

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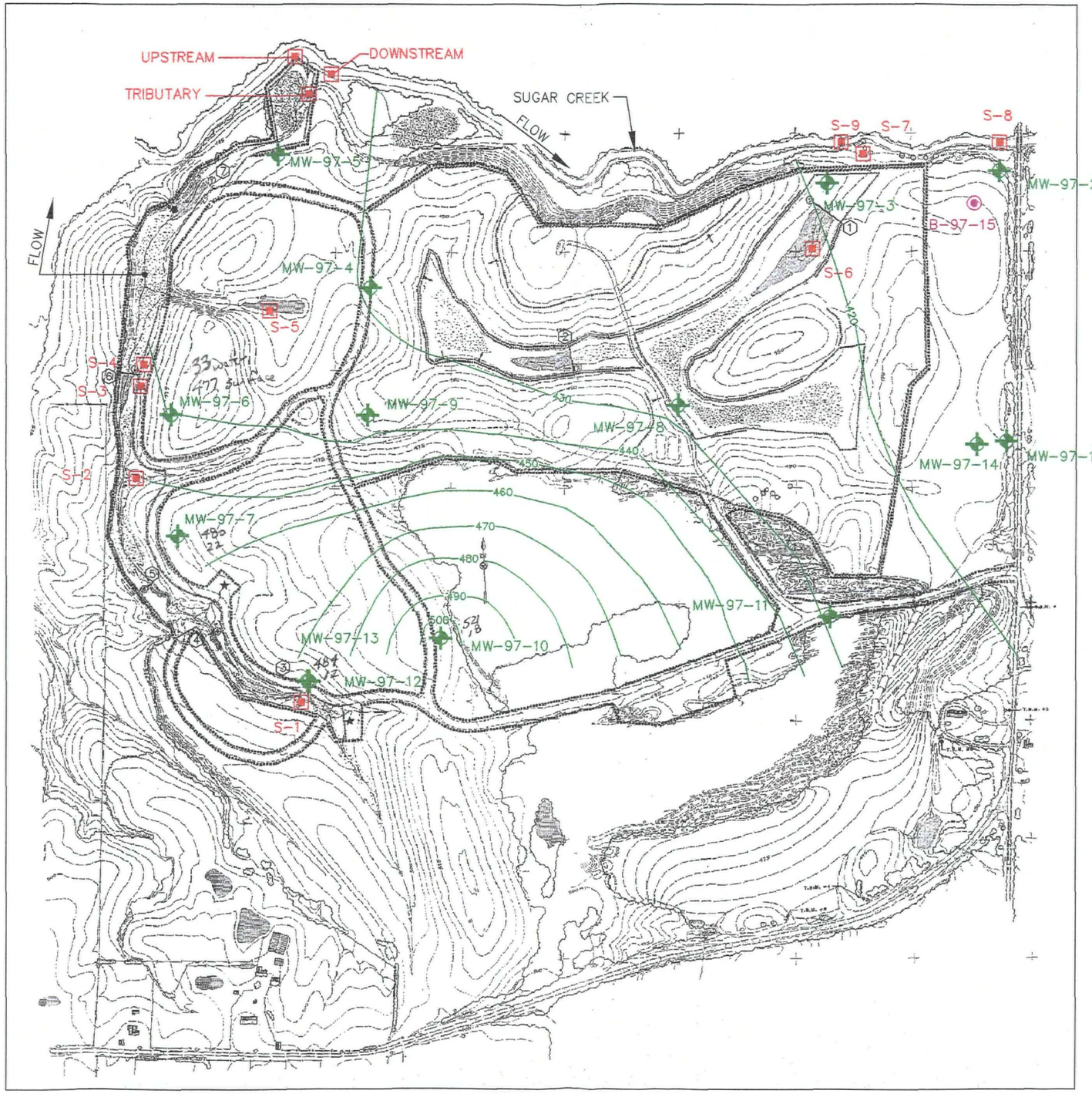
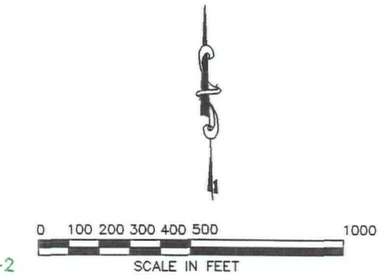
DIVISION OF ABANDONED MINED LAND RECLAMATION
PALZO SITE; AML-GsWA-9600J

TITLE: SURFACE WATER - CHEMICAL ANALYTES CONCENTRATION VALUE - ALKALINITY

PROJECT NO. 88-19-202.00

DRAWING NO. 204





LEGEND

MW-97-13 — MONITORING WELL LOCATION

420 — GROUNDWATER ELEVATION IN FEET

B-97-15 — BORING LOCATION

S-1 — SURFACE WATER MONITORING POINT

GENERAL NOTES:

1. FOR EXISTING TREATMENT LEGEND, SEE DRAWING 5.

2. FOR GEOLOGIC CROSS SECTIONS, SEE DRAWINGS 100 THRU 107.

3. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

REFERENCES:

TOPOGRAPHY AND EXISTING TREATMENT FROM PALZO SURFACE MINE, PHASE III, AML-GWmE-8454, DRAWINGS DATED 22 MAY 1986.

NO.	DESCRIPTION	DATE	APPROVED
1.	ADDED NOTES, LABELS, LEGEND - BM	5/2/98	

DRAWN LDB | SCALE AS SHOWN
CHECKED LDB | DATE 05/08/98
APPROVED ---

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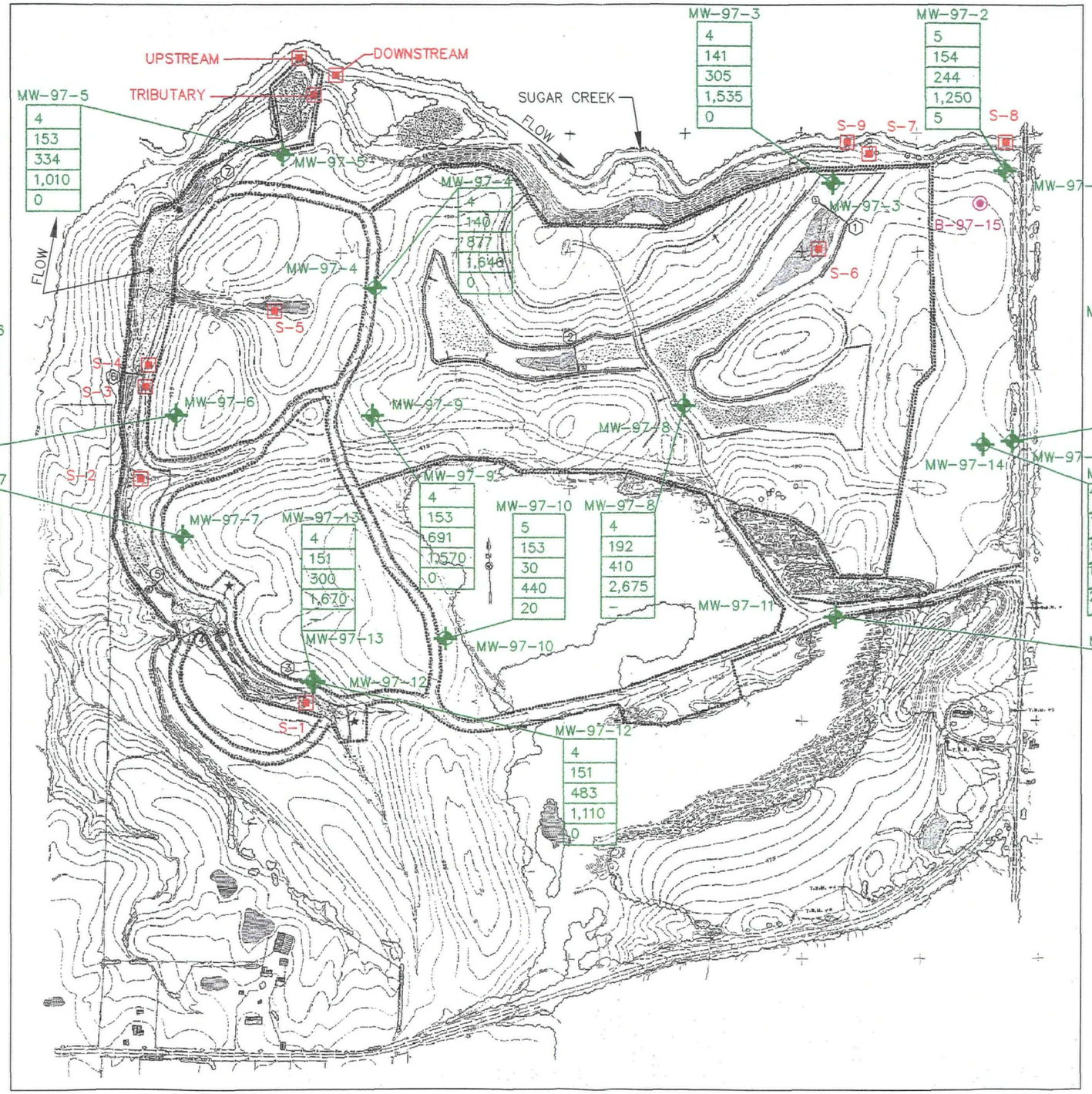
PALZO SITE; AML-GsWA-9600J

TITLE
GROUNDWATER CONTOUR MAP

PROJECT NO.
88-19-202.00

DRAWING NO.
300



LEGEND

MW-97-13 — MONITORING WELL LOCATION

MW-97-13	
4	pH – pH UNITS
151	SULFATE – mg/L SO_4^{2-}
300	IRON – mg/L Fe
1,670	ACIDITY – mg/L $CaCO_3$
–	ALKALINITY – mg/L $CaCO_3$

B-97-15 — BORING LOCATION

S-1 — SURFACE WATER MONITORING POINT

NOTES:

1. MW-97-14 SAMPLED ON 16 DECEMBER 1997 AND 12 MARCH 1998. ALL OTHER MONITORING WELLS SAMPLED ON 11 DECEMBER 1997.

2. FOR ANALYTE TEST DATA SUMMARIES, SEE APPENDIX F.

GENERAL NOTES:

1. FOR EXISTING TREATMENT LEGEND, SEE DRAWING 5.

2. FOR GEOLOGIC CROSS SECTIONS, SEE DRAWINGS 100 THRU 107.

3. FOR BORING/MONITORING WELL LOGS, SEE APPENDIX D.

REFERENCES:

TOPOGRAPHY AND EXISTING TREATMENT FROM PALZO SURFACE MINE, PHASE III, AML-GWmE-8454, DRAWINGS DATED 22 MAY 1986.

NO.	DESCRIPTION	DATE	APPROVED
1.	ADDED NOTES, LABELS, LEGEND – BM	5/2/98	

DRAWN LDB | SCALE AS SHOWN
CHECKED PHS | DATE 05/08/98
APPROVED --- | ---

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PALZO SITE; AML-GsWA-9600J

TITLE
GROUNDWATER – CHEMICAL ANALYTES
(pH, IRON, SULFATE, ACIDITY, & ALKALINITY)

PROJECT NO.
88-19-202.00

DRAWING NO.
301

SOUTHERN ILLINOIS INVESTIGATIVE SERVICES
PALZO SITE; AML-GsWA-9600J
WILLIAMSON COUNTY, ILLINOIS
SITE STUDY AND RECOMMENDATIONS

APPENDIX D

SOIL BORING LOGS/MONITORING WELL CONSTRUCTION DIAGRAMS

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ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-1 Elevation: 443.62
Date Started: 12/2/97 Completed: 12/2/97
Drilled by: J. COTHRON Logged by: K. CARLSON
Method of Drilling: 4.25 HSA Northing: 358931.09
Easting: 859652.77

Depth to Water: While Drilling: 30.0
24 Hrs After: 24.6

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks (SURFACE ELEVATION: 443.62)
						0	FILL BACKFILL - BROWN CLAYEY SAND, BLACK SHALE AND ROCK FRAGMENTS 443.6
1	H		15.2		34/16	5	
2	H	1.5	18			10	
3	H	4.0+	6.1			15	SANDY WEATHERED MICACEOUS IRON STAINED SANDSTONE BACKFILL MATERIAL
						20	
4	A		8.3				BLACK SHALE AND COAL SLURRY
5	H	1.5	10.9			25	BACKFILL MATERIAL
						30	COAL SLURRY AND BLACK WEATHERED SHALE BLACK WEATHERED SHALE WITH SOME COAL
6	H		8.1		34/21		
						35	BEDROCK 409.5
						40	
						45	
						50	
						55	
						60	

Monitor Well Installation

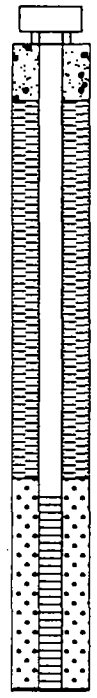

PLATE D-1

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ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-2 Elevation: 434.91
Date Started: 12/2/97 Completed: 12/2/97
Drilled by: J. COTHRON Logged by: K. CARLSON
Method of Drilling: 4.25 HSA Northing: 360089.26
Easting: 859619.07

Depth to Water: While Drilling: DRY
24 Hrs After: 22.6

Project No.: 88-19-202

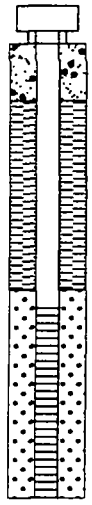
Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks SURFACE ELEVATION: 434.91	Monitor Well Installation
1	H	0	20.9			0	FILL BACKFILL - BROWN SANDY CLAY WITH ROCK FRAGMENTS AND COAL SLURRY (434.9)	
2	H	0.5	20.1			5		
2A	S	2.25				10		
3	H	1.25	16.6					
4	H		18.4			15	COAL AND SANDSTONE FRAGMENTS	
5	H	0	11.2			20	BLACK WEATHERED SHALE WITH PYRITE AND MINOR AMOUNT OF COAL	
						25	SH GRAY SHALE BEDROCK (411.4) (410.9)	
						30		
						35		
						40		
						45		
						50		
						55		
						60		

