CONTRACT DOCUMENTS AND SPECIFICATIONS

FOR THE

INDIANA DEPARTMENT OF NATURAL RESOURCES

CROSLEY LAKE DAM IMPROVEMENTS PROJECT
PROJECT NO. ENG1802321631/E020098

MAY 2018

SPECIFICATIONS FOR PROJECT
RE-BID SEPTEMBER 27, 2018

PREPARED BY

COMMONWEALTH™
ENGINEERS, INC.
A wealth of resources to master a common goal.

PROJECT # D13038

SET NO. _____

CONTRACT DOCUMENTS AND SPECIFICATIONS

FOR THE

INDIANA DEPARTMENT OF NATURAL RESOURCES

CROSLEY LAKE DAM IMPROVEMENTS PROJECT
PROJECT NO. ENG1802321631/E020098

MAY 2018

ROGER M. KOTTLOWSKI
REGISTERED
No. PE60020374
STATE OF
INDIANA
PROFESSIONAL ENGINEER

ENGINEER

COMMONWEALTH ENGINEERS, INC.
A wealth of resources to master a common goal.

DREW O. FLAMION
REGISTERED
No. PE11100003
STATE OF
INDIANA
PROFESSIONAL ENGINEER

APPROVED BY:

Roger M. Kottlowski

Roger M. Kottlowski, P.E.
Indiana P.E. No. 20374

DATE: 5/9/2018

CERTIFIED BY:

Drew O. Flamion, P.E.
Indiana P.E. No. 11100003

DATE: MAY 9, 2018

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PART A
PRE-BID DOCUMENTATION

STATE OF INDIANA

Eric J. Holcomb, Governor

NOTICE TO BIDDERS

BY STATE OF INDIANA DEPARTMENT OF ADMINISTRATION, PUBLIC WORKS DIVISION FOR A PUBLIC WORKS CONSTRUCTION PROJECT ESTIMATED AT ONE HUNDRED FIFTY THOUSAND DOLLARS OR ABOVE

SEALED BIDS FOR:

PROJECT NO. ENG1802321631/E020098
Crosley Lake Dam Improvements Project
JENNINGS COUNTY

will be received from Contractors, holding a current Certificate of Qualification, at the Bid Desk, Department of Administration, Public Works Division, 402 W. Washington St., Room W467, Indianapolis, Indiana, 46204 until 1:31 P.M. (Indianapolis Time), November 13, 2018, after which all bids will be publicly opened and read in the appropriate bid room.

State Certified Minority and Women-Owned firms are encouraged to submit bids on this project as a prime contractor or through a prime contractor.

Copies of the detailed Instructions to Bidders and Drawings and/or Specifications dated May 2018 (Re-bid September 27, 2018), may be obtained from: Department of Natural Resources Division of Engineering Website http://www.in.gov/dnr/engineer/2908.htm for a non-refundable fee of $0.00. Contractors are responsible for checking this website for additional documents or addenda that may be added before the bid opening date.

Bids shall be taken from Prime Contractors pre-qualified by the Public Works Certification Board in the following classification/s: 1542.01 Institutional Buildings or 1622.01 Bridge, Tunnel, Hwy Construction or 1629.03 Dam, Dike Construction or 1771.01 Concrete Construction or 1794.01 Earthmoving & Land Clearing.

The Specified construction period is 450 calendar days. The State of Indiana reserves the right to reject any and all bids.

A goal of 7% MBE and 5% WBE has been set for this project.

Project Manager: Dana Rl

Roger Kottlowski (317) 888-1177 Dated: September 27, 2018
Email rkottlowski@contactcei.com

Director of Public Works: 9-26-18

Bob Grossman, Director

Pre-Bid Information:
Tuesday, October 23, 2018 @ 10:00 a.m. Eastern Time at the Crosley Fish & Wildlife Area Front Office located at: 2010 IN-3, North Vernon, IN 47625

INSTRUCTIONS TO BIDDERS

PROJECT ESTIMATED BY DEPARTMENT OF ADMINISTRATION, PUBLIC WORKS DIVISION
TO BE BID AT ONE HUNDRED FIFTY THOUSAND DOLLARS ($150,000) AND ABOVE

01 GENERAL

A. This project is estimated by the Public Works Division, Indiana Department of Administration (the Owner), as stated in the Notice to Bidders, at One Hundred Fifty Thousand Dollars ($150,000) and above.

B. QUALIFICATION BY THE CERTIFICATION BOARD IS REQUIRED FOR THIS PROJECT PRIOR TO BID OPENING DATE. For information and procedure contact Executive Secretary, Certification Board, Indiana Department of Administration, 402 W. Washington St., Room W467, Indianapolis, Indiana 46204 or phone (317) 232-3005.

02 PROJECT NUMBER, DESCRIPTION AND LOCATION is as stated in the Notice to Bidders.

03 TITLE AND DEFINITIONS

Said building and/or land upon which it stands is the property of the State of Indiana. All references to the title owner of said property hereinafter will be by the term "State" and all references to the person, firm, or corporation awarded the contract for the project will be by the term "Contractor". All references to Designer shall refer to the consulting person or firm employed to contract with the Public Works Division, Indiana Department of Administration to provide architectural, engineering or other consulting services for the project, or to the Public Works Division. The preparation and issuance of contracts for this project are the responsibility of the Commissioner of the Indiana Department of Administration acting with approval of the Governor.

Contract: A written agreement between two or more parties enforceable by law.

Contractor: A person who has entered into or seeks to enter into a contract with Public Works Division.

Prime Contractor: A person or business which is primarily responsible for providing goods and service or performing a specific service, etc. under contract. A prime contractor can also be a Minority Business Enterprise.

Subcontractor: A person or a business who has a direct contract with a prime contractor who is under contract to provide goods and services or perform a specific service.

Joint Venture: An association of two or more businesses to carry out a single business enterprise for profit for which purpose they combine their property, capital, efforts, skills and knowledge.

Manufacturer: A supplier that produces goods from raw materials or substantially alters them before resale.

Minority or Women Business Enterprise (M/WBE): A business concern which is certified as at least fifty-one percent (51%) owned and controlled by a woman or women or, one or more of the individuals classified as a minority group which includes: African Americans, Hispanic Americans, Asian Americans, and other racial minorities.

Supplier: Any person or entity engaged to furnish goods, materials and/or equipment, but no on-site labor, is capable of furnishing such goods, materials and/or equipment either directly from its own stock or by ordering materials and/or equipment directly from a manufacturer, and is engaged to furnish such goods, materials and/or equipment directly to a prime contractor or one of its subcontractors.

04 PRE-BIDDING, BIDDING AND POST BIDDING REQUIREMENTS

A. The Director, Public Works Division will authorize the Designer to issue bidding documents, construction documents and addenda to bidders.

B. It is recommended that all Bidders visit the site prior to submitting bid, and become thoroughly familiar with the existing site conditions and work to be performed, as indicated in the bidding documents, construction documents and addenda. Extra compensation or extension of time will not be allowed for failure to examine the site prior to bidding.

C. During the bidding period, should questions arise as to the meaning of any part of the bidding documents, construction documents or addenda that may affect the Bidder, the Bidder shall contact the Designer and/or Public Works Division and submit a written request for clarification. The Designer and/or Public Works Division will make such clarification only by written Addendum that will be mailed to each document holder or may be obtained at the office of the Designer and/or Public Works Division. By submitting a bid, the Bidder acknowledges procurement of all Addenda. No written request for clarification will be accepted by the Designer and/or Public Works Division later than fourteen (14) calendar days prior to the scheduled bid date.

D. Bid as described in Contractor's Bid (DAPW 13) shall include Base Bid (in figures and in words) and Alternates as specified in Section entitled Alternates. In verifying bids, word amounts shall have precedence over figure amounts.

E. Alternate amount(s) shall be listed where indicated. Add Alternates are not to be included in the Base Bid Scope of Work. Deduct Alternates are to be included in the Base Bid Scope of Work. The bid form must be signed. Note that by signing the bid document, the Bidder is acknowledging the procurement of all addenda and is a certifying that the bid recognizes all items in all addenda.

F. A bid by a corporation shall be in the legal name of the corporation followed by the word "by" and the signature of the president. The secretary of the corporation shall sign indicating his/her authority to sign. A Certificate of Corporate Resolution (DAPW 41) is required with and as a part of the bid if anyone other than the president of the corporation is signing bid documents.

G. *The Form 96A-Questionnaire and Financial Statement is no longer required to be submitted.* The Director, Public Works Division reserves the right to request additional financial information or contractor experience as a basis for rejection of bid or award of contract.

H. Each Bidder must file with his bid a Non-Collusion Statement (DAPW-121) signed by the same authorized person(s) who signed the bid.

I. Each Bidder must file with his bid a completely filled in and executed Bid Bond (DAPW 15A) in accordance with IC 4-13.6-7-5. The bid bond penal sum shall be the minimum amount of five percent (5%) of the bid including all additive alternates.

J. Each Bidder must file with his bid a completed M/WBE Participation Plan and Good Faith Effort Work Sheet (DAPW 26SUP2). Refer to the Supplement to the General Conditions for M/WBE Participation Policy (DAPW 26SUP1) for specific requirements.

K. Each Bidder must file with his bid, the completed Contractor's Affidavit of Subcontractors Employed (DAPW 12) only if he proposes to perform any work with a subcontract amount of $150,000.00 or more.

L. Each bidder must file with his bid an Employee Drug Testing Plan (DAPW 150A) in accordance with IC 4-13-18 (P.L. 160-2006), or evidence that the contractor is subject to a collective bargaining agreement containing drug testing requirements that comply with IC 4-13-18.

M. Each Bidder must include his Federal ID number or Social Security number on page 1 of 3 of the Bid Form (DAPW 13). All required bid documents must contain original hand written signatures.

N. All documents required by statute, rule or these instructions to be included in the bid, must be submitted together in a single sealed envelope, plainly marked with the Name of Bidder, Project Identification, Project Number, Bid Time and Bid Date. Bids shall be rejected if all required documents are not in the single sealed envelope.

O. A Bidder with proper identification may withdraw his bid at any time prior to the scheduled time for receipt of the bids; however, no bid may be withdrawn without written consent of the Director, Public Works Division for a *period of sixty (60) days after the date of the bid opening*, or unless extended in accordance with IC 4-13.6-6-4. Bids received after the designated due time for any reason, shall be rejected and returned unopened to the Bidder. The Director, Public Works Division reserves the right to reject any or all bids.

P. Subcontractors whose work will equal or exceed One Hundred Fifty Thousand Dollars ($150,000.00) must attain a Certificate of Qualification by the Certification Board before commencing any work on this project. Note paragraph 01. (B) above.

Q. All Bidders (corporations) must be in good standing with the Indiana Secretary of State.

05 SIGNATURE AFFIDAVIT

A. A Signature Affidavit (DAPW-14) containing the Bidder's authorized signature(s), properly notarized, may be submitted as a signature supplement to all other bid documents, except the bid bond, including:

1. Contractor's Bid (DAPW 13)
2. Non-Collusion Statement (DAPW-121)
3. Contractor’s Affidavit of Subs Employed (DAPW 12)
4. M/WBE Participation Plan and Good Faith Effort Work Sheet (DAPW 26 SUP 2)

B. All documents herein before required with the bid may be unsigned if the signature affidavit is submitted, except for the BID BOND. BIDDER MUST SIGN THE BID BOND.

NOTE: SIGNING THE SIGNATURE AFFIDAVIT OR BID FORM IS ACKNOWLEDGMENT OF PROCUREMENT OF ALL ADDENDA AND CERTIFICATION BY BIDDER THAT THE BID RECOGNIZES ALL ITEMS IN ALL ADDENDA.

06 WORK BY CONTRACTOR

The Contractor shall perform a minimum of 15% of the value of work (measured in dollars of the total contract price) with his own forces, and not more than 85% of the value of work is to be subcontracted.

07 SUBSTITUTIONS

The materials, products, systems and equipment described in the bidding documents, construction documents and addenda establish a standard or required function, dimension, appearance and quality that shall also be met by any proposed substitution. No substitution by manufacturer, or trade name of product named, or of a quality specified will be considered unless written request for approval has been submitted by the Bidder and has been received by the Designer and/or Public Works Division at least fourteen (14) calendar days prior to the date for receipt of bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data and any other information necessary for an evaluation. A statement setting forth any changes in other materials, equipment or work that incorporation of the substitute would require shall be included. The burden of proof of the merit of the proposed substitute is upon the proposer. The Designer and/or Public Works Division decision of approval or disapproval of the proposed substitution shall be final. Products, materials or systems not specified or approved prior to bidding, shall not be accepted for use in this project. All such substitutions accepted shall be acknowledged by addendum. See paragraph. 04 (C).

08 NONDISCRIMINATION

Pursuant to IC 22-9-1-10, the Contractor and subcontractors, if any, shall not discriminate against any employee or applicant for employment, to be employed in the performance of this contract, with respect to his hire, tenure, terms, conditions or privileges of employment, or any matter directly or indirectly related to employment, because of his race, religion, color, sex, disability, national origin, or ancestry. Breach of this covenant may be regarded as a material breach of the contract. Pursuant to IC 5-16-6-1, the contractor agrees:

A. that in the hiring of employees for the performance of work under this contract or any subcontract hereunder, no contractor, or subcontractor, nor any person acting on behalf of such contractor or subcontractor shall, by reason of race, religion, color, sex, disability, national origin or ancestry, discriminate against any citizen of the State of Indiana who is qualified and available to perform the work to which the employment relates; and

B. that no contractor, subcontractor, nor any person on his behalf shall, in any manner, discriminate against or intimidate any employee hired for the performance of work under this contract on account of race, religion, color, sex, national origin or ancestry; and

C. that there may be deducted from the amount payable to the contractor by the State of Indiana or by any municipal corporation thereof, under this contract, a penalty of five dollars ($5.00) for each person for each calendar day during which such person was discriminated against or intimidated in violation of the provisions of the contract; and

D. that this contract may be canceled or terminated by the State of Indiana or by any municipal corporation thereof, and all money due or to become due hereunder may be forfeited, for a second or any subsequent violation of the terms or conditions of this section of the contract.

09 EMPLOYMENT ELIGIBILITY VERIFICATION

The Contractor affirms under the penalties of perjury that he/she/it does not knowingly employ an unauthorized alien.

The Contractor shall enroll in and verify the work eligibility status of all his/her/its newly hired employees through the E-Verify program as defined in IC 22-5-1.7-3. The Contractor is not required to participate should the E-Verify program cease to exist. Additionally, the Contractor is not required to participate if the Contractor is self-employed and does not employ any employees.

The Contractor shall not knowingly employ or contract with an unauthorized alien. The Contractor shall not retain an employee or contract with a person that the Contractor subsequently learns is an unauthorized alien.

The Contractor shall require his/her/its subcontractors, who perform work under this contract, to certify to the Contractor that the subcontractor does not knowingly employ or contract with an unauthorized alien and that the subcontractor has enrolled and is participating in the E-Verify program. The Contractor agrees to maintain this certification throughout the duration of the term of a contract with a subcontractor.

The State may terminate for default if the Contractor fails to cure a breach of this provision no later than thirty (30) days after being notified by the State.

The contractor shall submit, before work begins the E-Verify case verification number for each individual who is required to be verified under IC 22-5-1.7. An individual who is required to be verified under IC 22-5-1.7 whose final case result is final nonconfirmation may not be employed on the public works project.

A contractor may not pay cash to any individual employed by the contractor for work done by the individual on the public works project.

A contractor must be in compliance with the federal Fair Labor Standards Act of 1938, as amended (29 U.S.C. 201-209) and IC 22-2-2-1 through IC 22-2-2-8. A contractor must be in compliance with IC 22-3-5-1 and IC 22-3-7-34. A contractor must be in compliance with IC 22-4-1 through IC 22-4-39.5. A contractor must be in compliance with IC 4-13-18-1 through IC 4-13-18-7.

10 NOTICE OF AWARD

A. Prior to execution of the Contract, in accordance with IC 4-13.6-5-2, the Director of Public Works may require additional submittals from Bidder/s to clarify contractor's experience and plans for performing the proposed work. Submittals which may be required include a critical path construction schedule which coordinates all significant tasks sequences and durations; schedule of values, and documentation of efforts to include minority and woman owned businesses in the proposed work. The Director may require Bidder/s to provide a comprehensive list of subcontractors and suppliers within 24 hours of receipt of bids.

B. Prior to execution of the Contract, the successful Bidder shall furnish a completed Domestic Steel Affidavit (DAPW-11) to Public Works Division, Indiana Department of Administration as part of the contract. The Domestic Steel Affidavit is included for Bidder's review but need not be submitted at the time of the bid opening. Definition of Steel Products:

"Steel products" means products rolled, formed, shaped, drawn, extruded, forged, cast, fabricated, or otherwise similarly processed, or processed by a combination of two (2) or more of such operations, from steel made in the United States by the open hearth, basic oxygen, electric furnace, Bessemer or other steel making process.

C. Prior to execution of the Contract, the successful Bidder shall furnish a completed Contractor's Bond for Construction (DAPW 15) (combined performance and payment bond) to Public Works Division, Department of Administration as part of the contract. The Bond form is included for Bidder's review but need not be submitted at the time of the bid opening.

D Prior to execution of the Contract, the successful Bidder shall furnish a completed Contractor's Certificate of Insurance (DAPW 16) to Public Works Division, Department of Administration as part of the contract. The Insurance form is included for Bidder's review but need not be submitted at the time of the bid opening.

E. Prior to execution of the Contract, the State of Indiana will issue to the successful Bidder a letter stating that his bid was the lowest responsible and responsive bid and that the enclosed contract document is submitted to him for his consideration. If he finds it in accordance with the bid documents, it is to be returned to Public Works Division by certified mail or in person within ten (10) calendar days after receipt for further execution and with the caution that a contract will not exist until it is signed by all signatories required. Failure to execute the proper contract and furnish the ancillary documents shall constitute reason to surrender the bid bond.

F. Concurrent with execution of the Contract, the successful Bidder may be required to furnish executed copies of Contractor-Subcontractor agreements as required in Article 5 of the General Conditions.

11 SUMMARY

All required bid documents must contain original hand written signatures. Complete documents to be submitted with this bid:

A. The Bid Bond (DAPW-15A) must be signed by both the Bidder and Bonding Company. The Bonding Company must also attach a Power of Attorney. Bid bond information, may be on the Bonding Company's standard form.

B. The Contractor's Bid (DAPW-13)

Page 1: State the amount of the bid in figures and words.

Page 2: State the amount of the alternate(s), indicate add, deduct or no change (READ CAREFULLY).

Page 3: Authorized signature of the Company. If the signature affidavit is completed and submitted with the bid, this page must be submitted but need not be signed or notarized.

C. The Signature Affidavit (DAPW-14) must contain the completed authorized signatures properly notarized and submitted with the bid as a supplement.

