DOE/CS/30310--T5

M&R
FILE 8-1
CONTRACT #
DE FC03 79CS30310

ENVIRONMENTAL ASSESSMENT

DOE/CS/30310--T5

DE82 009373

DESIGN, CONSTRUCTION, OPERATION, AND EVALUATION OF SOLAR SYSTEMS FOR INDUSTRIAL PROCESS-HEAT APPLICATIONS IN THE INTERMEDIATE-TEMPERATURE RANGE (212°F-550°F)

COLUMBIA GAS SYSTEM SERVICE CORPORATION

1600 Dublin Road, Columbus, Ohio 43215

PROPOSED SITE

USS CHEMICALS

DIVISION OF UNITED STATES STEEL CORPORATION

HAVERHILL, SCIOTO COUNTY, OHIO

Name of Project Manager Edward A. Reid, Jr.

Position and Title Manager of Utilization Research

Telephone Number (614) 486-3681

Department Affiliation Research Department

DOE/CS/30310--T2

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Introduction

The Columbia Gas System Service Corporation and the USS Chemicals Division of United States Steel Corporation propose to install a 50,000 square foot field of single axis tracking, concentrating solar collectors to produce process steam for use in the production of polystyrene at the Haverhill chemical complex of USS Chemicals in southern Ohio. The solar energy absorbed by the collector system would be used to heat an aliphatic hydrocarbon synthetic heat transfer fluid to a maximum temperature of 500°F. This high temperature heat transfer fluid would be used to generate steam at 160 psig and 375°F in an unfired steam generator located immediately adjacent to the proposed solar collector field. The steam produced by the unfired steam generator would be introduced into the polystyrene plant steam header for delivery to the polystyrene process area.

Description of Existing Environment

The USS Chemicals Haverhill complex is located in a rural/industrial area along the Ohio River in southern Ohio. The Haverhill chemical complex occupies approximately 100 acres of an approximate 600 acre site bordered on the southwest by the Ohio River. The majority of the unused 500 acres at the plant site is contract-farmed at the present time.

The air quality in the Haverhill area is currently considered acceptable by the Ohio Environmental Protection Agency. Ohio EPA discontinued plant site air pollution monitoring in 1974 because there was no demonstrated need for continued monitoring. Ohio EPA currently records both particulate and SO_x measurements at four sites near Haverhill.

PARTICULATE MEASUREMENTS
IN HAVERHILL AREA

Location	Distance from Haverhill	Direction from Haverhill	Particulate Measurement (ugram/m^3) 1974	1976	1978
Sciotoville	12 miles	N - NW	69.0	65.1	62.7
South Webster	17 miles	N - NE	72.5	82.2	79.1
Hanging Rock	7 miles	E	75.6	87.8	71.2
Ironton	8 miles	S - SE	78.0	87.5	70.3

The Haverhill chemical complex is currently in compliance with all existing EPA regulations with the exception of two coal-fired boilers associated with the oxo-alcohol plant. These boilers are the subject of a Consent Decree dated January 21, 1980, between the Attorney General of the State of Ohio and United States Steel Corporation. This Consent Judgment is contained in Appendix A to this document.

Potential Environmental Impacts

Air

The proposed solar energy installation will have no adverse impact on air quality at the plant site or in the surrounding region. Operation of the solar energy system is anticipated to displace consumption of approximately 10 billion BTU/year of conventional energy currently supplied by either natural gas or #2 fuel oil. This displacement of fossil fuels will result in a net reduction of carbon monoxide, carbon dioxide, nitrogen oxides and sulphur oxides at the site. The heat transfer fluid in the solar collector loop will be Gulf Synfluid 4CS, a polyalphaolefin mixture of the aliphatic hydrocarbon family. Appendix B contains property data on Gulf Synfluid 4CS provided by the manufacturer.

The only potential for air pollution from the solar energy system is accidental release of the synthetic heat transfer fluid to the environment. Appendix C contains Drawing M-3 "Solar System Piping Schematic" and Drawing M-7 "Piping and Instrumentation Diagram" from the 80% design review drawing set for the Haverhill project. The solar collector loop designed for the Haverhill project consists of welded steel pipe, steel flexible hoses, steel valves and bolted flange connections. Under normal system operating conditions there is no opportunity for contact between ambient air and the synthetic heat transfer fluid.

There are two conditions in which the heat transfer fluid or its vapor could be released to the atmosphere:

1. Leakage in system piping, flexible hoses, valves or flanged fittings.
2. Relief of excessive solar system pressure due to failure of system temperature and pressure controls.

The solar system includes an 1125 gallon expansion tank. This expansion tank is provided with a nitrogen gas blanket maintained at a minimum pressure of 20 psig under low temperature conditions. The nitrogen blanket prevents vaporization of the heat transfer fluid and discharge of the vapor into the ambient air. The expansion tank is connected to an in-line gas separator to prevent gas entrainment in the heat transfer fluid and resulting foaming. Gases separated from the heat transfer fluid are added to the inert gas blanket in the expansion tank.

The solar system is equipped with a manual heat transfer fluid makeup system to avoid automatic makeup of fluid losses in the event of system leakage. At ambient temperature the solar collector loop could lose approximately 100 gallons of heat transfer fluid before the system shutdown due to unavailability of heat transfer fluid at the pump suction. No air pollution would result from such a discharge since the vapor pressure of the heat transfer fluid approaches zero at a temperature of 375°F.

At maximum system operating temperature, approximately 400 gallons of heat transfer fluid could leak from the system before system shutdown due to unavailability of heat transfer fluid at the pump suction. Under this failure condition, a limited quantity of heat transfer fluid vapor would be released to the atmosphere until the heat transfer fluid bulk temperature cooled to 375°F. The vaporized heat transfer fluid would rapidly recondense as its temperature cooled to 375°F.

In the event of failure of the pressure control in the solar collector loop and buildup of excessive pressure in the loop, a 200 psig pressure relief valve would relieve system pressure into a 275 gallon fluid relief tank which is vented to the atmosphere. There would be some discharge of solar collector fluid vapor from the relief tank vent until the bulk temperature of the fluid in the relief tank dropped to 375°F. Vented heat transfer fluid vapor would rapidly recondense when its temperature dropped to 375°F.

It is apparent from the above discussion that any air pollution resulting from the operation of the proposed solar energy system would be the result of an accidental discharge of fluid due to failure of the system piping or controls, would be of minimal quantity and short duration, and would be highly localized.

Appendix D contains the Department of Labor Occupational Safety and Health Administration material safety data sheet for Gulf Synfluid 4CS. This data sheet lists the threshold limit value for exposure to the mist from the heat transfer fluid at 5 milligrams per cubic meter. This threshold limit value could reasonably be expected to be exceeded only in the immediate vicinity of a high pressure leak. The threshold limit value would not be expected to be exceeded beyond the secured perimeter of the solar collector field because of the rapid recondensation of the heat transfer fluid vapor at temperatures below 375°F.

The design and operation of the proposed solar energy facility were reviewed with Mr. Robert Hodanbosi, Chief, Division of Air Quality Modeling and Planning, Office of Air Pollution Control, Ohio Environmental Protection Agency, 361 East Broad St., Columbus, Ohio 43215. Mr. Hodanbosi indicated that no discharge permit would be required for the facility since there is no planned intermittent or continuous discharge of air pollutants from the facility.

Water

The synthetic heat transfer fluid in the solar collector loop is the only potential water contaminant in the planned solar system. The heat transfer fluid could be discharged to the environment only in the event of a leak in the system piping. The discharge from such a leak would

Gulf Synfluid 4CS which leaked from the solar collector system piping and was collected by absorption or skimming could be incinerated, under controlled conditions, in the existing incinerator at the Haverhill plant.

The design and operation of the proposed solar energy system was discussed with Mr. Dennis Romankowski, Environmental Scientist, Southeast District, Ohio Environmental Protection Agency, 2195 Front St., Logan, OH. 43138. Mr. Romankowski indicated that his office would conduct a plan review and site inspection on request when final design drawings for the proposed solar energy installation are complete. Mr. Romanowski would determine whether it was necessary to submit the plans to ODOE Headquarters in Columbus for formal plan review and approval. He indicated that it probably would not be necessary to obtain a discharge permit for the site since there would be no planned intermittent or continuous discharge from the facility.

Soil

The site for the proposed solar collector field is shown in Appendix F on the United States Department of Interior Geological Survey Map for the Greenup quadrangle In Kentucky and Ohio. The solar collector field appears as an open square with heavy black border, at a location approximately 82° 49' 40" west longitude, and 38° 35' 20" north latitude. The field contours are shown in Drawing A-1 in Appendix E. The northwest third of the planned solar collector field is currently contract-farmed (1979 crop - corn). The remainder of the field currently lies fallow. The southwest corner of the unused area is a surplus earth accumulation area, as shown on the drawing.

There are approximately 20 second growth trees within, and immediately adjacent to, the proposed solar collector field location which must be moved to prevent shading of the solar collector field.

Appendix G contains a subsurface soil investigation performed for Columbia by Dunbar Geotechnical Engineers of Columbus, Ohio. While this study was done primarily to determine the structural stability of the soil, it provides detailed information on the composition and thickness of the various soil layers present on the site.

The site plans call for regrading of the collector field area to assure drainage to the new tile at the southwest edge of the field. The soil beneath the collectors will be covered with graded slag to control dusting and assure a stable, well-drained surface for access to the solar collector field.

The proposed solar energy system was discussed with Mr. Robert Drown, District Conservationist, Soil Conservation Service, United States Department of Agriculture, Room 402-Court House, Portsmouth, Ohio. Mr. Drown has requested a written description of the system and a map showing the proposed location of the solar collector field. He has also requested a plant tour. Columbia and USS Chemicals have arranged to comply with his request.

Flood

The U. S. Department of Interior map in Appendix F shows the gross elevation of the solar collector field area. Drawing A-1 in Appendix E shows detailed elevations for the solar collector field. The elevation of the 100 year flood line for the Ohio River at Haverhill, Ohio, which lies between the Ohio River and the USS Chemicals - Haverhill complex is 542.5'. The minimum elevation in the solar collector field is 549'. Therefore, the solar collector field is 6.5' above the 100 year flood line.

Endangered Species

The proposed solar energy installation is within the range of two species identified by the Federal Government under the Endangered Species Act of 1973.

1. Indiana bat
2. Pink mucket pearly mussel

This information was obtained in a conversation with Mr. Thomas Sheldrake, Fish & Wildlife Biologist, Region III, Office of Endangered Species, U.S. Fish & Wildlife Service, United States Department of Interior, Federal Building-Fort Snelling, Twin Cities, MN. 55111.

The Indiana bat ranges throughout the state of Ohio. Its habitat consists of two major elements; caves and the bark of large virgin trees in large groupings. The proposed site for installation of the solar collector field contains no caves and no virgin timber. There are approximately twenty second growth trees on the site which must be removed during construction of the solar collector field. However, these trees are not large enough, nor are they in a large enough grouping, to attract the Indiana bat.

The pink mucket pearly mussel is found in the Ohio River bed in a large area, including the area around Scioto County, Ohio. The proposed installation involves no dredging or excavation of the Ohio River bed, and no intermediate or continuous discharge of effluent into the Ohio River which would affect the habitat of the pink mucket pearly mussel.

At the suggestion of Mr. Sheldrake of the U.S. Fish & Wildlife Service, I contacted Mr. Denis Chase, Endangered Species Coordinator, Division of Wildlife, Ohio Department of Natural Resources. Mr. Chase indicated that the Ohio Department of Natural Resources would require plan approval if the program participants decide to construct the proposed site. This would involve submission of details of the planned site construction and operation to Mr. Carl Mosely, Jr., Chief, Division of Wildlife, Ohio Department of Natural Resources. This plan review would identify potential impacts of the proposed construction on any endangered species on the State of Ohio list of endangered species (Appendix H) and any steps required to mitigate these affects.

Archaeological and Historical Resources

The flood plain of the Ohio River is classed as an archaeologically sensitive area. The proposed solar energy installation was reviewed with Mr. Bert Drennan, Archaeologist, Department Head Review and Compliance, Ohio Historic Preservation Office, Columbus, OH. 43211. Mr. Drennan indicated that there is only sketchy archaelogical data available for the area immediately surrounding the proposed site. This information was developed by the U.S. Forest Service in a survey a number of years ago. To comply with the requirements of the Advisory Counsel on Historical Preservation (36 CFR 800) Columbia would be required to conduct a Phase I and Phase II Archaeological Evaluation at the proposed site.

There are a number of identified sites of archaeological significance several miles downstream from the proposed site. The detailed locations of the sites and the scope of the archaeological exploration which has occurred on them is available from Mr. Drennan's office.

If the program participants decide to proceed with construction of the proposed solar energy installation, a Phase I and Phase II Archaeological Evaluation of the site will be conducted using the guidelines set forth by the Ohio Archaeological Counsel in the Certification List contained in Appendix I, and will be performed by one of the certified archaeologists contained in the Certification List. The report from the archaeologists will conform to the specifications set forth by the Ohio Archaeological Counsel for reports of archaeological services performed in the State. A copy of these specifications are also included in Appendix I.

Glare

The proposed solar collector field will be located within a secured area on the USS Chemicals plant property to prevent unauthorized access to the solar collector field area. The solar collector system is designed to be under full automatic control; there will be no personnel assigned to maintenance or operation of the solar system on a full time basis. Day shift plant personnel assigned to periodic system maintenance will be trained to work safely in the solar collector field while it is active.

The solar collector field location would be south of the existing chemical plant complex. No glare from the solar collector field is expected for any workers at the chemical complex, which is located north of the collector field.

The proposed solar collector field would be located approximately one-half mile north of old US Route 52, which passes between Haverhill chemical complex and the Ohio River. The elevation of the solar collector field would be approximately 6-1/2' above the elevation of the highway.

With these vertical and lateral displacements, it is highly unlikely that glare from the solar collector field would affect drivers on the highway.

Virtually all of the solar radiation falling on the reflectors of the solar collectors will be reflected and concentrated on the absorber tube located at the focal point of the parabolic reflector surface. Losses past the ends of the absorber tubes caused by nonperpendicular approach of the solar radiation to the long axis of the collector would diffuse to ambient radiation levels within two focal lengths of the reflector surface.

Alternatives

The existing Haverhill chemical complex facilities occupy approximately 100 acres of the approximately 600 acre plant site. The location selected for the proposed solar collector field is the location closest to the polystyrene plant steam main where the solar energy will be used. The solar collector field location could conceivably be moved approximately two hundred feet to the southeast. This relocation would reduce the distance between the field and the polystyrene plant but would not shorten the distance between the solar collector field and the polystyrene steam main. This relocation would place the solar collector field directly in the primary path of expansion for the chemical complex. Any other location on the site would increase the distance between the field and the process loads and significantly increase warmup losses and piping losses when the system is operating.

Roof installation of the proposed solar collector field is impractical because there is not enough existing roof area at the plant in any one building to support the entire collector field, and because the existing roof structures are not strong enough to support the collectors. The unavailability of roof area at the plant site can be seen in the United States Department of Interior Geological Survey map in Appendix F.

Columbia has extensively investigated a variety of heat transfer fluids for use in the proposed solar installation. Gulf Synfluid 4CS was was chosen for this application because of its very high flame temperature and also ignition points and non-toxic characteristics. Other fluids which offer the ability to operate at the design temperatures anticipated for the proposed installation present significant safety hazards because of their lower flame temperature and auto ignition points, or because of specific toxicity problems. A list of the heat transfer fluids investigated in our study and their properties is included in Appendix J.

The proposed solar collector installation is designed to replace consumption of approximately 10,000 MCF/year of natural gas at the Haverhill chemical complex. The alternative to construction of this system is continued consumption of this quantity of natural gas, or of an equivalent quantity of energy from oil or coal. Failure to construct the solar facility will have no further negative impact on air quality or other aspects of the environment at the plant site. Replacement of the natural gas with an alternative fossil fuel would increase the air pollution impact of plant operation on the surrounding area.

APPENDIX A

CONSENT DECREE

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CLERK OF COURTS

IN THE COURT OF COMMON PLEAS
SCIOTO COUNTY, OHIO

STATE OF OHIO, ex rel.
WILLIAM J. BROWN
ATTORNEY GENERAL OF OHIO,) Case No. CIV-80-16

Plaintiff,

-vs-

UNITED STATES STEEL CORPORATION,

Defendant.

CONSENT JUDGMENT

The Complaint having been filed herein on

And the Plaintiff and Defendant by their respective attorneys having consented to the entry of this Consent Judgment;

NOW, THEREFORE, before the taking of any testimony, and upon the pleadings, it is Ordered, Adjudged, and Decreed as follows:

I.

This Court has jurisdiction of the subject matter herein and of the parties consenting hereto. The Complaint states a claim upon which relief can be granted against the Defendant.

II.

The provisions of this Consent Judgment shall apply to and be binding upon the parties to this action, their officers, directors, agents, servants, employees, and successors.

III.

The purpose of this Consent Judgment is to avoid the time and expense of litigation, and to settle all claims and controversy whatsoever existing between the parties with respect to the Defendant's alleged violations of Ohio Revised Code Sections 3704.05(A) and (G) and Ohio Administrative Code Sections 3745-17-07, 3745-17-10, and 3745-35-02(A), by the operation of U.S. Steel Chemical

Division, Haverhill Plant's two coal-fired boilers (herein referred to as the "boilers"). This Consent Judgment does not constitute any admission of culpability or of violation of any law or regulation by Defendant. Defendant's agreement to the conditions of this Consent Judgment and to the schedule set forth herein shall be in full satisfaction of Defendant's liability for any and all violations of State air pollution laws and regulations at its Haverhill Plant caused by the boilers occurring until the time this Consent Judgment is entered. The violations that are hereby satisfied include, but are not limited to: alleged violations of Revised Code Section 3704.05, and Ohio Administrative Code Sections 3745-17-07, 3745-17-10, and 3745-35-02(A).

IV.

The Defendant agrees and is hereby enjoined to install baghouse devices on its boilers, identified by applications nos. 0773000080 B001 and 0773000080 B002, in accordance with the compliance schedule set forth below. Such baghouses shall be designed to enable the boilers to achieve full compliance with O.A.C. Sections 3745-17-07 and 3745-17-10.

COMPLIANCE SCHEDULE

	Dates
Submit Final Control Plans	February 11, 1980
Award Contract(s)	April 18, 1980
Begin Construction	February 1, 1981
Complete Construction	July 7, 1981
Achieve and demonstrate compliance with the final emission limitations in this decree	August 7, 1981

If the Ohio Environmental Protection Agency requires an emission test for the purpose of determining compliance with the emission limitations in this Judgment, particulate emissions shall be determined according to the test method prescribed by applicable Ohio regulations on the date that Defendant conducts its compliance testing.

The Defendant further agrees and is enjoined to: (1) make such adjustments to or replacements of the over-fire air system as may be necessary, in conjunction with the installation of baghouses, to achieve compliance with O.A.C. 3745-17-07 and (2) install in-stack oxygen monitors for each boiler capable of being read and controlled from the control room. The adjustments to and/or replacements of the over-fire air system shall be completed no later than June 30, 1980, and the oxygen monitors shall be installed and operational no later than August 7, 1981.

V.

Pending installation and operation of the baghouses, pursuant to paragraph IV above, Defendant agrees and is hereby enjoined to use the best practicable systems of emission reduction. Such interim measures include:

(a) immediate initiation of an operation and maintenance procedure which will result in the minimization of particulate matter emission from the boilers on a day-to-day basis.

(b) the efficient operation of the existing multiclone collectors.

(c) the quarterly submission to plaintiff of an analysis of a representative sample of coal purchased during that quarter on an as received basis. This representative sample shall be obtained in accordance with the method ASTM D-2234-72 or an equivalent procedure which is acceptable to plaintiff. This analysis shall specify the average BTU content, the fusion temperature, the percent sulfur, the percent ash, the percent moisture, the total tonage received in the previous quarter from each supplier, and the amount of coal burned.

VI.

No later than thirty (30) days after the end of each quarter, commencing with the January 1 to March 31 quarter of 1980, Defendant shall submit a progress report to the Plaintiff describing the actual progress that the Defendant has made in achieving the milestones in the compliance schedule.

Defendant shall provide Plaintiff twenty (20) days' written notice prior to conducting the performance tests that may be required by or provided for under this Consent Judgment in order to afford Plaintiff an opportunity to approve the test procedure and to have observers present at such tests. A written report of the results of said performance tests shall be submitted to Plaintiff promptly, but no later than sixty (60) days after completion of such tests.

VII.

All reports, notices, control plans, and other information that must be submitted in satisfaction of the requirement of this Consent Judgment shall be submitted to:

Air Pollution Unit
Portsmouth City Health Department
740 Second Street
Portsmouth, Ohio 45662

VIII.

Defendant shall have the right to achieve compliance with any obligation in this Consent Judgment at any time by ceasing to operate any facility governed by said obligation.

IX.

Any condition contained in a future permit or variance issued to U.S. Steel Corporation by the Ohio Environmental Protection Agency that invalidates or otherwise limits any provision of this Consent Judgment shall overrride and supercede said provision of this Consent Judgment.

X.

Defendant's time for achievement of compliance as set forth in this Consent Judgment may be extended in the occurrence of, and to the extent of any delay caused by circumstances entirely beyond its control.

A. If any event occurs which causes or may cause delays in the achievement of compliance at Defendant's facilities provided in this Consent Judgment, Defendant shall notify the Court and Plaintiff in writing within twenty (20) days of the delay or anticipated delay, as appropriate, describing in detail the anticipated length of the delay, the precise cause or causes of the delay, the measures taken and to be taken to minimize any such delays, and a time-table by which those measures will be implemented. The Defendant shall adopt all reasonable measures to avoid or minimize any such delay.

B. If the parties agree that the delay or anticipated delay in compliance with this Consent Judgment has been or will be caused by circumstances entirely beyond the control of Defendant, the time for performance hereunder may be extended for a period no longer than the delay resulting from such circumstances. In such event, the parties shall stipulate to such extension of time and jointly petition the Court for a modification of this Consent Judgment accordingly. In the event the parties cannot agree, any party may submit the matter to this Court for resolution.

C. The burden of proving that any delay is caused by circumstances beyond the control of Defendant shall rest with Defendant. Increased costs or expenses associated with the implementation of actions called for by this Judgment shall not, in any event, be a basis for changes in this Judgment or extensions of time under paragraph B above. Delay in achievement of one interim step shall not necessarily justify or excuse delay in achievement of subsequent steps.

XI.

The Court retains jurisdiction of this suit for the purpose of making any order or decree which it may deem at any time to be necessary to carry out this Consent Judgment; provided, that this Judgment shall terminate six (6) months following the initial demonstration that compliance with the final emission limitations in this Judgment has been achieved.

XII.

This Judgment is in full settlement and satisfaction of any and all claims or demands that Plaintiff has against Defendant for the operation of the boilers arising out of the Clean Air Act, 42 U.S.C. §§7401 et seq.; Ohio's Air Pollution Control Laws, Ohio Revised Code §§3704.01 et seq., and regulations, including without limitation all claims or demands arising from actions or events prior to the entry of this Judgment.

XIII.

Within ten (10) days after entry of this Judgment, the Defendant shall file a withdrawal of its request for an adjudication hearing before the Ohio Environmental Protection Agency in Case No. 77-AP-129.

XIV.

This Consent Judgment is made in Ohio and shall be governed by Ohio law.

XV.

Defendant shall pay the Court costs.

John B. Marshall
JUDGE, COURT OF COMMON PLEAS

APPROVED:

WILLIAM J. BROWN
ATTORNEY GENERAL OF OHIO

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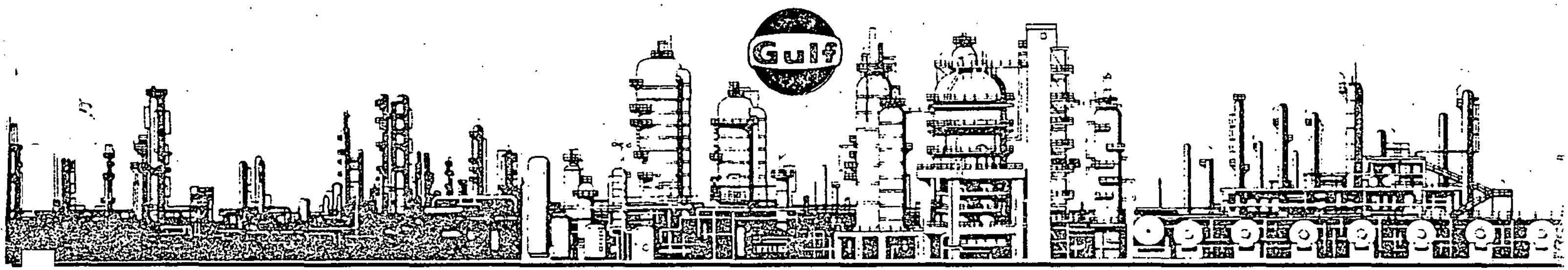
APPENDIX B

PROPERTY DATA OF GULF SYNFLUID 4CS



GULF PETROCHEMICALS GULF OIL CHEMICALS COMPANY / P. O. BOX 3766 / HOUSTON, TEXAS 77001

SYNFLUID® SYNTHETIC FLUIDS

(UNINHIBITED BASE FLUIDS)

TYPICAL PHYSICAL PROPERTIES

PROPERTY	ASTM * TEST METHOD	SYNFLUID VISCOSITY GRADE 2cSt	4cSt	6cSt
Viscosity, cSt	D445			
-65°F (-53.89°C)		1200	13,722	52,702
-40°F (-40 °C)		262	2,537	7,945
0°F (-17.78°C)		49.84	338	833
100°F (37.78°C)		5.38	18.27	33.33
210°F (98.89°C)		1.72	3.94	5.96
400°F (204.44°C)		0.64	1.11	1.45
Viscosity, SSU				
100°F (38°C)		43.6	90.6	156.6
210°F (98°C)		31.0	39.3	45.8
Viscosity Index	D2270	-	123	136
Viscosity Stability, 72 hr. at -40°F/40°C: % Change		+0.04	+0.61	+0.16
Viscosity, Injector Shear Stability:	DIN 51 382			
100°F, % Change After 10 min.		-	+1.53	+1.06
210°F, % Change After 10 min.		-	+0.76	+0.51
Cold Cranking Simulator, Centipoise	D2602			
0°F		-	a	740
-20°F		-	a	a
Pour Point, °F (°C)	D97	-100 (-73)	-100 (-73)	-90 (-68
Cloud Point, °F (°C)	D2500	-38 (-39)	<-100 (<-73)	<-90 (<-61

a) Result too low to be within range of test method. Range of viscosities covered by method: 2030-26500 cPs for -20°F, 553-4800 cPs for 0°F.

* ASTM Test Methods used unless otherwise indicated.