PLATE D-2

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ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-3
Date Started: 12/3/97
Drilled by: J. COTHRON
Method of Drilling: 4.25 HSA

Elevation: 432.69
Completed: 12/3/97
Logged by: K. CARLSON
Northing: 360036.47
Easting: 858883.87

Depth to Water: While Drilling: 18.0
24 Hrs After: 13.3

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks SURFACE ELEVATION: 432.69	Monitor Well Installation
1	H	0	22			0	FILL BACKFILL - SAND, LEAN CLAY AND SANDSTONE AND SHALE ROCK FRAGMENTS SANDSTONE BOULDERS BACKFILL MATERIAL 432.7	
2	A		8.8			5 10		
3	A		14.1			15 20	CLAY BACKFILL MATERIAL SANDSTONE BROWN SAND, BLACK SHALE AND SANDSTONE FRAGMENTS SAND AND SANDSTONE ROCK FRAGMENTS	
4	A		20.6		37/20		BLACK SHALE 408.7	
						25 30 35 40 45 50 55 60		

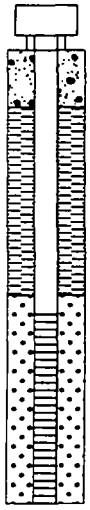

PLATE D-3

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ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No:	MW-97-4	Elevation:	456.98
Date Started:	12/3/97	Completed:	12/3/97
Drilled by:	J. COTHRON	Logged by:	K. CARLSON
Method of Drilling:	4.25 HSA	Northing:	359585.85
		Easting:	856910.85

Depth to Water: While Drilling: 35.0
24 Hrs After: 28.2

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks (SURFACE ELEVATION: 456.98)	Monitor Well Installation
1	H	0	19.4			0	FILL BACKFILL - BROWN CLAY, BLACK SHALE AND SANDSTONE FRAGMENTS (457.0)	
2	H	0	19.1			5		
3	A		23.2			10	BLACK SHALE BACKFILL MATERIAL	
4	H	4.0+	17.4			15	BLACK SHALE AND SANDSTONE FRAGMENTS BACKFILL MATERIAL	
						20	BLACK SHALE	
						25		
						30		
5	A		22.3		35/18	35	SH GRAY SHALE BEDROCK (420.0) (418.0)	
						40		
						45		
						50		
						55		
						60		

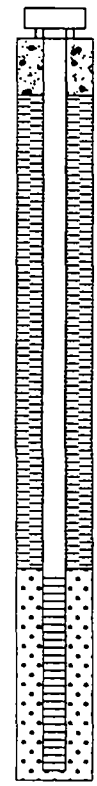

PLATE D-4

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Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-5
Date Started: 12/4/97
Drilled by: J. COTHRON
Method of Drilling: 4.25 HSA

Elevation: 443.72
Completed: 12/4/97
Logged by: K. CARLSON
Northing: 360156.03
Easting: 856513.09

Depth to Water: While Drilling: DRY
24 Hrs After: 9.0

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks SURFACE ELEVATION: 443.72	Monitor Well Installation
1	H	1.75	17.3			0	FILL BACKFILL - BROWN CLAY, COAL FRAGMENTS, SANDSTONE AND BLACK SHALE FRAGMENTS 443.7	
1A	S	4.0				5		
2	H	1.25	23.7					
2A	S	4.5+				10		
3	H	1.5	30.6					
4	H	0	11.7			15	BLACK SHALE WITH SOME GRAY SHALE FRAGMENTS 424.7	
						20		
						25		
						30		
						35		
						40		
						45		
						50		
						55		
						60		

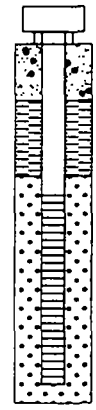

PLATE D-5

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ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-6 Elevation: 476.60
Date Started: 12/4/97 Completed: 12/4/97
Drilled by: J. COTHRON Logged by: K. CARLSON
Method of Drilling: 4.25 HSA Northing: 359040.58
Easting: 856049.21

Depth to Water: While Drilling: 33.0
24 Hrs After:

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks (SURFACE ELEVATION: 476.60)	Monitor Well Installation
1	H	1.0	21.1			0	FILL BACKFILL - BROWN CLAY, SAND, BLACK SHALE, COAL AND SANDSTONE FRAGMENTS 476.6	
2	H	1.5	19.7			5		
3	H	1.0	21.3			10		
4	H	0	21.1			15		
4A	S	3.25				20		
5	H	0	18.7					
6	H	0	19.5			25		
7	H	0	20			30		
8	H	4.5+	7.2			35	SH GRAY SHALE BEDROCK 442.6	
						40	437.6	
						45		
						50		
						55		
						60		

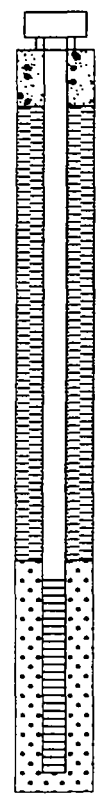

PLATE D-6

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ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-7 Elevation: 479.79
Date Started: 12/4/97 Completed: 12/4/97
Drilled by: J. COTHRON Logged by: K. CARLSON
Method of Drilling: 4.25 HSA Northing: 358520.46
Easting: 856077.20

Depth to Water: While Drilling: 24.0
24 Hrs After: 22.2

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks (SURFACE ELEVATION: 479.79)	Monitor Well Installation
1	H	1.75	27.3		43/24	0	FILL BACKFILL - CLAY, SAND AND BLACK SHALE, COAL AND SANDSTONE FRAGMENTS 479.8	
2	H	0	23.2			5		
3	H	0	19.3			10		
4	H	0	25.3			15	SANDY	
5	H	0	12.9			20		
5A	S	4.5+				25	SH GRAY SHALE BEDROCK 454.3	
6	H	4.5+	13.6				450.8	
						30		
						35		
						40		
						45		
						50		
						55		
						60		

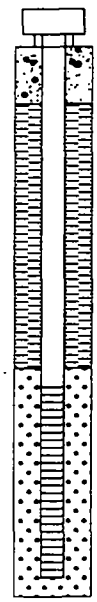

PLATE D-7

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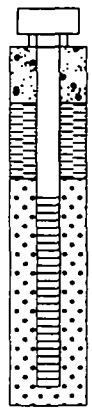
ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-8 Elevation: 434.26
Date Started: 12/5/97 Completed: 12/5/97
Drilled by: J. COTHRON Logged by: K. CARLSON
Method of Drilling: 4.25 HSA Northing: 359081.42
Easting: 858246.65

Depth to Water: While Drilling: 13.5
24 Hrs After: 8.5

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks SURFACE ELEVATION: 434.26	Monitor Well Installation
1	H	1.5	21.1			0	FILL BACKFILL - BROWN CLAY, SAND AND SANDSTONE FRAGMENTS 434.3	
2	H	0	19			5		
3	H	0				10	BLACK SHALE	
3A	S					15	BLACK AND GRAY SHALE	
4	H	2.0	24.2				415.3	
						20		
						25		
						30		
						35		
						40		
						45		
						50		
						55		
						60		

indeco
ENGINEERING AND CONSTRUCTION

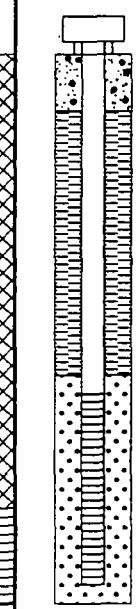
Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-9 Elevation: 453.45
Date Started: 12/5/97 Completed: 12/5/97
Drilled by: J. COTHRON Logged by: K. CARLSON
Method of Drilling: 4.25 HSA Northing: 359038.97
Easting: 856899.36

Depth to Water: While Drilling: 22.0
24 Hrs After:

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks SURFACE ELEVATION: 453.45	Monitor Well Installation
						0	FILL BACKFILL - BROWN CLAY, SAND, AND BLACK SHALE, COAL AND SANDSTONE FRAGMENTS 453.4	
1	H		15.9					
2	H	2.0	15.1			5		
3	H	0				10	BROWN SAND WITH BLACK SHALE CHIPS AND WEATHERED SANDSTONE FRAGMENTS	
4	H	0	10.1			15		
5	H	0.5				20	CLAY AND BLACK AND GRAY SHALE FRAGMENTS	
6	H	4.5+	4.6			25	SH GRAY SHALE BEDROCK 429.4	
						30	SANDY 424.4	
						35		
						40		
						45		
						50		
						55		
						60		



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ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-10
Date Started: 12/5/97
Drilled by: J. COTHRON
Method of Drilling: 4.25 HSA

Elevation: 521.31
Completed: 12/5/97
Logged by: K. CARLSON
Northing: 358081.56
Easting: 857214.78

Depth to Water: While Drilling: 19.0
24 Hrs After: 17.5

Project No.: 88-19-202

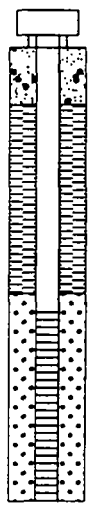
Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks SURFACE ELEVATION: 521.31	Monitor Well Installation
1	H		23			0	FILL BACKFILL - BROWN CLAY, BROWN SAND AND BLACK SHALE AND SANDSTONE FRAGMENTS (521.3)	
2	H	2.0	21.1			5		
						10		
3	H	0.5	22.9			15		
3A	S	2.5				20	GRAY CLAY WITH ORGANICS	
4	H		30		35/		BROWN CLAY	
5	H		23.7		19		(497.3)	
						25		
						30		
						35		
						40		
						45		
						50		
						55		
						60		

PLATE D-10

indeco
ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-11
Date Started: 12/9/97
Drilled by: J. COTHRON
Method of Drilling: 4.25 HSA

Elevation: 459.46
Completed: 12/9/97
Logged by: K. CARLSON
Northing: 358175.24
Easting: 858898.68

Depth to Water: While Drilling: 31.5
24 Hrs After: 30.3

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks SURFACE ELEVATION: 459.46	Monitor Well Installation
1	H		6.9			0	FILL BACKFILL - BROWN CLAY, SAND, AND BLACK SHALE AND SANDSTONE FRAGMENTS 459.5	
2	H		15.5			5	BROWN CLAY, AND SANDSTONE AND BLACK SHALE FRAGMENTS	
3	H		13.7			10		
4	H		11.5			15		
5	H		12.8			20	BLACK AND GRAY SHALE	
						25	SH BLACK AND GRAY SHALE BEDROCK 434.5	
						30		
6	H		8.6			35		
						40	420.5	
						45		
						50		
						55		
						60		

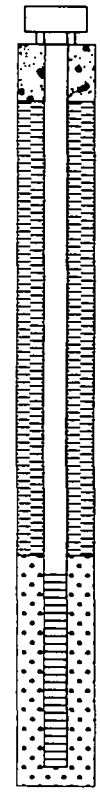


PLATE D-11

indeco
ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-12
Date Started: 12/9/97
Drilled by: J. COTHRON
Method of Drilling: 4.25 HSA

Elevation: 484.32
Completed: 12/9/97
Logged by: K. CARLSON
Northing: 357895.66
Easting: 856647.49

Depth to Water: While Drilling: 14.0
24 Hrs After:

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks (SURFACE ELEVATION: 484.32)
1	H		18.1			0	FILL BACKFILL - BROWN CLAY, SAND, AND SANDSTONE AND BLACK SHALE FRAGMENTS (484.3)
1A	S				31/17	5	
2	H		16.6				
2A	S					10	BLACK AND GRAY SHALE
3	H		15.2				
4	H		9.9			15	
5	H		3.1			20	SH GRAY SHALE BEDROCK NOTED HEALED FRACTURES (465.3)
						25	
						30	
						35	
						40	
						45	
						50	
						55	(429.3)
						60	

Monitor Well Installation

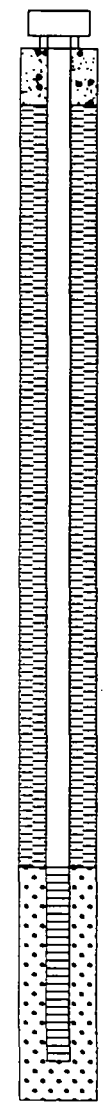


PLATE D-12

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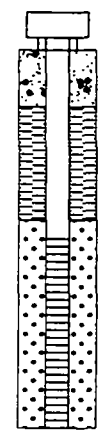
ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No:	MW-97-13	Elevation:	484.37
Date Started:	12/9/97	Completed:	12/9/97
Drilled by:	J. COTHRON	Logged by:	K. CARLSON
Method of Drilling:	4.25 HSA	Northing:	357897.59
		Easting:	856639.66

Depth to Water: While Drilling: 14.0
24 Hrs After: 12.0

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks SURFACE ELEVATION: 484.37	Monitor Well Installation
						0	FILL BACKFILL - BROWN CLAY, SAND, AND SANDSTONE AND BLACK SHALE FRAGMENTS 484.4	
						5		
						10	BLACK AND GRAY SHALE	
						15		
						20	SH GRAY SHALE BEDROCK 465.4 464.4	
						25		
						30		
						35		
						40		
						45		
						50		
						55		
						60		

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ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-14 Elevation: 444.98
Date Started: 12/10/97 Completed: 12/10/97
Drilled by: J. COTHRON Logged by: K. CARLSON
Method of Drilling: 4.25 HSA Northing: 358916.59
Easting: 859526.75

Depth to Water: While Drilling: 49.0
24 Hrs After:

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks (SURFACE ELEVATION: 444.98)	Monitor Well Installation
						0	FILL BACKFILL - BROWN CLAY, AND SANDSTONE AND BLACK SHALE FRAGMENTS 445.0	
						5		
						10		
						15		
1A	S					20		
						25		
1B	S					30		
						35		
1	H		11.5		32/16	40	SH 1" SEAM OF COAL, THEN 0.4' OF WEATHERED GRAY SHALE BEDROCK 406.4	
2A	S						SH 406.0	
2	H		9.8				GRAY SHALE BEDROCK	
						45		
3	H		5.8				GRAY SHALE BEDROCK FRACTURED AT TOP	
4	H		5.8			50		
						55		
						60		