This Signature Affidavit shall fulfill all of the signature requirements. NOTE: The Signature Affidavit does not apply to the Bid Bond (DAPW 15A). The Bid Bond document must be fully completed with all required signatures and submitted with the bid.

D. The Non-Collusion Statement (DAPW-121) must be signed by the same authorized person(s) who signed the bid documents. If the signature affidavit is completed and submitted with bid, this form shall be submitted, but need not be signed.

E. For corporations, if anyone other than the president of the corporation signs, a Certificate of Corporate Resolution (DAPW 41) giving signature authority for the signer must be included.

F. M/WBE Participation Plan and M/WBE Good Faith Effort Work Sheet (DAPW 26SUP2) must be completed and signed by the same authorized person who signed the bid documents.

G. The completed Contractor's Affidavit of Subcontractors Employed (DAPW-12) whose subcontract amount will be $150,000.00 or more.

H. The completed plan for Contractor's Employee Drug Testing Plan (or statement of collective bargaining agreement).

I. One copy only of the Bid Documents is required. Bidders may remove and use the Documents included in the project specifications or use reproductions of the Documents.

12 INDIVIDUAL BIDS SHALL BE REJECTED BY THE DIRECTOR, PUBLIC WORKS DIVISION FOR THE FOLLOWING REASONS (IC 4-13.6-5-2; IC 4-13.6-6-1; 25 IAC 2-6-5)

A. If the bid envelope is not sealed at the time of submission; if the envelope does not clearly identify the project number and description; if the name of the Bidder is not clearly indicated on the outside of the envelope and/or if the envelope is not date and time stamped by Public Works Division prior to the stated time for receipt of bids.

B. If the estimated base bid cost exceeds $150,000.00 and the bidding contractor is not certified by Public Works Certification Board to offer bids in one of the specified categories.

C. If the bidding contractor is under suspension by the Director of Public Works or by the Public Works Certification Board.

D. If the bidding contractor is a trust and does not identify all beneficiaries and empowered settlors of the trust.

E. If the contractor's drug plan is not included in the bid documents pursuant to and complies with IC 4-13-18

13 INDIVIDUAL BIDS MAY BE REJECTED BY THE DIRECTOR, PUBLIC WORKS DIVISION FOR THE FOLLOWING REASONS (25 IAC 2-6-5)

A. If the Contractor's Bid (DAPW 13) Non-Collusion Statement (DAPW 121) and/or Bid Bond (DAPW 15A) are not signed and notarized as required by these instructions, or the Signature Affidavit (DAPW 14) and the Bid Bond (DAPW 15A) are not signed and notarized as allowed as an alternative.

B. If all required bid or alternate(s) amounts, or unit prices are not submitted with the bid when specifically called for by the specifications issued for the project.

C. When the Bidder adds any provision reserving the right to accept or reject the award, or if the Bidder adds conditions or alternates to his bid not requested (voluntary alternates), or if there are unauthorized additions or irregularities of any kind which tend to make the proposal incomplete, indefinite or ambiguous as to its meaning or amount.

D. When no bids received are under or within funds that can be appropriated, or within the Designer's estimate or when situations develop which make it impossible or not practical to proceed with the proposed work.

E. If, subsequent to the opening of the bids, facts exist which would disqualify the Bidder, or that such Bidder is not deemed by the Director, Public Works Division to be responsive or responsible.

F. If an out-of-state contractor is not registered with the Indiana Secretary of State or if any bidding contractor is not in good standing with the Secretary of State.

PART A
BID DOCUMENTATION

CONTRACTOR'S AFFIDAVIT OF SUBS EMPLOYED

Public Works Project Number: _____ Date: _____

Project Description: _____

Prime Contractor: _____

Form Submitted for Bid:_____Contract:_____ or Payment No.:_____

The following companies are subcontractors on this project for the amount indicated:

Subcontractor Name	Subcontract For	Subcontract Amount	Revised Amount	DAPW Certified Y/N	MBE WBE	On Site Y/N

_____being duly sworn upon oath, deposes and says that he is _____ of the firm of _____ and is familiar with the affidavit herewith and that these entries are complete and true.

STATE OF }
} SS:
COUNTY OF }

_____ personally appeared before me, a Notary Public, in and for said County and State, this___day of_____,20__, after being duly sworn upon his oath, says that the facts alleged in the foregoing affidavit are true.

_____
NOTARY PUBLIC - SIGNATURE

My Commission Expires: _____

_____
NOTARY PUBLIC PRINTED NAME

(SEAL)

GENERAL BID FOR PUBLIC WORKS

CONTRACTOR'S BID

For_____
(Insert class of work)

Project Number_____

Project Description (Title)_____

_____

_____

Date_____

To: Department of Administration, Public Works Division
Room W467
402 West Washington Street
Indianapolis, Indiana 46204

Pursuant to notices given, the undersigned proposes to furnish and install work in accordance with the construction documents prepared by:

_____
(Designer Name, Address, Telephone)

---

for the sum of_____
(State amount in words)

_____$_____
(State amount in figures)

If required add attachment for all unit prices called for in the Specifications.

_____ Federal I.D. Number or Social Security Number

Contractor's Email address_____
(Contract and Purchase Order will be sent to email address provided)

Bidder ID Number _____

(If you do not have an Indiana Department of Administration Bidder ID Number, please obtain one online at: http://www.in.gov/idoa/2464.htm)

ALTERNATE BIDS

Add Alternates Are Not to be included as part of the Base Bid Scope of Work.

Deduct Alternates are items of work that Are to be included in the Base Bid Scope of Work, and deducted from the project as described herein.

The work shall be as described in Section, ALTERNATES.

Bidder shall provide a response to each alternate specified. Response must indicate the amount to be ADDED to the base bid, DEDUCTED from the base bid, or that there is NO CHANGE.

Failure to respond to all alternates may cause the bid to be rejected.

BIDDER SHALL CHECK APPLICABLE BOX for each listed alternate.

Alternate No. 1 ADD _____ DEDUCT _____ NO CHANGE _____ AMOUNT $_____

Alternate No. 2 ADD _____ DEDUCT _____ NO CHANGE _____ AMOUNT $_____

Alternate No. 3 ADD _____ DEDUCT _____ NO CHANGE _____ AMOUNT $_____

Alternate No. 4 ADD _____ DEDUCT _____ NO CHANGE _____ AMOUNT $_____

Alternate No. 5 ADD _____ DEDUCT _____ NO CHANGE _____ AMOUNT $_____

Alternate No.___ ADD _____ DEDUCT _____ NO CHANGE _____ AMOUNT $_____

Ethics Compliance. The Contractor and its agents shall abide by all ethical requirements that apply to persons who have a business relationship with the State, as set forth in Indiana Code § 4-2-6 et seq., the regulations promulgated there under, and Executive Order 04-08, dated April 27, 2004. If the Contractor is not familiar with these ethical requirements, the Contractor should refer any questions to the Indiana State Ethics Commission, or visit the Indiana State Ethics Commission website at <<<http://www.in.gov/ethics/>>>. If the Contractor or its agents violate any applicable ethical standards, the State may, in its sole discretion, terminate this contract immediately upon notice to the Contractor. In addition, the Contractor may be subject to penalties under Indiana Code § 4-2-6-12.

NOTE: ALTERNATE DESCRIPTIONS PROVIDED ON PLAN SHEET 2 AND WITHIN DETAILED SPECIFICATION SECTION 00 GENERAL

Pursuant to IC 22-9-1-10, the Contractor and subcontractors, if any, shall not discriminate against any employee or applicant for employment, to be employed in the performance of this contract, with respect to his hire, tenure, terms, conditions or privileges of employment, or any matter directly or indirectly related to employment, because of his race, religion, color, sex, disability, national origin, or ancestry. Breach of this covenant may be regarded as a material breach of the contract.

IN TESTIMONY WHEREOF, the Bidder (a sole proprietor) has hereunto set his hand this ___ day of_____, 20__.

_____
Proprietorship (Company Name)

(INDIVIDUAL)

_____
Bidder (Owner)

IN TESTIMONY WHEREOF, the Bidder (a partnership) has hereunto set their hands this ___ day of _____, 20__.

_____
Company Name

_____
Partner

_____
Partner

IN TESTIMONY WHEREOF, the Bidder (a corporation) has caused this proposal to be signed by its President or other authorized signatory and Secretary this _____ day of _____, 20__.

_____
Corporation Name

_____
By President or Other Authorized Signatory

_____
Secretary

If the bid is signed by other than the President, a Corporation Resolution designating other authorized signatory shall be submitted with this bid unless already on file with the Certification Board of the Public Works Division.

BY SIGNING THIS BID THE BIDDER ACKNOWLEDGES PROCUREMENT OF ALL ADDENDA AND CERTIFIES THAT THIS BID RECOGNIZES ALL ITEMS IN ALL ADDENDA.

SIGNATURE AFFIDAVIT

PROJECT NO:_____

STATE OF }
} SS:
COUNTY OF }

Before me, the undersigned notary public, appeared_____and being duly
(name of bidder)

sworn, on his oath says that he/she is_____
(president, general partner, owner)

of_____, bidder on Project No._____, and
(name of company)

Affirmed that:

1. This bid is submitted in good faith in the amount stated herein, and will be fulfilled according to the Contract Documents (contract, general and supplemental conditions, technical specification, drawings and addenda thereto), if his bid is accepted; and
2. The statements are true contained in the Non-Collusion Statement, and as applicable, the Contractor's Affidavit of Subs Employed, the M/WBE Participation Plan and the M/WBE Good Faith Effort Work Sheet.

By: _____
(Signature)

_____
(Printed name)

_____
(Printed or typed name of company)

(must be signed by principal of organization)

STATE OF }
} SS:
COUNTY OF }

_____ personally appeared before me, a Notary Public, in and for said County and State, this_____day of_____, 20_____, after being duly sworn upon his oath, says that the facts alleged in the foregoing affidavit are true.

My Commission Expires:

_____

_____
NOTARY PUBLIC – SIGNATURE

_____
NOTARY PUBLIC PRINTED NAME

(SEAL)

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we_____
(Contractor's Name and Address)

as Principal, hereinafter called the Principal, and the_____
(Bonding Company Name)

a corporation duly organized under the laws of the State of _____
as Surety, hereinafter called the Surety, are held and firmly bound unto Public Works Division/Department of Administration, State of Indiana, as Obligee, hereinafter called the Obligee,

in the sum of _____Dollars ($_____)
for the payment of which sum well and truly to be made, the said Principal and the said Surety, bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has submitted a bid for: (insert State Project Number, Description and Location)

Project No. _____

Project Description: _____

Project Location: _____

NOW THEREFORE, if the Obligee shall accept the bid of the Principal and the Principal shall enter into a contract with the Obligee in accordance with the terms of such bid, and give such bond or bonds as may be specified in the bidding or contract documents with good and sufficient surety for the faithful performance of such contract and for the prompt payment of labor and material furnished in the prosecution thereof, or in the event of the failure of the Principal to enter such contract and give such bond or bonds, if the Principal shall pay to the Obligee the difference not to exceed the penalty hereof between the amount specified in said bid and such larger amount for which the Obligee may in good faith contract with another party to perform the work covered by said bid, then this obligation shall be null and void, otherwise to remain in full force and effect.

Signed and sealed this_____day of_____,20___.

_____ _____
(Witness) (Principal)

By: _____
(Title)

_____
(Surety)

_____ _____
Witness) (Attorney-in-fact)

I. MINORITY AND WOMEN'S BUSINESS ENTERPRISES PARTICIPATION PLAN

A Respondent is expected to submit in each response a Minority and Women's Business Enterprises Participation Plan in accordance with IC 4-13-16.5 and 25 IAC 5. The Plan must show that there are, participating in the proposed contract, Minority Business Enterprises (MBE) and Women Business Enterprises (WBE) listed in the Minority and Women's Business Enterprises Division (MWBD) directory of certified firms. Respondents must indicate the name of the MBE and WBE with which it will work, the contact name and phone number at the firm(s), the service supplied by the firm(s), the specific dollar amount from this contract that will be directed toward each firm, and the approximate date these products and/or services will be utilized. If participation is met through use of vendors who supply products and/or services, the Respondent must also indicate the vendor's tax ID number as well as provide a description of products and/or services provided to the Respondent that are directly related to this proposal and the cost of direct supplies for this proposal. All prime contractors, including MBE and WBE prime contractors, must meet the contract goals through use of subcontractors. MBE and WBE prime contractors will get no credit toward the contract goal for the use of its own workforce. The State does not accept national plans.

Failure to meet these requirements will affect the evaluation of your Proposal. The Department reserves the right to verify all information included in the Plan.

Respondents are encouraged to contact and work with MWBD to design a plan to meet established goals. MWBD's website address is www.IN.gov/idoa/minority/ and contains a complete list of all the Department's certified MBE's and WBE's.

Minority & Women's Business Enterprises Participation
Letter of Commitment

A signed letter(s), on company letterhead, from the MBE and/or WBE must accompany the Plan. This letter(s) shall state and will serve as acknowledgement from the MBE and/or WBE of its amount of participation, the scope of products and/or services, and approximate date these products and/or services will be utilized.

By submission of the Proposal, the Respondent acknowledges and agrees to be bound by the regulatory processes involving the State's M/WBE Program. Questions involving the regulations governing the Plan should be directed to MWBD's Compliance Unit at 317/232-3061

MBE/WBE PARTICIPATION PLAN

RFP # / Bid # / Quote # _____ DUE DATE_____

(Circle One)

RFP / BID / QUOTE NAME _____

(Circle One)

RESPONDENT _____

ADDRESS _____

CITY/STATE/ZIP _____

PHONE ( ) _____

The following MBE and/or WBE's listed in the MWBD directory will be participating in the contract:

MBE/WBE	P HONE	COMPANY NAME	SCOPE OF PRODUCTS/SERVICES	UTILIZATION DATE	AMOUNT

***If additional room is necessary, indicate here_____. Please attach a separate page.**

THIS DOCUMENT MUST BE INCLUDED IN YOUR RESPONSE

Indiana Department of Administration
Public Works and State Office Building Commission
GOOD FAITH EFFORTS WORKSHEET

BIDDER _____ BID/PROJECT NUMBER _____

CONTRACT GOALS 7**% MBE** 5**% WBE**

List the M/WBEs contacted and complete the following information for each. Copies of all communications to and from each vendor should be maintained.

Company Name and Address	MBE	WBE	Type of Contact	Date of Contact	Date Response Due	Goods Or Services Requested	Result (Include Price Quote)

Indicate **Good Faith Efforts** made to utilize MWBEs. Check and explain all that apply or should be considered. Please provide evidence of the efforts that you want to be considered. A complete description of each criteria may be found in the **Indiana Department of Administration Public Works and State Office Building Commission MWBE Participation Policy.**

MBE and WBE Barrier Assistance	Describe
Advertisement	Describe
Agency Assistance	Describe
Other Criteria	Describe

CERTIFICATE OF CORPORATE RESOLUTION

I,_____, do hereby certify that I am the Secretary
Type Name
of_____, a corporation duly organized and existing under and by virtue of the Laws of the State of Indiana;

I further certify that a regular/special meeting of the members of the Board of Directors of said corporation, duly called held and convened in conformity with the Charter and By Laws of said corporation, on the_____day of_____, 20_____, a quorum being present and voting thereon, the following resolution was duly adopted, to-wit:

I further certify that the foregoing resolution is a full, true, and complete copy as the same appears on record in the Minute Record Book of said corporation of which I am the legal custodian; that the same has not been altered, amended or repealed and is now in full force and effect.

In Witness Whereof, I have hereunto set my hand for said corporation this_____day of_____, 20_____.

By:_____
(Signature)

(must be signed by principal of organization)

STATE OF }
} SS:
COUNTY OF }

personally appeared before me, a Notary Public, in and for said County and State, this day of_____, 20_____, after being duly sworn upon his oath, says that the facts alleged in the foregoing affidavit are true.

My Commission Expires:

_____

_____
NOTARY PUBLIC - SIGNATURE

_____
NOTARY PUBLIC PRINTED NAME

(SEAL)

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NON-COLLUSION STATEMENT

The undersigned attests, subject to the penalties for perjury, that the undersigned is the Contractor, or that the undersigned is the properly authorized representative, agent, member or officer of the Contractor. Further, to the undersigned's knowledge, neither the undersigned nor any other member, employee, representative, agent or officer of the Contractor, directly or indirectly, has entered into or been offered any sum of money or other consideration for the execution of this Contract other than that which appears upon the face hereof. **Furthermore, if the undersigned has knowledge that a state officer, employee, or special state appointee, as those terms are defined in IC 4-2-6-1, has a financial interest in the Contract, the Contractor attests to compliance with the disclosure requirements in IC 4-2-6-10.5.**

_____
Signature

_____
Printed Name

_____
Title

_____
Company

PART A
PRE-CONTRACT DOCUMENTATION

DOMESTIC STEEL AFFIDAVIT

STATE OF }
} SS:
COUNTY OF }

PROJECT NO:_____

I hereby swear, under penalties of perjury, that the steel products furnished for this project shall conform to the following Indiana Code Definitions and contract provisions:

IC 5-16-8-1 Definitions:

"Steel products" means products rolled, formed, shaped, drawn, extruded, forged, cast, fabricated, or otherwise similarly processed, or processed by a combination of two (2) or more of such operations, from steel made in the United States by the open hearth, basic oxygen, electric furnace, Bessemer or other steel making process.

"United States" refers to the United States of America. The term includes all territory, continental or insular, subject to the jurisdiction of the United States.

IC 5-16-8-2 Public agency contract provisions; rules for determining reasonable pricing.

Sec. 2. (a) Each public agency shall require that every contract for the construction, reconstruction, alteration, repair, improvement or maintenance of public works contain a provision that, if any steel or foundry products are to be used or supplied in the performance of the contract or subcontract, only steel or foundry made in the United States shall be used or supplied in the performance of the contract or any of the subcontracts unless the head of the public agency determines, in writing, that the cost of steel or foundry products is deemed to be unreasonable.

_____
(Signature)

_____
(Printed name)

_____ _____
(Attest) (Printed or typed name of company)
(Vice President/Secretary/Treasurer)

STATE OF }
} SS:
COUNTY OF }

_____ personally appeared before me, a Notary Public, in and for said County and State, this____day of_____,20___, after being duly sworn upon his oath, says that the facts alleged in the foregoing affidavit are true.

My Commission Expires: _____
NOTARY PUBLIC - SIGNATURE

_____ _____
NOTARY PUBLIC PRINTED NAME

(SEAL)

STATE FORM
12125R3

DAPW 11
Rev. 10/14

CONTRACTOR'S BOND FOR CONSTRUCTION

KNOW ALL MEN BY THESE PRESENT, that _____
(Contractor)
_____ of _____
(Address) (City, State)
as principal and _____
(Bonding Company)
_____
(Address) (City, State) (Zip Code)

as surety, are firmly bound unto the State of Indiana in the penal sum of $_____ Dollars, for the payment of which, well and truly to be made, we bind ourselves, jointly and severally, and our joint and several heirs, executors, administrators and assigns, firmly by these present, this _____ day of , 20_____.