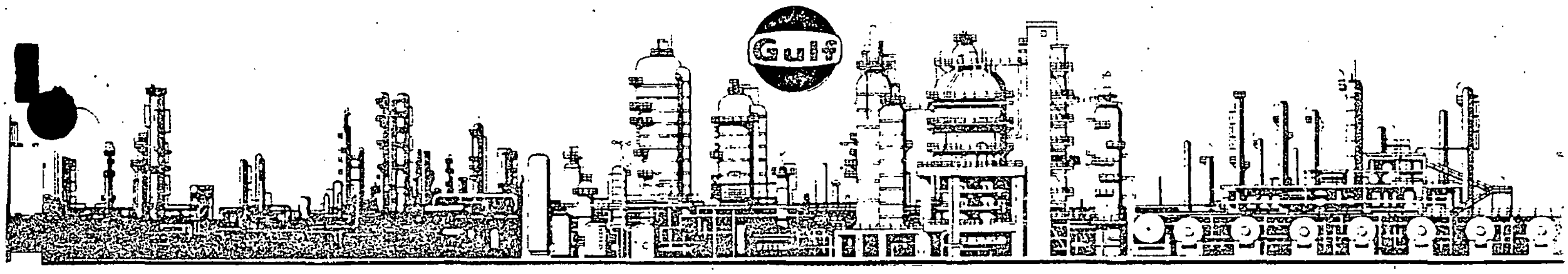
TYPICAL PROPERTIES

PROPERTY	ASTM TEST METHOD	SYNFLUID VISCOSITY GRADE		
		2cSt	4cSt	6cSt
Odor	GULF 519	MARKETABLE	MARKETABLE	MARKETABLE
		(ESSENTIALLY ODOR FREE)		
Appearance	GULF 498	Bright	Bright	Bright
Specific Gravity, 68°/68°F	GRM 112	0.7966	0.8151	0.8629
Specific Gravity, 60°/60°F	D1298	0.7963	0.8189	0.8265
Gravity, API	D287	46.1	41.2	39.4
Flash Point, °F	D92	320	445	465
Fire Point, °F	D92	360	495	520
Smoke Point, mm	D1322	+50	+35	+50
Autoignition Temperature, °F	D2155	615	710	710
Evaporation Loss, Wt.% (N_2 Atmosphere)	D972			
22 hrs. at 300°F, 760 mm Hg		5.1	1.0	0.3
6.5 hrs. at 400°F, 760 mm Hg		-	12.0	4.0
Carbon Residue, Conradsen, Wt.%	D524	<0.001	<0.001	<0.001
Ash, Wt. %	GULF 599	<0.001	<0.001	<0.001
Thermal Decomposition Temperature, °F	D2879	$>611^b$	$>611^b$	$>611^b$
Coefficient of Thermal Expansion @ 55°F			4.5×10^{-4}	4.2×10^{-4}
Thermal Conductivity @ 300°F: BTU/hr. $(ft.)^2$(°F/ft.)	D2717		0.073_7	0.074_5
Specific Heat	D2766			
0°F			$0.51_0{}^c$	$0.55_2{}^c$
50°F			$0.52_9{}^c$	$0.55_6{}^c$
75°F			$0.53_9{}^c$	$0.55_7{}^c$
100°F			0.54_9	0.55_9

b) No decomposition observed up to this temperature. Test terminated at 611°F.

c) Indicates value determined by extrapolation

		SYNFLUID VISCOSITY GRADE		
PROPERTY	ASTM TEST METHOD	2cSt	4cSt	6cSt
Specific Heat (continued)				
150°F			0.56_9	0.56_3
200°F			0.58_8	0.56_6
250°F			0.60_8	0.57_0
300°F			0.62_8	0.57_4
Total Acid Number, mg KOH/g	D974	<0.03	<0.03	<0.03
Water, ppm	GULF 525	37	46	17
Bromine Index	UOP 358-64	1116	150	308
Peroxide Number	GRM 1164	0.3	0.1	0.1



GULF PETROCHEMICALS GULF OIL CHEMICALS COMPANY / P. O. BOX 3766 / HOUSTON, TEXAS 77001

SYNFLUID® SYNTHETIC FLUIDS
(UNINHIBITED BASE FLUIDS)
MISCELLANEOUS PROPERTIES

	SYNFLUID VISCOSITY GRADE	
	4cSt	6cSt
*CORROSIVENESS AND OXIDATION STABILITY		
168 hr. @ 300°F		
Viscosity Increase at 100°F, %	6.35	6.72
Total Acid Number Increase, mg KOH/g	0.35	0.42
Total Sludge Formed, mg/100 ml	1.2	5.0
Copper Rod Weight Loss, mg/cm^2	0.22	0.09
Copper Rod Appearance	Lt. Stain	Lt. Stain
Steel Rod Weight Loss, mg/cm^2	0.05	-0.66
Steel Rod Lacquer Deposit	0	0
Steel Rod Appearance	Lt. Stain	Lt. Stain
*Cin. Milacron Stability Test, (300°F vs 275°F standard).		
HYDROLYTIC STABILITY, 96 hrs. @ 200°F FTM 791 b Meth. 3457.1		
CORROSION:		
1. Change in weight of copper specimen, mg/cm^2	-0.04	-0.03
2. Appearance of copper	Dark Tarnish 3B	Slight Tarnish 1B
RESISTANCE TO HYDROLYSIS:		
1. Viscosity @ 100°F, cs		
a. Before test	18.14	34.06
b. After test	18.12	34.02
c. Change, %	-0.1	-0.1
2. Neutralization No., mg KOH/gram		
a. Water layer as total acidity	1.79	0.62
b. Organic layer		
Before test	0.005	0.004
After test	0.018	0.019
Change	+0.013	+0.015
3. Saponification No. of Oil Layer		
a. Before Test	0.40	0.33
b. After Test	0.36	1.70
c. Change	-0.04	+1.37

		SYNFLUID VISCOSITY GRADE	
RESISTANCE TO HYDROLYSIS:		4cSt	6cSt
4. Color			
a. Before Test		L 0.5	L 0.5
b. After Test		L 0.5	L 0.5
5. Insoluble Matter in Oil Layer			
a. After Test		-	-
HUMIDITY CABINET, 24 hr. @ 120°F	ASTM D1748		
98% Relative Humidity		Fail	Fail
WATER EMULSION	MIL-C-4339		
Froth, 15 min., ml (H_2O Emulsion)		0	0
Separated Oil, 24 hr., Vol. % (H_2O Emulsion)		0	0
Separated Oil, 72 hr., Vol. % (H_2O Emulsion)		0	0
FOAM TEST,	D892		
Foam Tendency, 5 Min. Blowing		5	10
Sequence, 1		5	10
Sequence, 2		5	10
Foam Stability, 10 Min. Settling			
Sequence, 1		0	0
Sequence, 2		0	0
Sequence, 3		0	0
SEDIMENTATION, Vol. %	D2273	0.001	0.001
EFFECTS ON RUBBER SEALS @ 200°F	FTM 791 b METH. 3604 (Mod)		
Butyl Rubber, % swell		225.49	180.43
Neoprene, % shrinkage		-13.32	-11.09
Silicone Rubber, % Swell		17.03	10.59
Buna N, % shrinkage		-3.05	-3.41

APPENDIX C

DRAWING M-3 "SOLAR SYTEM PIPING SCHEMATIC"

DRAWING M-7 "PIPING & INSTRUMENTATION DIAGRAM"

SOLAR SYSTEM PIPING SCHEMATIC

SOLAR SYSTEM PIPING SCHEMATIC

RICHARD W. PAYNE 30219

DESIGNED BY J. R. LOCKARD, P.E.
DRAWN BY E.A.W./K.C.B.
CHECKED BY R.W.P. & L.L.R.

HAVERHILL PLANT SOLAR ENERGY PROJECT
FOR
THE COLUMBIA GAS SERVICE CORP. COLUMBUS, OHIO
AND
USS CHEMICALS HAVERHILL, OHIO

JOB NO 79199
DATE APR. 14, 1980
SET OF 14

REVISIONS

H. A. Williams and Associates, Inc.
CONSULTING ENGINEERS
980 WEST HENDERSON ROAD COLUMBUS, OHIO 43220

M-3

LEGEND

NOTE: See Sheet M-2 For Additional Symbols and Abbreviations

PIPE NUMBERING SCHEME

EXAMPLE 2" C - 13001 - B - II
Line Size
Piping Designation
(i.e., Condensate)
Area & Line Number
(i.e., Area 1300, Condensate Line #1)
Piping Specification
Insulation Class

PIPING DESIGNATION

BD	BLOW DOWN
BFW	BOILER FEED WATER
C	CONDENSATE
N	NITROGEN
P	PROCESS
PW	POTABLE WATER
SH	150# STEAM
V	VENT

INSULATION CLASS

I	COLD INSULATION
II	HOT INSULATION
III	PERSONNEL PROTECTION

SYMBOLS

FS	FLOW SWITCH
FT	FLOW TRANSMITTER
LAH	LEVEL ALARM HIGH
LAL	LEVEL ALARM LOW
LC	LEVEL CONTROLLER
LG	LEVEL GAGE
LS	LEVEL SWITCH
PC	PRESSURE CONTROLLER
PI	PRESSURE INDICATOR
PSV	PRESSURE RELIEF OR SAFETY VALVE
TI	TEMPERATURE INDICATOR
TW	TEMPERATURE TEST CONNECTION WITH WELL
TAH	TEMPERATURE ALARM HIGH
FAL	FLOW ALARM LOW

SYMBOLS

○	LOCAL MOUNTED DEVICE
⊖	LOCAL PANEL MOUNTED DEVICE
◎	DATA AQUISITION DEVICE
-//-//-	PNEUMATIC SIGNAL LINE
------	ELECTRICAL SIGNAL LINE
	PNEUMATIC CONTROL VALVE
	ELECTRIC CONTROL VALVE

PIPING AND INSTRUMENTATION DIAGRAM

STATE OF OHIO
RICHARD W. PAYNE
30219
REGISTERED PROFESSIONAL ENGINEER

DESIGNED BY E.A. WHITNEY
DRAWN BY E.A.W.
CHECKED BY J.L.R.

REVISIONS

PIPING & INSTRUMENTATION DIAGRAM

HAVERHILL PLANT SOLAR ENERGY PROJECT
FOR
THE COLUMBIA GAS SERVICE CORP. COLUMBUS, OHIO
AND
USS CHEMICALS HAVERHILL, OHIO

JOB NO. 79199
DATE APRIL 14, 1980
SET OF 14

H. A. Williams and Associates, Inc.
CONSULTING ENGINEERS
980 WEST HENDERSON ROAD COLUMBUS, OHIO 43220

M-7

APPENDIX D

DEPARTMENT OF LABOR OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
MATERIAL SAFETY DATA FOR GULF SYNFLUID 4 CS

Occupational Safety and Health Administration

MATERIAL SAFETY DATA SHEET

Synfluid 4 cs, Gulf

IHHICDRP

SECTION I

MANUFACTURER'S NAME Gulf Oil Company - U.S.	EMERGENCY TELEPHONE NO. 713-226-1011
ADDRESS (NUMBER, STREET, CITY, STATE & ZIP CODE) P. O. Box 1519, Houston, TX 77001	
CHEMICAL NAME & SYNONYMS Synthetic Hydrocarbon Base Fluid	TRADE NAMES & SYNONYMS Gulf Synfluid 4 cs
CHEMICAL FAMILY Aliphatic Hydrocarbon	FORMULA Polyalphaolefin Mixture

According to U.S. Department of Labor (DOL) Criteria, this is a non-hazardous material.

SECTION II — HAZARDOUS INGREDIENTS

MATERIALS	%	TLV (Units)	MATERIALS	%	TLV (Units

SECTION III — PHYSICAL DATA

BOILING POINT °C (°F) Overpoint	>149°C (300°F)	SPECIFIC GRAVITY (H_2O=1) 15.6° / 15.6°C	0.8184
VAPOR PRESSURE (mm Hg.)	Negligible	PERCENT, VOLATILE BY VOLUME (%)	0
VAPOR DENSITY (Air=1)	NA	EVAPORATION RATE (Ether=1)	0
SOLUBILITY IN WATER	Negligible		
APPEARANCE AND ODOR	Colorless, odorless fluid		

SECTION IV — FIRE AND EXPLOSION HAZARD DATA

FLASH POINT 225°C (435°F) COC	FLAMMABLE LIMITS ND	LEL	UEL

EXTINGUISHING MEDIA

☐ ALCOHOL FOAM ☒ CARBON DIOXIDE ☒ DRY CHEMICAL ☒ FOAM ☒ WATER SPRAY (FOG)

☐ OTHER

SPECIAL FIRE FIGHTING PROCEDURES

Use foam and water spray carefully to prevent excessive frothing.

FIRE AND EXPLOSION HAZARDS

Slight when exposed to heat or flame can react with oxidizing materials. Combustible.

NA = Not Applicable
ND = No Data Available

Observe current ACGIH TLV of 5 mg/m^3 for oil mist.

FFECTS OF OVEREXPOSURE
Prolonged and repeated overexposure may irritate the skin of some individuals.

IERGENCY AND FIRST AID PROCEDURES Skin Contact- Remove by wiping and wash with soap and .ter. Eye Contact- Wash with copious amounts water. Inhalation- Remove from exposure fumes, mists. Ingestion- DO NOT INDUCE VOMITING. Seek medical aid.

SECTION VI — REACTIVITY DATA

ABILITY:	UNSTABLE		STABLE	X	CONDITIONS TO AVOID NA

COMPATABILITY (Materials to avoid) NA

AZARDOUS DECOMPOSITION PRODUCTS NA

AZARDOUS LYMERIZATION:	MAY OCCUR		WILL NOT OCCUR	X	CONDITIONS TO AVOID NA

SECTION VII — SPILL OR LEAK PROCEDURES

☒ STOP FLOW
☐ ELIMINATE ALL SOURCES OF IGNITION, FLAMMABLES
☐ AVOID INHALATION
☐ AVOID DERMAL CONTACT
☐ RESPIRATORY PROTECTION (AS PER SECTION VIII)
☐ SKIN PROTECTION (AS PER SECTION VIII)
☒ ABSORB OR SCRAPE UP
☐ VACUUM UP
☐ EVAPORATE SMALL AMOUNTS IN HOOD
☐ OTHER
☒ INCINERATE UNDER CONTROLLED CONDITIONS
☐ INCINERATE USING AFTER BURNER & SCRUBBER
☐ BURY IN REMOTE AREA
☐ USE AS LANDFILL
☐ NEUTRALIZE
☐ WASH AWAY WITH WATER
☒ OBSERVE FEDERAL SPILL & WATER QUALITY REGULATIONS
☒ REMOVE SOILED CLOTHING

SECTION VIII — SPECIAL PROTECTION INFORMATION

	DURING NORMAL USE	FOR GASES, VAPORS, DUSTS, FUMES, MISTS EXCEEDING TLV	SPECIAL (E.G. THERMAL PROCESSING, SPRAY APPLICATIONS)
GENERAL VENTILATION	Usually none	Yes	Yes
CAL EXHAUST	Usually none	Yes	Yes
SPIRATORY PROTECTION (1-4)	1	2	2

1. USUALLY NONE
ARTICLE–REMOVING AIR PURIFYING RESPIRATOR (MECHANICAL FILTER)
3. GAS AND VAPOR–REMOVING AIR PURIFYING RESPIRATOR (CANISTER)
4. FULL FACE MASK POSITIVE PRESSURE–DEMAND TYPE SUPPLIED AIR

YE PROTECTION	SAFETY GLASSES	X	CHEMICAL GOGGLES		FACE SHIELD	
..JTECTIVE GLOVES	NEOPRENE	G	POLYVINYL ALCOHOL	E	POLYETHYLENE	E
	NATURAL RUBBER	P	BUTYL RUBBER	E	POLYVINYL CHLORIDE	F

TING: (E) EXCELLENT (G) GOOD (F) FAIR (P) POOR (NR) NOT RECOMMENDED)

OTHER PROTECTIVE EQUIPMENT Protective garment when applicable.

SECTION IX — SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
voíd frequent or prolonged skin contact or inhalation of fumes, mists, vapors.

O ER PRECAUTIONS
NA

NOTICE

a and recommendations presented herein are based upon our research research of others, and are believed to [illegible] their accuracy is made; however, and the [illegible] ithout warranty, express or implied, and the person receiving them shall make wn deter [illegible]

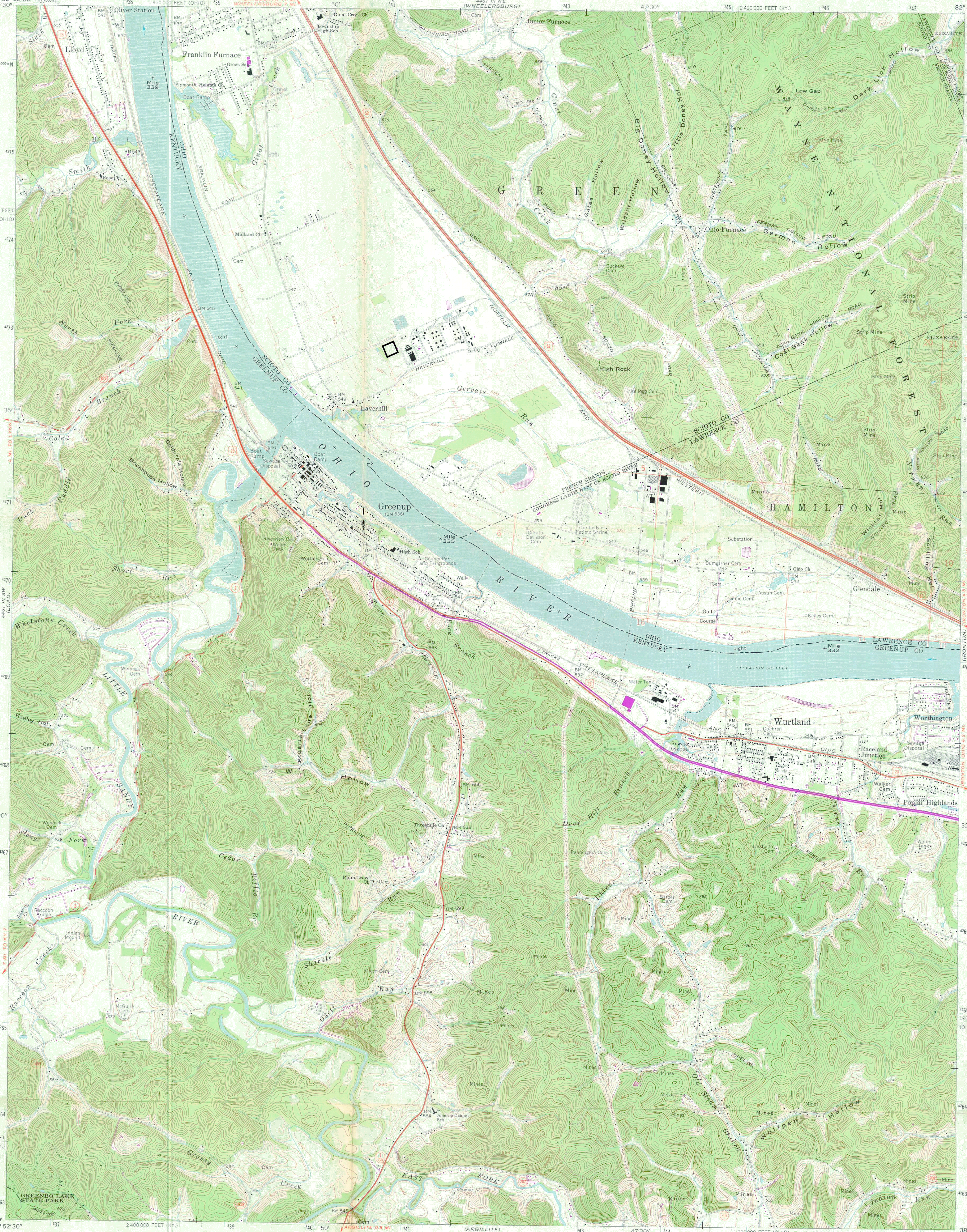
APPENDIX E

DRAWING A-1 - EXISTING GRADE AND SITE DRAINAGE PLAN

9

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GREENUP QUADRANGLE
KENTUCKY—OHIO
7.5 MINUTE SERIES (TOPOGRAPHIC)
SE/4 GREENUP 15′ QUADRANGLE



Mapped, edited, and published by the Geological Survey
in cooperation with Kentucky Geological Survey
and State of Ohio agencies

Control by USGS, USC&GS, USCE, and Tennessee Valley Authority

Topography in Kentucky by photogrammetric methods from aerial photographs taken 1952. Field checked 1953
Topography in Ohio by photogrammetric methods from aerial photographs taken 1960. Field checked 1961
Revised from aerial photographs taken 1971. Field checked 1972

Polyconic projection. 1927 North American datum
10,000-foot grids based on Kentucky coordinate system, north zone and Ohio coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, zone 17, shown in blue

Fine red dashed lines indicate selected fence and field lines where generally visible on aerial photographs. This information is unchecked

The state boundary as shown represents the approximate position of the low waterline as determined from U. S. Corps of Engineers Ohio River charts, surveyed 1914, and supplementary information

Land lines based on the Ohio River Base

UTM GRID AND 1975 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, RESTON, VIRGINIA 22092
KENTUCKY GEOLOGICAL SURVEY, LEXINGTON, KENTUCKY 40506,
AND KENTUCKY DEPARTMENT OF COMMERCE, FRANKFORT, KENTUCKY 40601
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1976

ROAD CLASSIFICATION

Primary highway, hard surface	▬	Light-duty road, hard or improved surface	═
Secondary highway, hard surface	‒ ‒ ‒	Unimproved road	‒ ‒ ‒ ‒

Interstate Route   U. S. Route   State Route

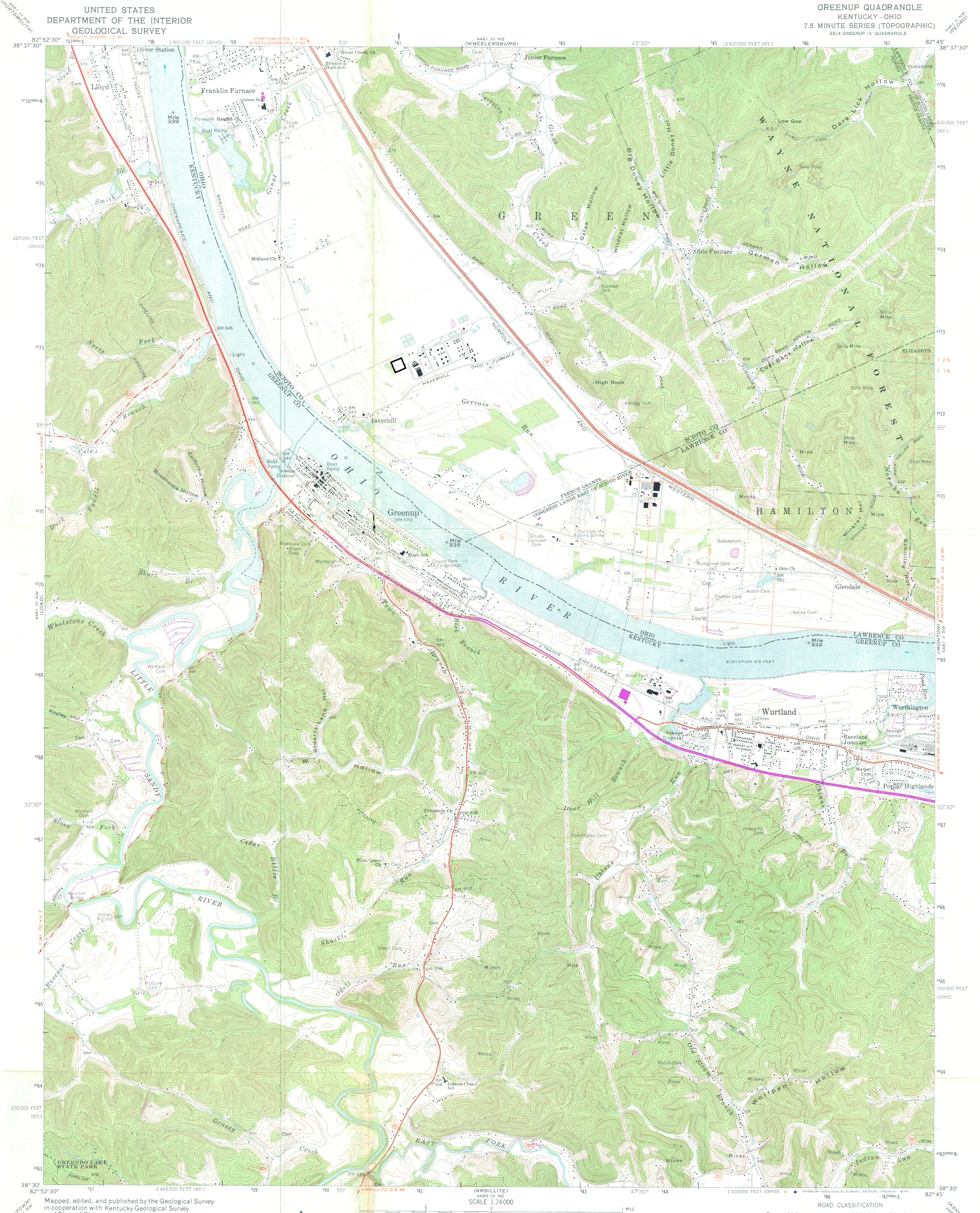
Revisions shown in purple compiled in cooperation with State of Ohio agencies from aerial photographs taken 1975. This information not field checked

GREENUP, KY.—OHIO
SE/4 GREENUP 15′ QUADRANGLE
N3830—W8245/7.5

1972
PHOTOREVISED 1975
AMS 4461 III SE—SERIES V853

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GREENUP QUADRANGLE
KENTUCKY—OHIO
7.5 MINUTE SERIES (TOPOGRAPHIC)
SE/4 GREENUP 15' QUADRANGLE



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Land lines based on the Ohio River Base

MN
GN
3°
53 MILS
1° 08'
20 MILS

UTM GRID AND 1975 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

1 ½ 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
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A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

KENTUCKY
QUADRANGLE LOCATION

Revisions shown in purple compiled in cooperation with State of Ohio agencies from aerial photographs taken 1975. This information not field checked

ROAD CLASSIFICATION

Primary highway, hard surface	Light-duty road, hard or improved surface
Secondary highway, hard surface	Unimproved road

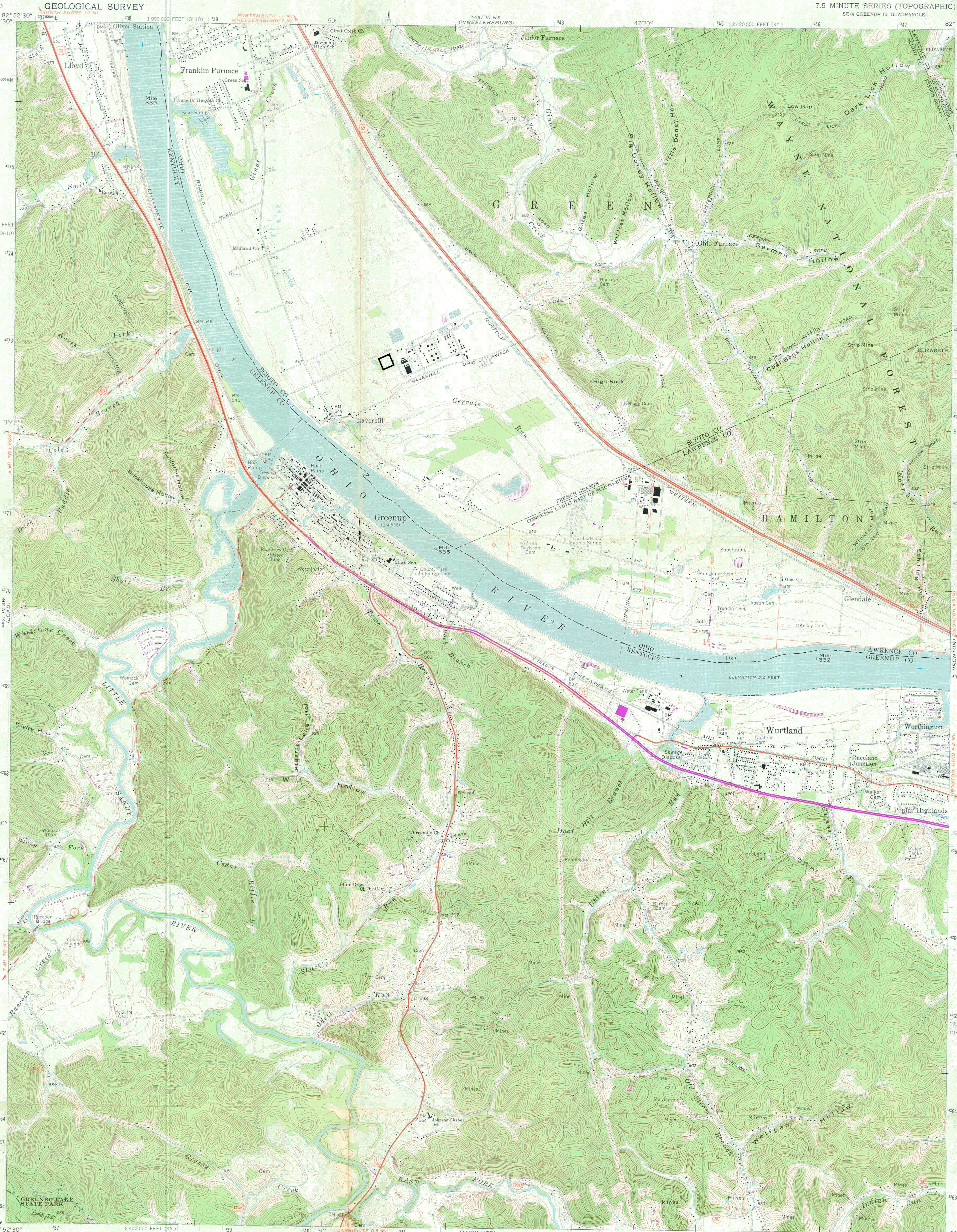
Interstate Route   U. S. Route   State Route

GREENUP, KY.—OHIO
SE/4 GREENUP 15' QUADRANGLE
N3830—W8245/7.5

1972
PHOTOREVISED 1975
AMS 4461 III SE—SERIES V853

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GREENUP QUADRANGLE
KENTUCKY—OHIO
7.5 MINUTE SERIES (TOPOGRAPHIC)
SE/4 GREENUP 15' QUADRANGLE



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Land lines based on the Ohio River Base

MN
GN
3°
53 MILS
1° 08′
20 MILS

UTM GRID AND 1975 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS

FOR SALE BY U. S. GEOLOGICAL SURVEY, RESTON, VIRGINIA 22092
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INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1976

ROAD CLASSIFICATION

Primary highway, hard surface	━	Light-duty road, hard or improved surface	═
Secondary highway, hard surface	╍	Unimproved road	┄

○ Interstate Route ○ U. S. Route ○ State Route

KENTUCKY
QUADRANGLE LOCATION

Revisions shown in purple compiled in cooperation with State of Ohio agencies from aerial photographs taken 1975. This information not field checked

GREENUP, KY.—OHIO
SE/4 GREENUP 15′ QUADRANGLE
N3830—W8245/7.5

1972
PHOTOREVISED 1975
AMS 4461 III SE—SERIES V853

APPENDIX F

U.S. DEPARTMENT OF INTERIOR GEOLOGICAL SURVEY MAP

APPENDIX G

SUBSURFACE SOIL INVESTIGATION

DUNBAR GEOTECHNICAL ENGINEERS
1286 WEST LANE AVENUE • COLUMBUS, OHIO 43221
614
486-0206

March 18, 1980

WIL/3

Columbia Gas of Ohio
1600 Dublin Road
Columbus, Ohio 43215

Attn: Mr. Phil Dechow

Re: Report of Subsurface Investigation, Solar Collector Project, U.S.S. Chemical Site, Haverhill, Ohio

Gentlemen:

In response to a request by Mr. R. Warner of U.S.S. Chemical and Mr. M. Gelderloos of H.A. Williams & Associates, we are pleased to submit our report of the subsurface investigation performed at the Solar Collector Project site at the U.S.S. Chemical plant in Haverhill, Ohio, northwest of Ironton. Logs of the test borings, laboratory test data, and other information are attached to this report.

The boring layout and test drilling was performed on March 4, 1980, at locations indicated on the Test Boring Plan provided by H.A. Williams & Associates. Due to extremely soft soil conditions in the field, only Borings B-1 through B-4 could be completed on that date. Following a discussion with Mr. Warner, it was decided to omit Boring B-5 because of the need for dozer access and since the first four borings were all similar to each other.

The test borings were performed utilizing a truck-mounted rotary drilling machine which advance the test holes through the medium of solid shaft augers. Standard Penetration testing was performed in each hole at intervals of 3 feet or less. The Standard Penetration Test is conducted by driving a 2-inch O.D. split-barrel sampler for 18 inches, utilizing a 140-pound hammer falling 30 inches. Driving resistance is recorded on the borehole logs in terms of blows per 6-inch interval of the driving distance. The second and third intervals are added to obtain the number of blows per foot. Results of the Standard Penetration Test appear pictorially on the boring logs and also on the Borehole Profile Summary in this report, plotted as a function of site elevation.