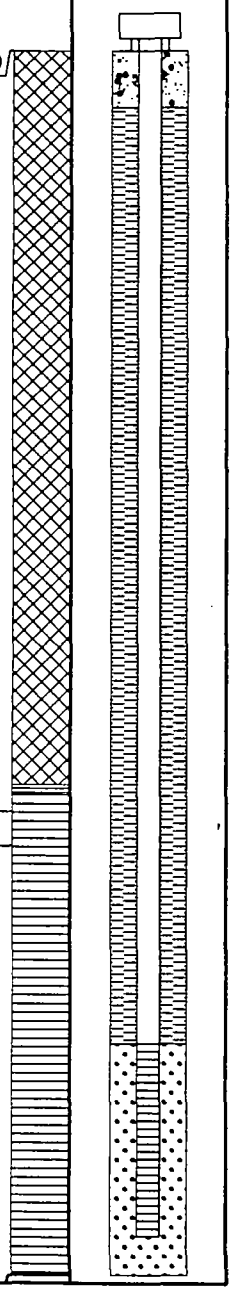

PLATE D-14

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ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No: MW-97-14
Date Started: 12/10/97
Drilled by: J. COTHRON
Method of Drilling: 4.25 HSA

Elevation: 444.98
Completed: 12/10/97
Logged by: K. CARLSON
Northing: 358916.59
Easting: 859526.75

Depth to Water: While Drilling: 49.0
24 Hrs After:

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks SURFACE ELEVATION: 444.98	Monitor Well Installation
						65	381.0	
						70		
						75		
						80		
						85		
						90		
						95		
						100		
						105		
						110		
						115		
						120		
						125		
						130		

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ENGINEERING AND CONSTRUCTION

Project: PALZO SITE - HYDROGEOLOGIC STUDY
AML-GsWA-9600J ILLINOIS DNR

Boring No:	B-97-15	Elevation:	440.02
Date Started:	12/10/97	Completed:	12/10/97
Drilled by:	J. COTHRON	Logged by:	K. CARLSON
Method of Drilling:	4.25 HSA	Northing:	359949.38
		Easting:	859513.20

Depth to Water: While Drilling: 32.0
24 Hrs After:

Project No.: 88-19-202

Sample No.	Sample Type	Pocket Penet (tsf)	MC %	Dry Dens (pcf)	LL/PL	Depth (ft)	Description & Remarks (SURFACE ELEVATION: 440.02)	Monitor Well Installation
						0	FILL BACKFILL - BROWN CLAY, BLACK SHALE, SAND AND SANDSTONE FRAGMENTS 440.0	
						5		
						10		
						15		
						20	PRIMARILY BLACK SHALE	
						25	BLACK AND GRAY SHALE	
						30		
							BLACK SHALE GRAY SHALE	
1	H		14.4			35		
2	H		5.4			40	SH GRAY SHALE BEDROCK 402.5	
3	H		10				399.0	
						45		
						50		
						55		
						60		

PLATE D-15

KEY TO SYMBOLS

Symbol	description
Strata symbols	
	Fill
	Shale
Misc. Symbols	
	Water table on given date
	Water table during drilling
Monitor Well Details	
	riser with cover and protective casing
	concrete seal
	bentonite pellets
	silica sand, blank PVC
	slotted pipe w/ sand
	no pipe, filler material
	silica sand, no pipe (end plug)

Notes:

1. Borings located in the field by INDECO.

2. These logs are subject to the limitations, conclusions, and recommendations in this report.

3. Results of tests conducted on samples recovered are reported on the logs.

4. Stratification boundaries indicated on the boring logs were based on observation during drilling, an extrapolation of information obtained by inspecting samples from the broings, and comparisons of similar engineering characteristics. However, in the nature of things, site exploration only identifies actual subsurface conditions at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and approporiate foundation design. Even under optimal circumstances, actual conditions may differ from those inferred to exist because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions.

SOUTHERN ILLINOIS INVESTIGATIVE SERVICES
PALZO SITE; AML-GsWA-9600J
WILLIAMSON COUNTY, ILLINOIS
SITE STUDY AND RECOMMENDATIONS

APPENDIX E

SOIL CLASSIFICATION TESTS

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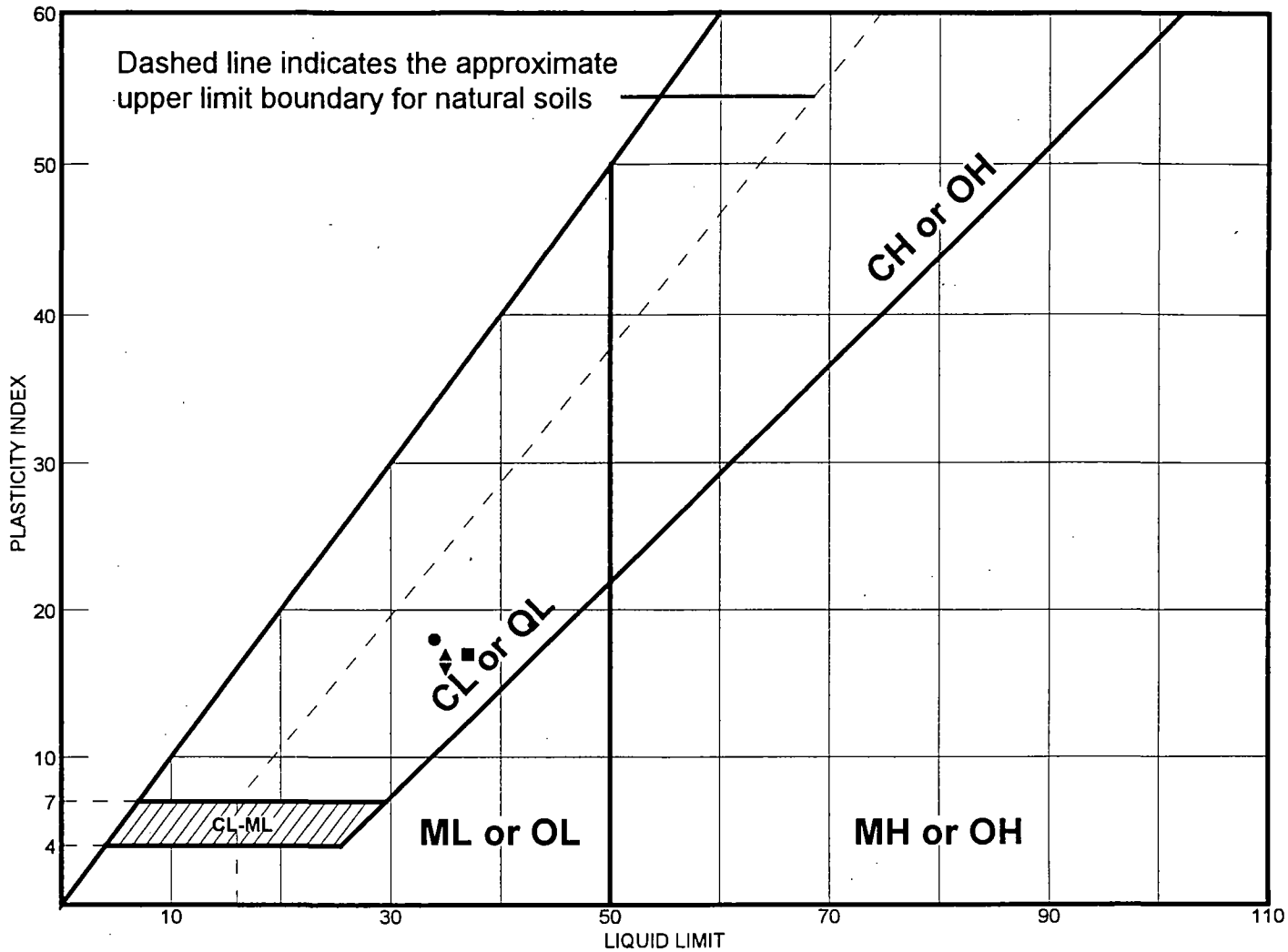
P.O. Box 1148 • 630 River Drive, Bettendorf, IA 52722 • Tel (319) 359-5451 • Fax (319) 359-4318

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	FILL	34	16	18	76.8	40.3	SC
■	FILL	37	20	17	65.0	43.1	SC
▲	GRAY SHALE	35	18	17			SH
◆	FILL	43	24	19	75.6	40.5	SC
▼	FILL	35	19	16	99.7	99.3	CL

Project No. 88-19-202.00 **Client:** Illinois AML

Project: Field Investigation & Hydro-Geologic Study

Palzo Site - AML-GsWA-9600J

● **Source:** MW-97-1 **Sample No.:** 1 **Elev./Depth:** 0

■ **Source:** MW-97-3 **Sample No.:** 4 **Elev./Depth:** 22

▲ **Source:** MW-97-4 **Sample No.:** 5 **Elev./Depth:** 34

◆ **Source:** MW-97-7 **Sample No.:** 1 **Elev./Depth:** 0

▼ **Source:** MW-97-10 **Sample No.:** 4 **Elev./Depth:** 21

Remarks:

● Tested by VAC

■ Tested by VAC

▲ Tested by VAC

◆ Tested by VAC

▼ Tested by VAC

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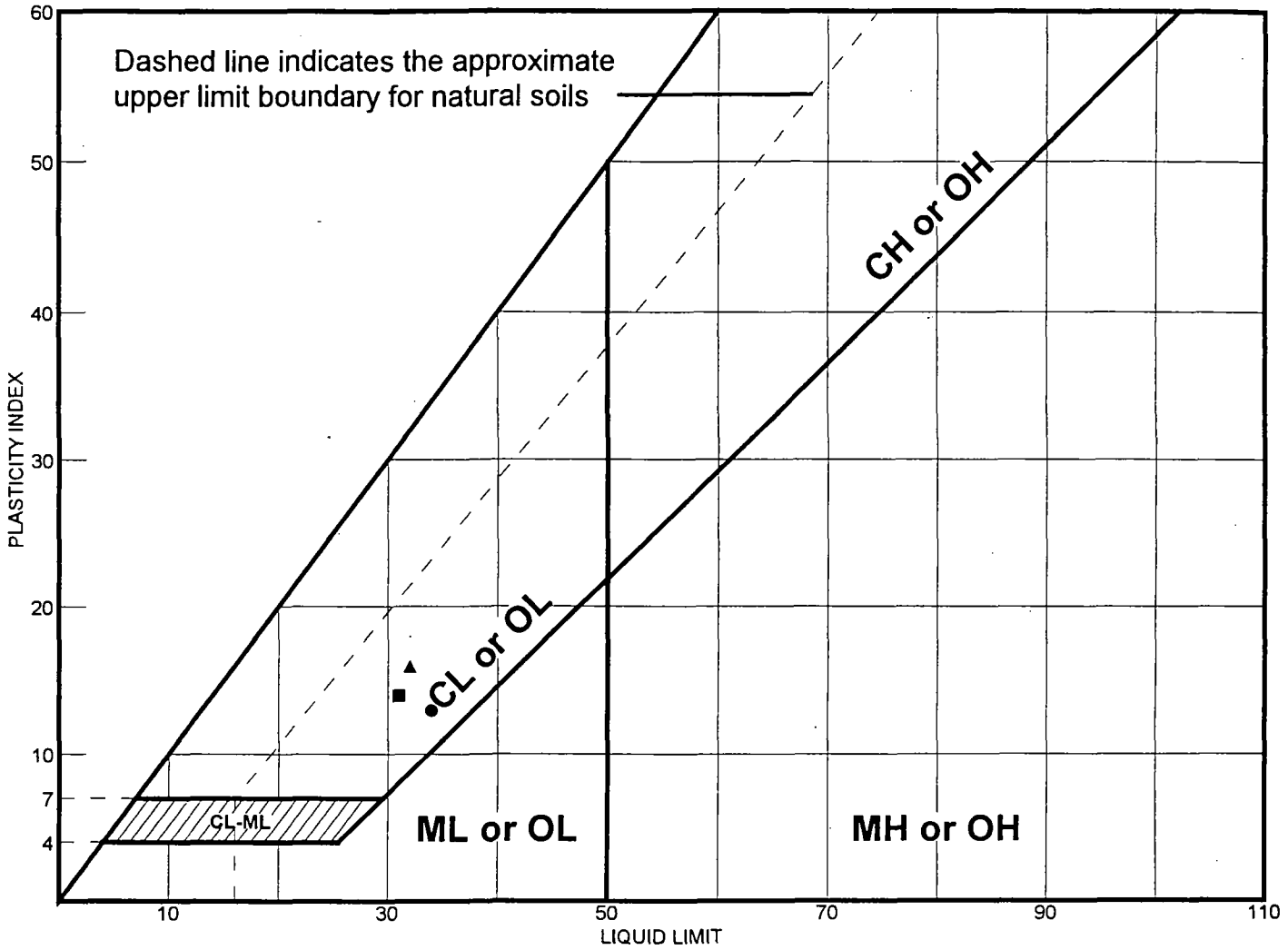
ENGINEERING AND CONSTRUCTION

Plate E-1

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	FILL	34	21	13	5.2	3.1	SH
■	FILL	31	17	14			CL
▲	GRAY SHALE	32	16	16			SH

Project No. 88-19-202.00 **Client:** Illinois AML

Project: Field Investigation & Hydro-Geologic Study

Palzo Site - AML-GsWA-9600J

● **Source:** MW-97-1 **Sample No.:** 6 **Elev./Depth:** 32

■ **Source:** MW-97-12 **Sample No.:** 1A **Elev./Depth:** 4

▲ **Source:** MW-97-14 **Sample No.:** 2A **Elev./Depth:** 39

Remarks:

● Tested by VAC

■ Tested by VAC

▲ Tested by VAC

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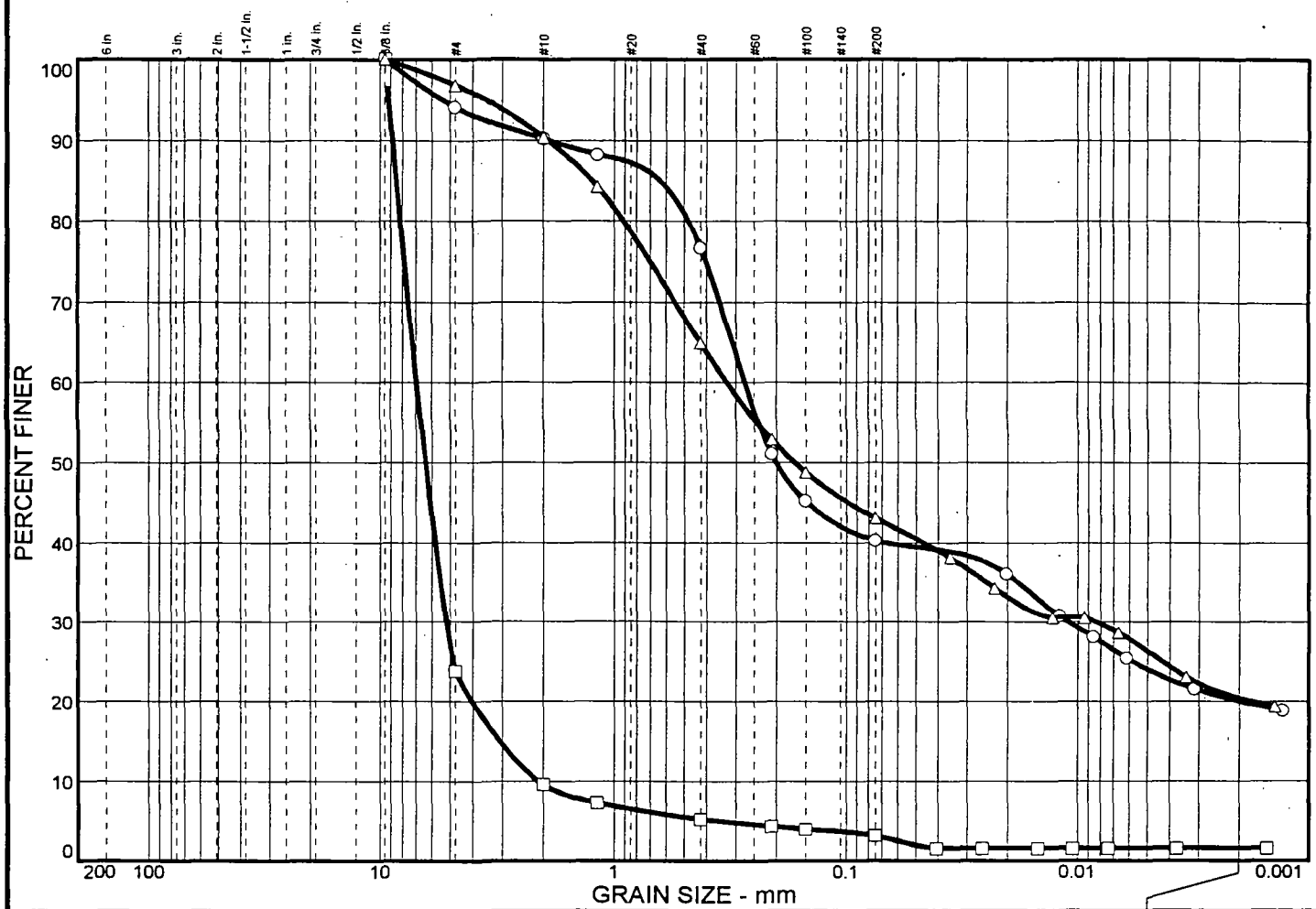
Plate E-2

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	5.9	3.9	13.4	36.5	20.3	20.0
□	0.0	0.0	76.2	14.2	4.4	2.1	1.6	1.5
△	0.0	0.0	3.2	6.4	25.4	21.9	22.7	20.4

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	34	16	0.634	0.273	0.201	0.0109				
□	34	21	8.49	6.95	6.37	5.17	3.07	2.09	1.84	3.33
△	37	20	1.24	0.326	0.167	0.0083				

MATERIAL DESCRIPTION	USCS	AASHTO
○ FILL	SC	
□ FILL	SH	
△ FILL	SC	

Project No. 88-19-202.00 **Client:** Illinois AML

Project: Field Investigation & Hydro-Geologic Study

Palzo Site - AML-GsWA-9600J

○ **Source:** MW-97-1 **Sample No.:** 1 **Elev./Depth:** 0

□ **Source:** MW-97-1 **Sample No.:** 6 **Elev./Depth:** 32

△ **Source:** MW-97-3 **Sample No.:** 4 **Elev./Depth:** 22

Remarks:

○ Tested by LDB; Gs=2.85

□ Tested by LDB; Gs=2.49

△ Tested by LDB; Gs=2.65

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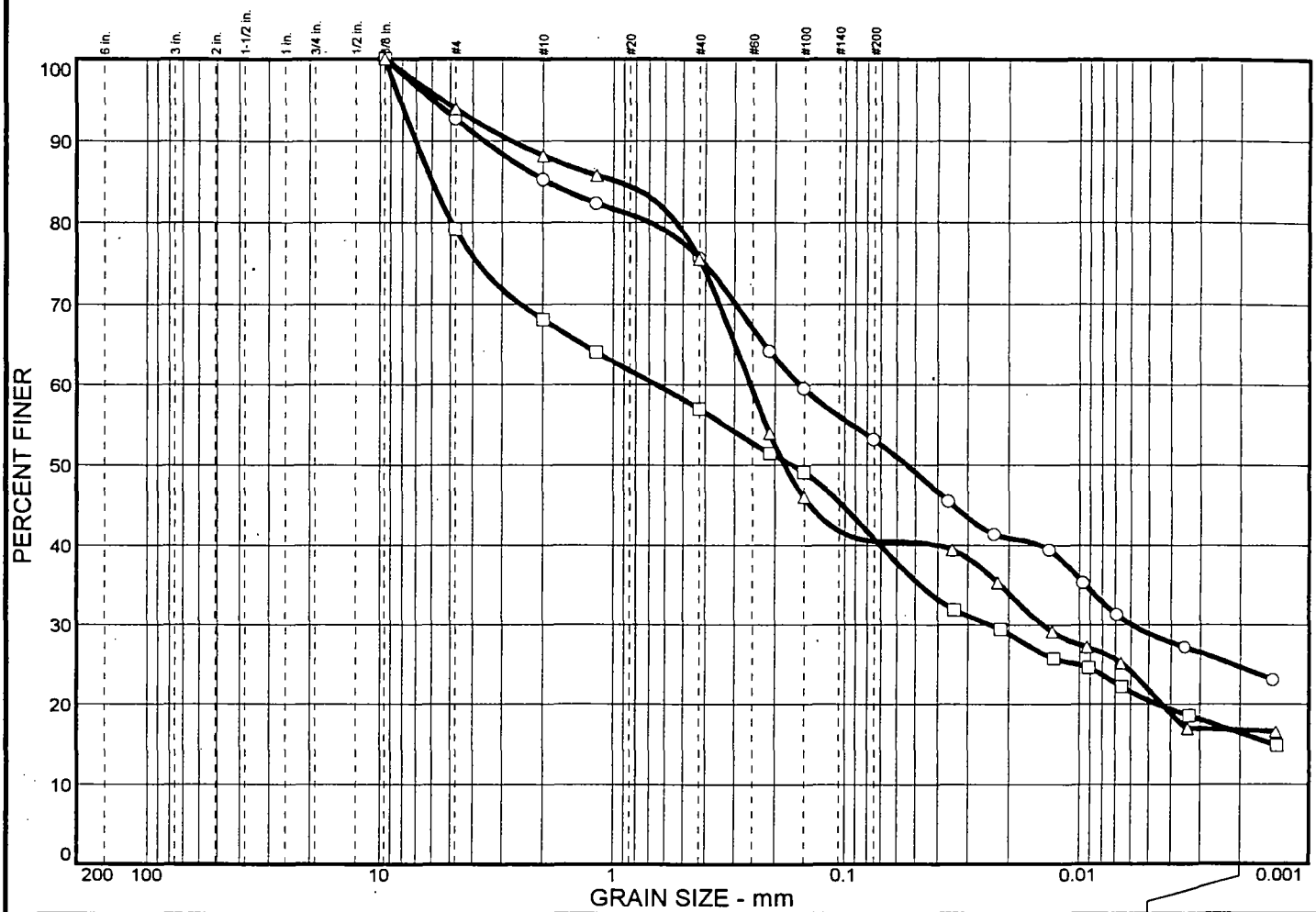
ENGINEERING AND CONSTRUCTION

Plate E-3

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	7.3	7.4	9.6	22.5	28.5	24.7
□	0.0	0.0	20.7	11.1	11.2	16.2	24.4	16.4
△	0.0	0.0	6.1	5.7	12.6	35.1	23.7	16.8

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.91	0.156	0.0542	0.0059				
□			5.94	0.654	0.168	0.0238	0.0014			
△	43	24	0.956	0.255	0.181	0.0143				

MATERIAL DESCRIPTION	USCS	AASHTO
○ FILL	ML	
□ FILL	SM	
△ FILL	SC	

Project No. 88-19-202.00 **Client:** Illinois AML

Project: Field Investigation & Hydro-Geologic Study

Palzo Site - AML-GsWA-9600J

○ **Source:** MW-97-4 **Sample No.:** 1 **Elev./Depth:** 0

□ **Source:** MW-97-4 **Sample No.:** 4 **Elev./Depth:** 34

△ **Source:** MW-97-7 **Sample No.:** 1 **Elev./Depth:** 0

Remarks:

○ Tested by LDB; Gs=2.55

□ Tested by LDB; Gs=2.65

△ Tested by LDB; Gs=2.74

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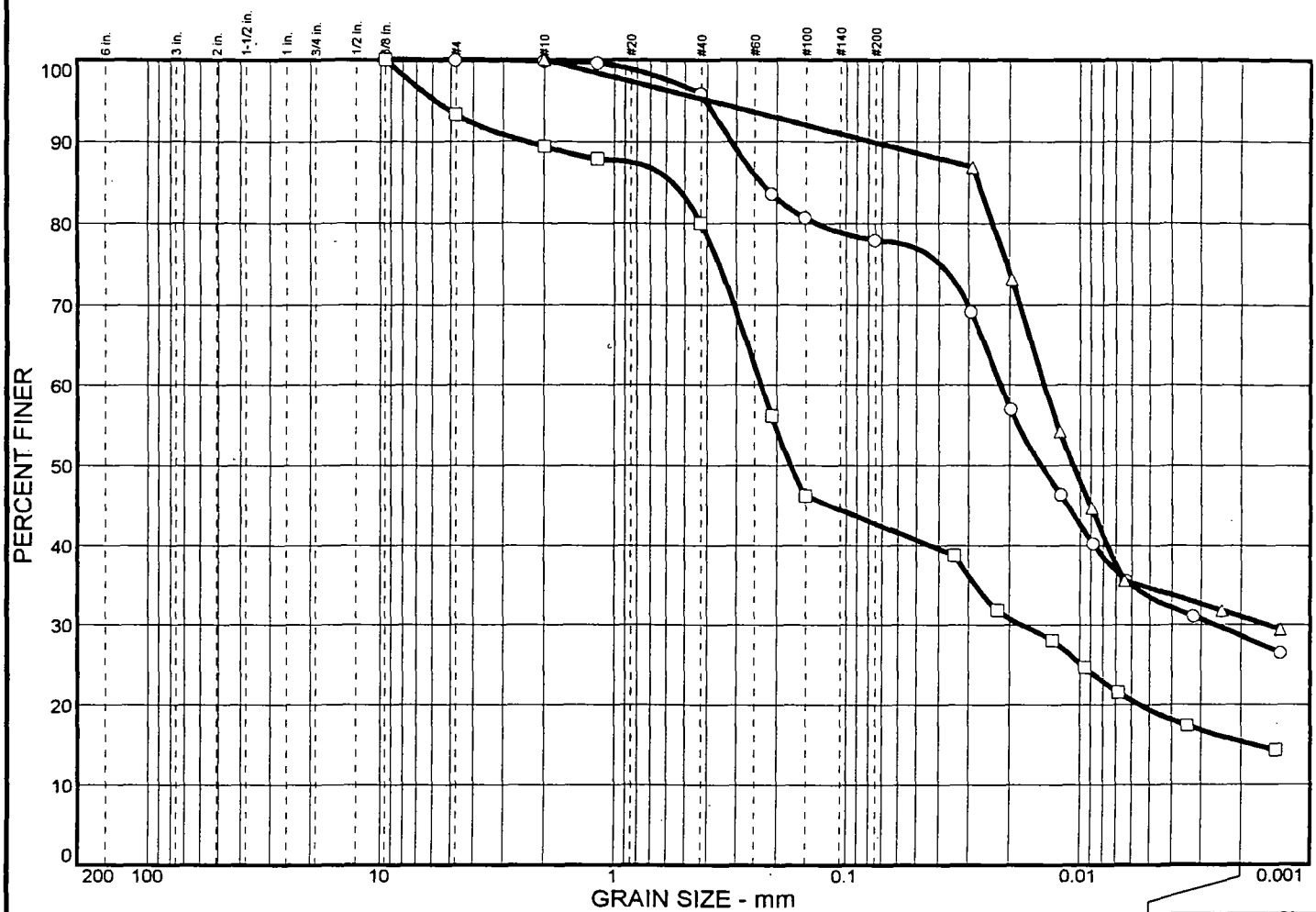
Plate E-4

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.1	0.1	4.0	17.8	49.4	28.6
□	0.0	0.0	6.7	3.9	9.3	37.4	27.4	15.3
△	0.0	0.0	0.0	0.0	0.3	0.4	68.3	31.0

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.234	0.0218	0.0147	0.0026				
□			0.562	0.233	0.174	0.0177	0.0018			
△	35	19	0.0269	0.0142	0.0107	0.0015				

MATERIAL DESCRIPTION	USCS	AASHTO
○ FILL	ML	
□ FILL	SM	
△ FILL	CL	

Project No. 88-19-202.00 **Client:** Illinois AML

Project: Field Investigation & Hydro-Geologic Study

Palzo Site - AML-GsWA-9600J

○ **Source:** MW-97-7 **Sample No.:** 4 **Elev./Depth:** 14

□ **Source:** MW-97-10 **Sample No.:** 1 **Elev./Depth:** 0

△ **Source:** MW-97-10 **Sample No.:** 4 **Elev./Depth:** 21

Remarks:

○ Tested by LDB; Gs=2.66

□ Tested by LDB; Gs=2.64

△ Tested by LDB; Gs=2.63

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Plate E-5

SOUTHERN ILLINOIS INVESTIGATIVE SERVICES
PALZO SITE; AML-GsWA-9600J
WILLIAMSON COUNTY, ILLINOIS
SITE STUDY AND RECOMMENDATIONS

APPENDIX F

CHEMICAL ANALYSES

indeco

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PLATE NO. 1
AML-GsWA-9600J
PALZO SITE
GROUNDWATER AND SURFACE WATER
LABORATORY TEST RESULTS

	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98
SAMPLE	pH	pH	Acidity	Acidity	Total Alkalinity	Total Alkalinity	TSS	TSS	Sulfate	Sulfate	Total Fe	Total Fe	Total Mn	Total Mn	Total Al	Total Al
LOCATION			mg/L CaCO3	mg/L CaCO3	mg/L CaCO3	mg/L CaCO3	mg TSS/L	mg TSS/L	mg/L SO_4^{2-}	mg/L SO_4^{2-}	mg Fe/L	mg Fe/L	mg Mn/L	mg Mn/L	mg Al/L	mg Al/L
1U(1),(2)	2.81	2.96	2,450	3,110			29.5	16			134.1	175.28	15.5	9.92		194.74
1F(1),(3)	2.84	2.97	2,410.00				13.50		1,429.00	1,205.00	173.80					
2U(1)	2.73	2.84	2,520.00	1,725.00			5.50	4.00			279.80	236.05	14.8	10.35		174.33
2F(1)	2.69	2.85	2,530.00				2.00		2,000.00	1,332.00	340.20					
3U(1)	2.67	2.72	2,520.00	1,820.00			10.50	4.00			240.40	230.48	13.6	11.97		198.41
3F(1)	2.67	2.72	2,400.00				1.00		1,857.00	1,242.00	323.60					
4U(1)	2.50	2.57	2,180.00	1,790.00			18.50	2.00			149.40	155.74	13.5	11.91		199.39
4F(1)	2.50	2.58	2,170.00				2.00		1,714.00	852.00	202.40					
5U(1)	5.90	7.32	135.00	-20.00	22.40	35.00	9.00	7.00			0.20	0.45	0.1	0.02		0.08
5F(1)	6.56	7.15	80.00		16.40		6.00		154.00	186.00	0.30					
6U(1)	3.09	3.43	610.00	95.00			18.00	3.00			5.00	1.12	5.7	1.06		8.85
6F(1)	3.11	3.50	605.00				3.00		714.00	931.00	6.60					
7U(1)	2.75	3.13	1,530.00	1,415.00			95.00	85.00			168.90	238.82	22.8	23.2		147.00
7F(1)	2.75	3.14	1,515.00				10.50		2,000.00	2,326.00	212.50					
8U(7)	3.16	5.70	210.00	25.00		12.50	82.00	34.00			34.00	11.22	3.8	1.14		6.08
8F(7)	3.23	5.65	210.00				14.00		1,057.00	405.00	13.20					
9U(7)		6.38		-10.00		30.00		22.00				5.25		0.8		2.85
9F(7)		6.47								371.00						
MW-14U(4)	4.46	5.94	1,590.00	-50.00	20.90	110.00	130.00	696.00			544.70	277.16	59.3	58.19		4.53
MW-14F	4.47	5.96	1,520.00		23.90		82.00		1,857.00	2,197.00	763.60					
MW-1F							16.50		179.20							
MW-1U	4.04		1,000.00		0.00						266.10		22.1		84.6	
MW-2F							37.00		153.60							
MW-2U	4.78		1,250.00		4.50						243.60		78.8		43.8	
MW-3F							53.00		140.80							
MW-3U	4.06		1,535.00		0.00						304.70		45.1		130	
MW-4F							43.00		140.80							
MW-4U	4.16		1,640.00		0.00						877.50		30.6		311	
MW-5F							11.50		153.60							
MW-5U	4.24		1,010.00		0.00						334.60		25.6		66.1	
MW-6F							6.00		166.40							
MW-6U	7.16		-150.00		615.00						14.50		1.1		4.3	
MW-7F							40.00		153.60							
MW-7U	5.49		480.00		0.00						129.70		49.2		27.1	
MW-8F							1.00		192.00							
MW-8U	3.85		2,675.00								410.50		44.6		290.3	
MW-9F							76.00		153.60							
MW-9U	4.31		1,570.00		0.00						691.90		87		76.5	
MW-10F							20.00		153.60							
MW-10U	5.07		440.00		20.00						30.00		41.2		17.6	
MW-11F							49.00		153.60							
MW-11U	3.80		2,790.00								1,207.50		72.3		392.6	
MW-12F							158.00		151.00							
MW-12U	4.47		1,110.00		0.00						483.50		32		1.5	
MW-13F							22.00		151.00							
MW-13U	3.96		1,670.00								300.90		63.5		187.5	
EXISTING-F(4)							9.00		172.80							
EXISTING-U(4)	2.96		1,920.00								120.30		16.5		239.6	
TRIB-F(1)		2.84					4.00		166.40	1,386.00						
TRIB-U(1)	2.73	2.83	2,370.00	1,905.00				20.00			205.40	187.35	15.1	11.58	240.1	209.00
UPSTREAM -F(7)		6.69					9.00		40.00	259.00						
UPSTREAM-U(7)	6.31	6.79	180.00	-25.00	35.00	48.00		24.00			5.30	2.17	0.7	0.39	0.2	0.91
DNSTREAM-F(7)		6.70					6.00		38.40	276.00						
DNSTREAM-U(7)	6.67	6.51	40.00	-30.00	69.00	40.00		21			3.80	2.77	0.7	0.44	0.3	1.90
AVERAGE VALUES(5)(8)	4.56	5.94	1,329.29	-50.00	60.04	110.00	43.93	696.00	278.56	2,197.00	417.12	277.16	46.60	58.19	125.61	4.53
(SITES MW-1 THRU MW-14 & EXISTING)																
AVERAGE VALUES(6)(9)(10)	3.15	3.48	1,789.38	1,480.00	22.40	35.00	23.25	17.63	1,254.30	1,182.50	147.90	153.16	12.64	10.00	240.10	141.48
(SITES 1U THROUGH 7U & TRIB-U,)																
AVERAGE VALUES(7)	5.38	6.35	143.33	-10.00	52.00	32.63	32.33	25.25	378.47	327.75	14.37	5.35	1.73	0.69	0.25	2.94
(SITES 8U/F,9U/F, UPSTREAM U/F & DNSTREAM U/F)																

NOTES:
(1) - SURFACE WATER SAMPLE
(2) - U = UNFILTERED WATER SAMPLE
(3) - F = FILTERED WATER SAMPLE
(4) - MW = MONITORING WELL
(5) - GROUNDWATER MONITORING WELLS
(6) - SITE SURFACE WATER SAMPLES
(7) - SUGAR CREEK SURFACE WATER SAMPLES
(8) - REPRESENTS A SINGLE DATA POINT FOR MARCH 1998 VALUES
(9) - REPRESENTS A SINGLE DATA POINT FOR DECEMBER 1997 AL VALUE
(10) - REPRESENTS A SINGLE DATA POINT VALUE FOR TOTAL ALKALINITY ON BOTH SAMPLE DATES

PLATE NO. 2
AML-GsWA-9600J
PALZO SITE - WESTERN PERIMETER
GROUNDWATER AND SURFACE WATER
LABORATORY TEST RESULTS

	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98
SAMPLE LOCATION	pH	pH	Acidity mg/L CaCO3	Acidity mg/L CaCO3	Total Alkalinity mg/L CaCO3	Total Alkalinity mg/L CaCO3	TSS mg TSS/L	TSS mg TSS/L	Sulfate[3] mg/L SO_4^{2}	Sulfate[3] mg/L SO_4^{2}	Total Fe mg Fe/L	Total Fe mg Fe/L	Total Mn mg Mn/L	Total Mn mg Mn/L	Total Al mg Al/L	Total Al mg Al/L
1[2],[4]	2.81	2.96	2,450.00	3110			29.5	16.00	1,429.00	1,205.00	134.1	175.28	15.5	9.92		194.74
2[2],[4]	2.73	2.84	2,520.00	1,725.00			5.50	4.00	2,000.00	1,332.00	279.80	236.05	14.80	10.35		174.33
3[2],[4]	2.67	2.72	2,520.00	1,820.00			10.50	4.00	1,857.00	1,242.00	240.40	230.48	13.60	11.97		198.41
4[2],[4]	2.50	2.57	2,180.00	1,790.00			18.50	2.00	1,714.00	852.00	149.40	155.74	13.50	11.91		199.39
5[2],[5]	5.90	7.32	135.00	-20.00	22.40	35.00	9.00	7.00	154.00	186.00	0.20	0.45	5.7	1.06		5.7
MW-5[1],[6],[10]	4.24		1,010.00		0.00		11.50		153.60		334.60		25.60		66.10	
MW-6[1],[6],[10]	7.16		-150.00		615.00		6.00		166.40		14.50		1.10		4.30	
MW-7[1],[6],[10]	5.49		480.00		0.00		40.00		153.60		129.70		49.20		27.10	
MW-12[1],[6],[10]	4.47		1,110.00		0.00		158.00		151.00		483.50		32.00		1.50	
MW-13[1],[6],[10]	3.96		1,670.00				22.00		151.00		300.90		63.50		187.50	
UPSTREAM-[1],[7],[10]	6.31	6.79	180.00	-25.00	35.00	48.00	9.00	24.00	40.00	259.00	5.30	2.17	0.70	0.39	0.20	0.91
DOWNSTREAM-[1],[7],[10]	6.67	6.51	40.00	-30.00	69.00	40.00	6.00	21.00	38.40	276.00	3.80	2.77	0.7	0.44	0.3	1.9
TRIB-[1],[4],[10]	2.73	2.83	2,370.00	1,905.00			4.00	20.00	166.40	1,386.00	205.40	187.35	15.10	11.58	240.10	209.00
AVERAGE VALUE[4],[8],[9] (SITES 1,2,3,4 & TRIB)	2.69	2.78	2,408.00	2,070.00			13.60	9.20	1,433.28	1,203.40	201.82	196.98	14.50	11.15	240.10	195.17
AVERAGE VALUE[6] (SITES MW's 5,6,7,12 & 13)	5.06		824.00		153.75		47.50		155.12		252.64		34.28		57.30	
AVERAGE VALUE[7] (SITES UPSTREAM & DOWNSTREAM)	6.49	6.65	110.00	-27.50	52.00	44.00	7.50	22.50	39.20	267.50	4.55	2.47	0.70	0.42	0.25	1.41

NOTES
(1) SAMPLED ON 12/11/97
(2) SAMPLED ON 12/16/97
(3) TEST PERFORMED UPON FILTERED SAMPLED
(4) SURFACE WATER SAMPLE COLLECTED FROM WESTERN DRAINAGEWAY
(5) SURFACE WATER SAMPLE COLLECTED FROM WESTERN POND
(6) GROUNDWATER SAMPLE COLLECTED FROM MONITORING WELL
(7) SURFACE WATER SAMPLE COLLECTED FROM SUGAR CREEK
(8) DOES NOT INCLUDE VALUES OBTAINED FROM SAMPLE LOCATION #5 SINCE THIS IS AN ON-SITE POND
(9) REPRESENTS A SINGLE DATA POINT VALUE FOR DEC. 97 AL VALUE
(10) DATA VALUES FOR TSS ON DEC 97 REFLECT FILTERED SAMPLE VALUES

PLATE NO. 3
AML-GsWA-9600J
PALZO SITE - NORTHERN PERIMETER
GROUNDWATER AND SURFACE WATER
LABORATORY TEST RESULTS

	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98	Dec-97	Mar-98
SAMPLE	pH	pH	Acidity	Acidity	Total Alkalinity	Total Alkalinity	TSS(3)	TSS	Sulfate(3)	Sulfate(3)	Total Fe	Total Fe	Total Mn	Total Mn	Total Al	Total Al
LOCATION			mg/L CaCO3	mg/L CaCO3	mg/L CaCO3	mg/L CaCO3	mg TSS/L	mg TSS/L	mg/L SO_4^{2-}	mg/L SO_4^{2-}	mg Fe/L	mg Fe/L	mg Mn/L	mg Mn/L	mg Al/L	mg Al/L
MW-5(1),(5),(8)	4.24		1,010.00		0.00		11.50		153.60		334.60		25.6		66.1	
EXISTING WELL(1),(8)	2.96		1,920.00				9.00		172.80		120.30		16.50		239.60	
MW-3(1),(5),(8)	4.06		1,535.00		0.00		53.00		140.80		304.70		45.10		130.00	
MW-2(1),(5),(8)	4.78		1,250.00		4.50		37.00		153.60		243.60		78.80		43.80	
6(2),(4)	3.09	3.43	610.00	95.00			18.00	3.00	714.00	931.00	5.00	1.12	5.70	1.06		8.85
7(2),(4)	2.75	3.13	1,530.00	1,415.00			95.00	85.00	2,000.00	2,326.00	168.90	238.82	22.80	23.20		147.00
8(2),(6)	3.16	5.70	210.00	25.00		12.50	82.00	34.00	1,057.00	405.00	34.00	11.22	3.80	1.14		6.08
9		6.38		-10.00		30.00		22.00		371.00		5.25		0.80		2.85
UPSTREAM-(1),(6),(8)	6.31	6.79	180.00	-25.00	35.00	48.00	9.00	24.00	40.00	259.00	5.30	2.17	0.7	0.39	0.2	0.91
DOWNSTREAM-(1),(6),(8)	6.67	6.51	40.00	-30.00	69.00	40.00	6.00	21.00	38.40	276.00	3.80	2.77	0.7	0.44	0.3	1.90
AVERAGE VALUE(5),(7)	4.36		1,265.00		1.50		33.83		149.33		294.30		49.83		79.97	
(SITES MW's-2,3 & 5)																
AVERAGE VALUE(4)	2.92	3.28	1,070.00	755.00			56.50	44.00	1,357.00	1,628.50	86.95	119.97	14.25	12.13		77.93
(SITES 6 & 7)																
AVERAGE VALUE(6),(8)	5.38	6.35	143.33	-10.00	52.00	32.63	32.33	25.25	378.47	327.75	14.37	5.35	1.73	0.69	0.25	2.94
(SITES 8,9,UPSTREAM & DOWNSTREAM)																