THE CONDITIONS OF THE ABOVE OBLIGATION ARE SURE, THAT, WHEREAS the State of Indiana acting by and through the Commissioner, Department of Administration, has entered into a certain written contract dated _____ of _____

_____
(Project Number and Description)

_____ situated in _____
Indiana, in accordance with the construction documents approved and adopted by said Commissioner, Department of Administration, which are made a part of this bond.

NOW THEREFORE, if the said _____
(Contractor)
_____, shall well and faithfully do and perform the same in all respects according to the plans and specifications adopted by said Commissioner, Department of Administration, and according to the time, terms and conditions specified in said contract and incurred by him or any subcontractor in the prosecution of said work, including labor, service and materials furnished, then this obligation shall be void; otherwise to remain in full force, virtue and effect. This bond shall adhere to the requirements of IC 4-13.6-7-6 and IC 4-13.6-7-7.

IN WITNESS WHEREOF, we hereunto set our hands and seals this _____ day

of _____ , 20_____.

By: _____ (Seal)
(Contractor)

By: _____ (Seal)
(Bonding Company)

By: _____
(Attorney-in-fact)

CONTRACTOR'S CERTIFICATE OF INSURANCE

This certifies to the addressee shown below that the following described policies, subject to their terms, conditions, and exclusions, have been issued to:

NAME AND ADDRESS OF INSURED: _____

COVERING (show State project number, name and location) _____

ADDRESSEE: **PUBLIC WORKS DIVISION/DEPARTMENT OF ADMINISTRATION** DATE: _____

TYPE OF INSURANCE	POLICY NUMBER	EFFECTIVE DATE	EXPIRATION DATE	LIMITS	
1. General Liability a. Bodily Injury Including Personal Injury				Each Person - Premises and Operations Each Person – Elevators Each Person – Independent Contractor Each Person - Products Completed Including Operations Each Person – Contractual Each Occurrence - Aggregate - Products Completed Including Operations	$ $ $ $ $ $ $
b. Property Damage				Each Occurrence – Premises and Operations Each Occurrence – Elevators Each Occurrence – Independent Contractor Each Occurrence – Products Completed Including Operations Each Occurrence – Contractual Aggregate - Aggregate - Operations Protective Products and Contractual	$ $ $ $ $ $ $
2. Automobile Liability a. Bodily Injury b. Property Damage				Each Person Each Occurrence Each Accident	$ $ $
3. Excess Liability Umbrella					$
4. a. Workmen's Compensation b. Employer's Liability				Statutory Workmen's Compensation One Accident And Aggregate Disease	$ $
5. Builder's Risk					$

	YES	NO
UNDER GENERAL LIABILITY POLICY OR POLICIES		
1. Does Property Damage Liability Insurance shown include coverage for **XC** and **U** hazards?	_____	_____
2. Is Occurrence Basis Coverage provided under Property Damage Liability?	_____	_____
3, Is Broad Form Property Damage Coverage provided for this Project?	_____	_____
4. Is Personal Injury Coverage included?	_____	_____
5. Is coverage provided for Contractual Liability (including indemnification provision) assumed by insured?	_____	_____
UNDER AUTOMOBILE LIABILITY POLICY OR POLICIES	_____	_____
1. Does coverage shown above apply to non-owned and hired automobiles?	_____	_____
2. Is Occurrence Basis Coverage provided under Property Damage Liability?	_____	_____

In the event of cancellation, fifteen (15) days written notice shall be given to the party to whom this certificate is addressed.

_____
NAME OF INSURANCE COMPANY

_____
ADDRESS

_____
SIGNATURE OF AUTHORIZED REPRESENTATIVE

CONTRACTOR'S EMPLOYEE DRUG TESTING

IC 4-13-18 IS ADDED TO THE INDIANA CODE AS A NEW CHAPTER TO READ AS FOLLOWS [EFFECTIVE JULY 1, 2006]:

Chapter 18. Drug Testing of Employees of Public Works Contractors

Sec. 1. This chapter applies only to a public works contract awarded after June 30, 2006.

Sec. 2. As used in this chapter, "bid" includes a quotation.

Sec. 3. (a) As used in this chapter, "contractor" refers to a person who:
(1) submits a bid to do work under a public works contract; or
(2) does any work under a public works contract.
(b) The term includes a subcontractor of a contractor.

Sec. 4. As used in this chapter, "public works contract" refers to:
(1) a public works contract covered by IC 4-13.6;
(2) a public works contract covered by IC 5-16 and entered into by a state agency; or
(3) a state highway contract covered by IC 8-23-9;
when the estimated cost of the public works project is one hundred fifty thousand dollars ($150,000) or more.

Sec. 5. (a) A solicitation for a public works contract must require each contractor that submits a bid for the work to submit with the bid a written plan for a program to test the contractor's employees for drugs.
(b) A public works contract may not be awarded to a contractor whose bid does not include a written plan for an employee drug testing program that complies with this chapter.
(c) A contractor that is subject to a collective bargaining agreement shall be treated as having an employee drug testing program that complies with this chapter if the collective bargaining agreement establishes an employee drug testing program that includes the following:
(1) The program provides for the random testing of the contractor's employees.
(2) The program contains a five (5) drug panel that tests for the substances identified in section 6(a)(3) of this chapter.
(3) The program imposes disciplinary measures on an employee who fails a drug test. The disciplinary measures must include at a minimum, all the following:
(A) The employee is subject to suspension or immediate termination.
(B) The employee is not eligible for reinstatement until the employee tests negative on a five (5) drug panel test certified by a medical review officer.
(C) The employee is subject to unscheduled sporadic testing for at least one (1) year after reinstatement.
(D) The employee successfully completes a rehabilitation program recommended by a substance abuse professional if the employee fails more than one (1) drug test.
A copy of the relevant part of the collective bargaining agreement constitutes a written plan under this section.

Sec. 6. (a) A contractor's employee drug testing program must satisfy all of the following:
(1) Each of the contractor's employees must be subject to a drug test at least one (1) time each year.
(2) Subject to subdivision (1), the contractor's employees must be tested randomly. At least two

percent (2%) of the contractor's employees must be randomly selected each month for testing.

(3) The program must contain at least a five (5) drug panel that tests for the following:

(A) Amphetamines.

(B) Cocaine.

(C) Opiates (2000 ng/ml).

(D) PCP.

(E) THC.

(4) The program must impose progressive discipline on an employee who fails a drug test. The discipline must have at least the following progression:

(A) After the first positive test, an employee must be:

(i) suspended from work for thirty (30) days;

(ii) directed to a program of treatment or rehabilitation; and

(iii) subject to unannounced drug testing for one (1) year, beginning the day the employee returns to work.

(B) After a second positive test, an employee must be:

(i) suspended from work for ninety (90) days;

(ii) directed to a program of treatment or rehabilitation; and

(iii) subject to unannounced drug testing for one (1) year, beginning the day the employee returns to work.

(C) After a third or subsequent positive test, an employee must be:

(i) suspended from work for one (1) year;

(ii) directed to a program of treatment or rehabilitation; and

(iii) subject to unannounced drug testing for one (1) year, beginning the day the employee returns to work.

The program may require dismissal of the employee after any positive drug test or other discipline more severe than is described in this subdivision.

(b) An employer complies with the requirement of subsection (a) to direct an employee to a program of treatment or rehabilitation if the employer does either of the following:

(1) Advises the employee of any program of treatment or rehabilitation covered by insurance provided by the employer.

(2) If the employer does not provide insurance that covers drug treatment or rehabilitation programs, the employer advises the employee of agencies known to the employer that provide drug treatment or rehabilitation programs.

Sec. 7. (a) The public works contract must provide for the following:

(1) That the contractor implement the employee drug testing program described in the contractor's plan.

(2) Cancellation of the contract by the agency awarding the contract if the contractor:

(A) fails to implement its employee drug testing program during the term of the contract;

(B) fails to provide information regarding implementation of the contractor's employee drug testing program at the request of the agency; or

(C) provides to the agency false information regarding the contractor's employee drug testing program.

(b) The provisions of the public works contract relating to cancellation of the contract by the agency awarding the contract apply to cancellation of the public works contract under this section.

PART A
CONTRACT
DOCUMENTATION

TABLE OF CONTENTS
STATE OF INDIANA - GENERAL CONDITIONS

ARTICLE 1 CONTRACT DOCUMENTS

1.1 Definitions

1.1.1 The Contract Documents

The Contract Documents consist of the Agreement, the Instructions to Bidders, the Contractor's Proposal (Bid), the Conditions of the Contract (General and Supplementary), Drawings, Specifications, and Addenda issued prior to bidding, Change Orders, any written interpretation issued as a field order by the Designer pursuant to Article 1.2, and all field orders for minor changes in the Work by the Designer pursuant to Article 12.3.

1.1.2 The Contract

The Contract Documents form the Contract for construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes all prior negotiations, representations, or agreements, either written or oral.

1.1.3 The Work

All labor, material, equipment, systems and services necessary to produce the result called for in the Contract Documents.

1.1.4 The Project

The Project is the total construction designed by the Designer of which the Work performed under the Contract Documents may be the whole or a part.

1.2 Execution, Correlation, Intent and Interpretations

1.2.1 The Contract Documents shall be signed by the Owner and the Contractor. The signature process may be done electronically at the discretion of the Owner.

1.2.2 By executing the Contract the Contractor represents that he has visited the site and correlated his observations with the requirements of the Contract Documents, and has no major question pertaining thereto.

1.2.3 The Contract Documents are complementary, and what is called for by any one shall be as binding as if called for by all. The intention of the Documents is to include all labor, equipment, supervision and materials, for the proper execution and completion of the Work, and also to include those things that may be reasonably inferable from the Contract Documents as being necessary to produce the intended results. Words that have a well-known technical or trade meaning are used herein, in accordance with such recognized meaning.

1.2.4 Written interpretations necessary for the proper execution of the Work, in the form of drawings or otherwise will be issued with reasonable promptness by the Designer. Such interpretations shall be consistent with and reasonably inferable from the Contract Documents, and may be issued by field order subject to Owner's approval.

1.3 Copies Furnished and Ownership

1.3.1 The Contractor will be furnished 5 copies of drawings and specifications and any other information necessary for the execution of the Work.

1.3.2 All drawings, specifications, and copies thereof furnished by the Designer are his property. They are not to be used on any other Project, and, with the exception of one Contract set for each party to the Contract, are to be returned on request to the Designer at the completion of the Work.

ARTICLE 2 DESIGNER

2.1 Definition

2.1.1. The Designer is the person or organization identified as Designer of the Project, and is referred to throughout the Contract Documents as if singular in number and masculine in gender. The terms Designer, Engineer, Architect, (and in certain projects Director, Public Works Division or his authorized representative), shall mean the Designer.

2.2 Administration of the Contract

2.2.1 The Designer will provide general administration of the Contract, including the functions hereinafter described.

2.2.2 Unless stated otherwise, the Designer shall be the Owner's representative during the construction phase. He shall have authority to act on behalf of the Owner only to the extent expressly provided in the Contract Documents or otherwise in writing, which will be shown to the Contractor. The Designer will advise and consult with the Owner and all of the Owner's instructions to the Contractor shall be issued through the Designer.

2.2.3 The Designer shall have access to the Work at all times wherever it is in storage, preparation and progress. The Contractor shall provide facilities for such access so that the Designer and Owner's Site Representative may perform their functions under the Contract Documents.

2.2.4 The Designer will make no less than weekly visits to the site when work is in progress to familiarize himself generally with the progress and quality of the Work and to determine in general if the Work is proceeding in accordance with the Contract Documents. He will not be required to make exhaustive or continuous on-site inspection to check the quality or quantity of the Work. On the basis of his on-site observations as Designer, he will keep the Owner informed of the progress of the Work, and will endeavor to guard the Owner against defects and deficiencies in the Work of the Contractor.

2.2.5 Based on such observation and the Contractor's applications for payment, the Designer will determine the amount owed to the Contractor and will issue Certificates for Payment in such amounts.

2.2.6 The Designer will be, in the first instance, the interpreter of the requirements of the Contract Documents and the judge of the performance thereunder. He will promptly render such interpretations as he may deem necessary for the proper execution or progress of the Work.

2.2.7 All interpretations and decisions of the Designer will be consistent with the intent of the Contract Documents. He will exercise his best efforts to insure faithful performance by the Contractor.

2.2.8 Claims, disputes and other matters in question relating to the execution or progress of the Work or interpretation of the Contract Documents shall be referred initially to the Designer for decision and be subject to written appeal within fifteen (15) days by the Contractor. The Designer shall submit his decision promptly in writing to the Director, Public Works Division, who shall have full authority to render the final and binding decision.

2.2.9 The Designer will have responsibility to recommend to the Owner the rejection of work that does not conform to the Contract Documents. Whenever the Designer considers it necessary or advisable, he shall recommend to the Owner the stoppage of the Work or any portion thereof, and to recommend special examination or testing of the Work (whether or not fabricated, installed, or completed).

2.2.10 The Designer will review and approve or take other appropriate action upon the Contractor's submittals such as shop drawings, product data and samples, but only for conformance with the design concept of the Work and with the information given in the Contract Documents. Such action shall be taken with reasonable promptness so as to cause no delay. The Designer's approval of a specific item shall not indicate approval of all assembly of which the item is a component.

2.2.11 The Designer will prepare change orders in accordance with Article 12.

2.2.12 The Designer will conduct reviews to determine the dates of Substantial Completion and Final Completion, will receive and forward to the Owner for the Owner's review written warranties and related documents required by the Contract and assembled by the Contractor, and will issue a final Certificate for Payment upon compliance with the requirements of Article 9.7.

2.2.13 The Designer, together with representatives from the Contractor and the Owner will conduct a review of the Work nine (9) months after the date of substantial completion to determine any work not in compliance with the Contract Documents at that time. A list of items to be corrected or completed will be forwarded to the Contractor for corrective action prior to the expiration of the one year warranty period.

2.2.14 The duties, responsibilities and limitations of authority of the Designer as the Owner's representative during construction as set forth in Articles 1 through 14 of these General Conditions shall not be modified or extended without written consent of the Owner.

2.2.15 The Designer will not be responsible for the acts or omissions of the Contractor, Subcontractor, or any of their superintendents, supervisory staffs, agents or employees, or any other persons performing any of the Work.

2.2.16 In case of the termination of the employment of the Designer, the Owner shall appoint a Designer against whom the Contractor makes no reasonable objections, whose status under the Contract shall be that of Designer.

ARTICLE 3 OWNER

3.1 Definition

3.1.1 The Owner is the State of Indiana, represented by the Commissioner; Department of Administration acting through the Director, Public Works Division and the Director's designated project manager.

3.2 Information and Service Required of the Owner

3.2.1 The Owner will furnish, through the Designer, surveys, describing known physical characteristics, legal limits and utility locations for the property on which the Project is to be erected, if in the Owner's possession.

3.2.2. Information or services under the Owner's control shall be furnished by the Owner with promptness to avoid delay in the orderly progress of the Work.

3.2.3 The Owner shall issue all instructions to the Contractor through the Designer unless specified elsewhere in these documents.

3.2.4 If the Contractor fails to correct defective work as required by Article 13 or persistently fails to carry out the Work in accordance with the Contract Documents, the Owner, by a written order may order the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of the Owner to stop the Work shall not give rise to any duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Article 6.1.

3.3 Owner's Site Representative

3.3.1 Notwithstanding the obligations of the Designer as Owner's representative during construction, the Owner may employ an on-site representative to observe the progress of the Work.

3.3.2 The Owner's Site Representative shall function as an observer only. He shall report his findings to the Designer for review and any required further action. The Owner's Site Representative is not authorized to make changes in the Work or to interpret the Contract Documents.

3.3.3 The Owner's Site Representative shall have at all times access to the Work wherever it is in storage, preparation and progress. He may attend meetings at the site and he may review and approve the Contractor payment requests.

ARTICLE 4 CONTRACTOR

4.1 Definition

4.1.1 The Contractor is the person or organization identified as such in the Agreement. He is referred to throughout the Contract Documents as if singular in number and masculine in gender. The term Contractor means the Contractor or his authorized representative.

4.2 Review of Contract Documents

4.2.1 The Contractor shall carefully study and compare the Contract Documents and shall at once report to the Designer and the Owner any error, inconsistency or omission he may discover. The Contractor shall perform no portion of the Work at any time without Contract Documents or, where required, approved shop drawings, product data or samples for such portion of the Work.

4.3 Supervision and Construction Procedures

4.3.1 The Contractor shall supervise and direct the Work, using his best skill and attention. He shall be solely responsible for the quality of the Work and for all construction techniques, sequences, and procedures, and for coordinating all portions of the Work.

4.3.2 The Contractor shall not be relieved from his obligations to perform the Work in accordance with the Contract Documents either by the activities or duties of the Designer in administration of the Contract, or by inspections, tests or approvals required or performed under Paragraph 7.9 by persons other than the Contractor.

4.4 Labor and Materials

4.4.1 Unless otherwise specified in Division 1, the Contractor shall provide and pay for all labor, material, equipment, tools, construction equipment, machinery, transportation, and other facilities and services necessary for the proper execution of the Work.

4.4.2 Unless otherwise specified in Division 1, the Contractor shall provide and pay for all electric current, water, heat, and telephone services and shall maintain necessary discipline to prevent waste.

4.4.3 If any item of work shall be the subject of a jurisdictional dispute as to the craft to be used for said work, the Contractor shall aid in such inter-craft resolution and if arbitrated, abide by the decision, holding the Owner free of involvement in the dispute, and if time is lost by the dispute, extra work days will only be considered through the provisions of Article 12.2. He will do whatever he can to eliminate any embarrassment to the Owner caused by picketing, etc.

4.4.4. The Contractor shall at all times enforce strict discipline and good order among his employees, and shall not employ on the Work any unfit person or any one employee unskilled in the Work assigned to him or unqualified as a tradesman in the trade involved.

4.5 Warranty and Guarantee

4.5.1 The Contractor warrants and guarantees that all materials and equipment incorporated in the Project shall be new unless otherwise specified, and all work will be of the highest quality, free from faults and defects, and in strict conformance with the Contract Documents for a period of one year from the date of substantial completion. All work not so conforming to the Contract Documents may be considered defective. If required by the Designer, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment. The warranties and guarantees provided in this Article and elsewhere in the Contract Documents shall be in addition to and not in limitation of any other warranty or guarantee or remedy called for the Contract Documents or otherwise prescribed by law. The Contractor, together with the Designer and representatives from the Owner, shall review the Work nine (9) months after the date of substantial completion to determine any work not in compliance with the Contract Documents. The Contractor shall correct such non-complying work prior to the expiration of the one year warranty.