CIVIL ENGINEERS
SPECIALIZING IN SOIL MECHANICS, TESTING AND ENGINEERING GEOLOGY

All soil samples obtained from the drilling operation were preserved in jars or tubes and visually classified in the laboratory. Selected soil samples were subjected to testing to determine natural moisture content, Atterberg limits, unit dry weight, gradation, and estimates of unconfined compressive strength. Results of the laboratory testing appear on the boring logs and in tabular form at the end of this report.

Subsurface Conditions

The Borehole Profile Summary, Figure 2, has been prepared in order to provide a visual representation of the various soil materials found in adjacent borings with respect to their actual site elevation. The profile has been constructed in roughly a south to north direction with no horizontal scale intended. The following is a generalization of what was found in the test borings and represented on the profile.

Topsoil, which has apparently been affected by past farming practices, appears to vary from 0.4 to 1.2 feet in depth in the test borings. In all four borings, the topsoil is immediately underlain by brown clayey silt soils exhibiting a highly variable sand content. The sand content varies from a trace in B-1 to a substantial amount in B-4. The clayey silts vary in thickness with a bottom depth ranging from 0.8 to 3.8 feet. The clayey silt soils are underlain in all four borings by a very silty fine to coarse sand, up to 2.5 feet in thickness, which overlies a fairly clean and well graded sand and gravel to the remaining depth of the test borings.

Standard Penetration testing in the four test borings exhibits blowcounts varying from 3 to 24 blows per foot (bpf) generally increasing with depth. At depths below 3 to 6 feet, all borings exhibit Standard Penetration Test blowcounts in excess of 10 bpf. Although no free water was observed during or immediately following the test drilling operation, the sand and gravel materials at depth are described as being in a moist to wet condition.

Foundation Considerations

The soil data obtained in this investigation has been used to estimate soil cohesion and angle of internal friction parameters for use in the analysis. Due to variations in sand content, particularly in the upper soils, the analysis utilized what might be termed as a lower quartile soil characteristic analysis wherein the clayey upper horizon was assumed to average 3 feet in thickness and be described as a brown clayey silt, some fine to medium sand. Below a depth of 3 feet, to the maximum depth of the borings, the deeper soil is assumed to be described as a brown fine to coarse sand, some to with fine gravel, trace to some silt. Moisture conditions vary from damp at the surface to wet at depth. The lower quartile analysis means that 75% of the soil values are better than those used in analysis, but that 25% may be poorer, thus requiring inspection.

With this generalized and poorer-than-average soil profile, lateral pressure capability in the passive case was calculated. Equivalent fluid weights were computed as 195 pounds per cubic foot (pcf) for the upper clayey silt and 389 pcf for the deeper-lying sand and gravel. Using the assumed depth of clay cover as 3 feet, a weighted average equivalent fluid weight value of 331 pcf was derived.

Since we are advised that the solar devices will be mounted on concrete piers of the cast-in-place, drilled shaft variety, bearing capacity analysis was performed. The analysis suggests that concrete piers bearing at a depth greater than 6 feet below the surface and in the sand and gravel as described may be founded at a maximum allowable bearing value of 7500 pounds per square foot (psf). This value is conservative, with adequate safety factor, and may be increased somewhat for deeper foundations with additional analysis. Although an accurate settlement analysis is not possible with the information available, rough estimates of settlement suggest that total settlement should not exceed 1/2 inch for the soil conditions exhibited in the test borings.

It must be pointed out that the test borings performed in this investigation are only 10 feet deep and if foundations are placed at a depth of 10 feet, foundation loads will be bearing on unknown materials. For this reason and since there is no way of being sure that the test borings revealed the total range of soil conditions at the site, inspection of construction by a qualified soils inspector is recommended. This investigation has been performed specifically for foundation design purposes and is not intended to be used for detailed construction estimating or bidding. It is probable, due to borehole spacing requirements and the passage of time, that variations in reported soil and ground water conditions may be found during construction. We strongly recommend that such variations be immediately brought to our attention to determine their effect on foundation design.

Please advise if further discussion may be required. Thank you for the opportunity to be of service.

Very truly yours,

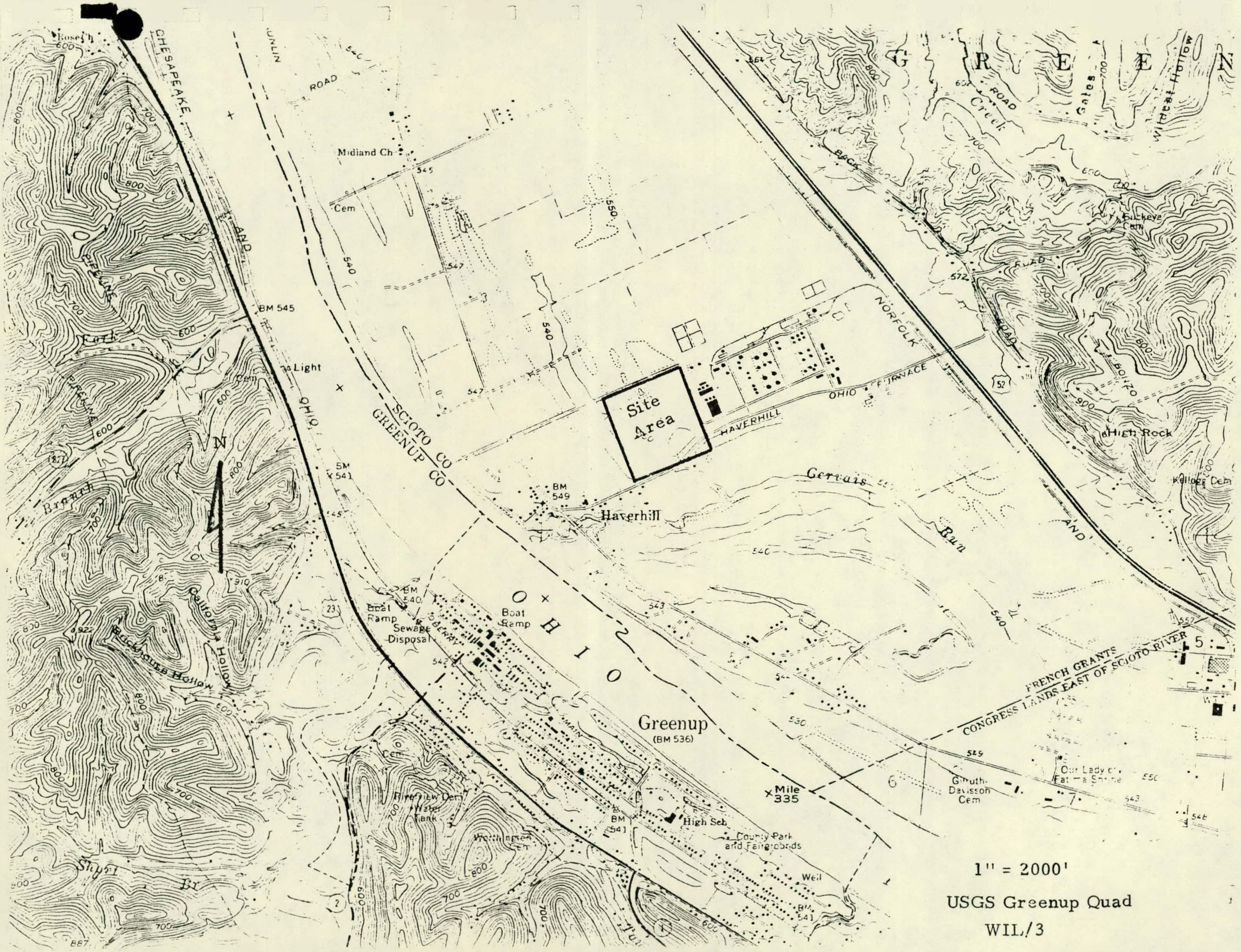
DUNBAR GEOTECHNICAL ENGINEERS

R A Dunbar

Robert A. Dunbar, P.E.

RAD/gw

Dist: U.S.S. Chemical (2)
H.A. Williams (1)
Columbia Gas (1)
File (1)
Enc: U.S.G.S. Map
Borehole Location Plan, Figure 1
Borehole Profile Summary, Figure 2
Log Legend
Boring Logs, B-1 through B-4
Laboratory Test Data



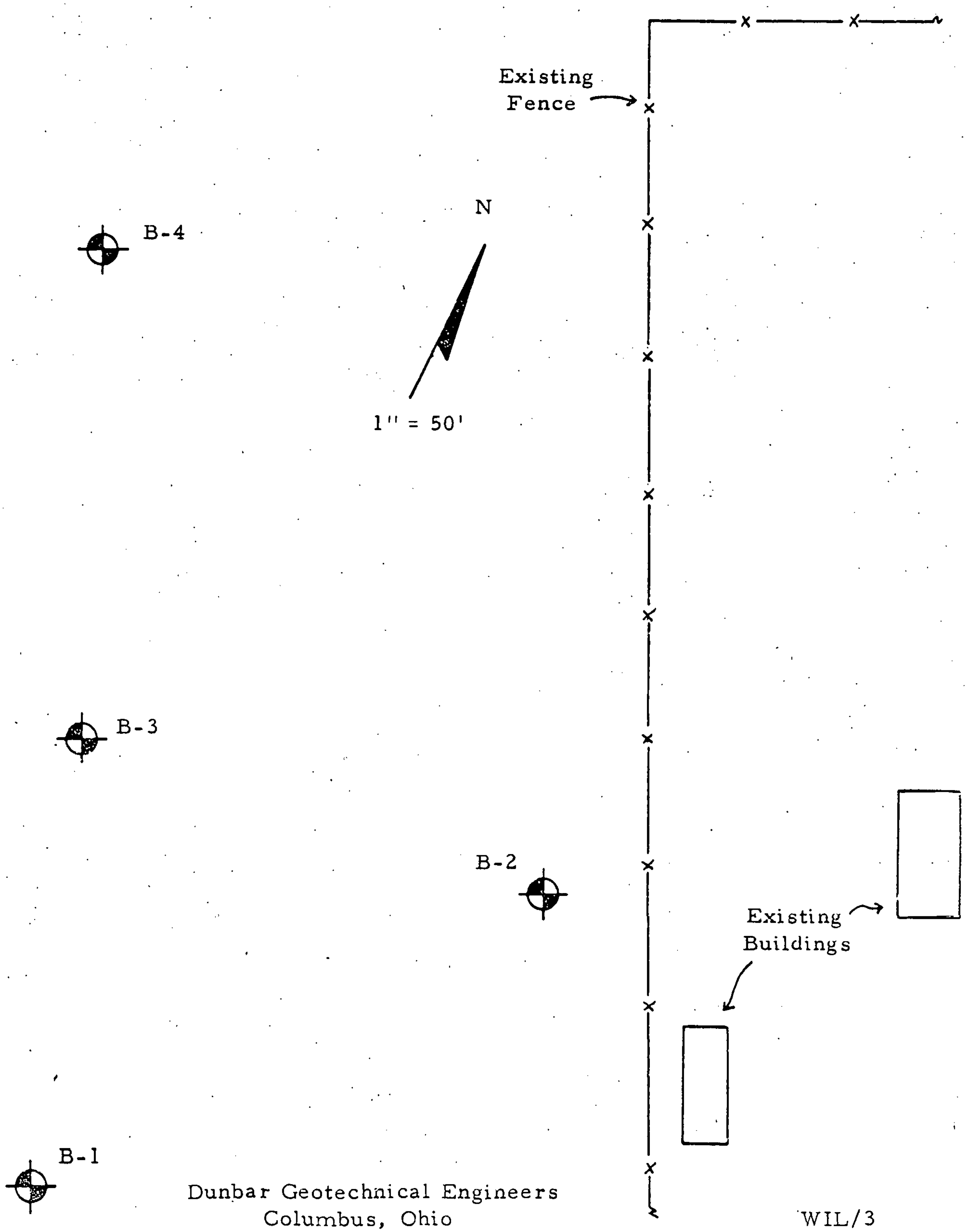
1" = 2000'

USGS Greenup Quad

WIL/3

BOREHOLE LOCATION PLAN
U.S.S. Chemical Solar Collectors
Haverhill, Ohio

Figure 1

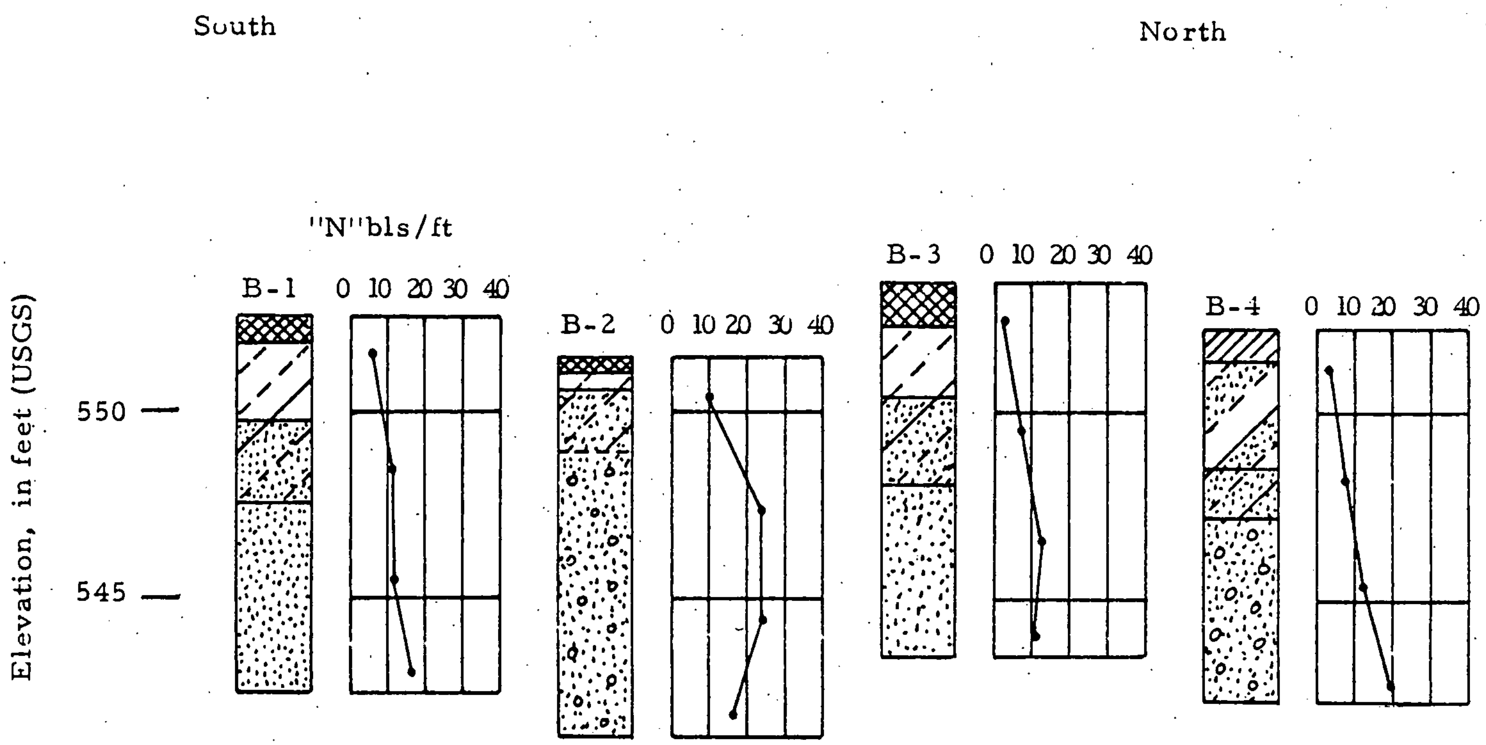


Dunbar Geotechnical Engineers
Columbus, Ohio

WIL/3

BOREHOLE PROFILE SUMMARY
U.S.S. Chemical Solar Collectors
Haverhill, Ohio

Figure 2



Scale: Vertical 1" = 5'
Horizontal - None

Dunbar Geotechnical Engineers
Columbus, Ohio

BOREHOLE LOG LEGEND

LABORATORY TESTS

Symbol on Log Sheet	Laboratory Test Performed
C	Consolidation Test, curves attached
DS	Direct Shear Test, curve attached
G	Grain Size Analysis, sieved material, curve attached
GH	Grain Size Analysis including Hydrometer, curve attached
H	Hydrometer Analysis, curve attached
HP	Hand Penetrometer, q_u (est.), tsf
LL •	Liquid Limit, %
P	Permeability Test, curve attached
PL •	Plastic Limit, %
RD	Relative Density, %
SG	Specific Gravity
SL	Shrinkage Limit, %
T	Triaxial Compression Test, curve attached
U	Unconfined Compression Test, curve attached
W	Dry Unit Weight, pcf
WC •	Natural Water Content, %

• Results often plotted on log sheet in last column

SAMPLE

TYPE:

FA - Flight Auger
HA - Hand Auger
PT - Piston-type Sampler
RB - Roller Bit
RC - Rock Core
SS - Standard Split Spoon, 2" O. D., 1-3/8" I. D.
ST - Shelby Tube or other thin-walled sampler
S3 - Split Spoon Sampler, other (3" I. D. shown)

STANDARD PENETRATION TEST:

The number of blows required to drive a 2-inch O. D., 1-3/8 inch I. D. split-spoon sampler, using a 140-pound hammer with a 30-inch free fall, is normally recorded for 6-inch drive increments. Standard Penetration resistance is determined from the total number of blows required for one foot of penetration by summing the second and third 6-inch increments. When rock is encountered, this column is used for the run-recovery record as follows:

a) Ratio: $\frac{\text{Core recovered}}{\text{Distance cored}}$

b) Percent: Ratio x 100

NUMBER:

Samples are numbered consecutively with depth as follows:

Soil: 1, 2, 3, 4, etc.
Rock: R-1, R-2, R-3, R-4, etc.

INTERVAL:

Sample intervals are designated as follows:

▮ Soil sample interval, sample retained
⌇ Soil sample interval, sample lost
↕ Rock core interval

DEPTH SCALE

The depth in feet below the ground surface, unless otherwise specified.

DESCRIPTION OF MATERIALS

COLOR:

a. A uniform color throughout the sample is so described, e.g., black, yellow, brown. Modifying adjectives such as light and dark are frequently used.

b. Often the predominate color is shaded by the presence of another color resulting in such descriptions as greenish-brown, brownish-gray.

c. If two or more predominate colors are equally mixed throughout the soil, the color description will be preceded with the term mottled, e.g., mottled yellow and brown.

DESCRIPTION OF MATERIALS CON'T

GM - Glacial Till

TEXTURE:

The Unified Soil Classification is the basis for particle size description as follows:

Description	Size
Boulders	Larger than 8"
Cobbles	3" to 8"
Gravel - Coarse	3/4" to 3"
Fine	4.8 ~~2.0~~ mm to 3/4"
Sand - Coarse	0.42 mm to 4.7 ~~2.0~~ mm
Fine	0.074 mm to 0.42 mm
Silt	0.005 mm to 0.074 mm
Clay	Smaller than 0.005 mm

The predominate material is listed first followed by secondary constituants according to the following proportions:

And	(50 to 40%)	Some	(25 to 10%)
With	(40 to 25%)	Trace	(10 to 0%)

Example: Sand (55%), With Silt (39%), Trace Clay (6%)

MOISTURE:

Moisture content, relative to plastic properties, is described as follows:

Term	Relative Moisture or Appearance
Dry	Powdery
Damp	Moisture content below plastic limit
Moist	Moisture content above plastic limit, but below liquid limit
Wet	Moisture content nearly equal to or greater than the liquid limit.

DENSITY:

Condition of the soil relative to compactness and consistency is defined by the following terms:

Granular Material

Description	Blows Per Foot Standard Penetration
Very Loose	2 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

Cohesive Material

Description	Blows Per Foot Standard Penetration	Hand Manipulation
Very soft	below 2	Easily penetrated by fist
Soft	2 - 4	Easily penetrated by thumb
Medium stiff	4 - 8	Penetrated by thumb with moderate effort
Stiff	8 - 15	Readily indented by thumb but not penetrated
Very stiff	15 - 30	Readily indented by thumb nail
Hard	Over 30	Indented with difficulty by thumb nail

LOG SYMBOLS:

A symbolic log of materials may appear at the right of the column labeled Description of Materials. The symbols used separately or in combination are:

▩	Topsoil	☰	Shale
▨	Clay	░	Sandstone
▧	Silt	▦	Limestone, Dolomite
░	Sand (FS-fine sand)	R	Rock, as described
▣	Gravel (with cobbles)	C	Organic (C-coal, Pt-Peat)
S	Soil, as described		

GRIDDED COLUMN

The gridded column is used for general notes or plots of the data indicated in the column heading.

Dunbar Geotechnical Engineers
Columbus, Ohio

DUNBAR GEOTECHNICAL ENGINEERS
COLUMBUS, OHIO

PAGE 1 OF 1

LOG OF BOREHOLE B-1

SURFACE ELEVATION 552.5' **DATUM** USGS (See below) **JOB** WIL/3

BORING METHOD Penn Drill, FA, SS

PROJECT U.S.S. Chemical Solar Collectors

LOCATION Ohio Furnace Road Haverhill, Ohio

WATER DEPTH DATA
ENCOUNTERED None
COMPLETION None
AFTER
DEPTH

HOLE DIAM. 4-1/2"
HAMMER WT. 140#
DROP 30"
CORE DIAM.

INSPECTOR BEB
START 3-4-80
FINISH 3-4-80

COMPLETED DEPTH 10.0 FT.

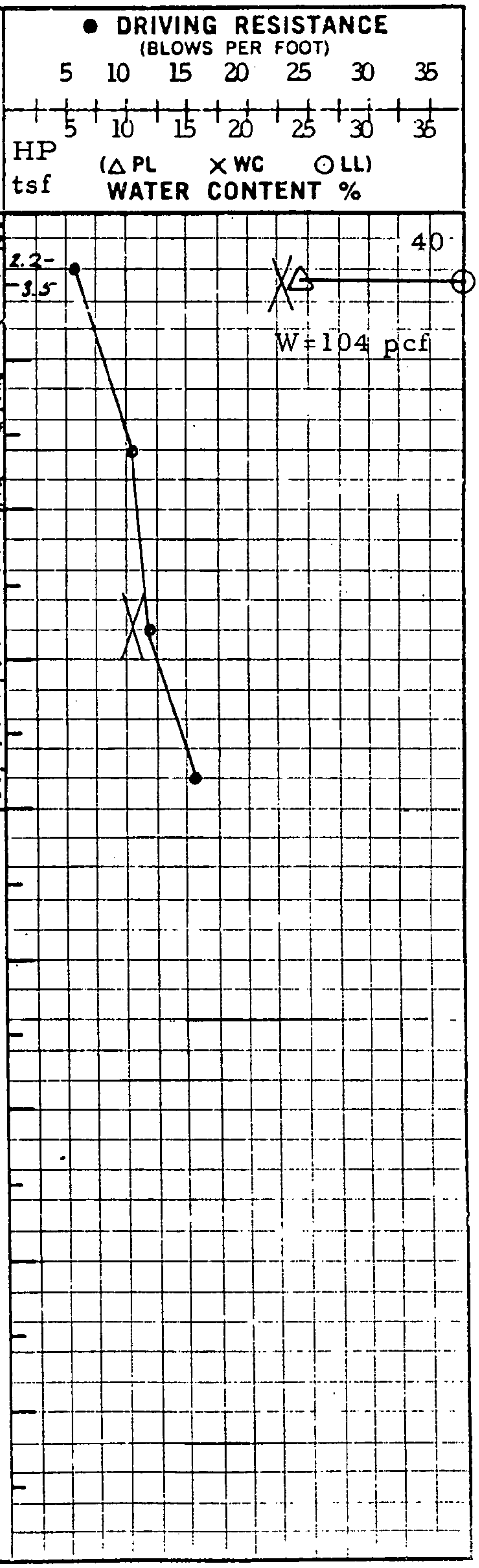
DESCRIPTION OF MATERIALS
COLOR, TEXTURE, DENSITY, MOISTURE

TEXTURE PROPORTIONS
AND (50 to 40%) WITH (40 to 25%) SOME (25 to 10%) TRACE (10 to 0%)

LABORATORY TESTS	SAMPLE TYPE	STD. PEN. TEST (6" INTERVALS)	NUMBER	DEPTH SCALE	DESCRIPTION OF MATERIALS
				0	TOPSOIL 0.7
WC LL PL W H	SS	1 3 3	1		Brown clayey SILT, trace fine sand. Medium stiff. Damp to moist. 2.8
	SS	4 5 6	2		Brown fine to coarse SAND, some to with clayey silt, trace fine gravel. Medium dense. Moist. 5.0
WC G	SS	4 4 8	3	5	Brown fine to coarse SAND, some to with fine gravel, some silt, few silt seams. Medium dense. Moist.
	SS	3 6 10	4	10	

Bottom of boring 10.0'

Note: Bench mark by U.S.S. Chemical. Nail in power pole #19 at northwest corner of site. Elev. 553.64 feet.



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COLUMBUS, OHIO

LOG OF BOREHOLE B-2

SURFACE ELEVATION 551.4' DATUM USGS - See B-1 JOB WIL/3

BORING METHOD Penn Drill, FA, SS

PROJECT U.S.S. Chemical Solar Collectors

LOCATION Ohio Furnace Road Haverhill, Ohio

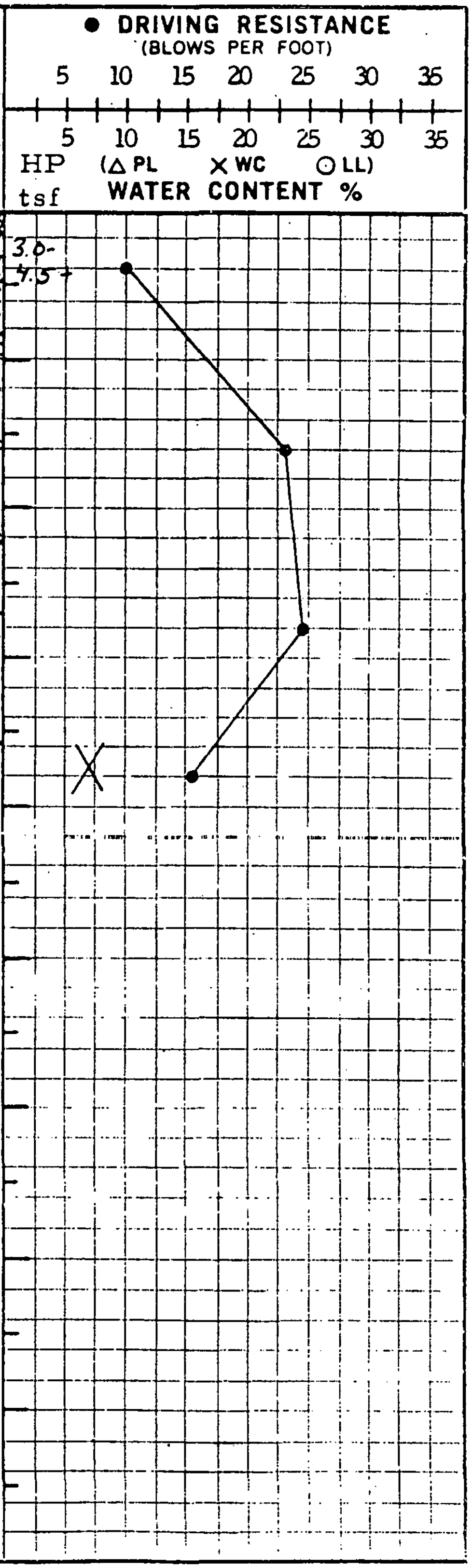
COMPLETED DEPTH 10.0 FT.

WATER DEPTH DATA	**HOLE DIAM.** 4-1/2"	**INSPECTOR** BEB	
ENCOUNTERED None	**HAMMER WT.** 140#		
COMPLETION None	**DROP** 30"	**START** 3-4-80	
AFTER			
DEPTH	**CORE DIAM.**	**FINISH** 3-4-80	

DESCRIPTION OF MATERIALS COLOR, TEXTURE, DENSITY, MOISTURE

TEXTURE PROPORTIONS: AND (50 to 40%) WITH (40 to 25%) SOME (25 to 10%) TRACE (10 to 0%)

LABORATORY TESTS	SAMPLE TYPE	STD. PEN. TEST (6" INTERVALS)	NUMBER	DEPTH SCALE	DESCRIPTION OF MATERIALS	HP tsf
				0	TOPSOIL 0.4	
	SS	3 6 4	1A 1B		Brown clayey SILT, with fine to medium sand, trace fine gravel Stiff. Damp to moist. 0.8	3.0-4.5+
					Brown fine to medium SAND, with clayey silt. Loose. Moist.	
	SS	6 11 12	2		Brown fine to coarse SAND, with fine gravel, trace silt. Medium dense. Moist to wet.	
				5		
	SS	6 11 13	3			
WC G	SS	5 8 8	4			
				10	Bottom of boring 10.0'	



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COLUMBUS, OHIO

PAGE 1 OF 1

LOG OF BOREHOLE B-3

SURFACE ELEVATION 553.5'
DATUM USGS - See B-1
JOB WIL/3

BORING METHOD Penn Drill, FA, SS
PROJECT U.S.S. Chemical Solar Collectors
LOCATION Ohio Furnace Road Haverhill, Ohio

WATER DEPTH DATA
ENCOUNTERED None
COMPLETION None
AFTER
DEPTH

HOLE DIAM. 4-1/2"
HAMMER WT. 140#
DROP 30"
CORE DIAM.