NOTES
(1) SAMPLED ON 12/11/97
(2) SAMPLED ON 12/16/97
(3) TEST PERFORMED UPON FILTERED SAMPLED
(4) SURFACE WATER SAMPLE COLLECTED FROM NORTHERN DRAINAGEWAY (LOCATIONS 6 & 7)
(5) GROUNDWATER SAMPLE COLLECTED FROM MONITORING WELL (LOCATIONS MW-5, MW-3,MW-2 & EXISTING WELL)
(6) SURFACE WATER SAMPLE COLLECTED FROM SUGAR CREEK (LOCATIONS 8,9,UPSTREAM & DOWNSTREAM)
(7) DOES NOT INCLUDE VALUES OBTAINED FROM EXISTING WELL SINCE IT IS UNKNOWN HOW THIS WELL WAS CONSTRUCTED
(8) DATA VALUES FOR TSS ON DEC 97 REFLECT FILTERED SAMPLE VALUES

PLATE NO. 4
AML-GsWA-9600J
PALZO SITE - WESTERN PERIMETER GROUNDWATER AND SURFACE WATER LABORATORY TEST RESULTS

SAMPLE LOCATION	Dec-97 pH	Mar-98 pH	Dec-97 Acidity mg/L CaCO3	Mar-98 Acidity mg/L CaCO3	Dec-97 Total Alkalinity mg/L CaCO3	Mar-98 Total Alkalinity mg/L CaCO3	Dec-97 TSS mg TSS/L	Mar-98 TSS mg TSS/L	Dec-97 Sulfate(3) mg/L SO_4^{2-}	Mar-98 Sulfate(3) mg/L SO_4^{2-}	Dec-97 Total Fe mg Fe/L	Mar-98 Total Fe mg Fe/L	Dec-97 Total Mn mg Mn/L	Mar-98 Total Mn mg Mn/L	Dec-97 Total Al mg Al/L	Mar-98 Total Al mg Al/L
1(2),(4)	2.81	2.96	2,450.00	3110			29.50	16.00	1,429.00	1,205.00	134.1	175.28	15.5	9.92		194.74
2(2),(4)	2.73	2.84	2,520.00	1,725.00			5.50	4.00	2,000.00	1,332.00	279.80	236.05	14.8	10.35		174.33
3(2),(4)	2.67	2.72	2,520.00	1,820.00			10.50	4.00	1,857.00	1,242.00	240.40	230.48	13.6	11.97		198.41
4(2),(4)	2.50	2.57	2,180.00	1,790.00			18.50	2.00	1,714.00	852.00	149.40	155.74	13.5	11.91		199.39
5(2),(5)	5.90	7.32	135.00	-20.00		35.00	9.00	7.00	154.00	186.00	0.30	0.00	5.7	0.00		0.08
MW-4(1),(6),(9)	4.16		1,640.00		0.00		43.00		140.80		877.50		30.60		311.00	
MW-5(1),(6),(9)	4.24		1,010.00		0.00		11.50		153.60		334.60		25.60		66.10	
MW-6(1),(6),(9)	7.16		-150.00		615.00		6.00		166.40		14.50		1.1		4.3	
MW-7(1),(6),(9)	5.49		480.00		0.00		40.00		153.60		129.70		49.2		27.1	
MW-10(1),(6),(9)	5.07		440.00		20.00		20.00		153.60		30.00		41.20		17.60	
MW-12(1),(6),(9)	4.47		1,110.00		0.00		158.00		151.00		483.50		32.00		1.50	
MW-13(1),(6),(9)	3.96		1,670.00				22.00		151.00		300.90		63.50		187.50	
UPSTREAM-(1),(7),(9)	6.31	6.79	180.00	-25.00	35.00	48.00	9.00	24.00	40.00	259.00	5.30	2.17	0.7	0.39	0.2	0.91
DOWNSTREAM-(1),(7),(9)	6.67	6.51	40.00	-30.00	69.00	40.00	6.00	21.00	38.40	276.00	3.80	2.77	0.7	0.44	0.3	1.90
TRIB-(1),(4),(9)	2.73	2.83	2,370.00	1,905.00			4.00	20.00	166.40	1,386.00	205.40	187.35	15.1	11.58	240.1	209.00
AVERAGE VALUE(4),(8) (SITES 1,2,3,4 & TRIB)	2.69	2.78	2,408.00	2,070.00			13.60	9.20	1,433.28	1,203.40	201.82	196.98	14.50	11.15	240.10	195.17
AVERAGE VALUE(6),(8) (SITES MW's 4-7,10, 12 & 13)	4.94		885.71		105.83		42.93		152.86		310.10		34.74		87.87	
AVERAGE VALUE(7),(8) (SITES UPSTREAM & DOWNSTREAM)	6.49	6.65	110.00	-27.50	52.00	44.00	7.50	22.50	39.20	267.50	4.55	2.47	0.70	0.42	0.25	1.41

NOTES
(1) SAMPLED ON 12/11/97
(2) SAMPLED ON 12/16/97
(3) TEST PERFORMED UPON FILTERED SAMPLED
(4) SURFACE WATER SAMPLE COLLECTED FROM WESTERN DRAINAGEWAY
(5) SURFACE WATER SAMPLE COLLECTED FROM WESTERN POND
(6) GROUNDWATER SAMPLE COLLECTED FROM MONITORING WELL
(7) SURFACE WATER SAMPLE COLLECTED FROM SUGAR CREEK
(8) DOES NOT INCLUDE VALUES OBTAINED FROM SAMPLE LOCATION #5 SINCE THIS IS AN ON-SITE POND
(9) DEC-97 TSS TEST PERFORMED UPON FILTERED SAMPLE

PLATE NO. 5
AML-GsWA-9600J
PALZO SITE
SOIL LABORATORY TEST RESULTS

SAMPLE LOCATION	Depth	Elev(1)	pH	Buffer pH	Neutralization Potential Tons CCE	Pyritic Sulfur %	Max. Potential Acidity Tons CCE	Net Alkalinity/Acidity Tons CCE	CEC meq/100g	Available Phosphorus lbs/acre	Phosphorus(P2) lbs/acre
B-1#3	10-15'	431.0	5.15	7.23	0.8	0	0	0.8	4	39	69
B-1#6	30-34'	411.6	3.65	5.01	-2.70	3.98	124.4	-127.1	30.1	58	216
B-2#1	0-5'	432.4	3.18	4.37	-5.10	5.22	163.1	-168.2	46.3	19	108
B-2#4	14-19'	418.4	3.20	4.90	-4	0.85	26.6	-30.6	30.4	77	201
B-2#5	19-24'	413.4	2.66	4.02	-9.30	1.92	60.0	-69.3	37.5	58	135
B-3#1	0-3.5'	430.9	3.81	6.26	0.90	0.44	13.8	-12.9	15.8	57	108
B-3#3	15-20'	415.2	6.35	7.02	8.3	0.78	24.4	-16.1	18.9	23	197
B-4#1	0-3.5'	455.3	3.43	5.11	-3	0.7	21.9	-24.9	30.4	189	366
B-4#3	9-14'	445.5	3.80	5.96	-1.5	2.23	69.7	-71.2	27.4	73	193
B-5#2	4-9'	437.2	4.10	5.60	-1.50	0.45	14.1	-15.6	24.7	35	100
B-5#3	9-14'	432.2	2.77	4.07	-11.60	1.34	41.9	-53.5	33.3	58	243
B-6#3	9-14'	465.1	3.10	4.30	-3.3	0.86	26.9	-30.2	32.1	50	120
B-6#6	24-29'	450.1	2.92	4.70	-3.8	2.03	63.4	-67.2	26.5	15	35
B-7#2	4-9'	473.3	3.26	4.34	-8.50	0.58	18.1	-26.6	30.5	19	46
B-7#5	19-24'	458.3	3.32	4.45	-4.70	0.83	25.9	-30.6	32.5	69	189
B-8#2	4-9'	427.8	3.23	4.55	-7.70	0.81	25.3	-33.0	35.3	120	201
B-8#3	9-14'	422.8	2.86	4.46	-6.3	2.37	74.10	-80.40	38.10	127.00	193.00
B-8#4	14-19'	417.8	3.37	4.42	-3.60	1.02	31.9	-35.5	33.4	85	197
B-9#1	0-4'	451.5	3.30	4.47	-4.5	0.46	14.40	-18.90	31.80	23.00	69.00
B-9#5	19-24'	432.0	2.87	4.00	-11.50	4.61	144.1	-155.6	34.0	58	139
B-10#2	4-9'	514.8	3.48	4.63	-1.80	0.66	20.6	-22.4	28.2	36	309
B-10#4	19-24'	499.8	4.05	5.83	-0.50	0.84	26.3	-26.8	21.8	15	135
B-11#1	5-10'	452.0	5.45	6.60	23	2.19	68.3	-45.3	37.8	31	123
B-11#5	19-24'	438.0	2.69	3.80	-16.50	3.84	120.00	-136.50	56.00	208.00	424.00
B-11#6	34-39'	423.0	6.51	7.44	17.80	0.60	18.80	-1.00	8.50	15.00	58.00
B-12#2	4-9'	477.8	3.16	5.23	-3.50	0.69	21.60	-25.10	24.60	23.00	73.00
B-12#3	9-14'	472.8	4.43	5.90	2.80	0.34	10.6	-7.8	33.6	31	141
B-12#4	14-19'	467.8	3.66	6.06	22.20	1.81	56.6	-34.4	18.8	19	38
B-14#1	38.6-39'	406.0	3.40	4.68	-3.30	0.64	20.0	-23.3	35.4	57	110
B-14#2	39-44'	403.5	4.10	6.82	26.40	0.70	21.9	4.5	12.9	26	112
AVERAGE VALUE(2)			3.71	5.21	-0.53	1.46	45.62	-46.15	29.02	57.10	154.93

NOTES:
1. ELEVATION WAS DERIVED BY AVERAGING SAMPLING DISTANCE
2. REFERENCE WORKSHEET 10 FOR TEST RESULT RELATIONSHIPS DISPLAYED BY DEPTH

PLATE NO. 6
AML-GsWA-9600J
PALZO SITE
GROUNDWATER AND SOIL
TEST RESULT RELATIONSHIPS

SAMPLE I.D.	Depth	Elev(1)	H_2O Elev	Screen Elev	Soil pH	Buffer pH	H_2O pH	Neutralization Potential Tons CCE	Pyritic Sulfur %	Max. Potential Acidity Tons CCE	Net Alkalinity/Acidity Tons CCE	CEC meq/100g
B-1#3	10-15'	431.0	419.0	419.6-409.6	5.15	7.23	4.04	0.80	0.00	0.0	0.8	4.0
B-1#6	30-34'	411.6	419.0	419.6-409.6	3.65	5.01	4.04	-2.70	3.98	124.4	-127.1	30.1
B-2#1	0-5'	432.4	412.5	421-411	3.18	-4.37	4.78	-5.10	5.22	163.1	-168.2	46.3
B-2#4	14-19'	418.4	412.5	421-411	3.20	4.90	4.78	-4.00	0.85	26.6	-30.6	30.4
B-2#5	19-24'	413.4	412.5	421-411	2.66	4.02	4.78	-9.30	1.92	60.0	-69.3	37.5
B-3#1	0-3.5'	430.9	419.5	418.7-408.7	3.81	6.26	4.06	0.90	0.44	13.8	-12.9	15.8
B-3#3	15-20'	415.2	419.5	418.7-408.7	6.35	7.02	4.06	8.30	0.78	24.4	-16.1	18.9
B-4#1	0-3.5'	455.3	429.0	428.5-418.5	3.43	5.11	4.16	-3.00	0.70	21.9	-24.9	30.4
B-4#3	9-14'	445.5	429.0	428.5-418.5	3.80	5.96	4.16	-1.50	2.23	69.7	-71.2	27.4
B-5#2	4-9'	437.2	434.5	435.7-425.7	4.10	5.60	4.24	-1.50	0.45	14.1	-15.6	24.7
B-5#3	9-14'	432.2	434.5	435.7-425.7	2.77	4.07	4.24	-11.60	1.34	41.9	-53.5	33.3
B-6#3	9-14'	465.1	440.3(2)	448.6-438.6	3.10	4.30	7.16	-3.30	0.86	26.9	-30.2	32.1
B-6#6	24-29'	450.1	440.3(2)	448.6-438.6	2.92	4.70	7.16	-3.80	2.03	63.4	-67.2	26.5
B-7#2	4-9'	473.3	457.0	462-452	3.26	4.34	5.49	-8.50	0.58	18.1	-26.6	30.5
B-7#5	19-24'	458.3	457.0	462-452	3.32	4.45	5.49	-4.70	0.83	25.9	-30.6	32.5
B-8#2	4-9'	427.8	426.0	426.3-416.3	3.23	4.55	3.85	-7.70	0.81	25.3	-33.0	35.3
B-8#3	9-14'	422.8	426.0	426.3-416.3	2.86	4.46	3.85	-6.30	2.37	74.1	-80.4	38.1
B-8#4	14-19'	417.8	426.0	426.3-416.3	3.37	4.42	3.85	-3.60	1.02	31.9	-35.5	33.4
B-9#1	0-4'	451.5	435.0	435.4-425.4	3.30	4.47	4.31	-4.50	0.46	14.4	-18.9	31.8
B-9#5	19-24'	432.0	435.0	435.4-425.4	2.87	4.00	4.31	-11.50	4.61	144.1	-155.6	34.0
B-10#2	4-9'	514.8	504.2	507.3-497.3	3.48	4.63	5.07	-1.80	0.66	20.6	-22.4	28.2
B-10#4	19-24'	499.8	504.2	507.3-497.3	4.05	5.83	5.07	-0.50	0.84	26.3	-26.8	21.8
B-11#1	5-10'	452.0	429.0	431.5-421.5	5.45	6.60	3.80	23.00	2.19	68.3	-45.3	37.8
B-11#5	19-24'	438.0	429.0	431.5-421.5	2.69	3.80	3.80	-16.50	3.84	120.0	-136.5	56.0
B-11#6	34-39'	423.0	429.0	431.5-421.5	6.51	7.44	3.80	17.80	0.60	18.8	-1.0	8.5
B-12#2	4-9'	477.8	472.3	441.3-431.3	3.16	5.23	4.47	-3.50	0.69	21.6	-25.1	24.6
B-12#3	9-14'	472.8	472.3	441.3-431.3	4.43	5.90	4.47	2.80	0.34	10.6	-7.8	33.6
B-12#4	14-19'	467.8	472.3	441.3-431.3	3.66	6.06	4.47	22.20	1.81	56.6	-34.4	18.8
B-14#1	38.6-39'	406.0	414.7	393-383	3.40	4.68	5.94	-3.30	0.64	20.0	-23.3	35.4
B-14#2	39-44'	403.5	414.7	393-383	4.10	6.82	5.94	26.40	0.70	21.9	4.5	12.9
AVERAGE VALUE(3)(4)					3.71	5.21	4.72	-0.53	1.46	45.62	-46.15	29.02