4.6 Permits, Fees and Notices

4.6.1 The Contract shall secure and pay for all permits, fees and licenses necessary for the execution of the Work.

4.6.2 The Contractor and Subcontractors must submit an “Exemption Certificate for Construction Contractors” (Form ST-105) to each supplier in order to obtain exemption from the Indiana Gross Tax (i.e., sales and use tax).

4.6.3 The Contractor shall give all notices and comply with all laws, ordinances, rules, regulations, and orders of any public authority bearing on the conduct of the Work. If he observes that any of the Contract Documents are at variance therewith in any respect, he shall promptly notify the Designer in writing, and any necessary changes shall be adjusted by change order. If he performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without such notice to the Designer, he shall bear all cost arising from such non-conformance.

4.7 Cash Allowances

4.7.1 The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. These allowances cover the net cost of the materials and equipment delivered and unloaded at the site which cost shall be determined by the Owner through proper procedures for receiving quotes or bids as required by law. The Contractor’s handling costs on the site, labor, installation costs, overhead, profit**,** and other expenses shall be included in the Contract sum and not in the allowance. The Contractor shall cause the Work required by these allowances to be performed by such persons as the Designer may direct, but he will not be required to employ persons against whom he has a reasonable objection. If the net cost above, when determined, is more than or less than the allowance, the Contract Sum will be adjusted accordingly by change order.

4.8 Superintendent

4.8.1 The Contractor shall keep on the Project, during the entire contract time, a competent superintendent and necessary assistants, all satisfactory to the Designer and the superintendent shall not be changed, except with the consent of the Owner, unless the superintendent proves to be unsatisfactory to the Contractor and ceases to be in his employ. The superintendent shall represent the Contractor and shall have full authority to act on his behalf. All communications given the superintendent shall be as binding as if given by the Contractor. Important communications shall be confirmed in writing.

4.9 Responsibility for Those Performing the Work

4.9.1 The Contractor shall be responsible for the quality of the Work, for acts and omissions of all the Subcontractors, their superintendents, their supervisory staffs, agents, or employees and of all other persons performing any of the Work under a Contract with the Contractor.

4.10 Progress Schedule

4.10.1 Unless otherwise indicated in Division 1, the Contractor, immediately after being awarded the Contract, shall prepare and submit for the Designer's approval a progress schedule for the Work in relation to the entire Project. This schedule in bar graph form, or other form approved by the Owner, shall indicate the dates for the starting and completion of the various stages of construction, and in addition, will state the contractual completion date. The contract completion date, based on the construction period stated in the notice to bidders, shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by change order. A more detailed schedule may be required elsewhere in the documents.

4.11 Record Documents at the Site

4.11.1 The Contractor shall maintain for the Owner as part of the Contract one record copy of all drawings, specifications, addenda, shop drawings, change orders and other modifications at the site in good order, and marked to record all changes made during construction. These shall be available to the Designer and the Owner's Site Representative at all times while Work is in progress. All changes made during construction shall be recorded monthly and reviewed by the Designer before approval of each partial progress payment. The record documents shall be submitted to the Designer prior to the Contractor's final payment.

4.12 Shop Drawings and Samples

4.12.1 Shop drawings are all drawings, diagrams, illustrations, schedules, brochures, and other data, which are prepared by the Contractor, or any Subcontractor, manufacturer, supplier, or distributor, and which illustrate the Work.

4.12.2 The Contractor shall submit all shop drawings and samples required by the Contract or by the Designer in a timely manner, allowing sufficient time for the Designer's review so as not to cause any delay in the Work or in work by any other Contractor.

4.12.3 At the time of such submission, the Contractor shall furnish or verify all field measurements, field construction criteria, materials, catalog numbers, and the like and shall individually check, coordinate and stamp with his approval each submission, and shall in writing call the Designer's attention to any deviations in the shop drawings or samples from the requirements of the Contract Documents.

4.12.4 The Designer will check and approve, with reasonable promptness so as to cause no delay, these shop drawings and samples only for conformance with the design concept of the Project, and with the information given in the Contract Documents. The Designer's approval of a separate item will not indicate approval of the assembly in which the item functions.

4.12.5 The Designer's approval of shop drawings or samples shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents unless the Contractor has in writing called the Designer's attention to such deviation at the time of submission and the Designer has given written approval to the specific deviation, nor shall this relieve the Contractor from errors or omissions in the shop drawings or samples.

4.12.6 No work requiring a shop drawing or sample submission shall be commenced until the submission has been approved by the Designer. All such work shall be in accordance with approved shop drawings and samples.

4.13 Use of Premises

4.13.1 The Contractor shall confine operations at the site to areas permitted by law, ordinances, permits and the Contract Documents, and shall not unreasonably encumber the premises with any materials or equipment.

4.14 Cutting and Patching

4.14.1 The Contractor shall do all cutting, fitting or patching of his work that may be required to make its several parts come together properly and shall not endanger any work by cutting, excavating, or otherwise altering the Work or any part of it. Costs caused by defective or ill-timed work shall be borne by the party responsible therefore.

4.15 Cleaning Up

4.15.1 The Contractor shall at all times keep the premises free from accumulation of waste materials or rubbish caused by his operations. At the completion of the Work, he shall remove all waste material and rubbish from and about the building as well as all his tools, scaffolding and surplus materials. Contractor shall clean all glass surfaces, lights and fixtures, ceilings, walls and shall leave the Work dusted, swept and wet mopped clean, unless more exactly specified.

4.15.2 In case of dispute the Owner may remove the rubbish and charge the cost to the several Contractors as the Designer shall determine to be just.

ARTICLE 5 SUBCONTRACTORS

5.1 Definition

As used in this article "contractor tier" refers collectively to the following classes of contractors on a public works project:

(1) "Tier 1 contractor" includes each person that has a contract with the public agency to perform some part of the work on, supply some of the materials for, or supply a service for, a public works project A person included in this tier is also known as a "prime contractor" or a "general contractor".

(2) "Tier 2 contractor" includes each person that has a contract with a tier 1 contractor to perform some part of the work on, supply some of the materials for, or supply a service for, a public works project A person included in this tier is also known as a "subcontractor".

(3) "Tier 3 contractor" includes each person that has a contract with a tier 2 contractor to perform some part of the work on, supply some of the materials for, or supply a service for, a public works project. A person included in this tier is also known as a "sub-subcontractor".

(4) "Lower tier contractor" includes each person that has a contract with a tier 3 contractor or lower tier contractor to perform some part of the work on, supply some of the materials for, or supply a service for, a public works project. A person included in this tier is also known as a "lower tier subcontractor".

A Subcontractor is a person or entity who has a direct Contract with the Contractor to perform any of the Work at the site. The term Subcontractor is referred to throughout the Contract Documents as if singular in number and masculine in gender and means a Subcontractor or his authorized representative. The term Subcontractor does not include any separate Contractor or his Subcontractors.

5.2 Award of Subcontracts and Other Contracts for Portions of the Work

5.2.1 Unless otherwise required by the Contract, the Contractor shall furnish to the Owner, with his bid on the prescribed form, the names of all persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for each of the principal portions of the Work with an installed value of $150,000.00 or more. The Designer will promptly reply to the Contractor in writing stating whether or not the Owner or the Designer, after due investigation, has reasonable objection to any such proposed person or entity. Failure of the Owner or Designer to reply within fourteen (14) days shall constitute notice of no reasonable objection.

5.2.2 The Contractor shall not subcontract with any such proposed person or entity to which the Owner or the Designer has made reasonable objection. The Contractor shall not be required to subcontract with anyone to whom he has a reasonable objection.

5.2.4 If the Owner or the Designer has reasonable objection to any such proposed person or entity, the Contractor shall submit a substitute to whom the Owner or the Designer has no reasonable objection.

5.2.5 The Contractor shall make no substitution of any Subcontractor, person or entity previously selected, if the Owner or Designer makes reasonable objection to such substitution.

5.2.3 The Contractor and his subcontractors shall employ only licensed plumbers and shall provide to the Owner the names and license numbers of all plumbers engaged in the Work. The Contractor shall submit this documentation with any monthly progress payment request that includes plumbing labor.

5.3 Subcontractual Relations

5.3.1 By an appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by the terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by these Documents, assumes toward the Owner. Said agreement shall preserve and protect the rights of the Owner under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor the benefit of all rights, remedies and redress against the Contractor that the Contractor, by these Documents, has against the Owner. Provisions of Article 9 for progress payments, retainage and payment for stored material shall be incorporated without modification in all Contractor-Subcontractor agreements. The Contractor shall require each Subcontractor to enter into similar agreements with his Sub-subcontractors. Prior to execution of the Contractor-Subcontractor agreement, the Contractor shall provide all Subcontractors a complete copy of all proposed Contract Documents for the Project to which the Subcontractor will be bound by this Paragraph 5.3. Each Subcontractor shall similarly make available to his Sub-Subcontractors copies of such Documents. Executed copies of all agreements shall remain on file with the Contractor and be available for review by the Owner at the Owner's discretion.

ARTICLE 6 SEPARATE CONTRACTS

6.1 Owner's Right to Let Separate Contracts

6.1.1 The Owner reserves the right to let other contracts in connection with other portions of the Project under these or similar General Conditions.

6.1.2 When separate contracts are awarded for different portions of the Project, "the Contractor" in the Contract Documents in each case shall be the Contractor who signs each separate contract with the Owner.

6.1.3 When separate contracts are awarded for portions of the Project, the General Construction Contractor shall be responsible for the overall coordination of all separate contracts for the Project.

6.2 Mutual Responsibility of Contractors

6.2.1 The Contractor shall afford each other Contractor reasonable opportunity for the introduction and storage of their materials and equipment and the execution of their work, and each shall properly connect and coordinate his work with all others as coordinated by the General Contractor.

6.2.2 If any part of the Contractor's work depends on proper execution or results upon the work of any other separate Contractor, the Contractor shall inspect and promptly report to the Designer any discrepancies or defects that shall cause his work to fail or be non-conforming. Failure of the Contractor to so inspect and report shall constitute an acceptance of the other Contractor's work as fit and proper for the reception of his work.

6.2.3 Should the Contractor cause damage to any separate Contractor on the Project, the General Contractor agrees, upon due notice, to settle with such other Contractor by agreement, if at all possible without involving the Owner. The Owner will be involved only after evidence is presented that sureties cannot settle the problem.

6.2.4 Any costs caused by defective or ill-timed work shall be borne by the party responsible.

ARTICLE 7 MISCELLANEOUS PROVISIONS

7.1 Delinquent State Taxes (IC. 4-13-2-14.5). The Public Works Division may allow the Department of State Revenue access to the name of each person who is either:

(1) Bidding on a Contract to be awarded under this chapter; or
(2) A Contractor or Subcontractor under this chapter.

If the Public Works Division is notified by the Department of State Revenue that a bidder is on the most recent tax warrant list, a Contract may not be awarded to that bidder until the bidder provides a statement from the Department of State Revenue that the Bidder's delinquent tax liability has been satisfied. The Department of State Revenue may notify:

(1) The Department of Administration; and
(2) The Auditor of State;

that a Contractor or Subcontractor under this chapter is on the most recent tax warrant list, including the amount owed in delinquent taxes. The Auditor of State shall deduct from the Contractor's or Subcontractor's payment the amount owed in delinquent taxes. The Auditor of State shall remit this amount to the Department of State Revenue and pay the remaining balance to the Contractor or Subcontractor.

7.2 Choice of Law

7.2.1 The Contract shall be governed by the laws of the State of Indiana.

7.3 Assignment

7.3.1 The Contractor shall not assign the Contract or sublet it as a whole without the written consent of the Owner, nor shall the Contractor assign any monies due or to become due to him hereunder, without the previous written consent of the Owner.

7.4 Written Notice

7.4.1 Written notice shall be deemed to have been duly served if delivered in person to the individual or member of the firm or to an officer of the corporation for whom it was intended, or sent by registered or certified mail to the last business address known to him who gives the notice.

7.5 Claims for Damages

7.5.1 Should either party to the Contract suffer injury or damage to person or property because of any act or omission of the other party or any of his employees, agents or others for whose acts he is legally liable, claim shall be made in writing to such other party within seven (7) days of the first observance of such injury or damage.

7.6 Performance Bond and Labor and Material Payment Bond

7.6.1 For projects advertised with an estimated base bid amount of One Hundred Fifty Thousand Dollars ($150,000) or more, the Contractor shall furnish and pay for an approved one hundred percent (100%) combination performance and payment bond (Contractor's Bond for Construction, Public Works Division Form DAPW 15). This bond shall adhere to the requirements of IC. 4-13.6-7-6 and IC. 4-13.6-7-7 as amended and shall cover the faithful performance of the Contract and the payment of all obligations arising thereunder, including reimbursement for any stored materials paid for but returned to materialmen, with such sureties as the Owner may approve. The combination bond shall remain in effect throughout the entire construction period and in addition for a period of one year from the date of final acceptance. The Contractor shall deliver the required bonds to the Owner prior to execution of the Contract by the Owner unless authorized to the contrary in writing by the Owner. All bonds must be issued by bonding companies, which are licensed and approved by the Indiana Insurance Commission.

7.7 Owner's Right to Carry Out the Work

7.7.1 If the Contractor should default or neglect to carry out the Work properly or fail to perform any provision of the Contract, the Owner may, after giving seven (7) days written notice to the Contractor, without prejudice to any other remedy it may have, make good such deficiencies. In such case, an appropriate change order shall be issued deducting the cost thereof including the cost of the Designer's additional service made necessary by such default, neglect or failure of the Contractor, from the payments then or thereafter due the Contractor, provided, however, that the Designer shall approve both such action and the amount charged to the Contractor. If such payments due to the Contractor are not sufficient to cover such amount, the Contractor shall pay the difference to the Owner.

7.8 Royalties and Patents

7.8.1 The Contractor shall pay all royalties and license fees. He shall defend all suits or claims for infringement of any patent rights and shall save the Owner harmless from liability of any nature or find including costs and expenses for or on account of any patented or unpatented invention, process, article or appliance manufactured or used in the performance of this Contract, including its use by the Owner.

7.9 Tests & Substitution of Materials

7.9.1 If the Contract Documents, laws, ordinances, rules, regulations, or orders of any public authority having jurisdiction require any work to be inspected, tested, or approved, the Contractor will give the Designer timely notice of its readiness and of the date fixed for such inspection, testing, or approval so that the Designer may observe the same. The Contractor shall bear all cost of such inspections, tests, and approvals unless otherwise provided.

7.9.2 If, after the commencement of the Work, the Designer, with approval of the Owner in writing, determines that the Work requires special inspection, testing, or approval for which subparagraph 7.9.1 does not provide, he will, upon written authorization from the Owner, order such special inspection, testing or approval. If such special inspection or test reveals a failure of the Work to fulfill the requirements of the Contract Documents, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction, the Contractor shall bear all costs thereof; otherwise the Owner shall bear such costs. An appropriate change order shall be issued.

7.9.3 Required certificates of inspection, testing or approval shall be secured by the Contractor and promptly delivered by him to the Designer.

7.9.4 Observations by the Designer of the inspections, tests, or approvals required by Article 7 will be promptly made, and where practicable at the source of supply at no additional cost to the Owner.

7.9.5 Neither the observations of the Designer in his administration of the Contract, nor inspections, tests or approvals by persons other than the Contractor shall relieve the Contractor from his obligations to perform the Work in accordance with the Contract Documents.

7.9.6 All building construction and work, alterations, repairs, plumbing, mechanical, and electrical installations and appliances connected therewith, shall comply with the Rules and Regulations of the Department of Fire and Building Services, State Board of Health, local ordinances, Rules for Licensure of Building Trades, and other statutory provisions pertaining to this class of work; such rules and regulations and local ordinances to be considered as a part of these specifications.

7.9.7 Where in these specifications, one or more certain materials, trade names, or articles of certain manufacture are mentioned, it is done for the express purpose of establishing a basis of durability and efficiency and not for the purpose of limiting competition. Approval of other acceptable products for those specified may be obtained by requesting to the Designer no later than fourteen (14) days in advance of bid date with all documentation required for the Designer to evaluate any approval. If approval is granted, the subject product will be added by addendum.

7.9.8 Should there be a reason for change of materials after award of the Contract, the following criteria shall apply:

a. Original material no longer manufactured,
b. Delivery not possible within time specified for job, and/or
c. Unavailability due to causes beyond the control of the Contractor.

7.9.9 After agreement by the Designer and the Owner that a change is necessary, the Contractor shall present a request for substitution to the Designer. The burden of proof of the merit of the proposed substitute is upon the proposing party. The decision of the Designer and the Owner regarding the substitution shall be final.

7.10 Certificate of Qualification

7.10.1 In accordance with IC. 4-13.6-4 as amended, all Contractors and Subcontractors performing work for the State of Indiana on projects estimated to be in excess of one hundred fifty thousand dollars ($150,000.00), must hold a valid Certificate of Qualification issued by the Public Works Certification Board. The Instructions to Bidders define the procedure for certification and bidding.

7.10.2 The Contractor must perform at least fifteen (15) percent of the total Contract Sum of the Work with his own forces. The Contractor shall submit copies of his payroll records, if requested by the Owner, showing the hours, rates and total costs for all personnel on his payroll detailed to the degree to ensure compliance with this paragraph and any Wage Determination provisions.

7.11 Appropriation

7.11.1 The Contract specifically limits payments to be made in accordance with appropriations made and funds made available under laws of the State of Indiana.

7.12 Federal Wage Determination if required

7.12.1 If a Davis-Bacon wage determination is included in the Contract Documents, it shall be used as the minimum wage and benefits to be paid for the trades indicated.

7.12.2 Contractor shall submit a schedule of hourly wages to be paid to each employee (including those of his subcontractors) engaged in work on the site. This submittal shall be on Contractor's letterhead stationery and shall be signed by the Contractor and notarized. A copy of this submittal shall be conspicuously posted at the site.

7.12.3 Said rates shall in no case be less than those set out in the Davis-Bacon wage schedule a copy of which is herein bound or is on file with the Owner if it is required.

7.12.4 The Contractor shall provide (and require each Subcontractor to provide) weekly payroll records listing employees engaged in work on the site for the week and the hourly rates for base pay and benefits paid to each employee listed. The payroll record form shall include a statement by the Contractor/Subcontractor certifying the accuracy and completeness of the information provided. Payroll records shall be maintained by the Contractor during the course of the Work until the end of the required warranty period.

7.13 Out-of-State Contractors

7.13.1 Proof of payment by Out-of-State Contractors of Indiana Gross Income Tax, as provided in IC. 6-2.1-5-1.1 (b) and 6-2.1-5-1.1 (a) (d) as amended shall be submitted before final payment will be approved.

7.13.2 Out-of-State Corporations must be authorized to do business in the State, IC. Title 23 prior to submitting bids. Forms may be obtained by contacting the Secretary of State, State of Indiana, Indianapolis, Indiana.