INSPECTOR BEB
START 3-4-80
FINISH 3-4-80

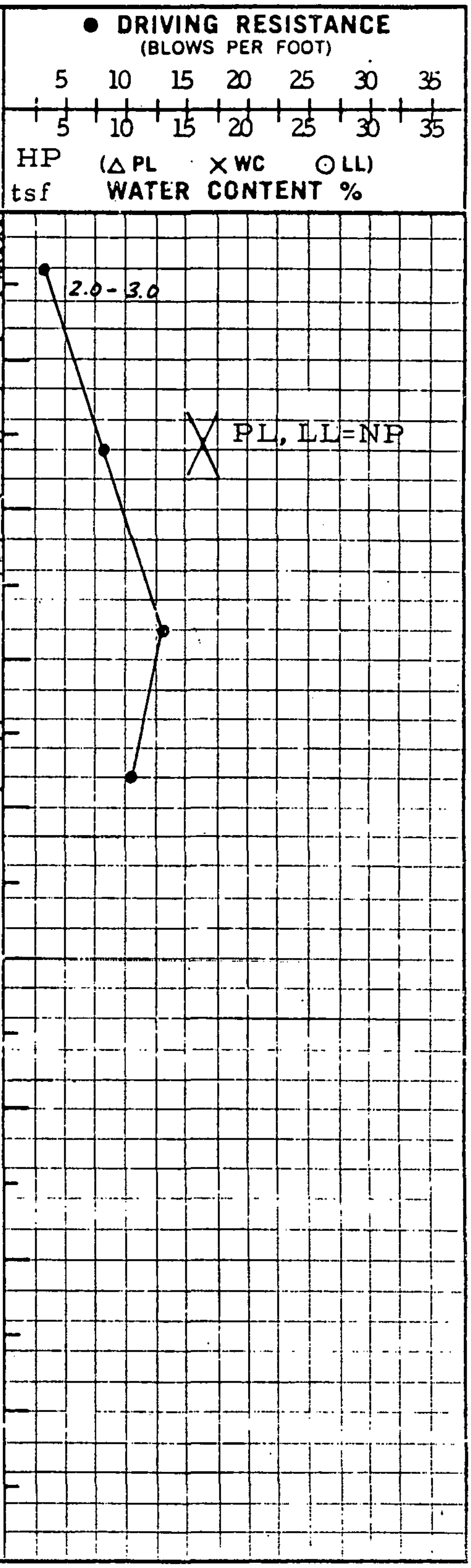
COMPLETED DEPTH 10.0 FT.

DESCRIPTION OF MATERIALS
COLOR, TEXTURE, DENSITY, MOISTURE

TEXTURE PROPORTIONS

AND (50 to 40%)	WITH (40 to 25%)	SOME (25 to 10%)	TRACE (10 to 0%)

LABORATORY TESTS	SAMPLE TYPE	SAMPLE STD. PEN. TEST (6" INTERVALS)	SAMPLE NUMBER	DEPTH SCALE	DESCRIPTION OF MATERIALS	
				0		
	SS	1 1 2	1		TOPSOIL(plowed zone)	1.2
					Brown clayey SILT, some fine to medium sand, trace fine gravel. Medium stiff. Damp to moist.	3.0
WC LL PL H	SS	4 4 4	2	5	Brown fine to medium SAND, with clayey silt. Loose. Moist.	5.5
	SS	3 6 7	3		Brown fine to coarse SAND, some to with fine gravel, some silt. Medium dense. Moist.	
	SS	4 4 7	4	10		
					Bottom of boring 10.0'	



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COLUMBUS, OHIO

PAGE 1 OF 1

LOG OF BOREHOLE B-4

SURFACE ELEVATION 552.3' **DATUM** USGS - See B-1 **JOB** WIL/3

BORING METHOD Penn Drill, FA, SS

PROJECT U.S.S. Chemical Solar Collectors

LOCATION Ohio Furnace Road Haverhill, Ohio

COMPLETED DEPTH 10.0 FT.

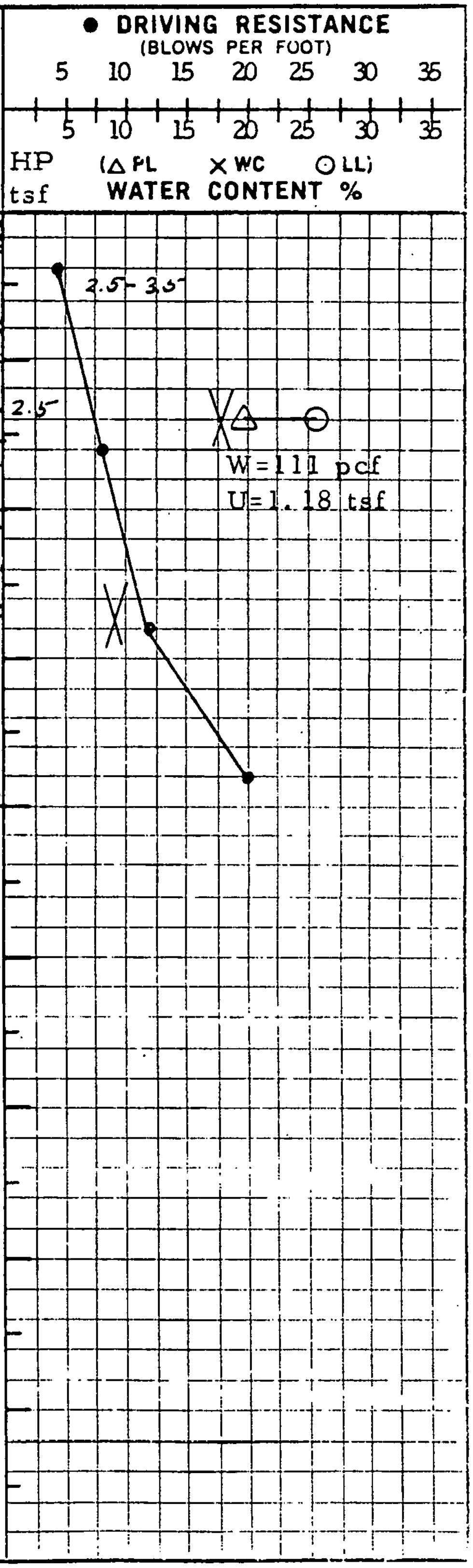
WATER DEPTH DATA
ENCOUNTERED None
COMPLETION None
AFTER
DEPTH

HOLE DIAM. 4-1/2"
HAMMER WT. 140#
DROP 30"
CORE DIAM.

INSPECTOR BEB
START 3-4-80
FINISH 3-4-80

LABORATORY TESTS	SAMPLE TYPE	STD. PEN. TEST (6" INTERVALS)	NUMBER	DEPTH SCALE	DESCRIPTION OF MATERIALS COLOR, TEXTURE, DENSITY, MOISTURE
	SS	1 1 3	1	0	TOPSOIL (plowed zone) 0.8
					Brown clayey SILT, with to and fine to medium sand. Medium stiff. Damp to moist. 3.8
WC LL PL W U H	SS	3 3 5	2A 2B		Brown fine to medium SAND, with clayey silt, trace fine gravel. Loose Moist. 5.0
WC G	SS	2 4 8	3	5	Brown fine to coarse SAND, with to some fine gravel, trace to some silt. Medium dense. Moist to wet.
	SS	3 10 10	4	10	
					Bottom of boring 10.0'

TEXTURE PROPORTIONS: AND (50 to 40%) WITH (40 to 25%) SOME (25 to 10%) TRACE (10 to 0%)



SUMMARY OF LABORATORY TEST RESULTS

Boring-Sample	Depth	Natural Moisture Content %	Liquid Limits %	Plastic Limits %	Unit Dry Weight pcf	Unconfined Compression	Gradation: G - Sieve H - Hydrometer
B-1/1	0.7' - 1.2'	23	40	24	104	--	H
B-1/3	6.2' - 7.2'	11	--	--	--	--	G
B-2/4	8.7' - 9.7'	7	--	--	--	--	G
B-3/2	3.2' - 4.2'	17	NP	NP	--	--	H
B-4/2A	3.1' - 3.8'	18	26	20	111	**	H
B-4/3	6.2' - 7.2'	9	--	--	--	--	G

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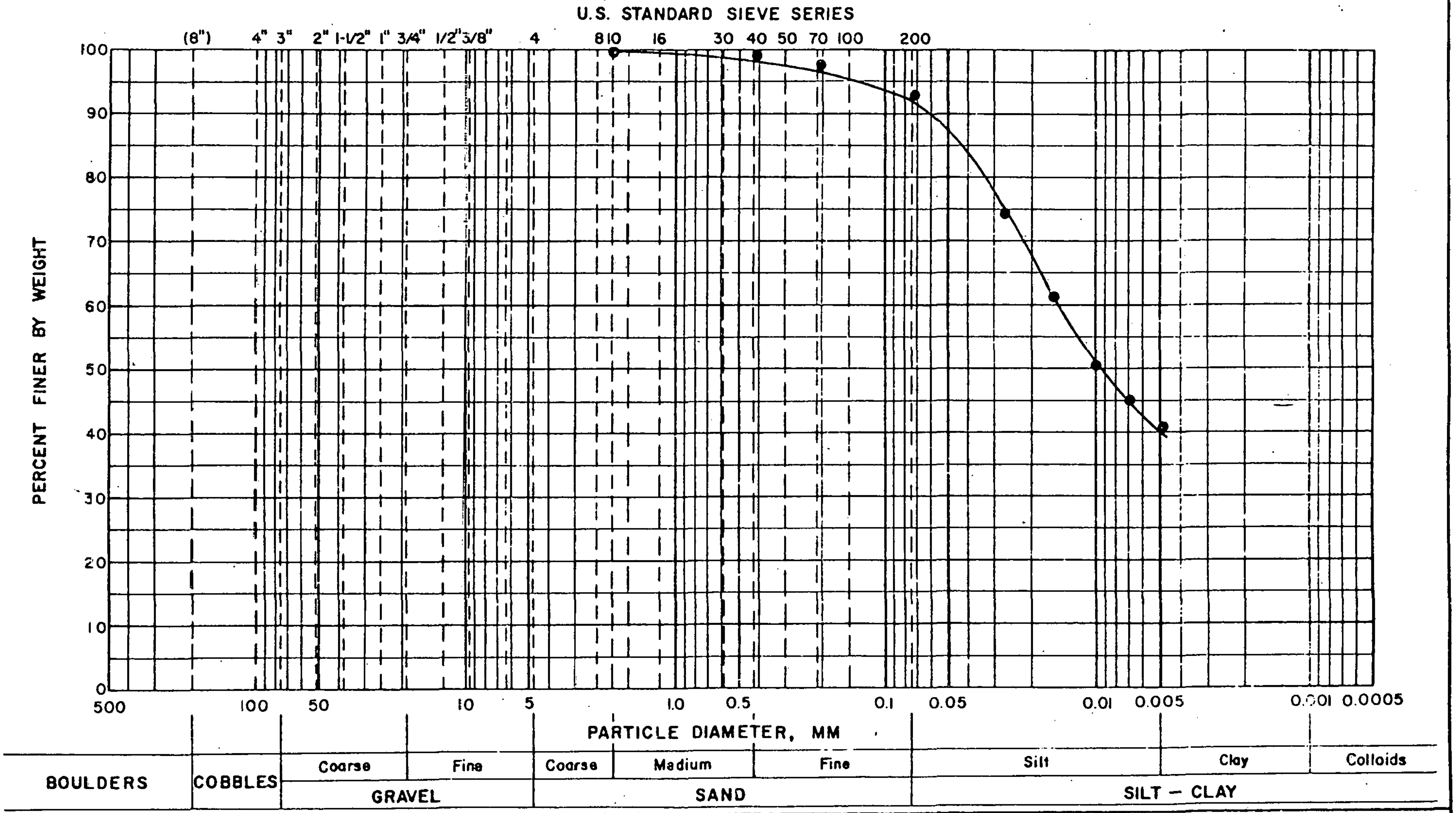
Columbus, Ohio

GRADATION CURVES



Boring: B-1 Sample: S-1 Depth: 0.7' - 1.2' LL = 40% PL = 24%

Description: Brown clayey silt, trace fine sand.

U.S.S. Chemical
Solar Collectors
Haverhill, Ohio

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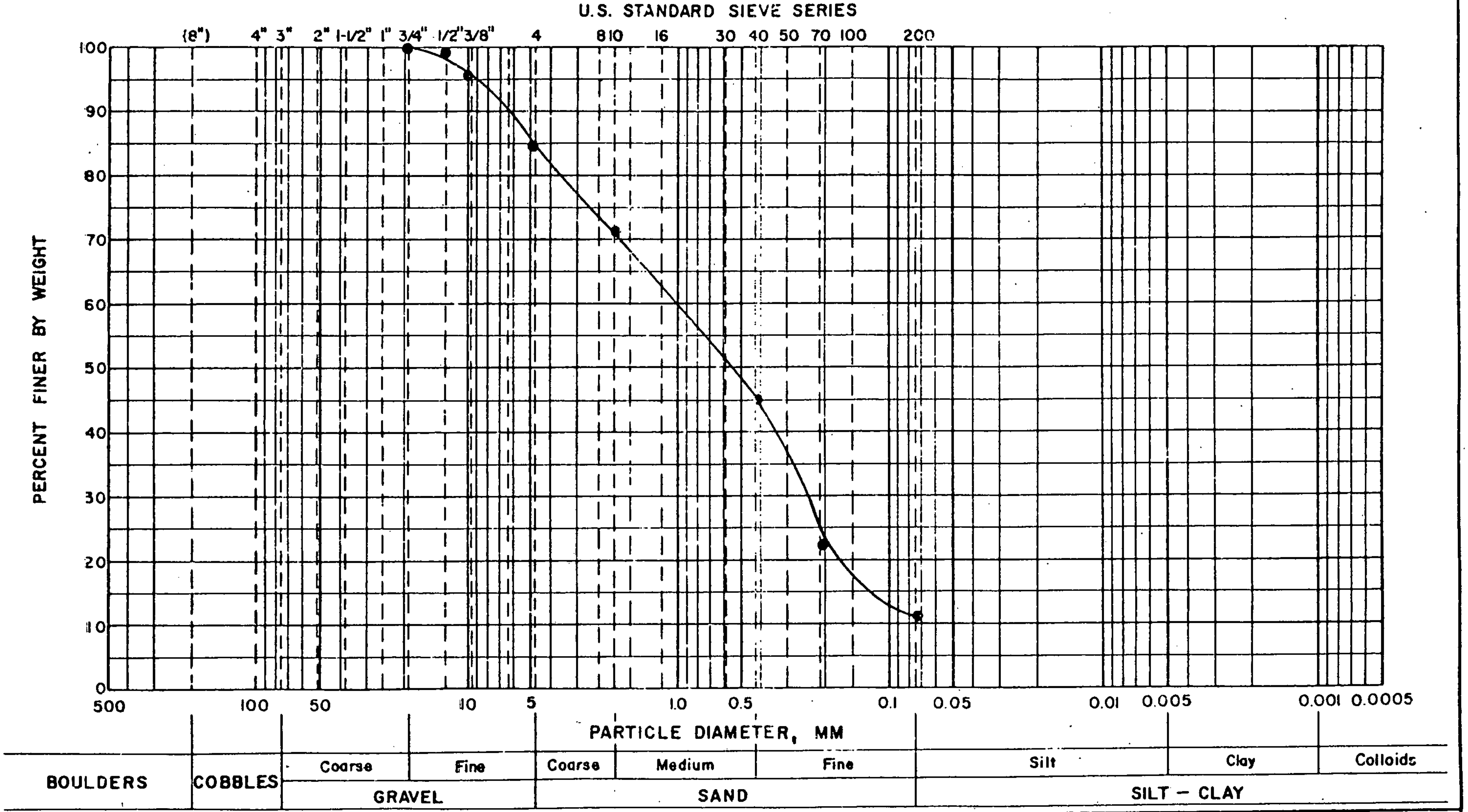
Geotechnical

GRADATION CURVES



Boring: B-1 Sample: S-3 Depth: 6.2' - 7.2'

Description: Brown fine to coarse sand, some fine gravel, some silt.

U.S.S. Chemical
Solar Collectors
Haverhill, Ohio

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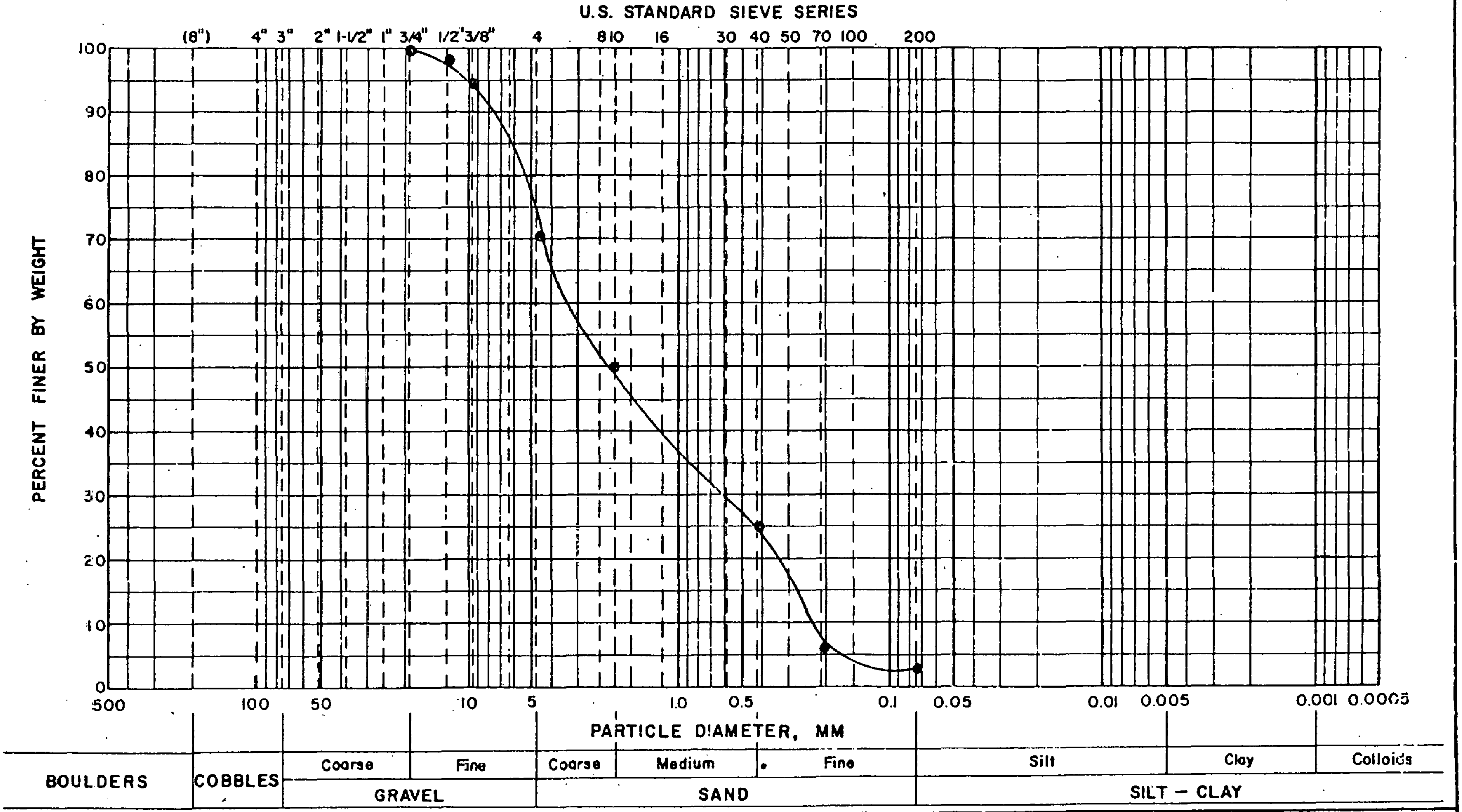
GRADATION CURVES



Boring: B-2 Sample: S-4 Depth: 8.7' - 9.7'

Description: Brown fine to coarse sand, with fine gravel, trace silt.

U.S.S. Chemical
Solar Collectors
Haverhill, Ohio

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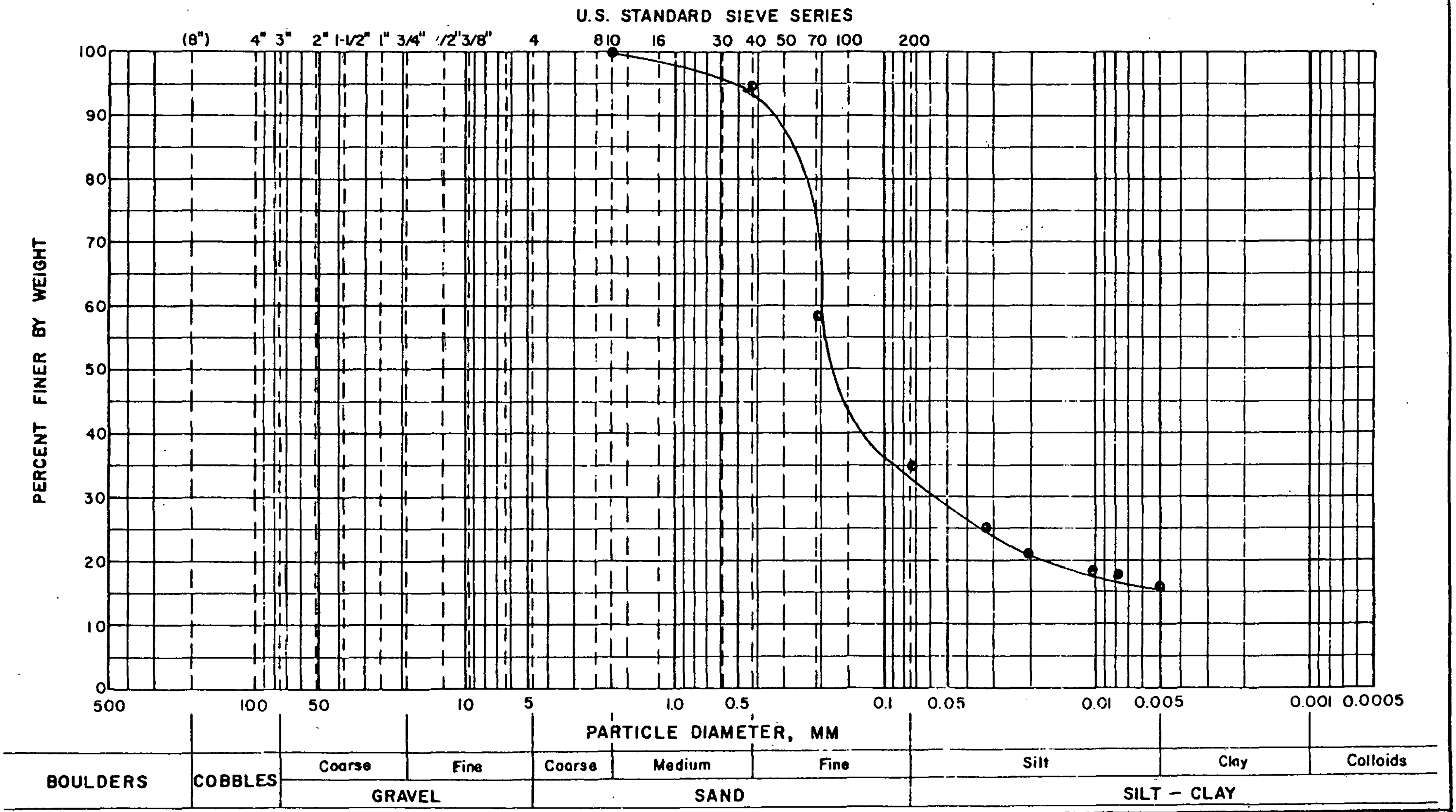
GRADATION CURVES



Boring: B-3 Sample: S-2 Depth: 3.2' - 4.2' LL = NP PL = NP

Description: Brown fine to medium sand, with clayey silt.

U.S.S. Chemical
Solar Collectors
Haverhill, Ohio

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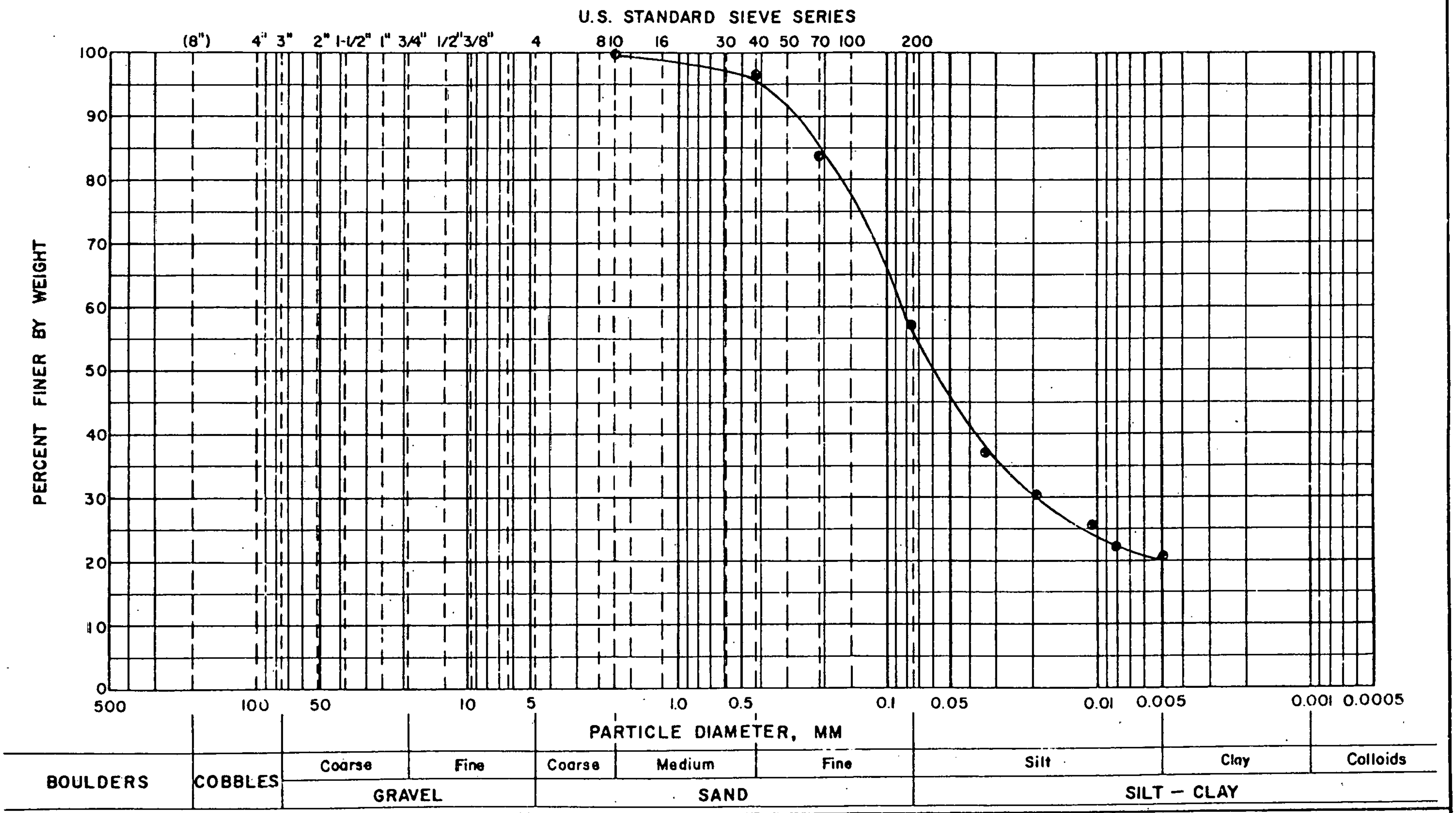
GRADATION CURVES



Boring: B-4 Sample: S-2A Depth: 3.1' - 3.8' LL = 26% PL =20%

Description: Brown clayey silt, and fine sand.

U.S.S. Chemical
Solar Collectors
Haverhill, Ohio

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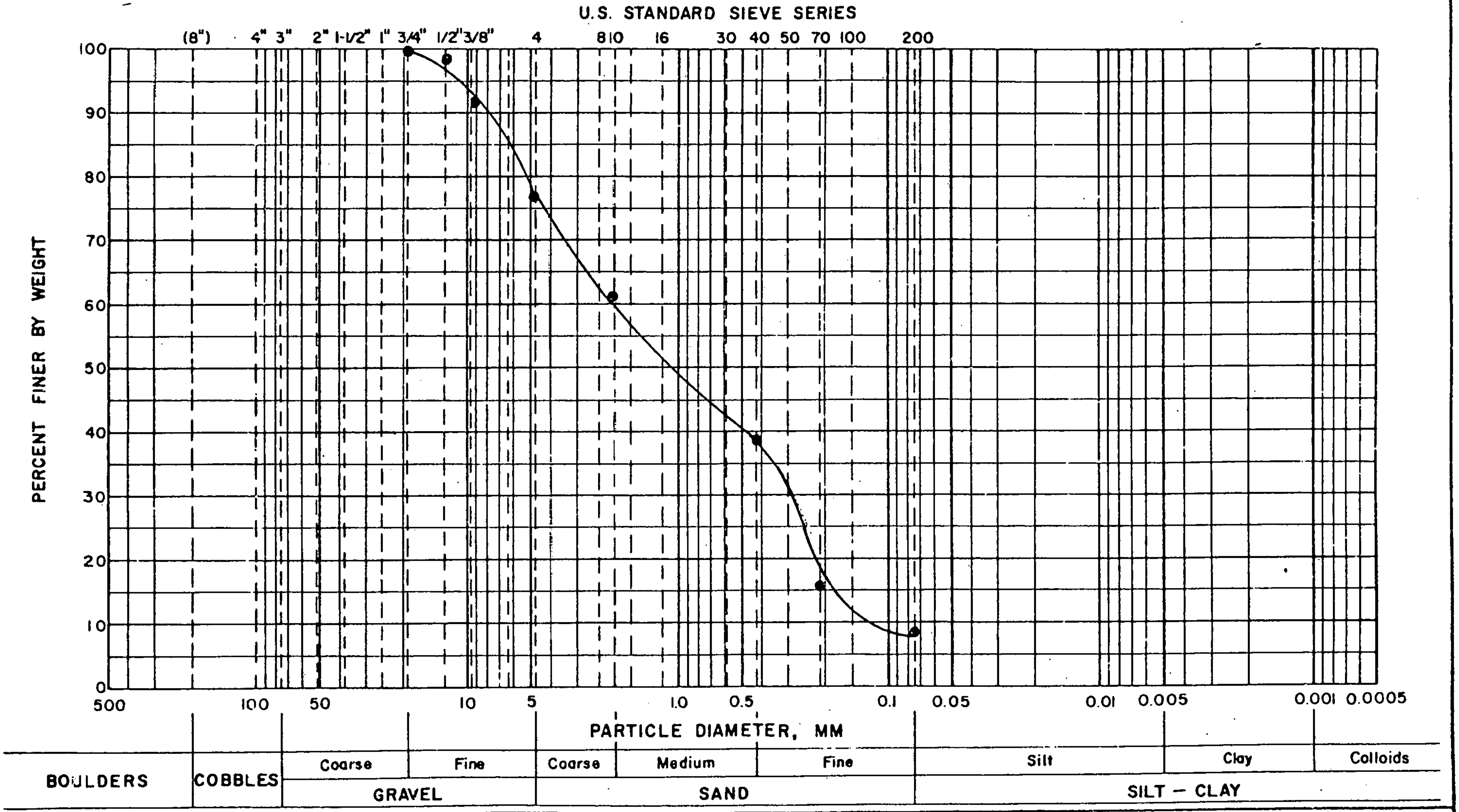
GRADATION CURVES



Boring: B-4   Sample: S-3   Depth: 6.2' - 7.2'

Description: Brown fine to coarse sand, some fine gravel, trace silt.