NOTES:
1. ELEVATION WAS DERIVED BY AVERAGING SAMPLING DISTANCE
2. ELEVATION WAS DERIVED BY AVERAGING 2 MEASURED DEPTHS ON 12/11 AND 12/16
3. REFERENCE WORKSHEET 10 FOR TEST RESULT RELATIONSHIPS DISPLAYED BY DEPTH
4. REFLECTS MAR 98 H_2O Ph VALUE FOR B-14#1 AND #2

PLATE NO. 7
AML-GsWA-9600J
PALZO SITE
LABORATORY SOIL ANALYSIS RECOMMENDATIONS

* CCE - Calcium Carbonate Equivalent in Tons / 1,000 Tons of Material

SAMPLE I.D.	Depth	Elev (1)	NEUTRALIZATION POTENTIAL %CCE	NEUTRALIZATION POTENTIAL TONS CCE	PYRITIC SULFUR %	MAX. POTENTIAL ACIDITY TONS CCE	NET ALKINITY OR ACIDITY (-) TONS CCE	LIME(2),(3) TONS/1000 TONS	P_2O_5(3) LBS/ACRE	K_2O(3) LBS/ACRE
B-1#3	10-15'	431	0.08	0.80	0	0.00	0.8	0	64	221
B-1#6	30-34'	411.6	-0.27	-2.70	3.98	124.38	-127.1	14	48	100
B-2#1	0-5'	432.4	-0.51	-5.10	5.22	163.13	-168.2	At least 15.5	104	281
B-2#4	14-19'	418.4	-0.4	-4.00	0.85	26.60	-30.6	14.7	48-RECOMMENDED	413
B-2#5	19-24'	413.4	-0.93	-9.30	1.92	60.00	-69.3	At least 15.5	48	317
B-3#1	0-3.5'	430.9	0.09	0.90	0.44	13.75	-12.9	4.6	48	317
B-3#3	15-20'	415.2	0.83	8.30	0.78	24.40	-16.1	0	100	329
B-4#1	0-3.5'	455.30	-0.3	-3.00	0.7	21.90	-24.9	13.2	0	413
B-4#3	9-14'	445.5	-0.15	-1.50	2.23	69.70	-71.2	6	48-RECOMMENDED	260
B-5#2	4-9'	437.2	-0.15	-1.50	0.45	14.06	-15.6	9.6	73	341
B-5#3	9-14'	432.2	-1.16	-11.60	1.34	41.88	-53.5	At least 15.5	48	197
B-6#3	9-14'	465.1	-0.33	-3.30	0.86	26.90	-30.2	At least 15.5	48-REQUIRED	413
B-6#6	24-29'	450.1	-0.38	-3.80	2.03	63.40	-67.2	At least 15.5	113	317
B-7#2	4-9'	473.30	-0.85	-8.50	0.58	18.13	-26.6	At least 15.5	104	269
B-7#5	19-24'	458.30	-0.47	-4.70	0.83	25.94	-30.6	At least 15.5	48	257
B-8#2	4-9'	427.80	-0.77	-7.70	0.81	25.31	-33.0	At least 15.5	0	149
B-8#3	9-14'	422.80	-0.63	-6.30	2.37	74.10	-80.4	At least 15.5	0	137
B-8#4	14-19'	417.8	-0.36	-3.60	1.02	31.88	-35.5	At least 15.5	48	0
B-9#1	0-4'	451.5	-0.45	-4.50	0.46	14.40	-18.9	At least 15.5	100	317
B-9#5	19-24'	432	-1.15	-11.50	4.61	144.06	-155.6	At least 15.5	48	100
B-10#2	4-9'	514.8	-0.18	-1.80	0.66	20.63	-22.4	At least 15.5	68	305
B-10#4	19-24'	499.8	-0.05	-0.50	0.84	26.25	-26.8	8.1	118	100
B-11#1	5-10'	452	2.3	23.00	2.19	68.30	-45.3	2.4	77	413
B-11#5	19-24'	438	-1.65	-16.50	3.84	120.00	-136.5	At least 15.5	0	317
B-11#6	34-39'	423	1.78	17.80	0.60	18.80	-1.0	0	113	100
B-12#2	4-9'	477.8	-0.35	-3.50	0.69	21.60	-25.1	12.5	152	413
B-12#3	9-14'	472.8	0.28	2.80	0.34	10.63	-7.8	4.8	82	100
B-12#4	14-19'	467.8	2.22	22.20	1.81	56.56	-34.4	4.9	104	100
B-14#1	38.6-39'	406	-0.33	-3.30	0.64	20.00	-23.3	At least 15.5	48	100
B-14#2	39-44'	403.5	2.64	26.40	0.70	21.88	4.5	1	91	100
AVERAGE VALUE				-0.53	1.46	45.62	-46.15			

NOTES:
1. ELEVATION WAS DERIVED BY AVERAGING SAMPLING DISTANCE
2. AGRICULTURAL GROUND LIMESTONE TNP AT LEAST 90%
3. LABORATORY RECOMMENDED APPLICATON AMOUNTS

PLATE NO. 8
AML-GsWA-9600J
PALZO SITE - WESTERN PERIMETER
SURFACE WATER, GROUNDWATER AND SOIL
TEST RESULT RELATIONSHIP

SAMPLE LOCATION/ID	Depth	Elev(1)	H_2O Elev	Screen Elev	Soil ph(2)	Buffer ph(2)	H_2O pH(3)	Neutralization Potential Tons CCE	Pyritic Sulfur(2) %	Max. Pot. Acidity(2) Tons CCE	Net Alkal/Acidity(2) Tons CCE	CEC(2) meq/100g	Acidity(3) mg/L CaCO3	Total Alkalinity(3) mg/L CaCO3	TSS(3) mg TSS/L	Sulfate(3),(4) mg/L SO_4^{2-}	Total Fe(3) mg Fe/L	Total Mn(3) mg Mn/L	Total Al(3) mg Al/L
1(5),(7)							2.89						2780.00		22.75	1317.00	154.69	12.71	194.74
2(5),(7)							2.79						2122.50		4.75	1666.00	257.93	12.58	174.33
3(5),(7)							2.70						2170.00		7.25	1549.50	235.44	12.79	198.41
4(5),(7)							2.54						1985.00		10.25	1283.00	152.57	12.71	199.39
UPSTREAM-(6),(11)							6.55						77.50	41.50	24.00	149.50	3.74	0.55	0.56
DOWNSTREAM-(6),(11)							6.59						5.00	54.50	21.00	157.20	3.29	0.57	1.10
TRIB-(6),(7)							2.78						2137.50		20.0	776.20	196.38	13.34	224.55
B-4#1	0-3.5'	455.3	429.0	428.5-418.5	3.43	5.11	4.16	-3	0.7	21.9	-24.9	30.4	1,640.0	0.0	43.0	140.8	877.5	30.6	311.0
B-4#3	9-14'	445.5	429.0	428.5-418.5	3.8	5.96	4.16	-1.5	2.23	69.7	-71.2	27.4	1,640.0	0.0	43.0	140.8	877.5	30.6	311.0
B-5#2	4-9'	437.2	434.5	435.7-425.7	4.1	5.6	4.24	-1.5	0.45	14.1	-15.6	24.7	1,010.0	0.0	11.5	153.6	334.6	25.6	66.1
B-5#3	9-14'	432.2	434.5	435.7-425.7	2.77	4.07	4.24	-11.6	1.34	41.9	-53.5	33.33	1,010.0	0.0	11.5	153.6	334.6	25.6	66.1
B-6#3	9-14'	465.1	440.3(8)	448.6-438.6	3.1	4.3	7.16	-3.3	0.86	26.9	-30.2	32.1	-150.0	615.0	6.0	166.4	14.5	1.1	4.3
B-6#6	24-29'	450.1	440.3(8)	448.6-438.6	2.92	4.7	7.16	-3.8	2.03	63.4	-67.2	26.5	-150.0	615.0	6.0	166.4	14.5	1.1	4.3
B-7#2	4-9'	473.3	457.0	462-452	3.26	4.34	5.49	-8.5	0.58	18.1	-26.6	30.53	480.0	480.0	40.0	153.6	129.7	49.2	27.1
B-7#5	19-24'	458.3	457.0	462-452	3.32	4.45	5.49	-4.7	0.83	25.9	-30.6	32.54	480.0	480.0	40.0	153.6	129.7	49.2	27.1
B-10#2	4-9'	514.8	504.2	507.3-497.3	3.48	4.63	5.07	-1.8	0.66	20.6	-22.4	28.16	440.0	20.0	20.0	153.6	30.0	41.2	17.6
B-10#4	19-24'	499.8	504.2	507.3-497.3	4.05	5.83	5.07	-0.5	0.84	26.3	-26.8	21.83	440.0	20.0	20.0	153.6	30.0	41.2	17.6
B-12#2	4-9'	477.8	472.3	441.3-431.3	3.16	5.23	4.47	-3.5	0.69	21.6	-25.1	24.6	1,110.0	0.0	158.0	151.0	483.5	32.0	1.5
B-12#3	9-14'	472.8	472.3	441.3-431.3	4.43	5.9	4.47	2.8	0.34	10.6	-7.8	33.62	1,110.0	0.0	158.0	151.0	483.5	32.0	1.5
B-12#4	14-19'	467.8	472.3	441.3-431.3	3.66	6.06	4.47	22.2	1.81	56.6	-34.4	18.77	1,110.0	0.0	158.0	151.0	483.5	32.0	1.5
MW-13(6a)			472.4	474.4-464.4			3.96						1,670.0		22.0	151.0	300.9	63.5	187.5
AVERAGE VALUE(9),(10),(12) (SITES B-4,B-5,B-6,B-7,B-10,B-12 & MW-13)					3.50	5.09	4.94	-1.44	1.03	32.12	-33.56	28.04	885.71	185.83	42.93	152.86	310.10	34.74	87.87
AVERAGE VALUE(7),(10) (SITES 1,2,3,4 & TRIB)							2.74						2239.0		13.0	1318.3	199.4	12.8	198.3
AVERAGE VALUE (11) (SITES UPSTREAM & DOWNSTREAM)							6.57						41.25	48.00	22.50	153.35	3.51	0.56	0.83

NOTES

(1) ELEVATION WAS DERIVED BY AVERAGING SAMPLING DISTANCES
(2) LABORATORY SOIL TEST RESULTS
(3) LABORATORY WATER TEST RESULTS - AVERAGED FOR DEC 97 & MAR 98 WHERE APPLICABLE
(4) TEST PERFORMED UPON FILTERED SAMPLED
(5) SAMPLED ON 12/16/97 & 3/12/98
(6) SAMPLED ON 12/11/97 & 3/12/98
(6a) SAMPLED ONLY ON 12/11/97
(7) SURFACE WATER SAMPLE - OBTAINED FROM WESTERN DRAINAGEWAY
(8) ELEVATION WAS DERIVED BY AVERAGING 2 MEASURED DEPTHS ON 12/11/97 & 12/16/97
(9) SOIL BORING & MONITORING WELL SAMPLES ONLY
(10) AVG. VALUES FOR GROUNDWATER ANALYTES WERE COMPUTED USING VALUES FROM SINGLE SAMPLE HORIZON/WELL; IE. NOTE THAT GROUNDWATER VALUES FOR A SINGLE MONITORING WELL ARE THE SAME FOR ALL SAMPLE HORIZONS FOR THAT WELL
(11) SURFACE WATER SAMPLE OBTAINED FROM SUGAR CREEK
(12) DATA VALUES FOR TSS REFLECT ONLY DEC 97 FILTERED SAMPLE VALUES