7.14 Material Delivery

7.14.1 Shipments of material to be used by the Contractor or any Subcontractor under this Contract should be delivered to the job site only during the regular working hours of the Contractor or Subcontractor. If a delivery is made during other than the normal working hours of the Contractor or Subcontractor, his authorized agent must be on duty to receive such material. No employee of the Owner is authorized to receive any shipments designated for the Contractor or Subcontractor.

7.15 Weather

7.15.1 The Contractor shall at all times provide protection against weather, rain, wind, storms, frost or heat, so as to maintain all work, materials, apparatus and fixtures free from injury or damage. At the end of the day's work, all new work likely to be damaged shall be covered.

7.15.2 During cold weather, the Contractor shall protect all work from damage. If low temperature makes it impossible to continue operations safely, in spite of cold weather precaution, the Contractor shall cease work and shall so notify the Owner and Designer.

7.15.3 Any work damaged by failure to provide protection above required, shall be removed and replaced with new work at the Contractor's expense.

7.15.4 The Contractor shall provide and maintain on the premises, where directed, watertight storage shed (or sheds) for storage of all materials, which might be damaged by exposure to weather.

7.16 Fire Hazards

7.16.1 Wherever and whenever any burning, welding, cutting or soldering operation is in progress, or equipment is in use, or any work involving a fire hazard, is performed, the Contractor responsible for such operation shall have at all times acceptable fire extinguisher or protection within five (5) feet of the operation.

7.17 Dismissal

7.17.1 Any foreman or workman employed by the Contractor or by any Subcontractor who, in the opinion of the Director, Public Works Division and/or the Designer, does not perform his work in a proper and skillful manner, or is disrespectful, intemperate, disorderly, intoxicated or otherwise objectionable shall at the written request of either of the above, be forthwith discharged by the Contractor or Subcontractor employing such foreman or workman and he shall not be employed again on any portion of the Work without the written consent of the Director of the Division of Public Works and the Designer. Should the Contractor fail to furnish suitable and sufficient machinery, equipment or personnel for the proper prosecution of the Work, the Owner or Designer may withhold all payments that are or may become due, or may suspend the Work until such orders are upheld.

ARTICLE 8 TIME

8.1 Definitions

8.1.1 Unless otherwise provided, the Contract Time is the period of time allotted in the Contract Documents for Substantial Completion of the Work as defined herein, including authorized adjustments thereto.

8.1.2 The date of commencement of the Work is the date established in a notice to proceed. If there is no notice to proceed, it shall be the date of the Governor's signature on the Owner-Contractor Agreement or such other date as may be established therein.

8.1.3 The Date of Substantial Completion of the Work, or designated portion thereof, is the date certified by the Director, Public Works Division when construction is sufficiently complete, in accordance with the Contract Documents, so the Owner may occupy or utilize the Work, or designated portion thereof, for the use for which it is intended.

8.1.4 The term day as used in the Contract Documents shall mean calendar day unless otherwise specifically designated.

8.2 Progress and Completion

8.2.1 All time limits stated in the Documents are of the essence of the Contract.

8.2.2 The Contractor shall begin the Work on the date of commencement as defined herein. He shall carry the Work forward expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

8.2.3 The Owner fully expects the Contractor to employ any and all means necessary to complete the Work within the Contract Time. Conduct of the Owner's affairs, such as unforeseen site conditions or delay in processing change orders, shall not be viewed as justification for delaying the Project unless the Owner can be shown to have breached the Contract. Contractor must employ all reasonable means to execute the Project in a timely manner and in conformance with the Contract Documents even if the Contractor or Designer seeks legal remedy against the Owner for claim of damage.

8.3 Delays and Extensions of Time

8.3.1 If the Contractor is delayed at any time in the progress of the Work by any act or neglect of the Owner or the Designer, or by any employee of either, or by any separate Contractor employed by the Owner, or by changes ordered in the Work, or by labor disputes, fire, unusual delay in transportation, adverse weather conditions not reasonable to anticipate, unavoidable casualties, or

any causes beyond the Contractor's control, or by delay authorized by the Owner pending arbitration, or by any other cause which the Designer determines may justify the delay, then the Contract Time shall be extended by a Change Order for such reasonable time as the Designer may determine.

8.3.2 Claims for extension of time shall be made in writing to the Designer. In case of a continuing delay only one claim is necessary. The Contractor shall provide an estimate of the probable effect of such delay on the progress of the Work.

8.3.3 If no agreement is made stating the dates upon which interpretations as provided in Article 2.2 shall be furnished, then no claim for delay shall be allowed on account of failure to furnish such interpretations until fifteen days after written request is made for them, and not unless such claim is reasonable.

8.3.4 This Paragraph 8.3 does not exclude the recovery of damages for delay by either party under other provisions of the Contract Documents.

ARTICLE 9 PAYMENTS AND COMPLETION

9.1 Contract Sum

9.1.1 The Contract Sum is the total amount payable by the Owner for the performance of the Work under the Contract Documents.

9.2 Schedule of Values

9.2.1 Before the first application for payment, the Contractor shall submit to the Owner a schedule of various parts of the Work, including quantities if required by the Owner, aggregating the total Contract Sum, divided so as to facilitate payments to Subcontractors in accordance with Article 5.3, made out in such form as the Owner and the Contractor may agree upon, and supported by such data to substantiate its correctness as the Owner may require. Each item in the Schedule of Values shall include its proper share of overhead, profit, and other general charges. This schedule, when approved by the Owner, shall be used as a basis for the Contractor's Applications for Progress and Final Payments.

9.3 Progress Payments

9.3.1 Completed work: The Contractor shall submit to the Designer an itemized Application for Payment, supported by such data substantiating the Contractor's right to payment as the Designer may direct. The Owner shall make payments on account of the Contract, upon issuance of Certificates of Payment certified by the Designer and the Owner's Representative, for labor and materials incorporated into the Work at the rate of ninety four (94%) percent of such value until fifty (50%) percent of the value of the Work is completed. After that fifty (50%) percent, no further retainage will be deducted. The Director, Public Works Division has the option to require that three (3%) percent of the value of the Work be retained throughout the duration of the entire Contract. The retainage schedule shall be determined prior to award of Contract. Retainage may be paid with final payment at the discretion of the Director, Public Works Division, but shall not be paid in any event until a minimum of sixty one (61) days after all work is completed.

9.3.2 Materials Stored: Payments may be made on account for materials or equipment not incorporated in the Work, but delivered and suitably stored at the site. With written approval of the Owner, materials may be stored at another location other than the Work site if properly identified as the property of the Owner and properly protected. Storage of material at the place of business of the vendor is not acceptable (25 IAC 2-9-2). Such payments shall be conditional upon the submission by the Contractor of one of the following: 1) receipts marked by the supplier as paid; 2) supplier's final waiver of lien listing specific materials involved; 3) invoice with copy of canceled check showing payment; or 4) such other evidence of payment as the Owner may require in lieu thereof to establish ownership of all items except those listed as miscellaneous materials below. For the aggregate of miscellaneous stored materials for which payment is requested and above proof of payment is not available, a complete list will be provided along with the affidavit of payment. Upon certification by the Owner's representative that the listed materials are suitably stored, payment can be made. Miscellaneous materials are defined as pipe, fittings, wire, conduit, etc., normally stored as stock items in Contractor's warehouse. For materials stored other than at the construction site applicable insurance and transportation to the site shall be provided by the Contractor.

9.3.3 As stored materials are incorporated into the Work, the value shall be removed from the total value of stored materials requested in successive payments. Proof of ownership through one of the above methods will be required for additional materials. When, in the judgment of the Owner, retainage for completed work is not sufficient in relation to excessive amounts requested for stored materials or equipment, the Owner may elect to place the retainage for such materials or equipment in escrow. This retainage shall apply as a credit toward retainage due to be held for completed work on future payments.

9.3.4 The Contractor warrants that title to all work, materials and equipment covered by an Application for Payment will pass to the Owner either by incorporation in the construction or upon the receipt by the Contractor of payment, whichever occurs first, free and clear of all liens, claims, security interest or encumbrances, hereinafter referred to in this Article 9 as "liens"; and that no Work, materials or equipment covered by an Application for Payment will have been acquired by the Contractor, or by any other person performing work at the site or furnishing materials and equipment for the Project, subject to an agreement under which an interest

therein or an encumbrance thereon is retained by the seller or otherwise imposed by the Contractor or such other person.

9.3.5 The Contractor shall accompany each application for payment request with a certification that he paid to all Subcontractors (fabricators) within ten (10) days of receipt of payment that pro rata amount of funds he has received from the Owner for the value of work or services (fabricated materials or equipment) performed by the Subcontractor (supplied by fabricator) contained in previous progress payments. The Contractor's inclusion of a value of subcontract work in his progress pay estimate is prima facie evidence of acceptance of work having such a value; therefore, if the Owner receives a certification from a Subcontractor that he has not been paid such amounts as were included in the Contractor's partial billing and subsequently paid to the Contractor by the Owner, then the Owner will hold all subsequent partial payment requests until satisfactory evidence is received from the Subcontractor that he has been paid such amounts presented to the Owner by the Contractor, paid to the Contractor by the Owner, and not distributed by the Contractor to the Subcontractor. The making of an incorrect certification of either partial payment or final payment may be considered by the Owner to be a breach of contract, and it may exercise all of its prerogatives set out in the Contract in addition to the remedies for falsifying an affidavit. Such an action could result in a suspension of qualification with the State Certification Board for a period of up to two (2) years.

9.4 Certificates for Payment

9.4.1 When the Contractor has made application for payment as above, the Designer will issue a Certificate of Payment to the Owner for such amount as he determines to be properly due, or state in writing his reasons for withholding a certificate as provided in Articles 9.5.1.

9.4.2 The issuance of a Certificate for Payment will constitute a representation by the Designer to the Owner, based on the Designer's observations at the site as provided in Article 2.2.4 and the data comprising the Application for Payment, that the Work has progressed to the point indicated, and that, to the best of his knowledge, information and belief, the quality of work is in accordance with the Contract Documents subject to an evaluation of the Work as a functioning whole upon substantial completion, to the results of any subsequent tests called for in the Contract documents, to minor deviations correctable prior to the next certificate for payment and to any specific qualifications stated in his certificate, and that the Contractor is entitled to payment in the amount certified.

9.4.3 The Designer's final Certificate for Payment will constitute a further representation that the conditions precedent to the Contractor's being entitled to final payment as set forth in Article 9.7 have been fulfilled. However, by issuing a Certificate, the Designer shall not thereby be deemed to represent that he has made any examination to ascertain how or for what purpose the Contractor has used the monies paid on account of the Contract Sum.

9.4.4 The Owner shall make payment as soon as the fiscal procedure of the State can process same after receipt from the Designer of the Certificate for Payment. The fiscal procedure by the State can include, but not be limited to, review by the Owner's using agency, verification of the Certificate by the Owner's Site Representative, review for accuracy of form and calculation by the Owner's accountant, review by the Owner's project management and execution by the Director, Public Works Division and others.

9.4.5 No certificate for a progress payment or progress payment for partial or entire occupancy of the Project by the Owner shall constitute an acceptance of work not in accordance with the Contract Documents.

9.4.6 Pursuant to IC. 4-13.6-7-2 all Contract awards of One Million Dollars ($1,000,000) or above, if elected by the Contractor, an escrow agent will be selected by the State with whom the retainage funds for this Contract will be deposited and held until receipt of notice from the Director, Public Works Division (Escrow Form DAPW 32A) and from all other necessary parties as specified in and in accordance with the procedures and provisions of said Act.

9.5 Payments Withheld

9.5.1 The Designer (or Owner) will not approve an application in whole or in part, if in his opinion, he is unable to make representations to the Owner as provided in Article 9.4. The Designer (or Owner) will not approve Application for Payment or, because of subsequent inspections, may nullify the whole or any part of the Certificate for Payment previously issued to such extent as may be necessary in his opinion to protect the Owner from loss because of:

A. defective work not remedied,
B. claim filed or reasonable evidence indicating probable filing of claims,
C. failure of the Contractor to make payments properly to Subcontractors or for materials, equipment or labor,
D. reasonable doubt that the Contract can be completed for the unpaid balance,
E. damage to another Contractor,
F. reasonable indication that the Owner may be damaged by delay in receiving use of the Work as scheduled, or,
G. unsatisfactory prosecution of the Work by the Contractor.

9.5.2 When the above grounds are removed, payment shall be processed for amounts withheld.

9.6 Failure of Payment

9.6.1 If the Designer should fail to issue any Certificate for Payment, through no fault of the Contractor, or if the Owner should fail to pay the Contractor in a reasonable time considering the fiscal procedures of the State for processing same after receipt from the Designer the amount certified by the Designer, then the Contractor may, after seven (7) additional days, give written notice to the Owner and Designer, that work will stop until payment of the amount owing has been received.

9.7 Substantial Completion and Final Payment

9.7.1 When advised by the Contractor that the Work or a designated portion thereof is substantially complete, the Designer; the Director, Public Works Division, and the Contractor shall determine jointly by inspection that the Work is substantially complete. If they determine that the Work is substantially complete, the Contractor shall then prepare a Certificate of Substantial Completion with an accompanying list of incomplete items of work (punch list), and submit it to the Designer for his signature and subsequent forwarding for approval by the Director, Public Works Division. The Certificate shall fix the date of Substantial Completion and shall state the responsibilities of the Owner and the Contractor for maintenance, heat, utilities and insurance.

9.7.2 Upon approval of the above, and notice that the Work is ready for final acceptance, the Designer, the Contractor and Owner will promptly make final review, and when they find the Work acceptable under the Contract and the Contract fully performed, the Contractor shall promptly submit the final Certificate for Payment with all other required documents, showing that the Work has been completed in accordance with the terms and conditions of the Contract, and that the entire balance in said final certificate, is due and payable.

9.7.3 Neither the final payment nor any part of the retained percentage shall become due until the Contractor shall submit to the Designer releases or waivers of all liens arising out of the Contract; an affidavit that the releases and waivers include all the labor, materials, and equipment for which a lien could be filed and that all payrolls, material bills, and other indebtedness connected with the Work for which the Owner or its property might in any way be responsible have been paid or otherwise satisfied; and such other data establishing payment or satisfaction of all such obligations as the Owner may require. If any such lien or claim remains unpaid, the Contractor shall refund to the Owner all monies that the latter may be compelled to pay in discharging such lien or claim, including all costs.

9.7.4 If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor, and the Designer so confirms, the Owner shall, upon certification by the Designer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted, or such portion as may be available from funds not already released to an escrow agent pursuant to IC 4-13.6-7. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

9.7.5 The making of final payment shall constitute a waiver of all claims by the Owner except those arising from:

A. unsettled liens,
B. faulty work appearing after Substantial Completion,
C. failure of the Work to comply with the requirements of the Contract Documents,
D. terms of any special guarantees required by the Contract Documents.

9.7.6 If upon Substantial Completion of the Work there are any remaining uncompleted minor items, the Owner shall withhold, until those items are completed, an amount equal to two hundred percent (200%) of the value of each item as determined by the Designer or Owner.

9.7.7 The acceptance of final payment shall constitute a waiver of all claims by the Contractor, except those previously made in writing and still unsettled and covered by other agreed arrangements.

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

10.1 Safety Precautions and Programs

10.1.1 The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work.

10.2 Safety of Person and Property

10.2.1 The Contractor shall take all necessary precautions for the safety of, and will provide all necessary protection to prevent damage, injury, or loss to:

A. all employees on the Project and all other persons who may be affected thereby,
B. all the Work and all materials and equipment to be incorporated therein, whether in storage on or off the site, and,
C. other property at the site or adjacent thereto, including trees, shrubs, lawns, pavements, roadways, structures and

utilities not designated for removal, relocation or replacement in the course of construction.

10.2.2 The Contractor shall comply with all applicable laws, ordinances, rules, regulations and orders of any public authority having jurisdiction for the safety of persons or property or to protect them from damage, injury, or loss. He shall erect and maintain, as required by the conditions and progress of the Work, all necessary safeguards for safety and protection, including posting danger signs and other warnings against hazards, promulgating safety regulations, and notifying owners and users of adjacent utilities.

10.2.3 All damage or loss to all property specified herein caused directly or indirectly, in whole or in part, by the Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable, shall be remedied by the Contractor, except damage or loss attributable solely to faulty Contract Documents or to the acts or omissions of the Owner, or Designer or their employees, or for those whose acts either of them may be liable.

10.2.4 The Contractor shall designate a responsible member of his organization on the Work whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent, unless otherwise designated in writing by the Contractor to the Owner and the Designer.

10.2.5 When the use or storage of explosives or other hazardous materials or equipment is necessary for the prosecution of the Work, the Contractor shall carry on such activities under the supervision of properly qualified personnel.

10.2.6 The Contractor shall not overload, or permit any part of the Work to be loaded so as to endanger its safety.

10.2.7 All excavations creating a trench of five (5) or more feet in depth shall strictly adhere to the shoring and other safety requirements called for and described under Indiana OSHA Regulation 29 C.F.R. 1926, Subpart "P", for trench safety systems.

10.3 Emergencies

10.3.1 In an emergency affecting the safety of persons or property, the Contractor shall act, at his discretion, to prevent threatened damage, injury or loss. Any additional compensation or extension of time claimed by the Contractor because of emergency work shall be determined as provided for in Article 12, Changes in the Work, and he shall notify the Owner of such a decision within seven (7) days of the event giving rise to such claim.

ARTICLE 11 INSURANCE

11.1 General Requirements for Insurance

11.1.1 The Contractor will be required to furnish to the Owner, evidence that he has complied with all items of insurance listed herein. All insurance policies/certificates shall be on file with the Owner prior to release of the signed Contract and commencement of work.

11.1.2 The Contractor shall purchase and maintain, with a company or companies licensed to do business in Indiana, such insurance as will protect him from claims set forth below, arising out of or resulting from the Contractor's operations under the Contract, whether such operations be by the Contractor or by any Subcontractor or by anyone directly or indirectly employed by any of them:

A. claims under Workmen's Compensation Acts and other employee benefit acts;
B. claims for damages because of bodily injury, personal injury, occupational sickness or disease, or death of his employees;
C. claims for damages because of bodily injury, personal injury, sickness, disease or death of any person other than his employees;
D. claims for damages to tangible property, including loss of use thereof.

11.1.3 This insurance shall be written for not less than any limits of liability specified herein, or required by law, whichever is greater. Policies or certificates of insurance, acceptable to the Owner, shall be filed with the Owner prior to execution of the Contract. These Certificates shall contain a provision that coverages afforded under the policies will be for the life of the Work.

11.1.4 Policies (certificates) shall show name and complete address of the Company, expiration date or dates, and policy number or numbers. Policies shall not be canceled until at least thirty (30) days prior written notice has been given to the Owner and acknowledged by the Owner in writing.