U.S.S. Chemical
Solar Collectors
Haverhill, Ohio

DUNBAR ~~GEOLOGICAL~~ ENGINEERS WIL/3
Geotechnical

DUNBAR GEOTECHNICAL ENGINEERS
1286 West Lane Avenue
Columbus, Ohio 43221

Project U.S.S. Chemical Solar Collectors Date 3-7-80 Job # WIL/3

Boring B-4 Sample S-2A Depth 3.1' - 3.8'

Unit Dry Weight 111 pcf Unit Wet Weight 131 pcf

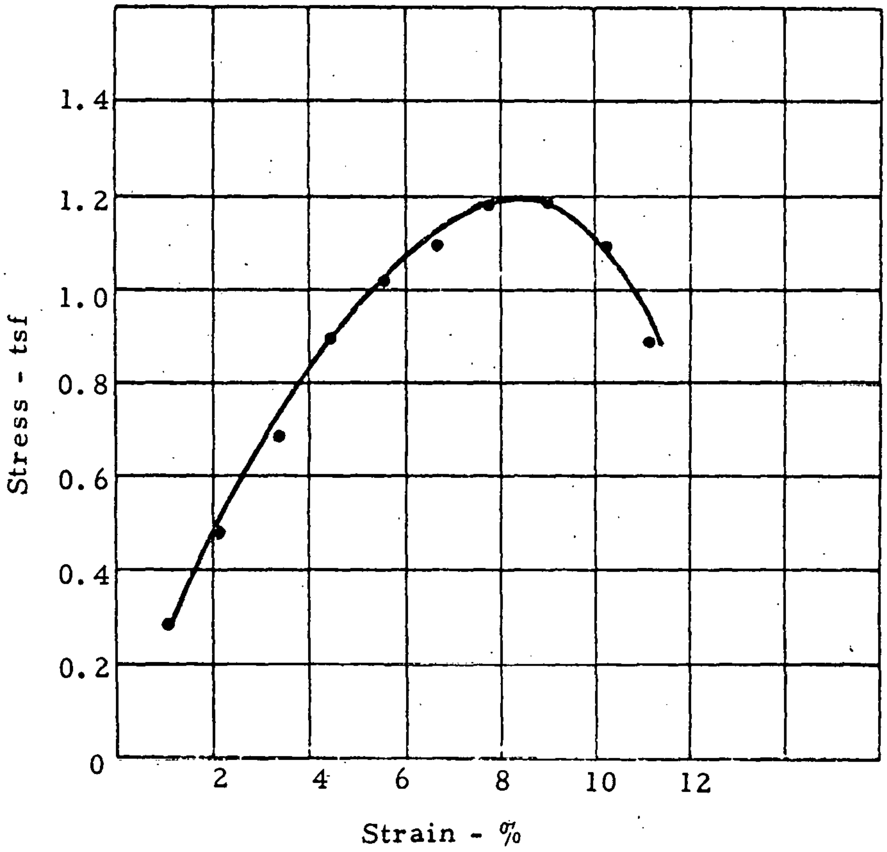
Moisture Content 18 % Sample Size 2.68 " x 1.41 " dia.

Sample Type SS Sample Shape cylindrical

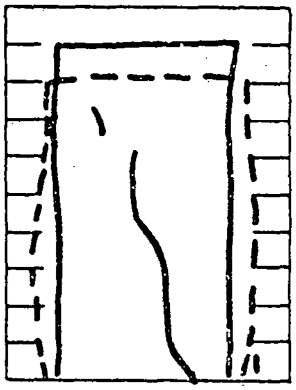
Material Brown clayey silt, and fine sand.

UNCONFINED COMPRESSION TEST

Maximum Stress = 1.18 tsf at 7.8 % Strain



Failure Condition



Remarks H.P. = 2.25 - 2.5 tsf

APPENDIX H

OHIO ENDANGERED SPECIES LIST

ODNR
Ohio Department of Natural Resources
DIVISION OF WILDLIFE
Fountain Square · Columbus, Ohio 43224

May 13, 1980

Mr. Ed Reid
Columbia Gas of Ohio
1600 Dublin Road
Columbus, Ohio 43215

Dear Mr. Reid:

This is in response to your request for endangered species information in an area in the vicinity of Haverhill, Scioto County. The following are considered to be reasonably likely to occur on the project area, but as migrants or transients only.

Indiana bat, Myotis sodalis
Sharp-shinned hawk, Accipiter striatus

In addition, the following are considered to be reasonably likely to occur in the Ohio River, in areas subject to runoff from the project area.

Ohio lamprey, Ichthyomyzon bdellium
Silver lamprey, Ichthyomyzon unicuspis
Paddlefish, Polyodon spathula
Lake sturgeon, Acipenser fulvescens
Mooneye, Hiodon tergisus
Ghost shiner, Notropis buchanani
Silver chub, Hybopsis storeriana
Blue sucker, Cycleptus elongatus
River redhorse, Moxostoma carinatum
Ohio pig toe, Pleurobema cordatum
Long-solid, Fusconaia subrotunda
Bullhead, Plethobasus cyphyus
Monkeyface, Quadrula metanevra
Orb mucket, Lampsilis orbiculata

Sincerely,

Denis S. Case
Wildlife Biologist

DSC:dr

JAMES A. RHODES, *Governor* • ROBERT W. TEATER, *Director* • CARL L. MOSLEY JR., *Chief*

APPENDIX I

OHIO ARCHAEOLOGICAL COUNSEL CERTIFICATION LIST

federal register

TUESDAY, JANUARY 30, 1979
PART IV

THE NATIONAL ARCHIVES OF THE UNITED STATES
1934

ADVISORY COUNCIL ON HISTORIC PRESERVATION

PROTECTION OF HISTORIC AND CULTURAL PROPERTIES

Final Amendments

[4310-10-M]

Title 36—Parks, Forests, and Public Property

CHAPTER VIII—ADVISORY COUNCIL ON HISTORIC PRESERVATION

PART 800—PROTECTION OF HISTORIC AND CULTURAL PROPERTIES

Amendments to Existing Regulations

AGENCY: Advisory Council on Historic Preservation.

ACTION: Final amendments to regulations.

SUMMARY: These regulations implement Section 106 of the National Historic Preservation Act 1966, as amended (16 U.S.C. 470), and two Presidential directives issued pursuant to Section 106—Executive Order 11593, May 13, 1971, "Protection and Enhancement of the Cultural Environment" (36 FR 8921, 16 U.S.C. 470), and the President's Memorandum on Environmental Quality and Water Resources Management, July 12, 1978. The regulations have been amended to reflect changes and additions to the Council's authorities, as well as experience gained in working with the process since the last publication of regulations in 1974. These amendments are intended to expedite and clarify the commenting process required by Section 106 of the National Historic Preservation Act.

EFFECTIVE DATE: March 1, 1979.

FOR FURTHER INFORMATION CONTACT:

John M. Fowler, Acting General Counsel, Advisory Council on Historic Preservation, 1522 K Street, NW, Washington, D.C. 20005, 202-254-3967.

SUPPLEMENTARY INFORMATION:

BACKGROUND

The Advisory Council on Historic Preservation is publishing these final amendments to its existing regulations to implement Section 106 of the National Historic Preservation Act, as amended (16 U.S.C. 470f). The purpose of Section 106 is to protect properties included in or eligible for inclusion in the National Register of Historic Places through review and comment by the Council on Federal undertakings that affect such properties. Properties are listed on the National Register or declared eligible for listing by the Secretary of the Interior. As implemented through these regulations, the Section 106 process is a public interest process in which the Federal agency proposing an undertaking, the State Historic Preservation Officer, the Council, and interested organizations and individuals participate. The process is designed to assure that alternatives to avoid or mitigate an adverse effect on a National Register or eligible property are adequately considered in the planning processes. The regulations are binding on all Federal agencies and specify the manner in which the Council will render its comments to Federal agencies when their undertakings affect properties included in or eligible for inclusion in the National Register of Historic Places. To facilitate processing of the large volume of cases submitted for Council comment each year, the regulations provide for agency consultation with the Council staff and State Historic Preservation Officers to reduce the number of undertakings that require consideration by the full Council.

The purpose of the present amendments is to reduce procedural delay, encourage agencies to develop internal regulations to comply with the requirements of the Act and these regulations, to clarify the process since the last publication of the Council's regulations in 1974, and to implement the directives in the President's Memorandum on Environmental Quality and Water Resources Management.

In late 1977, the Council staff began a reassessment of the existing regulations codified in 1974 in 36 CFR Part 800, in an effort to determine what changes, clarifications, or modifications were necessary. In July of 1978, the President issued the Memorandum on Environmental Quality and Water Resources Management which directed the Chairman of the Council to review and promulgate regulations implementing the Act and the Memorandum by March 1, 1979. Accordingly, the existing regulations were amended to reflect changes in statutory authority, experience gained in implementing the procedures since 1974, and to meet the demands of the President's Memorandum.

The Council published proposed amendments to the existing regulations in the FEDERAL REGISTER on October 30, 1978, and invited public comment for a 30 day period. A number of Federal agencies and others requested extension of the comment period. On November 28, 1978, the Council published notice in the FEDERAL REGISTER extending the comment period for an additional thirty days until December 29, 1978, providing for a 60 day comment period in total. A public briefing for interested agencies, organizations, and individuals on the proposed amendments was held on December 11, 1978. Council staff also actively cooperated with the Secretary of the Interior's Water Policy Implementation Task Force on Environmental Statutes. The Task Force was convened in response to the directives contained in the President's Memorandum. The Task Force was charged with reviewing the draft regulations and informally offering comments to the Council on whether the regulations comply with the directive.

Pursuant to the President's Memorandum, agencies with consultation responsibilities under the Act must develop regulations to be approved by the Chairman of the Council in response to these regulations. Such agencies must publish regulations no later than three months after the effective date of these regulations. Other agencies may choose to adopt counterpart regulations specifically tailored to their particular program needs as stipulated in these regulations.

These regulations issued pursuant to 16 U.S.C. 470s were adopted by unanimous vote of the full Council in open session on January 17, 1979. As directed by the President, the amended regulations will be effective March 1, 1979.

SUMMARY OF MAJOR CHANGES

The flow of the commenting process established by the 1974 regulations remains basically unchanged in the present amendments. However, the regulations have been renumbered and rearranged from the 1974 publication for greater clarity. The following major changes have been made in the regulations:

1. Section 800.4(a) has been substantially revised to provide further guidance to Federal agencies on the identification of National Register and eligible properties.
2. A new § 800.5 has been added to define the responsibilities of State Historic Preservation Officers in the commenting process.
3. Section 800.6(d) authorizes the Chairman to appoint a panel of five members of the Council to consider undertakings in lieu of consideration by the full Council.
4. A new § 800.7 has been added dealing with resources discovered during construction.
5. A new § 800.8 has been added dealing with Programmatic Memoranda of Agreement allowing an agency to obtain the Council's comments for a particular program or class of undertakings that would otherwise require numerous individual requests for comments.
6. Section 800.9 revises the original section dealing with the National Environmental Policy Act to reflect new Council on Environmental Quality regulations.
7. A new § 800.11 has been added to authorize counterpart regulations permitting agencies to develop regulations which, if approved by the Chair-

man, may be used to meet certain requirements of these regulations.

8. A new § 800.15 has been added dealing with public participation in the Section 106 review process.

9. A new § 800.14 has been added on Supplementary Guidance. The Supplementary Guidelines included in the proposed amendments have been deleted. Supplementary Guidelines II and IV have been included in § 800.13.

10. Throughout the amended regulations, time limits have been established to expedite the process while encouraging maximum public participation.

COMMENTS AND THE COUNCIL'S RESPONSE

The Council received 128 comments prior to the close of the comment period on December 29, 1978. An additional 16 comments were received between December 30, 1978, and the Council meeting on January 17 and 18, 1979. All comments were submitted to the Council members for review prior to the meeting. Comments were received from 32 Federal agencies, 27 State Historic Preservation Officers, 33 State or local governments, and 52 private organizations or individuals, and one U.S. Senator.

SECTION 800.1 PURPOSE AND AUTHORITIES

The section was slightly reworded in response to several suggestions to make the language closer to that of the Act and Executive Order. A section was added summarizing the President's Memorandum on Environmental Quality and Water Resources Management.

SECTION 800.2 DEFINITIONS

Section 800.2(c) was clarified in response to several agency comments that the scope of the term "undertaking" was too broad and unclear. Of particular concern was the inclusion of activities proposed by Federal agencies for Congressional authorization or appropriation. This definition is not to be construed as requiring general program authorization and program appropriation requests to be reviewed under these regulations. The purpose is to ensure proper and timely consideration of specific activities that will have significant impacts on National Register or eligible properties and that provide limited opportunity after Congressional action to consider alternatives to avoid or mitigate these impacts. Such activities are usually major Federal construction projects that are proposed for Congressional approval at a specific site or with specific design features, such as a dam. Section 106 review would be appropriate prior to authorization or, in the case of projects authorized without prior Section 106 compliance, during the agency's formulation of a budget request to be submitted to the Office of Management and Budget. In either event agencies should complete their Section 106 responsibilities prior to making submissions to the Office of Management and Budget. Agencies will comply with the requirements of OMB Circular A-10, which concerns budget confidentiality.

Authorizations for programs that will have uniform adverse effects on National Register or eligible properties and where the legislative terms of authorization may severely limit the opportunity to avoid or mitigate adverse effects on a case by case basis are also included. An example would be the recent Special Bridge Replacement Program, which, in its original form, prohibited the use of funds for anything but replacement of unsafe bridges. The result was that alternatives such as rehabilitation were foreclosed when a particular National Register or eligible bridge was proposed for replacement. When seeking Council comments on such a program agencies should follow the provisions of § 800.8, "Programmatic Memorandum of Agreement."

The definition of eligible property contained in § 800.2(f) has been rewritten to more closely reflect statutory language and was changed in response to a Federal member agency. Several commenters were of the opinion that the Council should review only those undertakings affecting properties actually listed on the National Register. Such a limitation is contrary to the mandate of the National Historic Preservation Act, and was not adopted.

A definition of the area of the undertaking's potential environmental impact is contained in § 800.2(o). Several comments expressed concern about the difficulty in defining this term. The definition no longer includes reference to secondary effects and is consistent with the definition adopted by the Council on Environmental Quality. This new section has been modified since the draft amendments by the addition of the requirement that the boundaries of such an area are to be determined by the Agency Official and the State Historic Preservation Officer.

Section 800.2(p), Consulting Parties, is a new section. Many commenters expressed confusion as to who the parties to the consultation process were.

SECTION 800.3 CRITERIA OF EFFECT AND ADVERSE EFFECT

Section 800.3 was the subject of many comments. The entire section has been reworked for greater clarity. A definition of direct and indirect effects has been added and the definition deliberately tracks that used by the Council on Environmental Quality for purposes of the National Environmental Policy Act. The new language of this section is now tied closely to the National Register Criteria. One commenter suggested that only significant effects be covered by these regulations. This comment was not adopted because it is contrary to statutory requirements.

SECTION 800.4 FEDERAL AGENCY RESPONSIBILITIES

This section describes the means by which a Federal agency should identify National Register or eligible properties and determine whether an undertaking affects such properties and provides for coordination with the State Historic Preservation Officers. A large number of comments were received on the entire section. Many Federal agencies felt that further clarification of the entire section was needed. In response to these comments, the section has been re-structured. The Council has adopted a reasonable effort standard for Federal agencies to meet in identifying National Register and eligible properties. Federal agency responsibilities for determination of effect are also set forth in this section. The ultimate responsibility for compliance with the regulations rests with the Federal agency and cannot be delegated by it.

Section 800.4(a) has been altered in response to numerous comments including several from Federal agencies. The section has been re-drafted to set forth a logical sequence needed to identify properties. Throughout the process of identification, there should be consultation between the Agency Official and the State Historic Preservation Officer. The section makes clear that an agency can request the Council's comments simultaneously with a request for eligibility from the Secretary of the Interior. The Council believes that the reorganized section is clearer and that it will allow agencies to know in more precise terms what is required to identify National Register or eligible properties.

Section 800.4(b), Determination of Effect, also received numerous comments from Federal agencies and others. The section on No Effect (800.4(b)(1)) has been clarified concerning how an objection can be made and the manner in which the Executive Director will respond.

Section 800.4(c) concerning Determination of No Adverse Effect has been clarified in response to several comments. No Adverse Effect Determinations must be made in consultation with the appropriate State Historic Preservation Officer and evidence of contact with a State Historic Preservation Officer must be included in the documentation forwarded to the

Council if the State Historic Preservation Officer does not respond to a request under the provisions of § 800.5.

Section 800.4(d) has been slightly altered in response to several comments. The transmittal of a Preliminary Case Report will be the request for the comments of the Council.

A new § 800.4(e) has been added providing that good faith consultation would prevent an agency from proceeding with an undertaking until the Council has provided its comments. The section, while appearing in substantially the same form in several sections in the draft amendments, is now one section. It is included as one section at the request of a Federal agency member of the Council.

SECTION 800.5 STATE HISTORIC PRESERVATION OFFICER RESPONSIBILITIES

Section 800.5, State Historic Preservation Officer Responsibilities, is a new section. The section establishes deadlines for response on the part of this official, after which the process may continue if no response has been received. Pursuant to a substantial number of comments, however, lack of response by the State Historic Preservation Officer will no longer be deemed concurrence, although the review may still proceed. Several commenters suggested that the "shoulds" used in this section be changed to "shalls." The suggestion was rejected because the Council lacks authority to impose mandatory requirements on these State officials.

SECTION 800.6 COUNCIL COMMENTS

This section concerns the manner in which the Council will render its comments. There were a substantial number of comments on this section. In response to these comments, numerous changes were made to clear up ambiguities and make the Council's commenting process more expeditious.

Section 800.6(a) concerns the manner in which the Executive Director will respond to an agency Determination of No Adverse Effect. In response to comments, a specific time limit has been placed on the Executive Director's acceptance of adequate documentation and the time period for review of such Determinations of No Adverse Effect has been reduced from the 45 days stipulated in the 1974 regulations to 30 days.

A new § 800.6(a)(2) provides that the Executive Director may specify conditions to remove an objection to a No Adverse Effect Determination. Several commenters suggested that the State Historic Preservation Officer should be included in this process. It is the intention of the Council to include the State Historic Preservation Officer through the addition of a provision in § 800.6(a)(2) which allows the Executive Director to consult the State Historic Preservation Officer and other interested parties.

Section 800.6(b) parallels the existing regulations. However, several changes have been made, including provisions for specific time limits throughout the consultation process. Although a number of commenters felt that parties in interest to an undertaking should have the status of a consulting party, these comments were not adopted because the Council does not believe that it can impose such a uniform requirement due to the wide variety of agency programs. At the request of several Federal agencies, a lead agency provision is also included in this section.

In response to comments, § 800.6(b)(3) has been changed to provide that the public information meeting should be held near the site of the undertaking.

A new § 800.6(b)(6) on acceptance of adverse effect has been included. Previously, the Council equated acceptance of Adverse Effect with mitigation measures such as recording of a structure that was being demolished. The Council realizes that there are circumstances in which adverse effects on National Register or eligible properties must be accepted in the public interest. In such instances, the adverse effect will be accepted, generally with a proviso that a recording effort be part of the agreement.

Section 800.6(b)(7) has been clarified in response to comments. Any one of the consulting parties may declare a failure in the consultation process upon written notice to the Executive Director who is required to notify the Chairman of the failure within 15 days.

Section 800.6(c) concerning the Memorandum of Agreement has been rewritten in response to comments. An important change from the existing regulations is an expedited method for preparing the Memorandum of Agreement. A Federal agency will prepare a proposal, which together with the written concurrence of the State Historic Preservation Officer can be transmitted to the Executive Director and incorporated into the Memorandum of Agreement.

Many commenters agreed with the Council that this would speed up the process, but only if there were time limits placed on the process for ratification of an agreement. The Council agreed and a limit of 10 days has been imposed for transmittal of such Memoranda to the Chairman.

A new § 800.6(c)(3) dealing with the effect of a Memorandum of Agreement has been added. This subsection provides that if an agency fails to carry out the terms of the agreement that the comments of the Council must again be requested. Several commenters suggested that in such instances agencies should be admonished that no further action on the undertaking should proceed until the Council has commented. The Council agrees and this section has been revised accordingly.

In response to comments, § 800.6(c)(4) has been changed to provide that any signatory to the agreement can request a change in the terms. At the request of several commenters a new section has also been added which requires the Agency Official to provide a report on actions taken to carry out the terms of the agreement.

Section 800.6(d) dealing with Council meetings has been revised in response to comments. When the Chairman decides against consideration by the Council of a proposed undertaking, it can be scheduled if three members of the Council object. The proposed amendments would have required that a majority of the members object. Numerous commenters felt that such a large number was unrealistic. A major change from the 1974 regulations is the provision for a panel of members to consider an undertaking on behalf of the full Council. Such a panel would be composed of 5 members, three non-Federal members and two Federal members, neither of whom represents the agency proposing the undertaking. The Council believes that this provision will serve to both increase the number of cases referred for Council consideration and to expedite those cases. Several Council members felt that consideration of an undertaking by a panel would not be representative of the full range of views provided by the entire Council membership. After discussion at the full Council meeting on January 17, 1979, it was agreed that panel consideration of an undertaking may be advantageous in some situations. However, the Council felt that this provision should be re-examined in one year to determine the effectiveness of panel review of undertakings.

A number of comments were received on the section dealing with the review of a panel decision. Many commenters pointed out that an appeal of a panel decision by any one of the parties involved as proposed in the draft amendments could actually delay the process rather than speeding it up. The Council agrees with this assessment and the appeal provision has been deleted. However, if an agency determines not to follow the comments of a panel after considering the comments, it must provide notice to the Chairman in order to provide opportunity to have the matter considered by the full Council. Because of the nature of panel consideration of an undertaking, the comments were not adopted which suggested that no consideration of an undertaking beyond a panel was necessary.

In response to comments, time limits for notice of Council meetings and statements to the Council have been extended to provide ample opportunity for public participation. Section 800.6(d)(5) has been changed to provide that the comments of the Council will be issued within 15 days after a meeting and that such comments will be made available to interested parties, including the State Historic Preservation Officer.

Section 800.7 Resources Discovered During Construction

This section was proposed as a addition to the 1974 regulations. As originally proposed, the section was intended to establish a limited time period for the Council to provide its comments to an agency when a resource eligible for the National Register was discovered during the actual construction of a project after an agency had previously completed its Section 106 responsibilities. While there were several unqualified endorsements, the majority of the commenters felt that the section as proposed would cause undue project delays resulting in additional costs. The section was substantially rewritten in light of these comments. The mandatory halt of construction has been eliminated, although the Council believes that good faith consultation requires that an agency make reasonable efforts to avoid foreclosing options while the Council's comments are being sought. As drafted, § 800.7 applies only to those resources discovered during construction that meet the National Register Criteria. Agencies that discover National Register eligible properties during construction are required to comply with the provisions of the Archeological and Historic Preservation Act of 1974. The Council is adopting, as the standard for Section 106 compliance, mitigation acceptable to the Secretary of the Interior under the provisions of the Archeological and Historic Preservation Act. Therefore, an agency will be deemed to have met its responsibilities to afford the Council an opportunity to comment if it complies with the provisions of the Archeological and Historic Preservation Act, unless the Secretary determines that certain aspects of the undertaking warrant Council consideration. If Council consideration is determined to be necessary, a 30-day time limit has been placed on the transmittal of comments. The Council believes that this provision will serve to reduce time delays and effectively protect the resource.

Section 800.8 Programmatic Memorandum of Agreement

This section was developed as a means of allowing the Council to comment on a particular program or class of actions that would otherwise require multiple individual requests for comments under the regulations. This will expedite the review process and eliminate individual reviews of undertakings that are repetitive in nature. For example, the Council has executed a programmatic agreement with the National Park Service concerning the Park planning system. Under the terms of the agreement, individual actions taken to implement a master plan for a particular park that has previously been reviewed by the Council will normally not be subjected to further Council review.

A number of commenters suggested that the process include the State Historic Preservation Officers in States affected by such an agreement or the National Conference of State Historic Preservation Officers when the agreement is nationwide in scope. The regulations have been revised to specifically allow for such participation. Other changes have been made in the section to clarify ambiguities pointed out by a number of commenters.

Section 800.9 Coordination with the National Environmental Policy Act

This section sets forth the manner in which the review conducted under Section 106 should be coordinated with that required by the National Environmental Policy Act. This section elaborates on § 800.2 of the 1974 regulations and has been developed in consultation with the staff of the Council on Environmental Quality. It is the intention of the two agencies to issue joint supplementary guidance on this subject in the near future. The purpose of the section is to combine to the maximum extent possible the information on resources, evaluation of effects, and analysis of alternatives required by the separate statutes. For most projects, the Council's comments should be requested during the preparation of the draft environmental impact statement. Some commenters noted several classes of Federal projects which cannot be coordinated in this manner. The regulations have been revised to specifically provide for this situation. It is the Council's objective to provide its comments on an agency undertaking that requires an environmental impact statement in time to be included in the final statement. This should result in less paperwork and reduce delays in fulfilling agency environmental review responsibilities by allowing a single document to be used to meet the information requirements of both statutes.

Section 800.10 Coordination with the President's Memorandum on Environmental Quality and Water Resources Management

This section recapitulates the mandates contained in the Memorandum to agencies with water resources responsibilities to develop regulations to implement the Council's Section 106 regulations. A number of commenters requested the Council to add requirements for additional review of the required regulations and to develop stringent standards for the regulations. The Council will issue guidance to agencies to develop such regulations.

Section 800.11 Counterpart Regulations

This section has been revised to allow Federal agencies greater flexibility in implementing the procedural requirements of these regulations. Section 800.11 as proposed in the draft amendments dealt briefly with the development of agency procedures under Section 1(3) of Executive Order 11593. The revised section was developed from suggestions received from several Federal agencies. Under this section, an agency may choose to develop counterpart regulations that can be tailored to meet the specific requirements of its planning and decision making processes. Section 800.11 would permit agencies to develop counterpart regulations for meeting their responsibilities under Section 800.4. This section requires that the regulations be jointly drafted with the Executive Director and approved by the Chairman and provides an opportunity for public participation.

Section 800.12 Investigation of Threats to National Register and Eligible Properties

This section deals with situations where the Council has reason to believe that a Federal undertaking affecting a National Register or eligible property has not been reviewed in accordance with these regulations. Several clarifications were made to this section in response to specific comments. Some Federal agencies expressed a desire that the Council use discretion in investigating such threats. The Council intends to do so. Previously, these provisions were included in § 800.13(b). In the draft of the proposed amendments § 800.13(a) included a provision for comment or report on non-Federal undertakings. This section has been deleted because it is based on the Council's general advisory authorities under Section 202 of the Act and not on Section 106. The Council will continue to exercise its general advisory authority under Section 202 and will consider matters in the public interest.

Section 800.13 Reports to the Council

This section sets standards for information that should be provided to the Council to enable it to make informed comments on Federal undertakings. Sections 800.13(a) and (b) were previously included in the Supplementary Guidelines section. A large number of commenters requested that these standards for adequate documentation be codified. The Council agrees with these comments and believes that codifying these sections will make the requirements clear to all the consulting parties and the public. Section 800.13(c) dealing with Reports for Council Meetings includes a new section prescribing the Secretary of the Interior's Report. This section requests the Secretary to verify existing information on the historical or cultural significance of a National Register or eligible property and reflects the current practice of the Council. A number of commenters felt that the section was not entirely clear concerning how reports for Council meetings should be coordinated. The section has been re-drafted to respond to these comments.

Section 800.14 Supplementary Guidance

This is a new section which provides that the Executive Director may issue further guidance to interpret certain portions of the regulations.

Section 800.15 Public Participation

This is a new section which is designed to encourage public participation throughout the process established by the regulations. A number of comments urged that the regulations contain more explicit direction concerning the means of involving the public. Several suggested that such reference to public participation be included in various specific sections. The Council believes that a specific section dealing with public participation will best serve to fulfill the intended purpose of involving the public. The Council notes that its process is advisory and does not constitute formal administrative hearings. Therefore, this section is intended for guidance and is not to be construed as setting a strict legal standard. For example, the use of the word "notice" in subsection (b) is not intended to be a formal legal requirement, but rather a means of informing the public of an opportunity to participate in the process.