PLATE NO. 9
AML-GsWA-9600J
PALZO SITE - NORTHERN PERIMETER
SURFACE WATER, GROUNDWATER AND SOIL
TEST RESULT RELATIONSHIP

SAMPLE LOCATION/ID	Depth	Elev(1)	H_2O Elev	Screen Elev	Soil ph(2)	Buffer ph(2)	H_2O pH(3)	Neu Pot.(2) Tons CCE	Pyritic Sulfur(2) %	Max. Pot. Acidity(2) Tons CCE	Net Alkal/Acid(2) Tons CCE	CEC(2) meq/100g	Acidity(3) mg/L CaCO3	Total Alkalinity(3) mg/L CaCO3	TSS(3) mg TSS/L	Sulfate(3),(4) mg/L SO_4^{2-}	Total Fe(3) mg Fe/L	Total Mn(3) mg Mn/L	Total Al(3) mg Al/L
6(5),(7)							3.26						352.50		10.50	822.50	3.06	3.38	8.85
7(5),(7)							2.94						1,472.50		90.00	2,163.00	203.86	23.00	147.00
8(5),(8)							4.43						117.50	12.50	58.00	731.00	22.61	2.47	6.08
9(8)							6.38						-10.00	30.00	22.00	371.00	5.25	0.80	2.85
UPSTREAM(6),(8)							6.55						77.50	41.50	24.00	149.50	3.74	0.55	0.56
DNSTREAM(6),(8)							6.59						5.00	54.50	21.00	157.20	3.29	0.57	1.10
B-2#1	0-5'	432.4	412.5	421-411	3.18	4.37	4.78	-5.1	5.22	163.125	-168.225	46.27	1,250.00	4.50	37.00	153.60	243.60	78.80	43.80
B-2#4	14-19'	418.4	412.5	421-411	3.2	4.9	4.78	-4	0.85	26.6	-30.6	30.4	1,250.00	4.50	37.00	153.60	243.60	78.80	43.80
B-2#5	19-24'	413.4	412.5	421-411	2.66	4.02	4.78	-9.3	1.92	60	-69.3	37.5	1,250.00	4.50	37.00	153.60	243.60	78.80	43.80
B-3#1	0-3.5'	430.9	419.5	418.7-408.7	3.81	6.26	4.06	0.9	0.44	13.75	-12.85	15.83	1,535.00	0.00	53.00	140.80	304.70	45.10	130.00
B-3#3	15-20'	415.2	419.5	418.7-408.7	6.35	7.02	4.06	8.3	0.78	24.4	-16.1	18.9	1,535.00	0.00	53.00	140.80	304.70	45.10	130.00
B-5#2	4-9'	437.2	434.5	435.7-425.7	4.1	5.6	4.24	-1.5	0.45	14.0625	-15.5625	24.7	1,010.00	0.00	11.50	153.60	334.60	25.60	66.10
B-5#3	9-14'	432.2	434.5	435.7-425.7	2.77	4.07	4.24	-11.6	1.34	41.875	-53.475	33.33	1,010.00	0.00	11.50	153.60	334.60	25.60	66.10
AVERAGE VALUE(9),(10)					3.72	5.18	4.36	-3.19	1.57	49.12	-52.30	29.56	1265.00	1.50	33.83	149.33	294.30	49.83	79.97
(SITES B-2,B-3 & B-5)																			
AVERAGE VALUE(7)							3.10						912.50		50.25	1492.75	103.46	13.19	77.93
(SITES 6 & 7)																			
AVERAGE VALUE(8)							5.99						47.50	34.63	31.25	352.18	8.72	1.10	2.65
(SITES 8,9,UPSTREAM & DOWNSTREAM)																			

NOTES

(1) ELEVATION WAS DERIVED BY AVERAGING SAMPLING DISTANCES
(2) LABORATORY SOIL TEST RESULTS
(3) LABORATORY WATER TEST RESULTS - AVERAGED FOR DEC 97 & MAR 98 WHERE APPLICA
(4) TEST PERFORMED UPON FILTERED SAMPLED
(5) SAMPLED ON 12/16/97 & 3/12/98
(6) SAMPLED ON 12/11/97 & 3/12/98
(7) SURFACE WATER SAMPLE OBTAINED FROM NORTHERN DRAINAGE WAY
(8) SURFACE WATER SAMPLE OBTAINED FROM SUGAR CREEK
(9) AVG. VALUES FOR GROUNDWATER ANALYTES WERE COMPUTED USING VALUES FROM SINGLE SAMPLE HORIZON/WELL; IE. NOTE THAT GROUNDWATER VALUES FOR A SINGLE MONITORING WELL ARE THE SAME FOR ALL SAMPLE HORIZONS FOR THAT WELL
(10) DATA VALUES FOR TSS REFLECT ONLY DEC 97 FILTERED SAMPLE VALUES

PLATE NO. 10
AML-GsWA-9600J
PALZO SITE
GROUNDWATER AND SOIL
TEST RESULT RELATIONSHIP

SAMPLE I.D.	Depth	Soil Elev(1)	H_2O Elev	Screen Elev	Soil pH	Buffer pH	H_2O pH	Neutralization Potential Tons CCE	Pyritic Sulfur %	Max. Potential Acidity Tons CCE	Net Alkalinity/Acidity Tons CCE	CEC meq/100g
B-3#1	0-3.5'	430.9	419.5	418.7-408.7	3.81	6.26	4.06	0.90	0.44	13.8	-12.9	15.3
B-4#1	0-3.5'	455.3	429.0	428.5-418.5	3.43	5.11	4.16	-3.00	0.70	21.9	-24.9	30.4
B-9#1	0-4'	451.5	435.0	435.4-425.4	3.30	4.47	4.31	-4.50	0.46	14.4	-18.9	31.8
B-2#1	0-5'	432.4	412.5	421-411	3.18	4.37	4.78	-5.10	5.22	163.1	-168.2	46.3
AVERAGE VALUES					3.43	5.05	4.33	-2.93	1.71	53.29	-56.22	31.08
B-10#2	4-9'	514.8	504.2	507.3-497.3	3.48	4.63	5.07	-1.80	0.66	20.6	-22.4	28.2
B-12#2	4-9'	477.8	472.3	441.3-431.3	3.16	5.23	4.47	-3.50	0.69	21.6	-25.1	24.6
B-5#2	4-9'	437.2	434.5	435.7-425.7	4.10	5.60	4.24	-1.50	0.45	14.1	-15.6	24.7
B-7#2	4-9'	473.3	457.0	462-452	3.26	4.34	5.49	-8.50	0.58	18.1	-26.6	30.5
B-8#2	4-9'	427.8	426.0	426.3-416.3	3.23	4.55	3.85	-7.70	0.81	25.3	-33.0	35.3
B-11#1	5-10'	452.0	429.0	431.5-421.5	5.45	6.60	3.80	23.00	2.19	68.3	-45.3	37.8
AVERAGE VALUES					3.78	5.16	4.49	0.00	0.90	28.00	-28.00	30.18
B-12#3	9-14'	472.8	472.3	441.3-431.3	4.43	5.90	4.47	2.80	0.34	10.6	-7.8	33.6
B-5#3	9-14'	432.2	434.5	435.7-425.7	2.77	4.07	4.24	-11.60	1.34	41.9	-53.5	33.3
B-8#3	9-14'	422.8	426.0	426.3-416.3	2.86	4.46	3.85	-6.30	2.37	74.1	-80.4	38.1
B-4#3	9-14'	445.5	429.0	428.5-418.5	3.80	5.96	4.16	-1.50	2.23	69.7	-71.2	27.4
B-6#3	9-14'	465.1	440.3(2)	448.6-438.6	3.10	4.30	7.16	-3.30	0.86	26.9	-30.2	32.1
B-1#3	10-15'	431.0	419.0	419.6-409.6	5.15	7.23	4.04	0.80	0.00	0.0	0.8	4.0
AVERAGE VALUES					3.69	5.32	4.65	-3.18	1.19	37.20	-40.38	28.09
B-12#4	14-19'	467.8	472.3	441.3-431.3	3.66	6.06	4.47	22.20	1.81	56.6	-34.4	18.8
B-8#4	14-19'	417.8	426.0	426.3-416.3	3.37	4.42	3.85	-3.60	1.02	31.9	-35.5	33.4
B-2#4	14-19'	418.4	412.5	421-411	3.20	4.90	4.78	-4.00	0.85	26.6	-30.6	30.4
B-3#3	15-20'	415.2	419.5	418.7-408.7	6.35	7.02	4.06	8.30	0.78	24.4	-16.1	18.9
AVERAGE VALUES					4.15	5.60	4.29	5.73	1.12	34.86	-29.13	25.38
B-10#4	19-24'	499.8	504.2	507.3-497.3	4.05	5.83	5.07	-0.50	0.84	26.3	-26.8	21.8
B-11#5	19-24'	438.0	429.0	431.5-421.5	2.69	3.80	3.80	-16.50	3.84	120.0	-136.5	56.0
B-2#5	19-24'	413.4	412.5	421-411	2.66	4.02	4.78	-9.30	1.92	60.0	-69.3	37.5
B-7#5	19-24'	458.3	457.0	462-452	3.32	4.45	5.49	-4.70	0.83	25.9	-30.6	32.5
B-9#5	19-24'	432.0	435.0	435.4-425.4	2.87	4.00	4.31	-11.50	4.61	144.1	-155.6	34.0
AVERAGE VALUES					3.12	4.42	4.69	-8.50	2.41	75.25	-83.75	36.38
B-6#6	24-29'	450.1	440.3(2)	448.6-438.6	2.92	4.70	7.16	-3.80	2.03	63.4	-67.2	26.5
AVERAGE VALUES					2.92	4.70	7.16	-3.80	2.03	63.4	-67.2	26.5
B-1#6	30-34'	411.6	419.0	419.6-409.6	3.65	5.01	4.04	-2.70	3.98	124.4	-127.1	30.1
B-11#6	34-39'	423.0	429.0	431.5-421.5	6.51	7.44	3.80	17.80	0.60	18.8	-1.0	8.5
B-14#1	38.6-39'	406.0	414.7	393-383	3.40	4.68	5.94	-3.30	0.64	20.0	-23.3	35.4
AVERAGE VALUES					4.52	5.71	4.59	3.93	1.74	54.39	-50.46	24.67
B-14#2	39-44'	403.5	414.7	393-383	4.10	6.82	5.94	26.40	0.70	21.9	4.5	12.9
AVERAGE VALUES					4.10	6.82	5.94	26.40	0.70	21.9	4.5	12.9

NOTES: 1. ELEVATION WAS DERIVED BY AVERAGING SAMPLING DISTANCE
2. ELEVATION WAS DERIVED BY AVERAGING 2 MEASURED DEPTHS ON 12/11 AND 12/16

SOUTHERN ILLINOIS INVESTIGATIVE SERVICES
PALZO SITE; AML-GsWA-9600J
WILLIAMSON COUNTY, ILLINOIS
SITE STUDY AND RECOMMENDATIONS

APPENDIX G

PERMEABILITY TEST RESULTS

indeco

P.O. Box 1148 • 630 River Drive, Bettendorf, IA 52722 • Tel (319) 359-5451 • Fax (319) 359-4318

PLATE NO. 1
AML-GsWA-9600J - PALZO SITE
HORIZONTAL AND VERTICAL
PERMEABILITY TEST RESULTS

BACKFILL WELLS

WELL NUMBER	SCREEN ELEV	SCREEN DEPTH	VERTICAL PERMEABILITY (CM/SEC)	VERTICAL PERM DEPTH	PERMEABILITY SLUG IN (FALLING HEAD) (FT/MIN)	PERMEABILITY SLUG IN (FALLING HEAD) (CM/SEC)	PERMEABILITY SLUG OUT (RISING HEAD) (FT/MIN)	PERMEABILITY SLUG OUT (RISING HEAD) (CM/SEC)	PERMEABILITY AVERAGE (FT/MIN)	PERMEABILITY AVERAGE (CM/SEC)
MW-5	435.7-425.7	7	2.18E-05	9-11'	1.09E-02	5.54E-03	8.69E-02	4.41E-02	4.89E-02	2.48E-02
MW-8	426.3-416.3	7			7.02E-04	3.57E-04	1.46E-04	7.42E-05	4.24E-04	2.15E-04
MW-13	474.4-464.4	9	0.0000234(2)	4-6'	1.35E-04	6.86E-05	8.41E-04	4.27E-04	4.88E-04	2.48E-04
MW-2	421-411	12.9					4.04E-04	2.05E-04	4.04E-04	2.05E-04
MW-3	418.7-408.7	13			5.10E-04	2.59E-04	7.07E-04	3.59E-04	6.09E-04	3.09E-04
MW-10	507.3-497.3	13			6.71E-05	3.41E-05	4.15E-04	2.11E-04	2.41E-04	1.22E-04
MW-7	462-452	16.8			3.87E-02	1.97E-02	1.59E-02	8.08E-03	2.73E-02	1.39E-02
MW-9	435.4-425.4	17			1.01E-04	5.13E-05	7.55E-05	3.84E-05	8.83E-05	4.48E-05
MW-1(1)	419.6-409.6	23			1.77E-03	8.99E-04	8.22E-05	4.18E-05	8.22E-05	4.18E-05
MW-6	448.6-438.6	27					5.03E-05	2.56E-05	5.03E-05	2.56E-05
MW-4	428.5-418.5	27.5			2.20E-04	1.12E-04	4.12E-04	2.09E-04	3.16E-04	1.61E-04
AVERAGE VALUE					6.42E-03	3.26E-03	9.63E-03	4.89E-03	7.17E-03	3.64E-03

NOTE: (1) THIS IS BASED UPON 2 DATA POINTS DURING SLUG IN TEST- DATA NOT UTILIZED IN AVERAGE VALUE COMPUTATIONS
(2) SAMPLE WAS OBTAINED FROM BORING B-12-97 WHICH IS LOCATED ~ 5' FROM B-13-97. SAMPLE PREMEABILITY REPRESENTS BACKFILL WELL CONDITIONS.

BEDROCK WELLS

WELL NUMBER	SCREEN ELEV	SCREEN DEPTH	VERTICAL PERMEABILITY (CM/SEC)	VERTICAL PERM DEPTH	PERMEABILITY SLUG IN (FALLING HEAD) (FT/MIN)	PERMEABILITY SLUG IN (FALLING HEAD) (CM/SEC)	PERMEABILITY SLUG OUT (RISING HEAD) (FT/MIN)	PERMEABILITY SLUG OUT (RISING HEAD) (CM/SEC)	PERMEABILITY AVERAGE (FT/MIN)	PERMEABILITY AVERAGE (CM/SEC)
MW-11	431.5-421.5	27			1.09E-02	5.54E-03	3.15E-02	1.60E-02	2.12E-02	1.08E-02
MW-12(1)	441.3-431.5	42			1.03E-05	5.23E-06	1.97E-05	1.00E-05	1.50E-05	7.62E-06
MW-14	393-383	51	1.32E-07	39.5'	2.48E-06	1.26E-06	6.49E-06	3.30E-06	4.49E-06	2.28E-06
AVERAGE VALUE - MONITORING WELLS MW-11, MW-12 & MW-14					3.64E-03	1.85E-03	1.05E-02	5.34E-03	7.07E-03	3.59E-03
AVERAGE VALUE - MONITORING WELLS MW-12 & MW-14					6.39E-06	3.25E-06	1.31E-05	6.65E-06	9.74E-06	4.95E-06

NOTE: (1) WEATHERED SHALE WITH PARTING LAMINATIONS AT TOP OF SHALE