11.2 Property Insurance

11.2.1 The Contractor shall furnish and maintain, at the Contractor's expense, Fire, Extended Coverage, Vandalism, and Malicious Mischief Insurance (Builder's Risk), in the sum of 100% of the Contract amount. Builder's Risk insurance shall cover the structure on/in which the Work of this Contract is to be done including items of labor and material connected therewith, whether in or adjacent to the structure insured; material in place or to be used as part of the permanent construction, including surplus materials; shanties, protective fences, bridges, or temporary structures; miscellaneous materials and supplies incident to the Work; scaffolding, staging, towers, forms, and equipment, if included in the cost of the Work. This insurance need not cover any tools owned by mechanics, or any tools, equipment, scaffolding, staging, towers, and forms owned or rented by the Contractor, the capital value of which is not included in the cost of the Work.

11.2.3 Any loss under this Article 11.2 is to be adjusted with the Owner, and made payable to the Owner as trustee for the insured, as their interests may appear.

11.3 Liability Insurance

11.3.1 The Contractor and their subcontractors (if any) shall secure and keep in force during the term of this Contract the following insurance coverages (if applicable) covering the Contractor for any and all claims of any nature which may in any manner arise out of or result from Contractor's performance under this Contract:

A. Commercial general liability, including contractual coverage, and products or completed operations coverage (if applicable), with minimum liability limits not less than $700,000 per person and $5,000,000 per occurrence unless additional coverage is required by the State. The State is to be named as an additional insured on a primary, non-contributory basis for any liability arising directly or indirectly under or in connection with this Contract.

B. Automobile liability for owned, non-owned and hired autos with minimum liability limits of $700,000 per person and $5,000,000 per occurrence. The State is to be named as an additional insured on a primary, non-contributory basis.

C. The Contractor shall provide proof of such insurance coverage by tendering to the undersigned State representative a certificate of insurance prior to the commencement of this Contract and proof of workers' compensation coverage meeting all statutory requirements of IC §22-3-2. In addition, proof of an "all states endorsement" covering claims occurring outside the State is required if any of the services provided under this Contract involve work outside of Indiana.

D. The Contractor's insurance coverage must meet the following additional requirements:

1. The insurer must have a certificate of authority or other appropriate authorization to operate in the state in which the policy was issued.

2. Any deductible or self-insured retention amount or other similar obligation under the insurance policies shall be the sole obligation of the Contractor.

3. The State will be defended, indemnified and held harmless to the full extent of any coverage actually secured by the Contractor in excess of the minimum requirements set forth above. The duty to indemnify the State under this Contract shall not be limited by the insurance required in this Contract.

4. The insurance required in this Contract, through a policy or endorsement(s), shall include a provision that the policy and endorsements may not be canceled or modified without thirty (30) days' prior written notice to the undersigned State agency.

5. The Contractor waives and agrees to require their insurer to waive their rights of subrogation against the State of Indiana.

E. Failure to provide insurance as required in this Contract may be deemed a material breach of contract entitling the State to immediately terminate this Contract. The Contractor shall furnish a certificate of insurance and all endorsements to the State before the commencement of this Contract.

F. Boiler and Machinery Explosion Insurance shall be required when the Work includes boiler, other pressure

vessels or steam piping installation or repair.

G. After June 30, 2015, this entire Article will apply to **any** contractor that will be on the construction site pursuant to IC 5-16-13 and an acceptable certificate of insurance will be provided by each and every contractor

ARTICLE 12 CHANGES IN THE WORK

12.1 Change Orders

12.1.1 The Owner, without invalidating the Contract, may order changes in the Work consisting of additions, deletions, or modifications, with the Contract Sum and the Contract Time being adjusted accordingly. All such changes in the Work shall be authorized by Change Order, and shall be executed under the applicable conditions of the Contract Documents.

12.1.2 A Change Order is a written order to the Contractor compiled and reviewed by the Designer, prepared by the Owner and then signed by the Owner and the Contractor. The order is issued after the execution of the Contract authorizing a change in the Work, and documenting any adjustment in the Contract Sum and/or the Contract Time. The Contract Sum may be changed only by change order.

12.1.3 The value of any work involved in a change in the Work shall be determined in one or more of the following ways, in order of priority listed:

A. by mutual acceptance of a lump sum. For all amounts over $500, the Contractor shall provide a complete listing of quantities and unit prices of materials, hours of labor with cost per hour, and separate agreed percentages for any overhead and profit. The maximum aggregate increase for overhead and profit (including all home office and field office overhead) for any Subcontractor or for the Contractor performing his own work is fifteen (15%) percent; the maximum increase for a Contractor on work performed by a Subcontractor is five (5%) percent. If the cost of performance and payment bond(s) is shown as a separate line item in the Contractor's schedule of values for the project, then an increase will be permitted to provide for the additional cost of the bond(s). If the cost of the bond(s) is not indicated on the Contractor's schedule of values for the Project, any increase in cost for bond(s) shall be included in the Contractor's allowed overhead. For listings under $500, list lump sum for each item, or,
B. by unit prices named in the Contract or subsequently agreed upon, or,
C. by cost plus a mutually acceptable fixed or percentage fee.

12.1.4 Should conditions be encountered below the surface of the ground that are:

A. at variance with the conditions indicated by the Contract Documents, and
B. different than could be expected after a reasonable viewing of the site by the bidders, and
C. not evident from available soil samples,

then the Contract sum may be equitably adjusted by Change Order upon claim by Contractor made within a reasonable time after the first observance of the conditions.

12.1.5 If the Contractor claims that a written interpretation issued pursuant to Article 1.2 or a written order for a minor change issued pursuant to Article 12.3 involves additional cost or time, the Contractor shall make such claim as provided in Article 12.2.

12.2 Claims for Additional Cost or Time

12.2.1 If the Contractor wishes to make a claim under the provisions of the Contract Documents for an increase in the Contract Sum or an extension in the Contract Time, he shall give the Designer written notice thereof within fifteen (15) days after the occurrence of the event giving rise to such claim. This notice shall be given by the Contractor and authority received in writing from the Owner before proceeding to execute the Work, except in an emergency endangering life or property. No such claim shall be valid unless so made. Any approved change in the Contract Sum or Contract Time resulting from such claim shall be incorporated in a Change Order, initiated by the Designer and executed by the Owner. If the Designer does not initiate or the Owner execute a Change Order within a reasonable time in response to the request, such lack of action shall be construed as prima facie evidence of rejection of the request. For the purpose of this section "reasonable time" is expected not to exceed 30 days after receipt by the Owner.

12.3 Minor Changes in the Work

12.3.1 The Designer shall have authority, with Owner's approval, to order minor changes in the Work not involving an increase in the Contract Sum or an extension of the Contract Time and not inconsistent with the intent of the Contract Documents. Such change may be affected by written field order, with copy transmitted to the Owner. Such minor changes need not be approved in writing by the Owner; however, the Owner may provide written approval of any substitution of significant materials or equipment.

12.4 Field Orders

12.4.1 The Designer may issue written field orders, which interpret the Contract Documents in accordance with Article 1.2.4 without change in Contract Sum or Contract Time. The Contractor shall carry out such field orders promptly. The Designer shall

transmit copies of field orders to the Owner.

ARTICLE 13 EXAMINATION AND CORRECTION OF WORK

13.1 Examination of Work

13.1.1 If any portion of the Work should be covered contrary to the request of the Designer or to requirements specifically expressed in the Contract Documents, it must, if required in writing by the Designer, be uncovered for his observation and shall be replaced at the Contractor's expense.

13.1.2 Examination of questioned work may be ordered by the Designer with the approval of the Owner, and if so ordered the Work must be uncovered by the Contractor. If such work were found in accordance with the Contract Documents, the cost of re-examination and replacement shall, by appropriate change order, be charged to the Owner. If such work be found not in accordance with the Contract Documents, the Contractor shall pay such costs, unless it is found that the defect in the Work was caused by a separate Contractor employed as provided in Article 6 and in that event, the separate Contractor shall pay such costs.

13.2 Correction of Work before Substantial Completion

13.2.1 The Contractor shall promptly remove from the site all work rejected by the Designer as failing to conform to the Contract Documents, whether or not incorporated in the Project, and the Contractor shall promptly replace and re-execute his own work in accordance with the Contract Documents and without cost to the Owner and shall bear the cost of repair to or replacement of all work of separate Contractors destroyed or damaged by such removal or replacement.

13.2.2 If the Contractor does not remove such rejected work within a reasonable time, fixed by written notice from the Designer, the Owner may remove and store the material at the expense of the Contractor. If the Contractor does not agree to pay or credit the Contract with the cost of such removal within ten days thereafter, the Owner may acquire a lien upon such property and materials. If proceeds of lien foreclosure do not cover all costs, which the Owner has then borne, the difference shall be deducted from the amount to be paid to the Contractor.

13.3 Correction of Work after Substantial Completion

13.3.1 The Contractor shall correct all faults and deficiencies in the Work which appear within one year of the date of substantial completion or such longer period of time as may be prescribed by the terms of any special guarantees called for by the Contract Documents, and he shall pay for all damage to other work caused thereby. The Contractor shall remove all defective work where necessary.

13.3.2 If the Contractor does not correct such faulty or defective work and remove defective work where necessary, within a reasonable time fixed by the Designer in writing, the Owner may do the corrective work and remove the defective work, as described in Article 13.2 above.

13.3.3 All costs attributable to correcting and removing faulty or defective work shall be borne by the Contractor.

13.3.4 The obligations of the Contractor under this Article 13.3 shall be in addition to and not a limitation of any obligations imposed upon him by special guarantees called for by the Contract Documents or otherwise prescribed by law.

ARTICLE 14 TERMINATION OF THE CONTRACT

14.1 Termination by the Contractor

14.1.1 If the Work is stopped for a period of thirty days under an order of any court or other public authority through no act of fault of the Contractor or of anyone employed by the Contractor, or if the Work should be stopped for a period of thirty days by the Contractor for the Designer's failure to issue a Certificate for payment as provided in Article 9.6, or for the Owner's failure to make payment thereon as provided in said Article, then the Contractor may, upon seven days' written notice to the Owner and the Designer, terminate the Contract and recover from the Owner, in satisfaction of all claims of the Contractor, payment for all work executed, except those items involved in Designer's failure to issue Certificate, or Owner's failure to make payment.

14.2 Termination by the Owner

14.2.1 If the Contractor should be adjudged bankrupt, or if he should make a general assignment for the benefit of his creditors, or if a receiver should be appointed on account of his insolvency, or if he should persistently or repeatedly refuse or should fail, except in cases for which extension of time is provided, to supply enough properly skilled workmen or proper materials, or if he should fail to make prompt payment to Subcontractors for materials or labor, or persistently disregard laws, ordinances, rules, regulations or orders of any public authority or otherwise be guilty of a substantial violation of a provision of the Contract Documents, then the Owner, upon certification by the Designer that sufficient cause exists to justify such action, may without prejudice to any right or remedy against the Contractor or his surety and after giving the Contractor and his surety seven days written notice, terminate the employment of the Contractor and take possession of the site and of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor and finish the Work by whatever method the Owner

deems expedient. In such case the Contractor shall not be entitled to receive any further payment until the Work is completed, and an accounting made as set out below.

14.2.2 If the unpaid balance of the Contract sum exceeds the cost of finishing the Work, including compensation for the Designer's additional services such excess shall be paid to the Contractor. If such cost exceeds such unpaid balance, the Contractor shall pay the difference to the Owner. The Designer shall certify the cost incurred by the Owner as herein provided.

END

Indiana Department of Administration
M/WBE Participation Policy for Construction Projects

I. Introduction

The Indiana Department of Administration ("IDOA") in its commitment to Minority and Women participation in the state's procurement and contracting process, will require MBE and WBE participation or a best-efforts waiver as a specification in bids for construction services $150,000 and over with subcontracting opportunities effective January 1, 2006. *See* Indiana Code 5-22-7, 5-22-7-2, 5-22-7-4.

II. Definitions

"Application for MBE and WBE Program Waiver" means documents submitted by Bidder for relief from contract goal after demonstrating all reasonable good faith efforts were made by the Bidder for the purpose of fulfilling the contract goal. The Application for MBE and WBE Program Waiver may be submitted prior to the bid due date or included in the bid package response.

"Certification" means verification by the Indiana Department of Administration, Minority and Women's Business Enterprises Division ("MWBED") or an organization accepted by MWBED with respect to the authenticity of a minority or women owned business enterprise.

"Commercially useful function" Determination that an enterprise performs a commercially useful function will be made based on the following considerations:

(1) An MBE or a WBE performs a commercially useful function when it is responsible for execution of the work of the contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved. To perform a commercially useful function, the MBE or WBE must also be responsible, with respect to materials and supplies used on the contract, for negotiating price, determining quality and quantity, ordering the material, and installing (where applicable) and paying for the material itself. To determine whether an MBE or a WBE is performing a commercially useful function, one must evaluate the following:

(A) The amount of work subcontracted.

(B) Industry practices.

(C) Whether the amount the enterprise is to be paid under the contract is commensurate with the work it is actually performing.

(D) The credit claimed for its performance of the work.

(E) Other relevant factors.

(2) An MBE or a WBE does not perform a commercially useful function if its role is limited to that of an extra participant in a transaction, contract, or project through which funds are passed in order to obtain the appearance of MBE or WBE participation. In determining whether an MBE or a WBE is such an extra participant, one must examine similar transactions, particularly those in which MBEs or WBEs do not participate.

(3) In the case of construction contracts, if:

(A) an MBE or a WBE does not perform or exercise responsibility for at least the agency's requisite percent of the total cost of its contract with its own workforce; or

(B) the MBE or WBE subcontracts a greater portion of the work of a contract than would be expected on the basis of normal industry practice for the type of work involved;

it is presumed that the enterprise is not performing a commercially useful function.

"Letter of Commitment" means a letter obtained from the MBE and WBE's by the Bidders. The Letter of Commitment is a signed letter(s), on company letterhead, from the minority and/or women certified business. It must be produced no later than 24 hours after the bid due date and time. This letter(s) shall state and will serve as acknowledgement from the minority and/or women certified business of their level of participation in this solicitation, the dollar amount of the commitment, the scope of service or product to be provided and the anticipated dates of utilization.

"Minority and Women Business Enterprises Division (MWBED)" means the Division which acts on behalf of the state to actively promote, monitor, and enforce the MBE AND WBE program. The final authority on all matters pertaining to the maintenance and administration of the MBE AND WBE program and compliance thereto.

"Minority/Woman Business Enterprise (MBE and WBE)" means an individual, partnership, corporation, limited liability company, or joint venture of any kind that is at least fifty-one percent (51%) owned and controlled by one (1) or more persons who are United States citizens and a member(s) of a minority group. The MBE and WBE must meet the eligibility requirements of 25 IAC 5.

"Participation Plan" means the IDOA prescribed document that sets forth the MBE and WBE subcontractors that will perform work under the contract.

III. Minority and Women Business Enterprise Certification

MBE and WBEs must be listed on the IDOA directory of certified firms at the time the bid is submitted to be eligible to meet the contract goals. The bidder should verify that a firm is certified before the bid is submitted.

Questions regarding Certification should be addressed to the following:

Indiana Department of Administration
Minority and Women's Business Enterprises Division
402 West Washington Street, Room W469
Indianapolis, IN 46204
(317) 232-3061
www.buyindiana.in.gov
mwbe@idoa.in.gov

IV. Bidding Process

IDOA will review projects for viable subcontracting opportunities. All projects will be governed by this policy unless otherwise stated.

A representative from MWBED will attend most pre-bid meetings to discuss and answer questions related to the MBE and WBE participation requirement. The MWBED will be available to assist Bidders in locating MBE and WBE firms to engage in the contract.

The 2007-2008 Contract Goals for construction projects are 7% for MBE's and 5% for WBE's.

Effective January 1, 2006, the following procedures will be implemented in the acceptance and evaluation of responsive and responsible bids.

Bidders must produce a Participation Plan on the approved form listing the utilization of MBE and WBE subcontractors who will be providing a commercially useful function on the project. Letter of Commitment from MBE and WBE firms they plan to engage in the contract if successful on the bid

Per 25 IAC 5-6-2(d), all prime contractors, including MBE and WBE prime contractors, must meet the sub-contracting goals through use of businesses found in the IDOA directory of certified firms. MBE and WBE prime contractors will get no credit toward the contract goal for the use of their own workforce.

If the bidder can not achieve the Contract Goals established for the bid package, the bidder shall submit a Waiver Application on the form supplied by MWBED. Bidders may submit waiver applications to MWBED up to two business days in advance of the bid due date to obtain advance approval of the waiver, or the application may be submitted without advance approval with the bid package. Bidders who submit a Participation Plan that will achieve the Contract Goals are not required to submit a Waiver Application.

If a partial waiver is being requested, a Participation Plan listing the MBE and WBE certified firms that will be used to satisfy the portion of the goal that will be met, must be included. Partial waivers may be requested using the waiver application process discussed above. A faxed copy of the Letter of Commitment for each MBE and WBE firm that is listed in the Participation Plan must be provided by the Low Bidder to the appropriate department no later than 24 hours after the bid due date and time. The original letter(s) must be provided upon receipt.

MWBED will review Applications for MBE and WBE Program Waivers and make a determination as to the bidder's responsiveness and good faith efforts. Evidence of efforts should be included with the waiver form. Any combination of the following criteria may be utilized in determining whether good faith efforts have been made:

A. Notice to MBE and WBEs. Whether and when the bidder provided written notice, by mail, hand delivery, facsimile or electronic transmission to all qualified MBE and WBEs that perform the type of work to be subcontracted and advising the MBE and WBEs:

   1. of the subject work the bidder intends to subcontract;

   2. that their interest in Subcontracts is being solicited;

   3. how to obtain information for the review and inspection of Contract plans and specifications; and

   4. how to bid on the subcontracting opportunities and deadlines.

B. Economically Feasible Subcontract. Whether the bidder selected economically feasible portions of the work to be performed by an MBE and WBE, including, when appropriate, breaking Subcontracts into smaller pieces or combining elements of work into economically feasible units. The ability of the bidder to perform the work with its own forces will not excuse the bidder from making positive efforts to meet the MBE and WBE goals.

C. Consideration of all MBE and WBE Quotations. Whether the bidder considered all quotations received from MBE and WBEs and, for those quotations not accepted, an explanation of why the MBE and WBE will not be used during the course of the Project. Receipt of a lower quotation from a non-MBE and WBE will not, in itself, excuse bidder's failure to meet the MBE and WBE goals. Price alone does not constitute an acceptable basis for rejecting MBE and WBE subcontractor bids unless the bidder can demonstrate that a reasonable price was not obtained from an MBE and WBE.

D. MBE and WBE Barrier Assistance. Whether the bidder provided assistance to interested MBE and WBE firms: in reviewing the Contract plans and specifications or addressing other barriers to subcontracting.