Other

The Supplementary Guidelines contained in the publication of the draft amendments have been deleted. Supplementary Guidelines II and IV have been codified as part of § 800.13. Supplementary Guideline I, the Criteria of the National Register of Historic Places, is contained in 36 CFR 60.6. Supplementary Guideline III, Determinations of No Effect and No Adverse Effect for Archeological Resources, will not be published at the present time. The Council's Task Force on Archeology will be considering this guideline and it will be revised based upon recommendations of the Task Force. This Guideline received numerous comments and they have been provided to the Task Force for its consideration.

Conclusion

The Council made a conscientious effort to incorporate all valid comments in these final amendments. As noted, revisions have been made to the regulations which we believe will serve to make the Section 106 commenting process an open and public process that can be tailored to the needs of individual agencies. The Council believes that the regulations set a clear standard for agencies to follow in meeting their Section 106 responsibilities, while being sufficiently flexible to respond to the wide variety of agency programs and needs.

The Council has determined that these amendments are not significant regulations within the meaning of Executive Order 12044 and consequently do not require a regulatory analysis. The purpose of these amendments is to simplify existing regulations and to clarify language in conformance with the goals enunciated by Executive Order 12044.

The Council has determined that an Environmental Impact Statement under the National Environmental Policy Act is not required.

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Part 800 is revised to read as set forth below:

PART 800—PROTECTION OF HISTORIC AND CULTURAL PROPERTIES

Sec.
800.1 Purpose and authorities.
800.2 Definitions.
800.3 Criteria of effect and advance effect.

Review of Individual Undertakings

800.4 Federal Agency Responsibilities.
800.5 State Historic Preservation Officer Responsibilities.
800.6 Council comments.
800.7 Resources discovered during construction.

Federal Program Coordination

800.8 Programmatic Memorandum of Agreement.
800.9 Coordination with the National Environmental Policy Act (42 U.S.C. 4321 et seq.)
800.10 Coordination with the Presidential Memorandum on environmental quality and water resources management.
800.11 Counterpart regulations.

Other Provisions

800.12 Investigation of threats to historic properties.
800.13 Reports to the Council.
800.14 Supplementary guidance.
800.15 Public participation.

Authority: Pub. L. 89-665, 80 Stat. 915 (16 U.S.C. 470), as amended, 84 Stat. 204 (1970), 87 Stat. 139 (1973), 90 Stat. 1320 (1976), 92 Stat. 3467 (1978); E.O. 11593, 3 CFR 1971 Comp. p. 154; President's Memorandum on Environmental Quality and Water Resources Management, July 12, 1978.

§ 800.1 Purpose and authorities.

(a) The National Historic Preservation Act of 1966, as amended, established the Advisory Council on Historic Preservation as an independent agency of the United States to advise the President and the Congress on historic preservation matters, recommend measures to coordinate Federal historic preservation activities, and comment on Federal actions affecting properties included in or eligible for inclusion in the National Register of Historic Places. Its members are the Secretary of the Interior, the Secretary of Housing and Urban Development, the Secretary of Commerce, the Administrator of General Services, the Secretary of the Treasury, the Attorney General, the Secretary of Agriculture, the Secretary of Transportation, the Secretary of State, the Secretary of Defense, the Secretary of Health, Education, and Welfare, the Chairman of the Council on Environmental Quality, the Chairman of the Federal Council on the Arts and Humanities, the Architect of the Capitol, the Secretary of the Smithsonian Institution, the Chairman of the National Trust for Historic Preservation, the President of the National Conference of State Historic Preservation Officers, and 12 citizen members from outside the Federal Government appointed for five-year terms by the President on the basis of their interest and experience in the matters to be considered by the Council.

(b) The Council protects properties of historical, architectural, archeological, and cultural significance at the national, State, and local level by reviewing and commenting on Federal actions affecting National Register and eligible properties in accordance with the following authorities:

(1) Section 106 of the National Historic Preservation Act. Section 106 requires that Federal agencies with direct or indirect jurisdiction over a Federal, federally assisted or federally licensed undertaking afford the Council a reasonable opportunity for comment on such undertakings that affect properties included in or eligible for inclusion in the National Register of Historic Places prior to the agency's approval of any such undertaking.

(2) Section 1(3) of Executive Order 11593, May 13, 1971, "Protection and Enhancement of the Cultural Environment." Section 1(3) requires that Federal agencies, in consultation with the Council, institute procedures to assure that their plans and programs contribute to the preservation and enhancement of non-federally owned historic and cultural properties.

(3) Section 2(b) of Executive Order 11593, May 13, 1971, "Protection and Enhancement of the Cultural Environment." Federal agencies are required by Section 2(a) of the Executive Order to locate, inventory, and nominate properties under their jurisdiction or control to the National Register. Until such processes are complete, Federal agencies must provide the Council an opportunity to comment on proposals for the transfer, sale, demolition, or substantial alteration of federally owned properties eligible for inclusion in the National Register.

(4) The President's Memorandum on Environmental Quality and Water Resources Management. The Memorandum directs the Council to issue final regulations under the National Historic Preservation Act by March 1, 1979, and further directs Federal agencies with water resource responsibilities and programs to publish procedures implementing the Act not later than three months after promulgation of final regulations by the Council. Federal agencies' procedures are to be reviewed and, if they are consistent with the Council's regulations, approved by the Council within 60 days and published in final form.

§ 800.2 Definitions.

As used in these regulations:

(a) "National Historic Preservation Act" means Pub. L. 89-665, approved October 15, 1966, an "Act to establish a program for the preservation of additional historic properties throughout the Nation and for other purposes" (80 Stat. 915, 16 U.S.C. 470, as amended; 84 Stat. 204 (1970), 87 Stat. 139 (1973), 90 Stat. 1320 (1976), 92 Stat. 3467 (1978)), hereinafter referred to as "the Act."

(b) "Executive Order" means Executive Order 11593, May 13, 1971, "Protection and Enhancement of the Cultural Environment" (36 FR 8921, 16 U.S.C. 470).

(c) "Undertaking" means any Federal, federally assisted or federally licensed action, activity, or program or the approval, sanction, assistance, or support of any non-Federal action, activity, or program. Undertakings include new and continuing projects and program activities (or elements of such activities not previously considered under Section 106 or Executive Order 11593) that are: (1) Directly undertaken by Federal agencies; (2) supported in whole or in part through Federal contracts, grants, subsidies, loans, loan guarantees, or other forms of direct and indirect funding assistance; (3) carried out pursuant to a Federal lease, permit, license, certificate, approval, or other form of entitlement or permission; or, (4) proposed by a Federal agency for Congressional authorization or appropriation. Site-specific undertakings affect areas and properties that are capable of being identified at the time of approval by the Federal agency. Non-site-specific undertakings have effects that can be anticipated on National Register and eligible properties but cannot be identified in terms of specific geographical areas or properties at the time of Federal approval. Non-site-specific undertakings include Federal approval of State plans pursuant to Federal legislation, development of comprehensive or area-wide plans, agency recommendations for legislation and the establishment or modification of regulations and planning guidelines.

(d) "National Register" means the National Register of Historic Places. It is a register of districts, sites, buildings, structures, and objects of national, State, or local significance in American history, architecture, archeology, and culture that is expanded and maintained by the Secretary of the Interior under authority of section 2(b) of the Historic Sites Act of 1935 (49 Stat. 666, 16 U.S.C. 461) and Section 101(a)(1) of the National Historic Preservation Act implemented through 36 CFR Part 60. The National Register is published in its entirety in the FEDERAL REGISTER each year in February. Addenda are usually published on the first Tuesday of each month.

(e) "National Register property" means a district, site, building, structure, or object included in the National Register.

(f) "Eligible property" means any district, site, building, structure, or object that meets the National Register Criteria.

(g) "National Register Criteria" means the criteria established by the Secretary of the Interior to evaluate properties to determine whether they are eligible for inclusion in the National Register. (See 36 CFR 60.6.)

(h) "Decision" means the exercise of or the opportunity to exercise discretionary authority by a Federal agency at any stage of an undertaking where alterations might be made in the undertaking to modify its impact upon National Register and eligible properties.

(i) "Agency Official" means the head of the Federal agency having responsibility for the undertaking or a designee authorized to act for the Agency Official.

(j) "Council" means the Advisory Council on Historic Preservation as established by Title II of the Act.

(k) "Chairman" means the Chairman of the Advisory Council on Historic Preservation or a member designated to act for the Chairman.

(l) "Executive Director" means the Executive Director of the Advisory Council on Historic Preservation as established by Section 205 of the Act, or a designee authorized to act for the Executive Director.

(m) "State Historic Preservation Officer" means the official, who is responsible for administering the Act within the State or jurisdiction, or a designated representative authorized to act for the State Historic Preservation Officer. These officers are appointed pursuant to 36 CFR Part 61.2 by the Governors of the 50 States, Guam, American Samoa, the Commonwealth of Puerto Rico, the Virgin Islands, the Trust Territory of the Pacific Islands, the Commonwealth of the Mariana Islands, and the Mayor of the District of Columbia.

(n) "Secretary" means the Secretary of the Interior or a designee authorized to carry out the historic preservation responsibilities of the Secretary under the Act, Executive Order 11593, and related authorities.

(o) "Area of the undertaking's potential environmental impact" means that geographical area within which direct and indirect effects generated by the undertaking could reasonably be expected to occur and thus cause a change in the historical, architectural, archeological, or cultural qualities possessed by a National Register or eligible property. The boundaries of such area should be determined by the Agency Official in consultation with the State Historic Preservation Officer as early as possible in the planning of the undertaking.

(p) "Consulting parties" means the Agency Official, the State Historic Preservation Officer, and the Executive Director.

§ 800.3 Criteria of effect and adverse effect.

The following criteria shall be used to determine whether an undertaking has an effect or an adverse effect in accordance with these regulations.

(a) *Criteria of Effect.* The effect of a Federal, federally assisted or federally licensed undertaking on a National Register or eligible property is evaluated in the context of the historical, architectural, archeological, or cultural signficance possessed by the property. An undertaking shall be considered to have an effect whenever any condition of the undertaking causes or may cause any change, beneficial or adverse, in the quality of the historical, architectural, archeological, or cultural characteristics that qualify the property to meet the criteria of the National Register. An effect occurs when an undertaking changes the integrity of location, design, setting, materials, workmanship, feeling, or association of the property that contributes to its significance in accordance with the National Register criteria. *An* effect may be direct or indirect. Direct effects are caused by the undertaking and occur at the same time and place. Indirect effects include those caused by the undertaking that are later in time or farther removed in distance, but are still reasonably foreseeable. Such effects may include changes in the pattern of land use, population density or growth rate that may affect on properties of historical, architectural, archeological, or cultural significance.

(b) *Criteria of Adverse Effect.* Adverse effects on National Register or eligible properties may occur under conditions which include but are not limited to:

(1) Destruction or alteration of all or part of a property;

(2) Isolation from or alteration of the property's surrounding environment;

(3) Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting;

(4) Neglect of a property resulting in its deterioration or destruction.

(5) Transfer or sale of a property without adequate conditions or restrictions regarding preservation, maintenance, or use.

REVIEW OF INDIVIDUAL UNDERTAKINGS

§ 800.4 Federal Agency responsibilities.

As early as possible before an agency makes a final decision concerning an undertaking and in any event prior to taking any action that would foreclose alternatives or the Council's ability to comment, the Agency Official shall take the following steps to comply with the requirements of Section 106 of the National Historic Preservation Act and Section 2(b) of Executive Order 11593. It is the primary responsibility of each Agency Official requesting Council comments to conduct the appropriate studies and to provide the information necessary for an adequate review of the effect a proposed undertaking may have on a National Register or eligible property, as well as the information necessary for adequate consideration of modifications or alterations to the proposed undertaking that could avoid, mitigate, or minimize any adverse effects. It is the responsibility of each Agency Official requesting consultation with a State Historic Preservation Officer under this section to provide the information that is necessary to make an informed and reasonable evaluation of whether a property meets National Register criteria and to determine the effect of a proposed undertaking on a National Register or eligible property. Although a Federal agency may require non-Federal parties to undertake certain steps required by these regulations as a prerequisite to Federal action and may authorize non-Federal participation under this section and in the consultation process under Section 800.6 pursuant to approved counterpart regulations, the ultimate responsibility for compliance with these regulations remains with the Federal agency and cannot be delegated by it.

(a) *Identification of National Register and Eligible Properties.* It is the responsibility of each Federal agency to identify or cause to be identified any National Register or eligible property that is located within the area of the undertaking's potential environmental impact and that may be affected by the undertaking.

(1) The Agency Official shall consult the State Historic Preservation Officer, the published lists of National Register and eligible properties, public records, and other individuals or organizations with historical and cultural expertise, as appropriate, to determine what historic and cultural properties are known to be within the area of the undertaking's potential environmental impact. The State Historic Preservation Officer should provide the Agency Official with any information available on known historic and cultural properties identified in the area (whether on the National Register or not), information on any previous surveys performed and an evaluation of their quality, a recommendation as to the need for a survey of historic and cultural properties, and recommendations as to the type of survey and/or survey methods should a survey be recommended, and recommendations on boundaries of such surveys.

(2) The Agency Official shall, after due consideration of the information obtained pursuant to § 800.4(a)(1), determine what further actions are necessary to discharge the agency's affirmative responsibilities to locate and identify eligible properties that are within the area of the undertaking's potential environmental impact and that may be affected by the undertaking. Such actions may include a professional cultural resource survey of the environmental impact area, or parts of the area, if the area has not previously been adequately surveyed. The recommendations of the State Historic Preservation Officer should be followed in this matter.

(3) The Agency Official, in consultation with the State Historic Preservation Officer, shall apply the National Register criteria to all properties that may possess any historical, architectural, archeological, or cultural value located within the area of the undertaking's potential environmental impact. If either the Agency Official or the State Historic Preservation Officer finds that a property meets the National Register Criteria or a question exists as to whether a property meets the Criteria, the Agency Official shall request a determination of eligibility from the Secretary of the Interior in accordance with 36 CFR Part 63. The opinion of the Secretary respecting the eligibility of a property shall be conclusive for the purposes of these regulations. If the Agency Official and the State Historic Preservation Officer agree that no identified property meets the Criteria, the Agency Official shall document this finding and, unless the Secretary has otherwise made a determination of eligibility under 36 CFR Part 63, may proceed with the undertaking.

(4) The Agency Official shall complete the preceding steps prior to requesting the Council's comments pursuant to Section 800.4(b)-(d). The Agency Official may, however, initiate a request for the Council's comments simultaneously with a request for a determination of eligibility from the Secretary when the Agency Official and the State Historic Preservation Officer agree that a property meets the National Register Criteria. Before the Council completes action pursuant to § 800.6, the Secretary must find the property eligible for inclusion in the National Register.

(b) *Determination of Effect.* For each National Register or eligible property that is located within the area of the undertaking's potential environmental impact, the Agency Official, in consultation with the State Historic Preservation Officer, shall apply the Criteria of Effect, (§ 800.3(a)), to determine whether the undertaking will have an effect upon the historical, architectural, archeological, or cultural characteristics of the property that qualified it to meet National Register Criteria.

(1) *No Effect.* If the Agency Official, in consultation with the State Historic Preservation Officer, finds that the undertaking will not affect these characteristics, the undertaking may proceed. The Agency Official shall document each Determination of No Effect, which shall be available for public inspection. If the State Historic Preservation Officer objects or other timely objection is made to the Executive Director to an Agency Official's Determination of No Effect, the Executive Director may review the Determination and advise the Agency Official, the State Historic Preservation Officer and any objecting party of the findings within 15 days.

(2) *Effect determined.* If the Agency Official or the Executive Director finds that the undertaking will have an effect upon these characteristics, the Agency Official, in consultation with the State Historic Preservation Officer, shall apply the Criteria of Adverse Effect, set forth in section 800.3(b), to determine whether the effect of the undertaking may be adverse.

(c) *Determinations of no adverse effect.* If the Agency Official, in consultation with the State Historic Preservation Officer, finds the effect on the historical, architectural, archeological, or cultural characteristics of the property not to be adverse, the Agency Official shall forward adequate documentation (See § 800.13(a)) of the Determination, including written evidence of the views of the State Historic Preservation Officer, to the Executive Director for review in accordance with Section 800.6. If the State Historic Preservation Officer fails to respond to an Agency Official's request as provided in Section 800.5, the Agency Official shall include evidence of having contacted the State Historic Preservation Officer.

(d) *Adverse effect determination.* If the Agency Official finds the effect on the historical, architectural, archeological, or cultural characteristics of the property to be adverse, or if the Executive Director does not accept an Agency Official's Determination of No Adverse Effect pursuant to review under Section 800.6, the Agency Official shall:

(1) Prepare and submit a Preliminary Case Report requesting the comments of the Council (See § 800.13(b)),

(2) Notify the State Historic Preservation Officer of this request, and

(3) Proceed with the consultation process set forth in § 800.6.

(e) *Suspense of action.* Until the Council issues its comments under these regulations, good faith consultation shall preclude a Federal agency from taking or sanctioning any action or making any irreversible or irretrievable commitment that could result in an adverse effect on a National Register or eligible property or that would foreclose the consideration of modifications or alternatives to the proposed undertaking that could avoid, mitigate, or minimize such adverse effects.

§ 800.5 State Historic Preservation Officer responsibilities.

(a) The State Historic Preservation Officer should participate in the review process established by these regulations whenever it concerns an undertaking located within the State Historic Preservation Officer's jurisdiction.

(b) Unless a longer time is agreed to by the Agency Official, the failure of a State Historic Preservation Officer to respond to an Ageny Official's request for consultation under Section 800.4 within 30 days after receipt shall not prohibit the Agency Official from proceeding with the review process under these regulations.

(c) The State Historic Preservation Officer, with the Agency Official and the Executive Director, should participate in any consultation under § 800.6(b) and sign any Memorandum of Agreement developed under § 800.6(c) of these regulations. Failure of a State Historic Preservation Officer to participate in a consultation under § 800.6(b) or to sign a Memorandum of Agreement as provided in § 800.6(c)(1) within 30 days of receipt without notifying the Executive Director and the Agency Official that the State Historic Preservation Officer disagrees with the terms of the Agreement shall not prohibit the Executive Director and the Agency Official from concluding the Agreement and having it ratified by the Chairman in accordance with § 800.6(c)(2).

§ 800.6 Council comments.

The following subsections specify how the Council will respond to Federal agency requests for the Council's comments required to satisfy an agency's responsibilities under Section 106 of the Act and Section 2(b) of the Executive Order.

(a) *Response to determinations of no adverse effect.* (1) Upon receipt of a Determination of No Adverse Effect from an Agency Official, the Executive Director will review the Determination and supporting documentation. Normally, the Executive Director will concur without delay. If the documentation is not adequate, the Executive Director will so inform the Agency Official within 15 days. Unless the Executive Director objects to the Determination within 30 days after receipt of an adequately documented Determination, the Agency Official will be considered to have satisfied the agency's responsibilities under Section 106 of the Act, Section 2(b) of the Executive Order, and these regulations, and may proceed with the undertaking.

(2) If the Executive Director objects to a Determination of No Adverse Effect, the Executive Director shall specify the basis for the objection and may specify conditions which will eliminate the objection. As appropriate, the Executive Director may consult the Agency Official, the State Historic Preservation Officer, and other interested parties in specifying conditions. If the Agency Official accepts the conditions in writing, the conditions will be incorporated into the agency's Determination and the Executive Director's objection will be withdrawn. The Agency Official then will be considered to have satisfied the agency's responsibilities under Section 106 of the Act, Section 2(b) of the Executive Order, and these regulations, and may proceed with the undertaking.

(3) If the Agency Official does not accept the Executive Director's conditions or if the Executive Director objects to a Determination of No Adverse Effect without specifying conditions that would remove the objection, the Executive Director shall initiate the consultation process pursuant to § 800.6(b).

(b) *Consultation Process.* The Agency Official, the State Historic Preservation Officer, and the Executive Director shall be the consulting parties to consider feasible and prudent alternatives to the undertaking that could avoid, mitigate, or minimize adverse effects on a National Register or eligible property. When an undertaking involves more than one Federal agency, these agencies may, upon notification to the Executive Director, coordinate their consultation responsibilities through a single lead agency. Grantees, permittees, licensees, or other parties in interest, and representatives of national, State, or local units of government and public and private organizations, may be invited by the consulting parties to participate in the consultation process.

(1) *Preliminary Case Report.* The Agency Official shall provide copies of the report to the consulting parties at the initiation of the consultation and make it readily available for public inspection.

(2) *On-site inspection.* At the request of any of the consulting parties, the Agency Official shall conduct an on-site inspection.

(3) *Public Information Meeting.* At the request of any of the consulting parties, the Executive Director shall conduct a meeting open to the public, where representatives of national, State, or local units of government, representatives of public or private or-

ganizations, and interested citizens may receive information and express their views on the undertaking, its effects on the National Register or eligible property, and alternate courses of action that could avoid, mitigate, or minimize any adverse effects on such properties. The Agency Official shall provide adequate facilities for the meeting near the site of the undertaking and shall afford appropriate notice to the public, generally at least 15 days in advance of the meeting.

(4) *Consideration of Alternatives.* Upon review of the proposed undertaking and after any on-site inspection or public information meeting, the consulting parties shall determine whether there are feasible and prudent alternatives to avoid the adverse effects on National Register or eligible property. If the consulting parties cannot agree on an alternative to avoid, they shall consult further to determine if there are alternatives that could satisfactorily mitigate the adverse effects.

(5) *Avoidance or Satisfactory Mitigation of Adverse Effect.* If the consulting parties agree upon a feasible and prudent alternative to avoid or satisfactorily mitigate the adverse effects of the undertaking on the National Register or eligible property, they shall execute a Memorandum of Agreement in accordance with § 800.6(c) specifying how the undertaking will proceed to avoid or mitigate the adverse effect.

(6) *Acceptance of Adverse Effect.* If the consulting parties determine that there are no feasible and prudent alternatives that could avoid or satisfactorily mitigate the adverse effects and agree that it is in the public interest to proceed with the proposed undertaking, they shall execute a Memorandum of Agreement in accordance with § 800.6(c) acknowledging this determination and specifying any recording, salvage, or other measures to minimize the adverse effects that shall be taken before the undertaking proceeds.

(7) *Failure to Agree.* Upon the failure of the consulting parties to agree upon the terms for a Memorandum of Agreement, or upon notice of such failure by any of the consulting parties to the Executive Director, the Executive Director shall notify the Chairman within fifteen days and shall recommend whether or not the matter should be scheduled for consideration at a Council meeting. The Agency Official and the State Historic Preservation Officer shall be notified in writing of the Executive Director's recommendation.

(c) *Memorandum of Agreement*—(1) *Preparation of Memorandum of Agreement.* It shall be the responsibility of the Executive Director to prepare each Memorandum of Agreement required under these regulations. Unless otherwise requested by the Executive Director, the Agency Official shall prepare a proposal for inclusion in the Agreement that details the actions agreed upon by the consulting parties to be taken to avoid, satisfactorily mitigate, or accept the adverse effects on the property. The State Historic Preservation Officer's written concurrence shall be included in this proposal by the Agency Official. If the Executive Director determines that the proposal represents the agreement of the consulting parties, he shall within 10 days forward it as a Memorandum of Agreement to the Chairman for ratification pursuant to § 800.6(c)(2). If the Executive Director determines that the proposal does not adequately represent the agreement reached by the consulting parties, it may be returned to the Agency Official, or a Memorandum of Agreement revising the proposal may be submitted to the Agency Official and the State Historic Preservation Officer. As appropriate other parties in interest may be invited by the consulting parties to indicate their concurrence with the proposal or to be a signatory to the Agreement.

(2) *Review of Memorandum of Agreement.* Upon receipt of an executed Memorandum of Agreement, the Chairman shall institute a 30-day review period. Unless the Chairman notifies the Agency Official that the matter has been placed on the agenda for consideration at a Council meeting, the Agreement shall become final when ratified by the Chairman or upon the expiration of the 30-day review period with no action taken. Copies will be provided to signatories and notice of executed Memoranda of Agreement shall be published in the Federal Register. The Memorandum of Agreement should be included in the final environmental impact statement prepared pursuant to the National Environmental Policy Act.

(3) *Effect of Memorandum of Agreement.* Agreements duly executed in accordance with these regulations shall constitute the comments of the Council and shall evidence satisfaction of the Federal agency's responsibilities for the proposed undertaking under Section 106 of the Act, Section 2(b) of the Executive Order, and these regulations. Failure to carry out the terms of a Memorandum of Agreement requires that the Federal agency again request the Council's comments in accordance with these regulations. In such instances, until the Council issues its comments under these regulations the Agency Official shall not take or sanction any action or make any irreversible or irretrievable commitment that could result in an adverse effect with respect to National Register or eligible properties covered by the Agreement or that would foreclose the Council's consideration of modifications or alternatives to the proposed undertaking that could avoid or mitigate the adverse effect.

(4) *Amendment of a Memorandum of Agreement.* If a signatory determines that the terms of the Memorandum of Agreement cannot be met or believes a change is necessary, the signatory shall immediately request the consulting parties to consider an amendment of the Agreement. Amendments will be executed in the same manner as the original Agreement.

(5) *Report on Memorandum of Agreement.* Within 90 days after carrying out the terms of the Agreement, the Agency Official shall report to all signatories on the actions taken.

(d) *Council Meetings.* The Council does not hold formal administrative hearings to develop its comments under these regulations. Reports and statements will be presented to the Council in open session in accordance with a prearranged agenda. Regular meetings of the Council generally occur quarterly.

(1) *Response to Recommendation for Consideration at Council Meeting.* Upon receipt of a notice and recommendation from the Executive Director concerning consideration of a proposed undertaking at a Council meeting, the Chairman shall determine within 15 days whether or not the undertaking will be considered and shall notify the Executive Director, the Agency Official, and the State Historic Preservation Officer of his decision. The Agency Official shall and the State Historic Preservation Officer should provide such reports and information as may be required to assist the Chairman in this determination.

If the Chairman decides against consideration of the undertaking at a Council meeting, a written summary of the undertaking, any recommendations for action by the Federal agency, and the decision shall be sent to each member of the Council. The Chairman shall also notify the Agency Official and the State Historic Preservation Officer and other parties in interest of the decision. If three members of the Council object within 10 days of the Chairman's decision, the undertaking shall be scheduled for consideration at a Council meeting. Unless three members of the Council object, the chairman shall notify the Agency Official, the State Historic Preservation Officer, and other parties in interest in writing that the undertaking may proceed. Such notice shall be evidence of satisfaction of the Federal agency's responsibilities for the proposed undertaking under Section 106 of the Act, Section 2(b) of the Executive Order, and these regulations.

(2) *Decision to Consider the Undertaking.* When the Council will consider an undertaking at a meeting, the Chairman shall either designate five members as a panel to hear the matter on behalf of the full Council, or schedule the matter for consideration by the full Council.

(i) A panel shall consist of three non-Federal members, one as Chairman; and two Federal members, neither of whom shall represent the Federal agency involved in the undertaking. The panel shall meet to consider the undertaking within 30 days of the Chairman's decision unless the Agency Official agrees to a longer time.

(ii) The full Council will consider an undertaking at the next regularly scheduled meeting and no less than 60 days from the date of the Chairman's decision. In exceptional cases the Chairman may schedule the matter for consideration at a special meeting of the full Council to be held less than 60 days from the date of the decision.

(iii) Prior to any panel or full Council consideration of a matter, the Chairman will notify the Agency Official and the State Historic Preservation Officer, and other parties in interest of the date on which the undertaking will be considered. The Executive Director, the Agency Official, and the State Historic Preservation Officer shall prepare reports in accordance with § 800.13. Reports required from the Agency Official and the State Historic Preservation Officer must be received by the Executive Director at least 21 days before any meeting. Failure by the Federal agency to submit its report may result in postponement of consideration of the undertaking.

(3) *Meeting Notice.* Generally, 21 days notice of all meetings involving Council review of undertakings in accordance with these regulations shall be given by publication in the FEDERAL REGISTER. In exceptional cases, no less than 7 days notice shall be given by publication in the FEDERAL REGISTER.

(4) *Statements to the Council.* An agenda shall provide for oral statements from the Executive Director; the Agency Official; other parties in interest; the Secretary of the Interior; the State Historic Preservation Officer; representatives of national, State, or local units of government, and interested public and private organizations and individuals. Parties wishing to make oral remarks should notify the Executive Director at least two days in advance of the meeting. Parties wishing to have their statements distributed to Council members prior to the meeting should send copies of the statements to the Executive Director at least 7 days in advance.

(5) *Comments of the Council.* The written comments of the Council will be issued within 15 days after a meeting. Comments shall be made to the head of the Federal agency requesting comment or having responsibility for the undertaking. Immediately after the comments are made to the Federal agency, the comments of the Council will be forwarded to the President and Congress as a special report under authority of Section 202(b) of the Act and a notice of availability will be published in the FEDERAL REGISTER. The comments of the Council shall be available to the State Historic Preservation Officer, other parties in interest, and the public upon receipt of the comments by the head of the Federal Agency. The comments of the Council should be included in the final environmental impact statement prepared pursuant to the National Environmental Policy Act.

(6) *Review of Panel Decision.* Upon receipt of the panel's comments after a meeting, the head of the Federal agency shall take these comments into account in reaching a decision in regard to the proposed undertaking. If the agency determines not to follow the panel's comments, the Agency Official shall immediately provide written notice of this decision to the Council. The Chairman may convene a meeting of the full Council to consider the matter within 30 days of receipt of such notice. In the interim period the Agency Official shall not take or sanction any action or make any irreversible or irretrievable commitment that could result in an adverse effect on the National Register or eligible property or that would foreclose the Council's consideration of modifications or alternatives to the proposed undertaking that could avoid or mitigate the adverse effect. If the Chairman decides against consideration of the proposed undertaking, the consulting parties shall be immediately notified and the undertaking may proceed.

(7) *Agency Action in Response to Council Comments.* Upon receipt of the Council's comments after a meeting, the head of the Federal agency shall take these comments into account in reaching a final decision in regard to the proposed undertaking. When a final decision regarding the proposed undertaking is reached by the Federal agency, the Agency Official shall submit a written report to the Council describing the actions taken by the Federal Agency in response to the Council's comments; the actions taken by other parties pursuant to the actions of the Federal Agency; and the effect that such actions will have on the affected National Register or eligible property. Receipt of this Report by the Chairman shall be evidence that the agency has satisfied its responsibilities for the proposed undertaking under Section 106 of the Act, Section 2(b) of the Executive Order and these regulations. The Council may issue a final report to the President and Congress under authority of Section 202(b) of the Act describing the actions taken by the agency in response to the Council's comments including recommendations for changes in Federal policy and programs, as appropriate.

(8) *Continuing Review Jurisdiction.* When the Council has met and commented upon an undertaking that will require subsequent site-specific undertakings by a Federal agency, the Council's comment extends only to the undertaking as reviewed. The Agency Official shall ensure that subsequent actions related to the undertaking that have not been considered by the Council will be submitted to the Council for review in accordance with these regulations.

§ 800.7 Resources discovered during construction.

(a) *Federal Agency Responsibilities.* If a Federal agency has previously met its responsibilities for identified National Register and eligible properties under Section 106 of the Act, Section 2(b) of the Executive Order, these regulations, and the National Environmental Policy Act (42 U.S.C. 4321 et seq.), and an Agency Official finds or is notified after contruction has started that an undertaking will have an effect on a previously unidentified National Register or eligible property, the Federal agency may fulfill its responsibilities under Section 106 of the Act, Section 2(b) of the Executive Order, and these regulations, by complying with the requirements of the Archeological and Historic Preservation Act (16 U.S.C. 469(a)) as implemented by the Secretary, unless the Secretary determines that the significance of the property, the effect, and any proposed mitigation actions warrant Council consideration. If the Secretary determines the Council's comments are warranted, the Agency Official shall request the comments of the Council.

(b) *Council Comments.* Within 30 days of receipt of a request for comments from an Agency Official under this section, the Executive Director, with the concurrence of the Chairman, shall transmit comments on behalf of the Council to the Agency Official or the Chairman shall convene a meeting of the Council pursuant to § 800.6.

FEDERAL PROGRAM COORDINATION

§ 800.8 Programmatic Memoranda of Agreement.

(a) *Application.* At the request of an Agency Official, the Council will consider execution of a Programmatic Memorandum of Agreement to fulfill ments of NEPA, Section 106, Executive Order 11593, and these regulations.

(a) It is normally intended that the Section 106/Executive Order commenting period run concurrently with the NEPA review process. Initiation of the consideration of historic and cultural resources should coincide with the initiation of other environmental reviews. To the maximum extent possible, agencies should reflect the status of compliance with Section 106, the Executive Order, and these regulations in all documents prepared under NEPA (environmental assessments, draft environmental impact statements, and final environmental impact statements) to provide the public with the fullest and most complete information available on effects on historic and cultural resources and alternatives to reduce those effects. If the commenting process under Section 106 and the Executive Order is not completed before the final environmental impact statement is issued, as with undertakings where subsequent design stage reviews occur, agencies should include the council's comments in any supplemental statement that is prepared pursuant to NEPA.

(b) Federal agencies should initiate compliance with Section 106 of the Act and the Executive Order in accordance with these regulations during initial environmental assessments that are undertaken to meet the requirements of NEPA and agency environmental procedures. In any event, this should occur no later than during the preparation of the draft environmental impact statement. Identification of National Register and eligible properties should be carried out in accordance with § 800.4 of these regulations. Potential effects should then be evaluated in accordance with the Criteria of Effect and Adverse Effect in § 800.3 of these regulations. The environmental assessment and the draft environmental impact statement should fully describe any National Register or eligible properties within the area of the undertaking's potential environmental impact and the nature of the undertaking's effect on them.

(c) If evaluation of the effect resulted in a Determination of No Effect or No Adverse Effect under § 800.4, that finding, along with supporting documentation, should be included or referenced in the environmental assessment and the draft environmental impact statement.

(d) If evaluation of the effect resulted in a Determination of Adverse Effect, that finding and a copy of the agency's request for the Council's comments in accordance with § 800.4(d)(1) of these regulations should be included in or referenced in the environmental assessment and the draft environmental impact statement. Agencies should include all available relevant information on National Register and eligible properties, the effects of the undertaking and alternative courses of action so that the draft environmental impact statement can be submitted as the preliminary case report under § 800.13(b) of these regulations. In some instances, the Section 106/Executive Order commenting process will be completed prior to issuance of a draft environmental impact statement. In that event, the comments of the Council should be included in the draft.

(e) Completion of the Council commenting process in accordance with these regulations should precede issuance of the final environmental impact statement. Comments of the Council obtained pursuant to § 800.6 or § 800.8 of these regulations should be incorporated into the final statement.

(f) The Council, in its review of environmental impact statements for undertakings that affect National Register or eligible properties, will look for evidence of proper compliance with Section 106 of the Act, Section 2(b) of the Executive Order, and these regulations. The Council's views on the agency's compliance with those authorities will be included in its comments on environmental impact statements.

§ 800.10 Coordination with the Presidential Memorandum on Environmental Quality and Water Resources Management.

Federal Agencies with water resources responsibilities shall, not later than three months after publication of these regulations as finally adopted in the FEDERAL REGISTER, publish procedures to implement these regulations as required by the Presidential Memorandum on Environmental Quality and Water Resources Management. Each agency shall consult with the Council while developing its procedures and shall provide an opportunity for public review and comment on their proposed regulations. Agency procedures shall be effective when the Chairman approves them as conforming to the Presidential Memorandum and these regulations. Agency procedures must at a minimum include acceptable measures to prevent or mitigate losses of historic or cultural resources and provisions to insure that all projects not yet constructed will comply with these regulations. Additionally, such procedures shall prescribe a clear way to identify funding for environmental mitigation in an agency's appropriation requests. The procedures shall be approved by the Chairman within 60 days if they are consistent with these regulations. Once in effect they shall be filed with the Council and made readily available to the public. Agencies are also encouraged to publish explanatory guidance for the procedures.

§ 800.11 Counterpart regulations.

Individual Federal agencies may, in accordance with Section 1(3) of the Executive Order, the President's Memorandum on Environmental Quality and Water Resources Management, and these regulations, choose to adopt counterpart regulations related to their specific programs and authorities to assist in meeting their responsibilities under Section 106 of the Act and Section 2(b) of the Executive Order.

(a) Responsibilities of individual Federal agencies pursuant to § 800.4 may be met by counterpart regulations jointly drafted by that agency and the Executive Director and approved by the Chairman. The Federal agency shall provide ample opportunity for public participation in the development of such counterpart regulations, including publication in the FEDERAL REGISTER as proposed and final rule making with provision for a minimum 60 day period for public comment. Once in effect such counterpart regulations may, as appropriate, supercede the requirements of § 800.4. The Federal agency shall file approved counterpart regulations with the Council and shall make them readily available to the public.

(b) Counterpart regulations may include:

(1) A definition of undertaking as it applies to that agency's particular activities and programs,

(2) Methods to identify National Register and eligible properties for each class of undertakings,

(3) Methods to evaluate effects on National Register or eligible properties,

(4) Authorization for non-Federal participation in the consultation process, and

Standards, guidelines and other measures to ensure avoidance or mitigation of adverse effects on National Register and eligible properties for each class of undertakings.

(c) To the maximum extent possible, counterpart regulations developed pursuant to this section should be intergrated with agency regulations for the National Environmental Policy Act.

OTHER PROVISIONS

§ 800.12 Investigation of threats to National Register and eligible properties.

(a) The Council is frequently advised by State Historic Preservation Officers and others of undertakings that threaten National Register or eligible properties and that appear to involve a Federal agency. In order to protect these properties, the Executive Director investigates these matters, generally by writing to the Federal agency that appears to be involved in the undertaking. Federal agencies should respond to these inquiries within 30 days. If there is Federal involvement in the undertaking, the agency shall fulfill its responsibilities under these regulations.

(b) The Council will exercise its authority to comment to Federal agencies under these regulations in certain special situations even though written notice that an undertaking will have an adverse effect has not been received.

§ 800.13 Reports to the Council.

In order to meet responsibilities under these regulations, the Council prescribes that certain reports and documents be made available to it. The content of such reports is set forth below. The purpose is to provide sufficient information for the Council to evaluate the significance of affected National Register and eligible properties, understand the objectives and requirements of the undertaking, assess the effect in terms of the criteria specified in these regulations, and analyze the feasibility and prudence of alternatives. The Council further recognizes that the Act requires that National Register and eligible properties should be preserved "as a living part of our community life and development," and considers those elements in an undertaking that have relevance beyond historical and cultural concerns. To assist it in weighing the public interest, the Council seeks information not only bearing upon physical, esthetic, or environmental effects but also information concerning economic, social, and other benefits or detriments that will result from the undertaking. Agencies should consider these reports in the context of their compliance with the National Environmental Policy Act and incorporate their content in environmental assessments, draft environmental impact statements and final environmental impact statements as specified in § 800.9.

(a) *Documentation for Determination of No Adverse Effect.* Adequate documentation of a Determination of No Adverse Effect pursuant to § 800.4 should include the following information:

(1) A description of the agency's involvement with the proposed undertaking with citations of the agency's program authority and applicable implementing regulations, procedures, and guidelines;

(2) A description of the proposed undertaking including, as appropriate, photographs, maps, drawings, and specifications;

(3) A list of National Register and eligible properties that will be affected by the undertaking, including a description of the property's physical appearance and significance;

(4) A brief statement explaining why each of the Criteria of Adverse Effect (See Section 800.3) was found inapplicable;

(5) Written views of the State Historic Preservation Officer concerning the Determination of No Adverse Effect, if available; and,

(6) An estimate of the cost of the undertaking, identifying Federal and non-Federal shares.

(b) *Preliminary Case Reports.* Preliminary Case Reports should be submitted with a request for comments pursuant to Section 800.4 and should include the following information:

(1) A description of the agency's involvement with the proposed undertaking with citations of the agency's program authority and applicable implementing regulations, procedures, and guidelines;

(2) The status of this project in the agency's approval process;

(3) The status of this project in the agency's National Environmental Policy Act compliance process and the target date for completion of all environmental responsibilities;

(4) A description of the proposed undertaking including, as appropriate, photographs, maps, drawings, and specifications;

(5) A description of the National Register or eligible properties affected by the undertaking, including a description of the properties' physical appearance and significance;

(6) A brief statement explaining why any of the Criteria of Adverse Effect (See § 800.3) apply;

(7) Written views of the State Historic Preservation Officer concerning the effect on the property, if available;

(8) The views of other Federal agencies, State and local governments, and the other groups or individuals, when known;

(9) A description and analysis of alternatives that would avoid the adverse effects;

(10) A description and analysis of alternatives that would mitigate the adverse effects; and,

(11) An estimate of the cost of the undertaking, identifying Federal and non-Federal shares;

(c) *Reports for Council Meeting.* Consideration of an undertaking by either the full Council or a panel pursuant to § 800.6 is based on reports from the Executive Director, the Agency Official, the Secretary of the Interior, the State Historic Preservation Officer, and others. The reports consist of the following:

(1) *Secretary of the Interior's Report.* The report from the Secretary shall include a verification of the legal and historical status of the property and an assessment of the historical, architectural, archeological, or cultural significance of the property.

(2) *Agency Official's Report.* The report from the Agency Offical requesting comments shall include a general discussion and chronology of the proposed undertaking; an account of the steps taken to comply with the National Environmental Policy Act (NEPA); any relevant supporting documentation in studies that the agency has completed; an evaluation of the effect of the undertaking upon the property, with particular reference to the impact on the historical, architectural, archeological, and cultural values; steps taken or proposed by the agency to avoid or mitigate adverse effects of the undertaking; a thorough discussion of alternate courses of action; and an analysis comparing the advantages resulting from the undertaking with the disadvantages resulting from the adverse effects on National Register or eligible properties. The Agency Official shall arrange for the submission and presentation of any report by a grantee, permittee, licensee, or other party receiving Federal assistance or approval to carry out the undertaking.

(3) *Other Federal Agency Reports.* A report from any other Federal agency involved in the undertaking or a related action that affects the property in question, including a general description and chronology of that agency's involvement and its relation to the undertaking being considered by the Council.

(4) *State Historic Preservation Officer's Report.* A report from the State Historic Preservation Officer should include an assessment of the significance of the property within the State preservation program; an evaluation of the effect of the undertaking upon the property and its specific components; an evaluation of known alternate courses of action; a discussion of present or proposed participation of State and local agencies or organizations in preserving or assisting in preserving the property; an indication of the support or opposition of units of government and public and private agencies and organizations within the State; and the recommendation of the State Historic Preservation Officer.

(5) *Executive Director's Report.* A report from the Executive Director shall include a description of the actions taken pursuant to these regulations, an evaluation of the effect of the undertaking on the property, a review of any known alternate courses of action, an analysis comparing the advantages resulting from the undertaking with the disadvantages resulting from the adverse effects on Na-

tional Register or eligible properties and recommendations for Council action.

(6) *Other Reports.* The Council will consider other pertinent reports, statements, correspondence, transcripts, minutes, and documents received from any and all parties, public or private. Reports submitted pursuant to this section should be received by the Council at least 7 days prior to a Council meeting.

§ 800.14 Supplementary Guidance.

The Executive Director may issue further guidance to interpret these regulations to assist Federal agencies and State Historic Preservation Officers in meeting their responsibilities. The guidelines are for informational purposes only and will be published in the FEDERAL REGISTER and will be readily available to the public.

§ 800.15 Public Participation.

The Council encourages maximum public participation in the review process under these regulations. The Council, Federal agencies, and State Historic Preservation Officers should seek assistance from the public including other Federal agencies, units of local and State government, public and private organizations, individuals and federally recognized Indian tribes in evaluating National Register and eligible properties, determining effect, and developing alternatives to avoid or mitigate an adverse effect. The public has considerable information available that could assist Federal agencies, the State Historic Preservation Officer and the Council in meeting their responsibilities under these regulations. The Council especially urges that Federal agencies make every effort to involve grantees, permittees, licensees, and other parties in interest in the consultation process. To this end, the Council, the Agency Official, and the State Historic Preservation Officer should:

(a) Make readily available, to the extent possible, documents, materials, and other information and data concerning the undertaking and effects on National Register and eligible properties that may be of interest to the public. Such information should be made available within the limits of the Freedom of Information Act (5 U.S.C. 552) and need not necessarily include information on budget, financial, personnel, and other proprietary matters or the specific location of archeological sites. Material to be made available to the public by the agency and the State Historic Preservation Officer should be provided to the public at the minimum cost permissible.

(b) Make the public aware of Public Information Meetings (§ 800.6(b)(3)), full or panel Council meetings (§ 800.6(d)), and the availability of other information related to the review process under these regulations such as a Determination of No Effect, a Determination of No Adverse Effect, a Memorandum of Agreement (See § 800.6(c)) or a Programmatic Memorandum of Agreement (See § 800.8). The purpose of such notice is to inform persons, agencies, and organizations that may be interested or affected by the proposed undertaking of the opportunity to participate in the review process under these regulations. This may include:

(1) Mailing notice to those who have requested it on an individual undertaking or Programmatic Memorandum of Agreement.

(2) Use of notice in local newspaper, local media, and newsletters that may be expected to reach potentially interested persons.

(3) Posting of notice on- and off-site in the area where the undertaking is proposed to be located.

(c) Solicit relevant information from the public during the identification of National Register and eligible properties, the evaluation of effects, and the consideration of alternatives.

(d) Hold or sponsor public meetings on proposed undertakings and make diligent efforts to include the public.

[FR Doc. 79-3248 Filed 1-29-79; 8:45 am]

The Ohio Archaeological Council
Certification List

The following is a list of Ohio Archaeological Council Members that have been sanctioned by the O.A.C. to serve as Principle Investigator for public archaeology projects at or below the level for which they have been certified.

Four levels of certification have been established, which correspond with each of four phases of archaeological work and which are consistent with state and federal regulations. For purposes of correlation with certification levels, the phases are defined:

Phase 1. Literature Research

The purposes of this activity are to locate existing information from published literature and unpublished comments or other sources regarding known or suspected archaeological resources (including sites and site collections) in the area, and to summarize these data for effective use in managing those resources. Phase I is a preliminary step in cultural resource management which will not usually satisfy the data requirements of Environmental Impact Statements or other evaluations of a project's impact on archaeological resources.

Phase 2. Location

The Location Phase accommodates a broad spectrum of archaeological survey with the common objective of locating archaeological resources in an area of proposed impact as an in-the-field activity. Location studies may be conducted on several levels consistent both with federal regulations (36 CFR Part 64, Appendix A; 36 CFR 66) and with the nature and objectives of specific projects.

At one end of the spectrum is low-intensity reconnaissance of an area's archaeological resources and potential data yield. In addition to identifying obvious or well-known sites, the existence of sites in suspected locations represented in the literature or by informant interview may be determined and an impression gained of the topographic settings in which sites are likely to occur. Such a survey may provide planning guidance during the early stages of a project to aid in selecting the specific area(s) to be directly impacted. Predictive data on the nature and distribution of archaeological sites and archaeologically sensitive areas may also be derived preliminary to developing more detailed survey strategies.

More comprehensive approaches to archaeological survey commonly include sampling designs and sub-surface testing which may or may not result in the identification of all existing archaeological resources in the area to be impacted. Sampling may involve varying degrees of random or selected procedures, including systematic designs representing statistically valid samples providing detailed and meaningful predictive models for the entire area. Testing is commonly coordinated with or incorporated into a sampling strategy and is undertaken in an effort to identify sites whose superficial indications are obscured and/or to clarify or amplify relevant data. Deriving from these activities should be at least limited justification for protective stipulation for certain sites identified. Information gained is therefore evaluated, but not necessarily to determine the eligibility of specific sites for inclusion in the National Register of Historic Places or the Ohio State Registry of Archaeological Landmarks.

Phase 2 corresponds with the combined "Field Inspection" and "Reconnaissance Survey" categories of archaeological activity described in 36 CFR Part 64, Appendix A (C) and (D), and with "Intensive Survey" (E) to the extent that an attempt may be made to locate all existing archaeological sites in the proposed project area. Combined Phase 1 and 2 correspond with the "Location Phase" described in Archaeological Preservation in Ohio, edited by David R. Bush, Ohio Historical Society, Columbus, 1978 (pp. 23-27).

Phase 3. Eligibility Assessment

The purpose of this activity is to collect and evaluate adequate data from a known site or sites and/or from one or more areas known or suspected to be archaeologically sensitive specifically to serve as the bases for determining eligibility for inclusion in the National Register of Historic Places, applying the National Register Criteria set forth in 36 CFR Part 800.10: "Procedures for the Protection of Historic and Cultural Properties", or the Ohio State Registry of Archaeological Landmarks. The eligibility assessment is usually conducted in the specific area that will be impacted and is commonly preceded by a systematic effort to identify all existing sites in that area. Research designs consistent with the objective of this phase should include the pre-conceived development of explicit, systematic sampling and sub-surface testing strategies, the classification and analysis of resulting data and materials appropriate to a responsible evaluation of the local, state or national significance of the site (s)/area (s), and detailed justifications for protective stipulations. Specific recommendations for the future disposition of all identified sites/areas should be offered, particularly those believed to be eligible for registry inclusion and/or those which it is believed should be excavated if their avoidance is not a feasible alternative, along with sufficient information about them upon which to base such decisions.

This phase corresponds with at least that part of "Intensive Survey" described in 36 CFR 64, Appendix A (E) having to do with evaluations of sites for possible National Register of Historic Places inclusion. There is also a correspondence with the "Assessment Phase" described by Bush (1978: 27-31).

Phase 4. Excavation

The purpose of this activity is to mitigate the adverse effects of proposed projects on the archaeological resources of an area by recovery and analysis of data and material remains through excavation that is either total or at least more intensive in scope than the sub-surface investigation that was accomplished in Phase 3. Phase 4 is applicable in those cases where it is agreed that avoidance is not feasible. Excavation is one of several alternatives described in Bush's "Mitigation Phase" (1978: 31-33).

Name	Certification Level
Mr. James Addington 2590 Dibblee Avenue Columbus, Ohio 43204	4
Mr. Bruce Aument 1930 A-4 North Star Road Columbus, Ohio 43212	1
Mr. Stan Baker Ohio Historical Society I-71 & 17th. Avenue Columbus, Ohio 43211	3
Ms. Beula Barkes 564 E. Shrock Road Westerville, Ohio 43081	1
Mr. Thomas Berres 2423 Parkview Kalamazoo, Michigan 49008	2
Mr. Donald R. Bier, Jr. Ohio Historical Society I-71 & 17th Avenue Columbus, Ohio 43211	4
Dr. John E. Blank Department of Anthropology Cleveland State University Cleveland, Ohio 44135	4
Mr. Jonathan Bowen Ohio Historical Society I-71 & 17th. Avenue Columbus, Ohio 43211	1
Dr. David S. Brose Cleveland Museum of Natural History Wade Oval, University Circle Cleveland, Ohio 44106	4
Mr. Jeff Brown Kent State University Tuscarawas Campus University Drive, N.E. New Philadelphia, Ohio 44663	4
Mr. Ron Burdick Archaeological Preservation Office Defiance College Defiance, Ohio 45312	3
Mr. David R. Bush 1094 Argonne Road South Euclid, Ohio 44121	4
Mr. Thomas Cinadr Miami Purchase Association 812 Dayton Street Cincinnati, Ohio 45214	4
Mr. Wesley Clark 10 West Park Street Westerville, Ohio 43081	3
Ms. Ann Cramer 153 East Walnut Lancaster, Ohio 43130	2
Mr. Timothy Dalbey 924 Shadyside Lane Apt. A Dallas, Texas 75223	3
Dr. William Dancey Ohio State University Department of Anthropology Columbus, Ohio 43210	4

Name	Certification Level
Dr. Ken Deaver Ohio State University Department of Anthropology Columbus, Ohio 43210	4
Mr. John DeWert Ohio Historical Society I-71 & 17th. Avenue Columbus, Ohio 43211	3
Ms. Patricia Essenpreis Department of Anthropology Loyola University 6525 N. Sheridan Road Chicago, Illinois 60626	4
Dr. Gary Fry Department of Sociology and Anthropology Youngstown Universtiy Youngstown, Ohio 44503	4
Mr. Bob Genheimer Miami Purchase Association John Hauck House 812 Dayton Street Cincinnati, Ohio 45214	3
Ms. Mary Gordon Ohio State University Department of Anthropology Columbus, Ohio 43210	1
Ms. Gail Graham The Cleveland Museum of Natural History Wade Oval, University Circle Cleveland, Ohio 44106	2
Mr. Paul Graham 39 East Logan Avenue Westerville, Ohio 43081	2
Mr. Joel Mark Greene Apt. 3A Vairo Boulevard State College, Pennsylvania 16801	2
Dr. N'omi Greber Cleveland Museum of Natural History Wade Oval, University Circle Cleveland, Ohio 44106	4
Ms. Ruth Grunwald 2188 Cranston Road Cleveland, Ohio 44118	2
Mr. Everett E. Hale 2567 Scioto View Lane Columbus, Ohio 43221	3
Mr. Jay Heilman Dayton Museum of Natural History 2629 Ridge Road Dayton, Ohio 45414	4
Mr. Dale Herbort 4125 Summit Road Batavia, Ohio 45102	3
Mr. Joseph E. Kole Ohio State University Department of Anthropology Columbus, Ohio 43210	4
Ms. Christine Krebs Cincinnati Museum of Natural History Cincinnati, Ohio 45202	2 ✓
Mr. Christopher R. Lindner 2340 Victory Parkway #37 Cincinnati, Ohio 45206	2

Name	Certification Level
Ms. Susan Loughridge Department of Sociology and Anthropology Ohio University Athens, Ohio 45701	3
Dr. Robert Maslowski Corps of Engineers P.O. Box 2127 Huntington, W. Va.	4
Ms. Jamie McIntyre Dayton Museum of Natural History Dayton, Ohio 45414	3
Ms. Margaret McMinn 426 Zimpfer Street Columbus, Ohio 43206	3
Mr. David Morse OSU Mansfield Campus Bromfield Center Historic Preservation Office Mansfield, Ohio 44906	4
Mr. Dana Ormerod Kent State University East Liverpool Campus 400 East Fourth Street East Liverpool, Ohio 43290	3
Ms. Martha Otto, Head Department of Archaeology Ohio Historical Society I-71 & 17th Avenue Columbus, Ohio 43211	4

Name	Certification Level
Mr. Leonard Piotrowski Ohio State University Department of Anthropology Columbus, Ohio 43210	3
Mr. Richard Pleise Box 43, Rt. 1 Millfield, Ohio 45761	2
Mr. Michael Pratt Department of Anthropology University of Toledo Toledo, Ohio 43606	4
Dr. Olaf H. Prufer Kent State University Department of Sociology & Anthropology Kent, Ohio 44242	4
Mr. Jeffery Reichwein 25635 Center Ridge Road #203B Westlake, Ohio 44145	2
Mr. George Reymond 418 East Fourth Street Dover, Ohio 44622	4
Mr. Rodney Riggs Cincinnati Museum of Natural History 1720 Gilbert Avenue Cincinnati, Ohio 45202	4
Mr. Franco Ruffini 2648 Summit Street Columbus, Ohio 43202	3

Name	Certification Level
Mr. William E. Rutter Department of Anthropology Western Michigan University Kalamazoo, Michigan 49008	3
Dr. Arthur Saxe Department of Sociology and Anthropology Ohio University Athens, Ohio 45701	4
Dr. Mark Seeman Department of Anthropology Kent State University Kent, Ohio 44240	4
Ms. Shaune Skinner Dept. of Archaeology Ohio Historical Society 1982 Velma Ave. Columbus, Ohio 43211	3
Mr. John Stidham 321 20th Street Toledo, Ohio 43624	1
Dr. David Stothers Department of Anthropology University of Toledo Toledo, Ohio 43606	4
Dr. William M. Sumner Department of Anthropology The Ohio State University Columbus, Ohio 43210	4

Name	Certificatior Level
Mr. Alan Tonetti Archaeology Lab Wright State Univeristy Dayton, Ohio 45431	3
Mr. Patrick M. Tucker Laboratory of Ethno- Archaeology University of Toledo Toledo, Ohio 43606	3
Dr. Kent Vickery Department of Anthropology University of Cincinnati Cincinnati, Ohio 45221	4
Mr. Keith Voll Cleveland Museum of Natural History Wade Oval, University Circle Cleveland, Ohio 44106	1
Mr. Robert M.R. Waterworth 1640 Indianola Avenue Columbus, Ohio 43201	1
Ms. Carmon Weber 162½ W. Northwood Ave. Columbus, Ohio 43201	1
Mr. Duncan C. Wilkie Department of Sociology and Anthropology Southeast Missouri State University Cape Girardeau, Missouri 63701	4

Name	Certification Level	Name	Certification Level
Dr. John J. Winsch 399 East Main Street Newark, Ohio 43055	1		
Ms. Dee Anne Wymer 1640 Indianola Avenue Columbus, Ohio 43201	1		
Ms. Karen M. Young 2812 Kensington Place West Columbus, Ohio 43202	1		

8/79

A. names of investigators or institutions

B. dates, extent, results, and adequacy of previous research as it reflects on the interpretation of what might be found in the project area

C. location and nature of field notes, unpublished manuscripts, and collected materials

D. statement that a check has been made of the National Register, the State Registry, the Ohio Archaeological Inventory, Regional Archaeological Files (universities, museums, Regional Preservation Offices, societies), and appropriate state, county, and local histories

Section IV - Cultural Development/Archaeological Background

The project area shall be placed in its regional setting with respect to the known cultural history. This shall include a description of the major outlines of prehistoric and historic cultures of the project area, including chronology, settlement and subsistence patterns, and any other significant data available.

Section V - Field Methods and Techniques

A. sampling strategy - description and justification

B. field techniques:
   1. a description and justification of the field techniques employed
   2. environmental conditions during the survey and their effects upon the survey results
   3. a description of data collecting techniques, and types of data collected (e.g., artifacts and cultural debris as well as spatial relationships between them), sampling techniques (complete, systematic, or specific form of random sampling), and artifact-retrieval procedures
   4. procedures used to locate landowners, collectors, and others knowledgeable in the archaeological resources
   5. controls for personal bias, if utilized

C. data recording requirements:
   1. dates of fieldwork
   2. measuring devises c and circumstances when used and not used
   3. graphic as well as written summary descriptions of all surface and subsurface collection stations, including any limitations of access. The description of the survey route should include spacing and number of traverses. Descriptions of test units employed, including graphic locations at appropriate scale should be included.
   4. when cultural materials are encountered, the following information is required:
      a. surface survey -
         indicate methods utilized to determined density and extent of recovered materials
      b. subsurface survey -
         information on each of the test units should minimally include:
         aa. the location and size of each unit within the site
         bb. the types of levels excavated (natural, cultural or arbitrary) and the justification for such techniques

OHIO ARCHAEOLOGICAL COUNCIL

Specifications for Reports of Archaeological Services
Ohio Archaeological Council
Approved May 4, 1979

Archaeological Services Report - The report shall, in form and substance, conform to recognized professional standards applicable to archaeological reports. The report is designed to provide the State Historic Preservation Officer with (1) the inventory, (2) statements of archaeological significance, and (3) a means for the management of archaeological resources. The report is also designed to provide a systematic body of data for future evaluation and research. The specifications are <u>not</u> designed to exclude categories of information not listed, nor to offer a rigid format for the final report. The reports should consist of the appropriate sections for the type of archaeological services being conducted. Sections applicable to specific types of research are outlined in Part B.

Part A - Report Categories

Section I - Introductory Statements

A. Title Page - This shall include all pertinent information
   1. title, author, principal investigator, date
   2. consulting firm/archaeologist, address
   3. client for whom report is prepared, address
   4. lead federal agency

B. Table of Contents - This shall be arranged in accordance with the sequence of topical headings with corresponding page numbers.

C. Abstract (suitable for publication) to include a resource management summary which summarizes the research strategy, results, suggestions, and recommendations.