E. Advertisement. Whether the bidder advertised to search for prospective MBE and WBEs to participate in the Contract.

F. Agency Assistance. Whether the bidder contacted any of the following agencies for the purpose of locating prospective MBE and WBEs:

1. Indiana Department of Administration
Minority and Women's Business Enterprises Division
402 West Washington Street, Room W469
Indianapolis, IN 46204
(317) 232-3061
mwbe@idoa.in.gov

2. Indiana Business Diversity Council, Inc.
2126 North Meridian Street
Indianapolis, IN 46202
(317) 921-2678
mdhouse@inbdc.org

G. Research Participation Areas. Whether the bidder made efforts to research other possible areas of participation including supplying, shipping, engineering and any other role that may contribute to the production and delivery of the products or services needed to fulfill the Contract.

H. Response Time. The time the bidder allowed for a meaningful response to its solicitations.

I. Documentation of Statements from MBE and WBEs. Any documentation or statements received from MBE and WBEs who have been listed as having been contacted by the bidder.

J. Availability of MBE and WBEs. The availability of MBE and WBEs to perform the work and the availability, or lack of availability, of MBE and WBEs in the location where the work is to be performed.

K. Other Criteria. Any other criteria deemed appropriate by MWBED.

This list is not intended to be exclusive or exhaustive. The bidder may also submit documentation of other types of efforts that they have taken which reflect the quality, quantity and intensity of those efforts.

When evaluating Waiver Applications, MWBED reserves the right to verify that any information supplied on the Participation Plan and Wavier Application is accurate. By the submittal of a bid, the bidder acknowledges the right of MWBED to ensure compliance with the Participation Program and thereby agrees to provide, upon request, earnest, diligent and prompt cooperation in MWBED's verification process.

In cases where MWBED concludes the bidder's Participation Plan and the Waiver Application is deficient through no fault of the bidder, the bidder may be instructed to submit a modified Participation Plan within five (5) working days from the date of such notice. Failure to submit the modified Participation Plan within the specified period of time, may result in the bid being considered non-responsive and may be rejected.

In cases where MWBED concludes that the Participation Plan and Waiver Application is deficient or in cases where MWBED has determined that the bidder has not cooperated with its efforts to verify the submitted documentation, a bid may be considered non-responsive and may be rejected.

If the established Contract Goals are not achieved but the Waiver Application is granted, the bid will be considered responsive. If the established Contract Goals are not achieved and the Waiver Application is denied, a bid may be considered non-responsive and may be rejected.

Failure to provide the Participation Plan and/or a Waiver Application accounting for the total participation goal set for the project will result in the bid being considered non-responsive and the bid may be rejected.

By submission of a bid, a bidder thereby acknowledges and agrees to be bound by the regulatory process set forth in 25 IAC 5.

A bidder who knowingly or intentionally misrepresents the truth about either the status of a firm that is being proposed as an MBE and WBE or who misrepresents the level of the nature of the amount to be subcontracted to the MBE and WBE may suffer penalties pursuant to Indiana Code 5-16-6.5-5.

A Contractor who knowingly or intentionally misrepresents the truth about his/her status as an MBE and WBE or who misrepresents the level or the nature of the amount subcontracted to his/her firm may suffer penalties pursuant to Indiana Code 35-44-2-1.

V. Compliance

Contractors shall contract with all MBE and WBE firms listed on the Participation Plan. The subcontract or purchase order shall be for an amount that is equal to, or greater than, the total dollar amount listed on the form.

Contractors shall notify MWBED immediately if any firm listed on the Participation Plan refuses to enter into a subcontract or fails to perform according to the requirements of the subcontract.

The Contractor's proposed MBE and WBE Contract Goals will become incorporated into and a requirement of the Contract. Contractors shall not substitute, replace or terminate any MBE and WBE firm without prior written authorization from MWBED and the Owner.

Contractors shall cooperate and participate in compliance reviews as determined necessary by MWBED. Contractors shall provide all necessary documentation to show proof of compliance with the requirements as requested by MWBED.

VI. Non Compliance

A bid governed by this policy that does not meet the participation goals or does not receive an approved waiver will NOT be considered.

After the bid is awarded and if it is determined by MWBED that the Contractor is not in compliance with this Participation Program, MWBED will notify the Contractor within ten (10) days after the initial compliance review or the site visit and identify the deficiencies found and the required corrective action that should be taken to remedy the deficiencies within a specific time period.

If a Contractor is found non-compliant, the Contractor must submit, in writing, a specific commitment, in writing, to correct the deficiencies. The commitment must include the precise action to be taken and the date for completion.

If MWBED determines the Contractor has failed to comply with the provisions of this Participation Program, Contractor's Utilization Statement or 25 IAC 5, IDOA may impose any or all of the following sanctions:

a. Withholding payment on the Contract until such time that satisfactory corrective measures are made.

b. Adjustment to payments due or the permanent withholding of retainages of the Contract.

c. Suspension or termination of the specific Contract in which the deficiency is known to exist. In the event this sanction is employed, the Contractor will be held liable for any consequential damages arising from the suspension or termination of the Contract, including damages caused as a result of the delay or from increased prices incurred in securing the performance of the balance of the work by other Contractors.

d. Recommendation to the certification board to revoke the contractor's certification status with the Public Works Division of IDOA. This recommendation may result in the suspension or revocation of the contractor's ability to perform on future state contracts for a period no longer than thirty-six (36) months.

e. Continued non-compliance may be deemed a material breach of the agreement between MWBED and Contractor, whereupon MWBED shall have all the rights and remedies available to it under the Contract or at law.

f. Suspension, revocation, or denial of the MBE or WBE certification and eligibility to participate in the MBE or WBE program for a period of not more than thirty-six (36) months.

VII. Forms and Attachments

Minority Participation Plan
Good Faith Efforts Worksheet

STATE OF INDIANA'S
STANDARD CONTRACT FOR PUBLIC WORKS CONSTRUCTION PROJECT
(for projects estimated more than $150,000)
WORKS PROJECTNUMBER XXXXX
[INSERT] PROJECT DESCRIPTION
[INSERT] INSTITUTION/DEPARTMENT

THIS IS A PUBLIC WORKS CONSTRUCTION CONTRACT ("Contract"), entered into by and between the Indiana Department of Administration's Public Works Division ("State") and **XXXXXXXXXX** ("Contractor"), executed pursuant to the terms and conditions set forth herein and is governed by Indiana Code 4-13.6, *et seq*.

1. Definitions. The following definition applies throughout this Contract:

For purposes of the State's Public Works Project Number **XXXXX** ("Project"), the term "Contract Documents" shall mean and include the following: this Contract and the Project Bid Package, which includes the Contractor's Application for Pre-Qualification, the Public Work's Solicitation for Quotation (DAPW 30), Bid Documentation, Pre-Contract Document, General Conditions (DAPW 26), Supplementary Conditions, Instructions to Bidders, Drawings, Specifications, and Addenda issued by the State in connection with the Project and prior to the submission of the Contractor's Proposal.

Subject to Section 39, *Order of Precedence, Incorporation by Reference*, of this Contract, Contract Documents shall also consist of the Contractor's Proposal and Response, as well as any other documentation submitted by it in response to the Project (hereinafter collectively referred to as "Contractor's Proposal").

Additionally, Contract Documents shall include any subsequent amendments, change orders and any written interpretations issued as field orders by the Designer pursuant to General Conditions, Article 1.2 (DAPW 26) and all field orders for minor changes by the Designer pursuant to General Conditions, Article 12.3 (DAPW 26). Change orders and amendments shall be executed in the manner authorized by Section 35, *Merger and Modification*, of this Contract.

When applicable, Contract Documents shall include the Performance Bond and/or the Labor and Materials Payment Bond, as required by IC 4-13.6-7-6 and IC 4-13.6-7-7, and fully described and captured in the General Conditions (DAPW 26).

The Contract Documents are specifically and collectively incorporated herein by reference.

2. Duties of Contractor. The Contractor shall furnish all labor and materials, perform all of the work, and otherwise fulfill all of its obligations in conformance with the Contract Documents. These duties are described and captured in the Contract Documents. The Contractor agrees that not less than fifthteen percent (15%) of the work, measured in dollar volume, will be performed by its own forces. Any subcontractor employed for any part of this Contract awarded in excess of One Hundred Fifty Thousand Dollars ($150,000.00) shall be qualified with the State of Indiana's Public Works Division Certification Board and shall have a valid Certificate of Qualification in the prime classification of work for this Contract.

3. Consideration. All payments provided herein are subject to appropriations made and funds allocated as provided by laws of the State of Indiana. The State shall pay the Contractor for performance of this Contract in current funds as follows:

BASE BID: **$XXXXXX.00**
ALTERNATE(S):
TOTAL CONTRACT PRICE: **$XXXXXX.00**

4. Term. The work to be performed under this Contract shall commence within ten (10) days of the last signatory to this Contract. The work shall be completed within **XXX** calendar days.

5. Conflict of Interest. As used in this section:

"Immediate family" means the spouse, partner, housemate or the unemancipated children of an individual, as defined by 42 Indiana Administrative Code 1-3-13.
"Interested party," means:

1. The individual executing this Contract;
2. An individual who has an ownership interest of three percent (3%) or more of the Contractor, if the Contractor is not an individual; or
3. Any member of the immediate family of an individual specified under Subdivision 1 or 2.

"State" means the Indiana Department of Administration.
"State employee" means a state employee, a special state appointee or a state officer, as defined by IC 4-2-6-1(a)(9), (a)(18) and (a)(19), respectively.

A. The Contractor covenants that it neither has, nor will it have, a direct or indirect financial interest by way of an interested party in any other contract connected or associated with this Contract. The Contractor further represents and warrants that no state employee, who is an interested party of the Contractor as sole proprietor, or who serves as an officer, director, trustee, partner or employee of the Contractor as a legal business entity, participated in any decision or vote of any kind in the award of this Contract. As such and by the execution of this Contract, the Contractor represents and warrants that the result of this Contract does not and will not create a conflict of interest under IC 4-2-6-9 or IC 4-2-6-10.5.

B. The State may cancel this Contract, without recourse by the Contractor, if an interested party is a state employee and a violation of IC 4-2-6-9 or IC 4-2-6-10.5 has occurred.

C. The State will not exercise its right of cancellation under Section B above, if the Contractor provides the State an opinion from the State Ethics Commission indicating that the existence of this Contract and the employment by the State of the interested party does not violate any statute or rule relating to ethical conduct of state employees. The State may take action, including cancellation of this Contract, consistent with an opinion of the State Ethics Commission obtained under this Section.

D. The Contractor has an affirmative obligation under this Contract to disclose to the State when an interested party is or becomes a state employee. The obligation under this section extends only to those facts that the Contractor knows or reasonably should know.

6. Licensing Standards. The Contractor and its employees and subcontractors shall comply with all applicable licensing standards, certification standards, accrediting standards and any other laws, rules or regulations governing services to be provided by the Contractor pursuant to this Contract. The State shall not be required to pay the Contractor for any services performed when the Contractor, its employees or

subcontractors are not in compliance with such applicable standards, laws, rules or regulations. If licensure, certification or accreditation expires or is revoked, or if disciplinary action is taken against the applicable licensure, certification or accreditation, the Contractor shall notify the State immediately and the State, at its option, may immediately terminate this Contract.

7. Escrow Agreement. Contemporaneously with the execution of this Contract, the parties may provide for the escrow of retained portions of payments to the Contractor by entering into a separate Escrow Agreement, pursuant to IC 4-13.6-7, with an escrow agent described in IC 4-13.6-7-2(b). Should the Contractor elect to escrow retainage, the Escrow Agreement will become a part of this contract as if fully contained herein.

8. Contractor's Certification. The Contractor certifies that it has been pre-qualified by the State of Indiana's Public Works Division Certification Board to perform the work and furnish the services required by this Project. The Contractor further certifies that all information and documentation submitted by it in its Application for Prequalification Certification, the Contractor's Proposal and submitted in response to the Project, is true, accurate and complete as of the date of this Contract's effectiveness. The Contractor shall immediately notify the State of any material change to such information. The Contractor shall immediately notify the State if, during the course of performance of this Contract, it or any of its principals are proposed for debarment or ineligibility, or become debarred or declared ineligible, from entering into contracts with the federal government or any department, agency or political subdivision of the State.

9. Contractor Employee Drug Testing. Pursuant to IC 4-13-18, the Contractor shall implement the employee drug testing program submitted as part of its Contractor's Proposal. The State may cancel this Contract if it determines that the Contractor:

A. Has failed to implement its employee drug testing program during the term of this Contract;

B. Has failed to provide information regarding implementation of the Contractor's employee drug testing program at the request of the State; or

C. Has provided to the State false information regarding the Contractor's employee drug testing program.

10. Access to Records. The Contractor and its subcontractors, if any, shall maintain all books, documents, papers, accounting records, and other evidence pertaining to all costs incurred under this Contract. They shall make such materials available at their respective offices at all reasonable times during this Contract, and for three (3) years from the date of final payment under this Contract, for inspection by the State or its authorized designees. Copies shall be furnished at no cost to the State if requested.

11. Assignment; Successors. The Contractor binds its successors and assignees to all the terms and conditions of this Contract. The Contractor shall not assign or subcontract the whole or any part of this Contract without the State's prior written consent. The Contractor may assign its right to receive payments to such third parties as the Contractor may desire without the prior written consent of the State, provided that the Contractor gives written notice (including evidence of such assignment) to the State thirty (30) days in advance of any payment so assigned. The assignment shall cover all unpaid amounts under this Contract and shall not be made to more than one party.

12. Assignment of Antitrust Claims. As part of the consideration for the award of this Contract, the Contractor assigns to the State all right, title and interest in and to any claims the Contractor now has, or

may acquire, under state or federal antitrust laws relating to the products or services which are the subject of this Contract.

13. Audits. The Contractor acknowledges that it may be required to submit to an audit of funds paid through this Contract. Any such audit shall be conducted in accordance with IC §5-11-1, *et seq.*, and audit guidelines specified by the State.

The State considers the Contractor to be a "vendor" for purposes of this Contract. However, if required by applicable provisions of the Office of Management and Budget Circular A-133 (Audits of States, Local Governments, and Non-Profit Organizations), following the expiration of this Contract the Contractor shall arrange for a financial and compliance audit of funds provided by the State pursuant to this Contract. Such audit is to be conducted by an independent public or certified public accountant (or as applicable, the Indiana State Board of Accounts), and performed in accordance with Indiana State Board of Accounts publication entitled "Uniform Compliance Guidelines for Examination of Entities Receiving Financial Assistance from Governmental Sources," and applicable provisions of the Office of Management and Budget Circulars A-133 (Audits of States, Local Governments, and Non-Profit Organizations). The Contractor is responsible for ensuring that the audit and any management letters are completed and forwarded to the State in accordance with the terms of this Contract. Audits conducted pursuant to this paragraph must be submitted no later than nine (9) months following the close of the Contractor's fiscal year. The Contractor agrees to provide the Indiana State Board of Accounts and the State an original of all financial and compliance audits. The audit shall be an audit of the actual entity, or distinct portion thereof that is the Contractor, and not of a parent, member, or subsidiary corporation of the Contractor, except to the extent such an expanded audit may be determined by the Indiana State Board of Accounts or the State to be in the best interests of the State. The audit shall include a statement from the Auditor that the Auditor has reviewed this Contract and that the Contractor is not out of compliance with the financial aspects of this Contract.

If Federal Funds are involved in this Contract, the State also considers the Contractor to be a "Contractor" under 2 C.F.R. 200.330 for purposes of this Contract. However, if required by applicable provisions of 2 C.F.R. 200 (Uniform Administrative Requirements, Cost Principles, and Audit Requirements), Contractor shall arrange for a financial and compliance audit, which complies with 2 C.F.R. 200.500 *et seq*.

14. Authority to Bind Contractor. The signatory for the Contractor represents that he/she has been duly authorized to execute this Contract on behalf of the Contractor and has obtained all necessary or applicable approvals to make this Contract fully binding upon the Contractor when his/her signature is affixed, and accepted by the State.

15. Changes in Work. The Contractor shall not commence any additional work or change the scope of the work until authorized in writing by the State. The Contractor shall make no claim for additional compensation in the absence of a prior written approval and amendment executed by all signatories hereto. This Contract may only be amended, supplemented or modified by a written document executed in the same manner as this Contract.

16. Compliance with Laws.

A. The Contractor shall comply with all applicable federal, state, and local laws, rules, regulations, and ordinances, and all provisions required thereby to be included herein are hereby incorporated by reference. The enactment or modification of any applicable state or federal statute or the promulgation of rules or regulations thereunder after execution of

this Contract shall be reviewed by the State and the Contractor to determine whether the provisions of this Contract require formal modification.

B. The Contractor and its agents shall abide by all ethical requirements that apply to persons who have a business relationship with the State as set forth in IC §4-2-6, *et seq*., IC §4-2-7, *et seq*., the regulations promulgated thereunder, and Executive Order 04-08, dated April 27, 2004. **If the Contractor has knowledge, or would have acquired knowledge with reasonable inquiry, that a state officer, employee, or special state appointee, as those terms are defined in IC 4-2-6-1, has a financial interest in the Contract, the Contractor shall ensure compliance with the disclosure requirements in IC 4-2-6-10.5 prior to the execution of this contract.** If the Contractor is not familiar with these ethical requirements, the Contractor should refer any questions to the Indiana State Ethics Commission, or visit the Inspector General's website at http://www.in.gov/ig/. If the Contractor or its agents violate any applicable ethical standards, the State may, in its sole discretion, terminate this Contract immediately upon notice to the Contractor. In addition, the Contractor may be subject to penalties under IC §§4-2-6, 4-2-7, 35-44-1-3, and under any other applicable laws.

C. The Contractor certifies by entering into this Contract that neither it nor its principal(s) is presently in arrears in payment of taxes, permit fees or other statutory, regulatory or judicially required payments to the State of Indiana. The Contractor agrees that any payments currently due to the State of Indiana may be withheld from payments due to the Contractor. Additionally, further work or payments may be withheld, delayed, or denied and/or this Contract suspended until the Contractor is current in its payments and has submitted proof of such payment to the State.

D. The Contractor warrants that it has no current, pending or outstanding criminal, civil, or enforcement actions initiated by the State, and agrees that it will immediately notify the State of any such actions. During the term of such actions, the Contractor agrees that the State may delay, withhold, or deny work under any supplement, amendment, change order or other contractual device issued pursuant to this Contract.

E. If a valid dispute exists as to the Contractor's liability or guilt in any action initiated by the State or its agencies, and the State decides to delay, withhold, or deny work to the Contractor, the Contractor may request that it be allowed to continue, or receive work, without delay. The Contractor must submit, in writing, a request for review to the Indiana Department of Administration (IDOA) following the procedures for disputes outlined herein. A determination by IDOA shall be binding on the parties. Any payments that the State may delay, withhold, deny, or apply under this section shall not be subject to penalty or interest, except as permitted by IC §5-17-5.

F. The Contractor warrants that the Contractor and its subcontractors, if any, shall obtain and maintain all required permits, licenses, registrations, and approvals, and shall comply with all health, safety, and environmental statutes, rules, or regulations in the performance of work activities for the State. Failure to do so may be deemed a material breach of this Contract and grounds for immediate termination and denial of further work with the State.