D. Introductory Statements:
   1. a statement as to the purpose and circumstances of the contracted archaeological services
   2. general description of the project and project area with appropriate mapping

Section II - The Setting/Environmental Background

This shall be a detailed description not only of the physiographic province, but also of the project area with attention given to flora, fauna, geology, soils and climatic history, and historic patterns of land use. Site potential shall be discussed, e.g., chance of deeply buried sites on a flood plain. The environmental background shall be described in a way to provide information on resource utilization potential, e.g., soils favorable for cultivation, availability of raw lithic resources.

Section III - Previous Research and Literature Search

This shall be a comprehensive and detailed review of past and current archaeologic and historic investigations of the project area and surrounding region, including but not limited to, the following:

cc. a description of all natural and/or cultural material observed and/or collected within the test units including soil descriptions and the description, dimensions and interpretation of any features encountered. Graphic representations of all test pit locations, profiles and features should be included.

Section VI - Description of Analytical Techniques

Laboratory and analytic methods should be summarized so that they are clear to other researchers, minimally including:

A. classificatory scheme (typology) or schemes used in artifact description and analysis. If using a scheme developed by other archaeologist, give full reference.

B. method of chronological determination (typological, radiometric, etc.)

C. other special analytical methods and techniques (e.g. predictive models)

D. the curation location of all artifacts and research data (including field notes) must be specified. This curation must be open to inspection by the State Historic Preservation Office and the Ohio Archaeological Council. The final disposition of all data and artifacts must be acceptable to the State Historic Preservation Office and the Ohio Archaeological Council.

Section VII - Site Descriptions

This section shall include the following information:

A. a completed Ohio Archaeological Inventory form which must be referenced here but may be appended

B. a general description of the site location

C. the environmental setting including topography, proximity to water, soils, and elevation

D. dimensions and boundaries of the site

E. the nature and amount of previous disturbance

F. the materials recovered including a description of the assemblage or assemblages with illustrations and distribution tables. Illustrations of the materials collected should include photographs and/or line drawings of all diagnostic artifacts when reasonable and should, in case of a large quantity of recovered material, include representative examples of those materials

G. the cultural/temporal affiliation, if known

H. a discussion of the potential impact of the project on the site

I. a statement of significance and recommendations for further work. Statements of significance for each site located are determined by Historic, Scientific, and Social values. Such statements will consider, but not be limited to, the following definitions:

1. historical value of cultural resource depends on the potential for identification and reconstruction of specific cultures, periods, lifeways and events. Cultural resources are historically significant if they provide a typical or well-preserved example of a prehistoric, or historic tribe or society, period of time or category of human activity. Archaeological remains are also historically significant if they can be associated with a specific individual, event or aspect of history.
2. scientific value is the potential for using cultural resources to establish reliable generalizations concerning past societies and cultures and deriving explanations for the differences and similarities between them. Much of the same data is used for scientific purposes as in historic studies, but the treatment and scope of information differ. Generalizations and explanations require controlled comparison of statistically representative samples of all types of data relevant to past human life. Samples include artifacts, settlements, dietary remains and evidence of past environments. Scientific significance depends on the degree to which archaeological resources in the project or program area constitute a representative sample of data which can be used in comparative studies. The value of this data is determined in the regional context of the project or program area and in relation to general anthropological or historical problems.

   The scientific significance of cultural remains is assessed by consideration of a variety of factors, including:
   a. the relative abundance of the resources
   b. the degree to which specific resources and situations are confined to a given area
   c. the quality of preservation conditions as it relates to the potential for future research
   d. the cultural and environmental relationships of the archaeology of a given area to the surrounding province or provinces
   e. the variety of evidence for human activities and their environmental surroundings that is contained within a given area
   f. the range of research topics to which the resources may contribute
   g. special deficiencies in current knowledge that the study of these resources may correct
3. social value consists of direct and indirect ways by which society at large benefits from study and preservation of cultural resources.
   a. the acquisition of knowledge concerning Man's past
   b. indirect benefits received by educational and research institutions and their communities, from salaries and funds supporting archaeological and historical studies and increased opportunities for professional training
   c. the acquisition and preservation of objects and structures for public exhibit and enjoyment
   d. educational and economic benefits from tourism attracted by archaeological and historical exhibits

e. the practical application of scientific findings acquired in archaeological and historical research

Section VIII - Eligibility Assessment

When sufficient information is available, each site shall be evaluated in terms of its eligibility for listing on the National Register of Historic Places and the State Registry of Archaeological Landmarks. The investigator must state the justification for considering any resource eligible for these Registries.

In such a consideration the following National Register criteria will apply to all cultural properties possessing historical, architectural, archaeological, or cultural value located within the area of the actual or proposed project's potential environmental impact. National Register criteria means the following criteria established by the Secretary of the Interior for use in evaluating and determining the eligibility of properties for the National Register: Ref. 36 CFR 800. The quality of significance in American history, architecture, archaeology and culture is present in districts, sites, buildings, structures, and objects of National, State and local importance that possess integrity of location, design, setting, materials, workmanship, feeling and association and:

A. that are associated with events that have made a significant contribution to the broad patterns of our history

B. that are associated with the lives of persons significant in our past

C. that embody the distinctive characteristics of a type, period or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction

D. that have yielded, or may be likely to yield information important in prehistory or history

Ordinarily historic cemeteries, birthplaces, or graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years shall not be considered eligible for the National Register.

An archaeological property, prehistoric or historic, is eligible for listing in the State Registry of Archaeological Landmarks if it:

A. possesses integrity of location, context, or materials and;

B. has yielded, or may be likely to yield information important in furthering the understanding of prehistory or;

C. exemplifies elements of our heritage that have made significant contributions to the broad patterns of history

An archaeological property can include, but is not limited to, any village, earthwork, mound, burial, campsite, quarry, prehistoric or historic ruin, or other location which is or may be the source of important archaeological data.

In addition to these basic statements of National Register criteria, the following twenty categories (among many others) of archaeological information (from Thompson, 1977, American Society for Conservation Archaeology Newsletter, 3:17) taken singly or in any combination, are deemed as a basis for eligibility:

1. chronology
2. stratigraphic sequence
3. short time period (single component site)
4. long time period (multiple component site)
5. extreme antiquity
6. historic contact
7. ethnic identity
8. geographic distribution
9. culture contact
10. culture history
11. socio-culture processes
12. uniqueness of cultural expression
13. rich assemblage
14. replication of pattern evidence
15. potential for testing techniques
16. degree of disturbance
17. place in history of archaeology
18. potential for public interpretation
19. potential for training professional archaeologists
20. potential for interpreting a particular prehistoric culture

Section IX - Summary and Recommendations

The summary section should discuss the following items:

A. methodology

B. findings

C. evaluation of findings including:
   1. the theoretical orientation of the principal investigator and/or author's bias and assumptions shall be explicitly stated as they pertain to this cultural resource
   2. the significance of each site in terms of its scientific (archaeological), historical or cultural value. If the examination did not offer an opportunity to gain data sufficient to arrive at a satisfactory conclusion, offer recommendations for further research.
   3. primary impact
   4. secondary impact

D. when applicable, the principal investigator shall consider mitigation possibilities and evaluate the most appropriate and feasible alternative, for sites within the project area. This section of the report should offer suggestions for:
   1. protecting any portion of the site, or sites, that will remain after examination from damage or destruction by any agency, natural or cultural
   2. protecting any site, sites, or portions of a site that are proven or

suspected to be either directly or indirectly affiliated (e.g., culturally, spacially, etc.) with the site or sites under investigation

3. interpreting the site or sites for public information and educational programs. With regards to numbers one and two, please use your own professional judgement concerning the size of the project and the impact it will have on the surrounding environment.

Section X - Required Appendices

A. bibliography (Society for American Archaeology format) and field contacts (names and addresses)

B. U.S.G.S. 7 1/2' Topo Map showing project and site locations to scale or reduced

C. Ohio Archaeological Inventory forms

D. survey permits - if applicable

E. Archaeological Services Proposal (budget and curriculum vitae of principal investigator may be omitted)

Part B - Final Report

The following is a list of the sections required for the type of research being conducted. Since literary research, location, eligibility assessment and excavation are frequently sequential activities for the same project, report categories previously published may be referenced.

Literature Research

No Sites	Known or Suspected Sites Within Project Area
Section I	Section I
Section II	Section II
Section III	Section III
Section IV	Section IV
Section IX	Section VI
Section X	Section VII
	Section VIII (if applicable)
	Section IX
	Section X

Location

No Sites	Known Site
Section I	Section I
Section II	Section II
Section III	Section III
Section IV	Section IV
Section V	Section V

Location (con't)

No Sites	Known Sites
Section VI (if applicable)	Section VI
Section IX	Section VII
Section X	Section VIII (if applicable)
	Section IX
	Section X

Eligibility Assessment

All catagories are applicable

Excavation

All catagories are applicable

The final report (including all original photographs) and individual site survey forms for each site located must be filed simultaneously with the following:

Ohio Archaeological Council
1982 Velma Avenue
Columbus, Ohio 43211

Regional Archaeological Preservation
Office(s) involved.

APPENDIX J

STUDY OF HEAT TRANSFER FLUIDS AND THEIR PROPERTIES

HEAT TRANSFER FLUID

Columbia has evaluated the synthetic heat transfer fluids produced by several manufacturers. The preliminary portion of this evaluation was based on a report prepared by the General Electric Company as part of the high temperature solar collector research. Columbia also contacted several manufacturers to discuss the properties of their fluids in greater detail.

The following criteria were identified for the heat transfer fluid.

(a) Viscosity - Fluids with viscosities less than 0.055 Ft^2/Hr. at operating temperature are acceptable on the basis of thermal performance. This limit was used as a screening element in comparing the various candidate fluids.

(b) Thermal Conductivity - Thermal conductivity at operating temperature should be greater than 0.05 BTU Ft/Hr. Ft^2°F for thermal performance. This limit was also incorporated into the screening process.

(c) Operating Temperatures - Peak operating temperature was estimated at 500°F. Maximum stagnation temperature is approximately 900°F for the Solar Kinetics 40X collector. Based on Portsmouth, Ohio weather data and extremes of ± 30°F, the lowest temperature would be about +5°F. A temperature of -25°F was, therefore, arbitrarily established as the minimum for a pour or freeze point of the fluid to be evaluated further, and factored into the screening process.

(d) Flammability - Since the average operating temperature was established as 440°F, 400°F was chosen as the lowest allowable flash point temperature.

(e) Boiling or Distillation Temperature - From the standpoint of preventing any high temperature build-up during operation, fluids showing a boiling or distilling temperature as high as possible above 400°F were preferred.

(f) Other Consideration - Data and information in addition to the above were also collected for comparative purposes on the following elements:

(1) Thermal Properties:

- Recommended use temperature range
- Autoignition temperature
- Specific heat
- Coefficient of expansion

(2) Physical Properties:

- Density
- Vapor pressure

(3) Operational Characteristics

- Materials compatibility
- Temperature stability
- Toxicity
- Pollution potential
- Disposibility
- Maintenance/Monitoring
- Cost

The General Electric survey selected 25 nonaqueous organic fluids for for comparative evaluation with each other and with water.

The types and manufacturers or suppliers of the potential fluids are listed in Table 1. Available data on the thermal properties of these fluids are given in Table 2. The properties covered include recommended use temperature, flash and fire points, autoignition point, specific heat and thermal conductivity at 440°F, and coefficient of expansion. Table 3 lists the physical properties, which include the available data on boiling point, pour or freeze point, and

Table 1

IDENTIFICATION OF POTENTIAL FLUIDS EVALUATED

FLUID	TYPE	MANUFACTURER/SUPPLIER
1. Therminol 44	Modified Ester Based	Monsanto Industrial Chem. Co
2. Therminol 55	Syn. Hydrocarbon Mixture	Monsanto Industrial Chem. Co
3. Therminol 60	Polyaromatic Compounds	Monsanto Industrial Chem. Co
4. Therminol 66	Modified TER Phenyl	Monsanto Industrial Chem. Co
5. Dowtherm G	Mixt. of Di & Tri aryl Ethers	Dow Chemical
6. Dowtherm HP	Aromatic Oil	Dow Chemical
7. Dowtherm J	Alkylated Aromatic	Dow Chemical
8. Caloria HT43	Refined Petroleum Oil	Exxon Co.
9. Mobiltherm 600	Petroleum (Mineral) Oil	Mobil Oil Corp.
10. Mobiltherm 603	Petroleum (Mineral) Oil	Mobil Oil Corp.
11. Sun 21	Paraffinic Oil	Sun Oil Co.
12. R Temp	High Molecular Weight Paraffinic Oil	RTE Corp.
13. MCS 1958	Developmental Chlorinated, Organic Fluid	Monsanto Industrial Chem. Co
14. Drewsol	Water Miscible, Organic Heat Transfer Fluid/ Corrosion Inhibitor	Drew Chemical Co.
15. Sun-Temp	Nonaqueous Heat Transfer Fluid	Resource Technology Corp.
16. H-30c	Synthetic Hydrocarbon	Mark Enterprises, Inc.
17. Uniroyal PAO	Synthetic Polyalphaolefin	Uniroyal Chemical
18. Synfluids	Synthetic Polyalphaolefin	Gulf Oil Chemicals Co.
19. Ethyl ESH Series	Synthetic Polyalphaolefin	Ethyl Corp.
20. Syltherm 800	Stripped Silicone Oil + Additive	Dow Corning Corp.
21. UCON HTF 500	Partially Water Soluble UCON Fluid	Union Carbide

Table 2

THERMAL PROPERTIES

FLUID	USE TEMP., °F	FLASH POINT °F	FIRE POINT, °F	AUTO IGNITION POINT, °F	Cp BTU/lb.°F @ 440 °F	K @ 440 °F	COEF. OF EXPANSION, ML/ML/°C
1. Therminol 44	- 50 to 425	405	438	705	0.574	0.0651	8.0×10^{-4}
2. Therminol 55	0 to 600	355	410	675	0.611	0.0627	8.7×10^{-4}
3. Therminol 60	- 60 to 600	310	320	835	0.543	0.0681	8.2×10^{-4}
4. Therminol 66	0 to 650	355	382	705	0.534	0.0612	7.0×10^{-4}
5. Dowtherm G	12 to 650	305	315	>1,030	0.478	0.0720	-
6. Dowtherm HP	15 to 550	420	460	880	0.640	0.0705	-
7. Dowtherm J	-100 to 575	145	155	806	0.595	0.0680	-
8. Caloria HT43	15 to 600	400	~450	-	0.599	0.0555	-
9. Mobiltherm 600	- 5 to 600	350	390	-	0.560	0.0620	-
10. Mobiltherm 603	20 to 600	380	430	-	0.650	0.0695	-
11. Sun 21/25	0 to 600	440	490	715	0.650	0.0683	-
12. R Temp	- 20 to -	545	594	1,004	0.46(77°F)	0.0750	8.5×10^{-4}
13. MCS 1958	- 40 to 500	360	None	1,080	0.384	0.0550	4.4×10^{-4} (to 500°F)
14. Drewsol	- 29 to 230	None	-	-	0.7 (77°F)	-	
15. Sun-Temp	- 40 to 671	380	-	824	0.56 (77°F)	0.0700	-
16. W - 30C	- 40 to 620	360	-	-	0.60(250°F)	0.07-.075 (212°F)	-
17. UCON HTF 500	- 35 to 500	500	600	750	0.560	0.081	-
18. Uniroyal PAO-LV	- 80 to 600	395	425	-	0.50 (68°F)	0.0726 (68°F)	7.5×10^{-4}
19. Uniroyal PAO-10	- 40 to 600	400	500	-	0.50 (68°F)	0.0726 (68°F)	7.5×10^{-4}
20. Uniroyal PAO-20E	- 35 to 600	530	585	-	0.50 (68°F)	0.0726 (68°F)	7.5×10^{-4}
21. Synfluid PAO 4cs	-100 to 600	445	495	710	0.669	0.0737 (300°F)	4.5×10^{-4}
22. Synfluid PAO 6cs	- 90 to 600	465	520	710	0.590	0.0729	4.2×10^{-4}
23. Ethyl PAO ESH-4	<- 90 to 600	435	475	740	0.69 (392°F)	0.065 (392°F)	4.5×10^{-4}
24. Ethyl PAO ESH-6	<- 90 to 600	460	510	760	0.59 (392°F)	0.067 (392°F)	4.2×10^{-4}
25. Syltherm 800	- 40 to 795	310	380	820	0.460	0.072	-
26. Water	32 to -	None	None	None	1.080	0.382	-

[redacted]

Table 3

PHYSICAL PROPERTIES

FLUID	B. P., °F	POUR/ FREEZING POINT, °F	DENSITY, lb/FT^3, @ 440 °F	VISCOSITY, FT^2/HR, 440 °F	VAPOR PRESSURE, mm Hg, 440 °F
1. Therminol 44	638 (10%)	- 80 (P)	48.7	0.0329	5.5
2. Therminol 55	635 (10%)	- 40 (P)	47.3	0.0399	18.2
3. Therminol 60	550 (10%)	- 90 (P)	54.6	0.0240	65.0
4. Therminol 66	643 (10%)	- 18 (P)	55.0	0.0376	20.0
5. Dowtherm G	575	- 18 (P)	59.6	0.0277	1.3 PSIA
6. Dowtherm HP	695	15 (P)	46.8	0.045	0.3 PSIA
7. Dowtherm J	358	<-100	44.4	0.0077	25.3 PSIA
8. Caloria HT43	700 (1%)	15 (P)	52.7	0.0568	28.5
9. Mobiltherm 600	645 (10%)	0 (P)	53.7	0.0454	200.0
10. Mobiltherm 603	705 (10%)	20 (P)	46.8	0.0473	75.0
11. Sun 21/25	720 (1%)	0/5 (P)	47.4	0.030	-
12. R Temp	-	- 22 (P)	54.6 (77°F)	0.0853	-
13. MCS 1958	620	- 40.5 (P)	70.5	0.0223	25.0
14. Drewsol	230	- 28.5	70.9 (77°F)	-	-
15. Sun-Temp	671	- 40.0	-	-	21.0
16. H-30C	620	- 40.0	46.2 (300°F)	0.0775 (300°F)	-
17. UCON HTF 500	-	- 35.0 (P)	56.7	0.1300	-
18. Uniroyal PAO-LV	-	- 80.0 (P)	51.9 (68°F)	0.0202	-
19. Uniroyal PAO-10	-	- 40.0 (P)	52.0 (68°F)	0.0581	-
20. Uniroyal PAO-20E	-	- 35.0 (P)	52.4 (68°F)	0.0853	-
21. Synfluid PAO-4cs	743 (10%)(1)	-100.0 (P)	45.0	0.0430	4.1
22. Synfluid PAO-6cs	802 (10%)(1)	- 90.0 (P)	45.1	0.0543	3.8
23. Ethyl ESH-4	779 (10%)(2)	- 90.0 (P)	43.7	0.0465	1.0
24. Ethyl ESH-6	819 (10%)(2)	- 90.0 (P)	44.1	0.062	0.7
25. Syltherm 800	>670	- 40.0	48.4	0.050	<760 (670°F)
26. Water	212	32.0	52.7	0.0061	247 PSIA

Notes:
(1) Vacuum Distillation @ 1mm Hg adjusted to 760 mm.
(2) Vacuum Distillation @ 1mm Hg.
(P) Pour Point.

density, viscosity, and vapor pressure at 440°F. The screening process was applied to all the fluids. The five best fluids are compared in Table 4 for operational considerations, such as materials compatibility, temperature stability, toxicity, pollution potential, disposibility, maintenance and monitoring requirement, and cost per gallon.

TABLE 4

COMPARATIVE OPERATIONAL CHARACTERISTICS

	ETHYL ESH-4	SYNFLUID 4cs	SYNFLUID 6cs	THERMINOL 44	MCS 1958
MATERIALS COMPATIBILITY					
Effect on Metals (MG/CM^2,100 Hrs. @ 200°F):					
Al	<-0.1	-	-	S to 400°F	ND
Cu	<-0.1	-0.04 -0.22(3)	-0.03 -0.09(3)	S to 400°F	ND
Steel	<-0.1	-0.05(3)	-0.66(3)	S	ND
Effect on Elastomers @ 200°F:					
Butyl Rubber (1)	+225	+225.49	-180.43	ND	ND
Neoprene (2)	-13	-13.32	-11.09	Fell Apart (4)	ND
Buna N (2)	-3.0	-3.05	-3.41	+28 (4)	ND
Silicone (1)	+17	+17.03	+10.59	+37 (4)	ND
Building Materials Asphalt Roofing	Light Yellowish Coloration (5)	Light Yellowish Coloration (5)	Very Light Yellowish Coloration (5)	ND	Immediate Attack At RT
Reaction with Air	ND	See Temp. Stability	See Temp. Stability	When Hot May Oxidize in Air. N$_2$ Blanketing Recommended.	ND
Reaction with Water	ND	Resistant to Hydrolysis, 96 Hrs. @ 200°F shows -0.1% Change in Viscosity.		Moisture Removal Recommended.	ND
TEMPERATURE STABILITY	ND	No Decomposition up to 611°F. Cincinnati Millicron Hydraulic Fluid Test, 168 Hrs. @ 300°F in air, shows 6-7% increase in Viscosity and 1-5MGS/100 ML Sludge.		Max. Bulk Temp. 425°F;Max Film Temp. 475°F	Successful Loop Tests >1,900Hrs @ 500°F
TOXICITY	Higher Viscosity Similar Hydrocarbon showed Oral LD50 (Mouse) is 57400MG/Kg. WT.Considered Nontoxic orally & dermally.Avoid contact with eyes.	Acute Oral LD50 (Rats) is >33600MG/KG Wt;TLV of 5MG/M^3 for Oil Mist. Ordinary skin Contact Nontoxic; Avoid eye Contact & Prolonged Fume Inhalation. Considered relatively harmless.		Oral LD50 (Rats) is 13000MG/KG Wt Dermal LD$_{50}$ (Rabbits) is >7900MG/Kg Wt. Practically Nontoxic by ingestion in single doses & single Dermal Applications.Hot Vapors may be mildly irritating on prolonged exposure.	Acute Oral LD50 (Rats) is 8000 Mg/Kg Wt. Practically Nontoxic by Single Dose Ingestion.
POLLUTION POTENTIAL	No Serious Problem	No Serious Problem	No Serious Problem	No Serious Problem	ND
DISPOSABILITY	ND Should be Similar to Synfluids	Absorb & Scrape Up; Incinerate under Controlled Conditions, Observe Federal Spill & Water Quality Regulations; Biodegradable.		Observe Local Regulations	Biodegradable
FLUID MONITORING	ND Should be Similar to Synfluids	Fluid Analysis Every 3 Mos. in 1st Year, then Every 6 Mos.			ND
COST, $/GAL., 55 Gal. Drums	6.60	6.60	6.60	9.30	11-17

Notes:
- (1) % Swell
- (2) % Shrinkage
- (3) 168 Hrs. @ 300°F in Air
- (4) 166 Hrs. @ 302°F
- (5) No Immediate Attack. Observations Made After One Hour Immersion @ RT.
- ND - No Data
- S - Satisfactory

Data and characteristics shown in the various tables included in this report were obtained from brochures and letter/or telephone conversations with the manufacturers of the candidate fluids.

Flammability:

Of the candidate fluids, water is the only fluid without a flammability characteristic. Using a requirement of greater than 400°F for the flash and fire points in the screening process, leaves only the Synfluids and Ethyl's ESH-4, and Therminol 44. MCS 1958 was, also, included, based on its fire resistance.

Materials Compatibility:

Table 4 shows the only available data on compatibility of the five fluids, with aluminum, copper, and steel. The data for 200°F and 300°F exposures for Ethyl ESH-4, Synfluid 4cs and 6cs indicate no gross attack, a satisfactory condition for Therminol 44 at 400°F, but no data is available for the developmental fluid MCS 1958.

Temperature Stability:

There is very little data available on the long term stability of any of these fluids. Most of the statements made in manufacturers' literature are qualitative, indicating that exposure of the fluid below the maximum temperature in closed systems will give excellent stability. Gulf reports that no decomposition was observed at temperatures up to 611°F for the polyalphaolefins.

Toxicity:

Based on the data included in Table 4 and using the widely accepted Sterner & Hodge acute toxicity classification system (Table 5), the three polyalphaolefins are relatively harmless. It is interesting to note that the latter are sometimes referred to as synthetic mineral oils. The levels of toxicty

TABLE 5

STERNER & HODGE ACUTE TOXICITY

TERMINOLOGY & CORRELATION

ACTIVE TOXICITY CLASS	LD50 RAT ORAL AMOUNT/KG. WT. (1)	PROBABLE LETHAL ORAL DOSE FOR MAN
Extremely Toxic	1 mg.	A Taste
Highly Toxic	1-50 mg.	1 Teaspoon
Moderately Toxic	50-500 mg.	1 Ounce
Slightly Toxic	0.5-5 g.	1 Pint
Practically Non-Toxic	5-15 g.	1 Quart
Relatively Harmless	>15 g.	>1 Quart

Notes:

(1) LD50 is the lethal dose for 50% of the animals in a test group.

Ref: Solvents and Safety, J. M. Nielsen, Material Information Services, GE CR&D Center, Schenectady, N. Y., 1977.

shown in Table 5 refer to ingestion in a single dose. Single dermal applications are, also, considered relatively harmless for the polyalphaolefins. However, precautions are given to avoid prolonged vapor inhalation and eye contact. Hot vapors may be mildly irritating on prolonged exposure for the polyalphaolefins, Therminol 44, and MCS 1958.

Pollution Potential and Disposibility:

Each of the fluids listed in Table 4 have been described as not presenting a serious pollution hazard.

The Material Safety Data Sheets (Form OSHA-20) prepared for the Synfluid polyalphaolefin fluids describe a procedure for spillage or leakage involving absorbing and scraping up, incinerating under controlled condition, and observing Federal spill and water quality to many organic fluids. The economics of reclamation of any fluid would depend on the extent of contamination, the initial cost of fluid, and cost of reprocessing including packaging and delivery.

Fluid Monitoring:

In the absence of data on the long term stability life of any of these fluids, quarterly sampling and testing during the first year is a wise precaution for maintaining close surveillance of the fluid in the early stages of a new application. The tests recommended are intended to detect the presence of contamination and degradation products and develop some indication of the decomposition rate. After the first year testing, the results should give a better indication for the necessary follow-on sampling frequency.

Fluid Costs:

To bring the total cost for fluid used in a collector system into perspective, it is necessary to approximate the total fluid inventory. This quantity is estimated to be 2700 gallons.

Fluid	Estimated Total Cost, $
ESH - 4	$ 17,820
Synfluid 4cs	17,820
Synfluid 6cs	17,820
Therminol 44	25,110
MCS 1958	37,800

As shown above, the polyalphaolefin fluids offer a significant cost savings.

Screening of Fluids:

Specific requirements were identified for thermal conductivity and viscosity.[2] These were used as the first two screening steps. Pour/freeze point and flash/fire point limits were arbitrarily selected and used as the second and third screening steps. This resulted in the selection of five fluids; three saturated polyalphaolefin types, ESH-4, Synfluids 4cs and 6cs, Therminol 44, and MCS 1958. These fluids were then ranked in the order of decreasing specific heat at 440 F, of increasing vapor pressure at 440°F,

[2] General Electric Company "Program Information Request" #1E30-JRF-348, 3/14/78

decreasing temperature for the 10% distillation point, and decreasing recommended use bulk temperature to identify the fluids showing superior properties. The five fluids were further compared for operational characteristics in Table 4, and rated in a preferential order in Table 6, for each property and other considerations. Numbers were assigned for each consideration in a preferential order, with number 1, being the most preferable and 5 the least preferable. The ratings for each fluid were then added for a total value, showing the fluids with the lowest total as the most preferable. On the basis of the properties, materials compatabilities, toxicity, and cost, the polyalphaolefin type fluids ESH-4, Synfluids 4cs and 6cs emerge as preferable for the 40X collector operating conditions. While this type of fluid should show excellent stability up to 550°-600°F, exposure to the estimated stagnation temperature of 900°F should be avoided. Based on available data, the base stock Synfluids apparently begin to decompose at 611°F. It is quite possible that the addition of a small amount (~0.1%) of oxidation inhibitor can increase the temperature resistance, but this approach would require experimental investigation.

Conclusions and Recommendations:

Based on the overall requirements applied to the 25 nonaqueous fluids selected for evaluation, only five fluids emerge as potential candidates:

Ethyl ESH-4
Gulf Synfluids 4cs and 6cs
Monsanto's Therminol 44 and MCS 1958

A comparison of overall properties and other considerations for the five fluids as detailed in Table 7, shows the superiority of the polyalphaolefin type fluids ESH-4, Synfluids 4cs and 6cs over Therminol 44 and MSC 1958. The

TABLE 6

RATING OF SCREENED FLUIDS FOR SPECIFIC CONSIDERATIONS

	ESH-4	SYNFLUID 4cs	SYNFLUID 6cs	THERMINOL 44	MCS 1958
Viscosity	4	3	5	2	1
Pour/Freeze Point	2	1	2	3	4
Flammability Props.	4	3	2	5	1
Distillation Props.	2	3	1	4	5
Max. Use Temp.	1	1	1	3	2
Vapor Pressure	1	3	2	4	5
Cp	1	2	3	4	5
K	2	1	1	3	4
Materials Compat.	2	2	1	3	3
Toxicity	1	1	1	2	3
Cost	1	1	1	2	3
Total Rating	21	21	20	35	36

Notes:

Numbers correspond to relative preferential rating for each consideration

1 = Most Preferable

5 = Least Preferable

Based on Data in Tables, 2, 3, 4, 5, and 6.

ratings applied to the polyalphaolefin fluids indicate that there is small differences among them, with Sunfluid 6cs being slightly superior overall. If the viscosity requirement is the prime consideration, Ethyl ESH-4 or Synfluid 4cs could be used.

Columbia has tentatively selected Gulf Synfluid 4cs as the heat transfer fluid for the Haverhill Solar System. We believe this fluid offers the best combination of heat transfer and viscosity properties with low flammability and low toxicity.

Columbia's second fluid choice is Ethyl ESH-4.