G. The Contractor affirms that, if it is an entity described in IC Title 23, it is properly registered and owes no outstanding reports to the Indiana Secretary of State.

H. As required by IC §5-22-3-7:

(1) The Contractor and any principals of the Contractor certify that:

(A) The Contractor, except for de minimis and nonsystematic violations, has not violated the terms of:

(i) IC §24-4.7 [Telephone Solicitation Of Consumers];
(ii) IC §24-5-12 [Telephone Solicitations]; or
(iii) IC §24-5-14 [Regulation of Automatic Dialing Machines];

in the previous three hundred sixty-five (365) days, even if IC §24-4.7 is preempted by federal law; and

(B) The Contractor will not violate the terms of IC §24-4.7 for the duration of the Contract, even if IC §24-4.7 is preempted by federal law.

(2) The Contractor and any principals of the Contractor certify that an affiliate or principal of the Contractor and any agent acting on behalf of the Contractor or on behalf of an affiliate or principal of the Contractor, except for de minimis and nonsystematic violations,

(A) Has not violated the terms of IC §24-4.7 in the previous three hundred sixty-five (365) days, even if IC §24-4.7 is preempted by federal law; and

(B) Will not violate the terms of IC §24-4.7 for the duration of the Contract, even if IC §24-4.7 is preempted by federal law.

17. Condition of Payment. All services provided by the Contractor under this Contract must be performed to the State's reasonable satisfaction, as determined at the discretion of the undersigned State representative and in accordance with all applicable federal, state, local laws, ordinances, rules and regulations. The State shall not be required to pay for work found to be unsatisfactory, inconsistent with this Contract or performed in violation of and federal, state or local statute, ordinance, rule or regulation.

18. Confidentiality of State Information. The Contractor understands and agrees that data, materials, and information disclosed to the Contractor may contain confidential and protected information. The Contractor covenants that data, material, and information gathered, based upon or disclosed to the Contractor for the purpose of this Contract will not be disclosed to or discussed with third parties without the prior written consent of the State.

The parties acknowledge that the services to be performed by Contractor for the State under this Contract may require or allow access to data, materials, and information containing Social Security numbers maintained by the State in its computer system or other records. In addition to the covenant made above in this section and pursuant to 10 IAC 5-3-1(4), the Contractor and the State agree to comply with the provisions of IC §4-1-10 and IC §4-1-11. If any Social Security number(s) is/are disclosed by Contractor, Contractor agrees to pay the cost of the notice of disclosure of a breach of the security of the system in addition to any other claims and expenses for which it is liable under the terms of this Contract.

19. Continuity of Services.

A. The Contractor recognizes that the service(s) to be performed under this Contract are vital to the State and must be continued without interruption and that, upon Contract expiration, a successor, either the State or another contractor, may continue them. The Contractor agrees to:

1. Furnish phase-in training; and
2. Exercise its best efforts and cooperation to effect an orderly and efficient transition to a successor.

B. The Contractor shall, upon the State's written notice:

1. Furnish phase-in, phase-out services for up to sixty (60) days after this Contract expires; and
2. Negotiate in good faith a plan with a successor to determine the nature and extent of phase-in, phase-out services required. The plan shall specify a training program and a date for transferring responsibilities for each division of work described in the plan, and shall be subject to the State's approval. The Contractor shall provide sufficient experienced personnel during the phase-in, phase-out period to ensure that the services called for by this Contract are maintained at the required level of proficiency.

C. The Contractor shall allow as many personnel as practicable to remain on the job to help the successor maintain the continuity and consistency of the services required by this Contract. The Contractor also shall disclose necessary personnel records and allow the successor to conduct on-site interviews with these employees. If selected employees are agreeable to the change, the Contractor shall release them at a mutually agreeable date and negotiate transfer of their earned fringe benefits to the successor.

D. The Contractor shall be reimbursed for all reasonable phase-in, phase-out costs (i.e., costs incurred within the agreed period after contract expiration that result from phase-in, phase-out operations).

20. Debarment and Suspension.

A. The Contractor certifies by entering into this Contract that neither it nor its principals nor any of its subcontractors are presently debarred, suspended, proposed for debarment, declared ineligible or voluntarily excluded from entering into this Contract by any federal agency or by any department, agency or political subdivision of the State of Indiana. The term “principal” for purposes of this Contract means an officer, director, owner, partner, key employee or other person with primary management or supervisory responsibilities, or a person who has a critical influence on or substantive control over the operations of the Contractor.

B. The Contractor certifies that it has verified the state and federal suspension and debarment status for all subcontractors receiving funds under this Contract and shall be solely responsible for any recoupment, penalties or costs that might arise from use of a suspended or debarred subcontractor. The Contractor shall immediately notify the State if any subcontractor becomes debarred or suspended, and shall, at the State’s request,

take all steps required by the State to terminate its contractual relationship with the subcontractor for work to be performed under this Contract.

21. Default by State. If the State, sixty (60) days after receipt of written notice, fails to correct or cure any material breach of this Contract, the Contractor may cancel and terminate this Contract and institute measures to collect monies due up to and including the date of termination.

22. Disputes.

A. Should any disputes arise with respect to this Contract, the Contractor and the State agree to act immediately to resolve such disputes. Time is of the essence in the resolution of disputes.

B. The Contractor agrees that, the existence of a dispute notwithstanding, it will continue without delay to carry out all of its responsibilities under this Contract that are not affected by the dispute. Should the Contractor fail to continue to perform its responsibilities regarding all non-disputed work, without delay, any additional costs incurred by the State or the Contractor as a result of such failure to proceed shall be borne by the Contractor, and the Contractor shall make no claim against the State for such costs.

C. If the parties are unable to resolve a contract dispute between them after good faith attempts to do so, a dissatisfied party shall submit the dispute to the Commissioner of the Indiana Department of Administration for resolution. The dissatisfied party shall give written notice to the Commissioner and the other party. The notice shall include (1) a description of the disputed issues, (2) the efforts made to resolve the dispute, and (3) a proposed resolution. The Commissioner shall promptly issue a Notice setting out documents and materials to be submitted to the Commissioner in order to resolve the dispute; the Notice may also afford the parties the opportunity to make presentations and enter into further negotiations. Within 30 business days of the conclusion of the final presentations, the Commissioner shall issue a written decision and furnish it to both parties. The Commissioner's decision shall be the final and conclusive administrative decision unless either party serves on the Commissioner and the other party, within ten business days after receipt of the Commissioner's decision, a written request for reconsideration and modification of the written decision. If the Commissioner does not modify the written decision within 30 business days, either party may take such other action helpful to resolving the dispute, including submitting the dispute to an Indiana court of competent jurisdiction. If the parties accept the Commissioner's decision, it may be memorialized as a written Amendment to this Contract if appropriate.

D. The State may withhold payments on disputed items pending resolution of the dispute. The unintentional nonpayment by the State to the Contractor of one or more invoices not in dispute in accordance with the terms of this Contract will not be cause for the Contractor to terminate this Contract, and the Contractor may bring suit to collect these amounts without following the disputes procedure contained herein.

E. With the written approval of the Commissioner of the Indiana Department of Administration, the parties may agree to forego the process described in subdivision C. relating to submission of the dispute to the Commissioner.This paragraph shall not be construed to abrogate provisions of Ind. Code 4-6-2-11 in situations where dispute

resolution efforts lead to a compromise of claims in favor of the State as described in that statute. In particular, releases or settlement agreements involving releases of legal claims or potential legal claims of the state should be processed consistent with Ind. Code 4-6-2-11, which requires approval of the Governor and Attorney General.

F. This paragraph shall not be construed to abrogate provisions of Ind. Code 4-6-2-11 in situations where dispute resolution efforts lead to a compromise of claims in favor of the State as described in that statute. In particular, releases or settlement agreements involving releases of legal claims or potential legal claims of the state should be processed consistent with Ind. Code 4-6-2-11, which requires approval of the Governor and Attorney General.

23. Drug-Free Workplace Certification. As required by Executive Order No. 90-5 dated April 12, 1990, issued by the Governor of Indiana, the Contractor hereby covenants and agrees to make a good faith effort to provide and maintain a drug-free workplace. The Contractor will give written notice to the State within ten (10) days after receiving actual notice that the Contractor, or an employee of the Contractor in the State of Indiana, has been convicted of a criminal drug violation occurring in the workplace. False certification or violation of this certification may result in sanctions including, but not limited to, suspension of contract payments, termination of this Contract and/or debarment of contracting opportunities with the State for up to three (3) years.

In addition to the provisions of the above paragraph, if the total amount set forth in this Contract is in excess of $25,000.00, the Contractor certifies and agrees that it will provide a drug-free workplace by:

A. Publishing and providing to all of its employees a statement notifying them that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the Contractor's workplace, and specifying the actions that will be taken against employees for violations of such prohibition;

B. Establishing a drug-free awareness program to inform its employees of (1) the dangers of drug abuse in the workplace; (2) the Contractor's policy of maintaining a drug-free workplace; (3) any available drug counseling, rehabilitation and employee assistance programs; and (4) the penalties that may be imposed upon an employee for drug abuse violations occurring in the workplace;

C. Notifying all employees in the statement required by subparagraph (A) above that as a condition of continued employment, the employee will (1) abide by the terms of the statement; and (2) notify the Contractor of any criminal drug statute conviction for a violation occurring in the workplace no later than five (5) days after such conviction;

D. Notifying the State in writing within ten (10) days after receiving notice from an employee under subdivision (C)(2) above, or otherwise receiving actual notice of such conviction;

E. Within thirty (30) days after receiving notice under subdivision (C)(2) above of a conviction, imposing the following sanctions or remedial measures on any employee who is convicted of drug abuse violations occurring in the workplace: (1) taking appropriate personnel action against the employee, up to and including termination; or (2) requiring such employee to satisfactorily participate in a drug abuse assistance or rehabilitation program approved for such purposes by a federal, state or local health, law enforcement, or other appropriate agency; and

F. Making a good faith effort to maintain a drug-free workplace through the implementation of subparagraphs (A) through (E) above.

24. Employment Eligibility Verification. As required by IC §22-5-1.7, the Contractor swears or affirms under the penalties of perjury that:

A. The Contractor does not knowingly employ an unauthorized alien.

B. The Contractor shall enroll in and verify the work eligibility status of all his/her/its newly hired employees through the E-Verify program as defined in IC §22-5-1.7-3. The Contractor is not required to participate should the E-Verify program cease to exist. Additionally, the Contractor is not required to participate if the Contractor is self-employed and does not employ any employees.

C. The Contractor shall not knowingly employ or contract with an unauthorized alien. The Contractor shall not retain an employee or contract with a person that the Contractor subsequently learns is an unauthorized alien.

D. The Contractor shall require his/her/its subcontractors who perform work under this Contract to certify to the Contractor that the subcontractor does not knowingly employ or contract with an unauthorized alien and that the subcontractor has enrolled and is participating in the E-Verify program. The Contractor agrees to maintain this certification throughout the duration of the term of a contract with a subcontractor.

The State may terminate for default if the Contractor fails to cure a breach of this provision no later than thirty (30) days after being notified by the State.

25. Employment Option. If the State determines that it would be in the State's best interest to hire an employee of the Contractor, the Contractor will release the selected employee from any non-competition agreements that may be in effect. This release will be at no cost to the State or the employee.

26. Force Majeure. In the event that either party is unable to perform any of its obligations under this Contract or to enjoy any of its benefits because of natural disaster or decrees of governmental bodies not the fault of the affected party (hereinafter referred to as a "Force Majeure Event"), the party who has been so affected shall immediately give notice to the other party and shall do everything possible to resume performance. Upon receipt of such notice, all obligations under this Contract shall be immediately suspended. If the period of nonperformance exceeds thirty (30) days from the receipt of notice of the Force Majeure Event, the party whose ability to perform has not been so affected may, by giving written notice, terminate this Contract.

27. Funding Cancellation. When the Director of the State Budget Agency makes a written determination that funds are not appropriated or otherwise available to support continuation of performance of this Contract, this Contract shall be canceled. A determination by the Director of State Budget Agency that funds are not appropriated or otherwise available to support continuation of performance shall be final and conclusive.

28. Governing Law. This Contract shall be governed, construed, and enforced in accordance with the laws of the State of Indiana, without regard to its conflict of laws rules. Suit, if any, must be brought in the State of Indiana.

29. HIPAA Compliance. If this Contract involves services, activities or products subject to the Health Insurance Portability and Accountability Act of 1996 (HIPAA), the Contractor covenants that it will appropriately safeguard Protected Health Information (defined in 45 CFR 160.103), and agrees that it is subject to, and shall comply with, the provisions of 45 CFR 164 Subpart E regarding use and disclosure of Protected Health Information.

30. Indemnification. The Contractor agrees to indemnify, defend, and hold harmless the State, its agents, officials, and employees from all claims and suits including court costs, attorney's fees, and other expenses caused by any act or omission of the Contractor and/or its subcontractors, if any, in the performance of this Contract. The State shall not provide such indemnification to the Contractor.

31. Independent Contractor; Workers' Compensation Insurance. The Contractor is performing as an independent entity under this Contract. No part of this Contract shall be construed to represent the creation of an employment, agency, partnership or joint venture agreement between the parties. Neither party will assume liability for any injury (including death) to any persons, or damage to any property, arising out of the acts or omissions of the agents, employees or subcontractors of the other party. The Contractor shall provide all necessary unemployment and workers' compensation insurance for the Contractor's employees, and shall provide the State with a Certificate of Insurance evidencing such coverage prior to starting work under this Contract.

32. Information Technology Enterprise Architecture Requirements. If the Contractor provides any information technology related products or services to the State, the Contractor shall comply with all IOT standards, policies and guidelines, which are online at http://iot.in.gov/architecture/. The Contractor specifically agrees that all hardware, software and services provided to or purchased by the State shall be compatible with the principles and goals contained in the electronic and information technology accessibility standards adopted under Section 508 of the Federal Rehabilitation Act of 1973 (29 U.S.C. 794d) and IC §4-13.1-3. Any deviation from these architecture requirements must be approved in writing by IOT in advance. The State may terminate this Contract for default if the Contractor fails to cure a breach of this provision within a reasonable time.

33. Insurance

A. The Contractor and their subcontractors (if any) shall secure and keep in force during the term of this Contract the following insurance coverages (if applicable) covering the Contractor for any and all claims of any nature which may in any manner arise out of or result from Contractor's performance under this Contract:

1. Commercial general liability, including contractual coverage, and products or completed operations coverage (if applicable), with minimum liability limits not less than $700,000 per person and $5,000,000 per occurrence unless additional coverage is required by the State. The State is to be named as an additional insured on a primary, non-contributory basis for any liability arising directly or indirectly under or in connection with this Contract.

2. Automobile liability for owned, non-owned and hired autos with minimum liability limits of $700,000 per person and $5,000,000 per occurrence. The State is to be named as an additional insured on a primary, non-contributory basis.

3. The Contractor shall secure the appropriate Surety or Fidelity Bond(s) as required by the state department served or by applicable statute.

4. The Contractor and their subcontractors shall provide proof of such insurance coverage by tendering to the undersigned State representative a certificate of insurance prior to the commencement of this Contract and proof of workers' compensation coverage meeting all statutory requirements of IC §22-3-2. In addition, proof of an "all states endorsement" covering claims occurring outside the State is required if any of the services provided under this Contract involve work outside of Indiana.

B. The Contractor's insurance coverage must meet the following additional requirements:

1. The insurer must have a certificate of authority or other appropriate authorization to operate in the state in which the policy was issued.

2. Any deductible or self-insured retention amount or other similar obligation under the insurance policies shall be the sole obligation of the Contractor.

3. The State will be defended, indemnified and held harmless to the full extent of any coverage actually secured by the Contractor in excess of the minimum requirements set forth above. The duty to indemnify the State under this Contract shall not be limited by the insurance required in this Contract.

4. The insurance required in this Contract, through a policy or endorsement(s), shall include a provision that the policy and endorsements may not be canceled or modified without thirty (30) days' prior written notice to the undersigned State agency.

5. The Contractor waives and agrees to require their insurer to waive their rights of subrogation against the State of Indiana.

C. Failure to provide insurance as required in this Contract may be deemed a material breach of contract entitling the State to immediately terminate this Contract. The Contractor shall furnish a certificate of insurance and all endorsements to the State before the commencement of this Contract.

34. Key Person(s).

A. If both parties have designated that certain individual(s) are essential to the services offered, the parties agree that should such individual(s) leave their employment during the term of this Contract for whatever reason, the State shall have the right to terminate this Contract upon thirty (30) days' prior written notice.

B. In the event that the Contractor is an individual, that individual shall be considered a key person and, as such, essential to this Contract. Substitution of another for the Contractor shall not be permitted without express written consent of the State.

Nothing in Sections A and B, above shall be construed to prevent the Contractor from using the services of others to perform tasks ancillary to those tasks which directly require the expertise of the key person.

Examples of such ancillary tasks include secretarial, clerical, and common labor duties. The Contractor shall, at all times, remain responsible for the performance of all necessary tasks, whether performed by a key person or others.

Key person(s) to this Contract is/are:

35. Merger & Modification. This Contract constitutes the entire agreement between the parties. No understandings, agreements, or representations, oral or written, not specified within this Contract will be valid provisions of this Contract. This Contract may not be modified, supplemented, or amended, except by written agreement signed by all necessary parties.

36. Minority and Women's Business Enterprises Compliance. Award of this Contract was based, in part, on the Minority and/or Women's Business Enterprise ("MBE" and/or "WBE") participation plan**.** The following certified MBE or WBE subcontractors will be participating in this Contract:

MBE/WBE	PHONE	COMPANY NAME	SCOPE OF PRODUCTS and/or SERVICES	UTILIZATION DATE	PERCENT

Terms for participation are as provided in the Contractor's Proposal to the State's request for participation, which are described and captured in the Contract Documents.

A copy of each subcontractor agreement must be submitted to IDOA's MBE/WBE Division within thirty (30) days of the effective date of this Contract. Failure to provide a copy of any subcontractor agreement will be deemed a violation of the rules governing MBE/WBE procurement, and may result in sanctions allowable under 25 IAC 5-7-8. Failure to provide any subcontractor agreement may also be considered a material breach of this Contract. The Contractor must obtain approval from IDOA's MBE/WBE Division before changing the participation plan submitted in connection with this Contract.

The Contractor shall report payments made to MBE/WBE Division subcontractors under this Contract on a monthly basis. Monthly reports shall be made using the online audit tool, commonly referred to as "Pay Audit." MBE/WBE Division subcontractor payments shall also be reported to the Division as reasonably requested and in a format to be determined by Division.

37. Nondiscrimination. Pursuant to the Indiana Civil Rights Law, specifically including IC §22-9-1-10, and in keeping with the purposes of the federal Civil Rights Act of 1964, the Age Discrimination in Employment Act, and the Americans with Disabilities Act, the Contractor covenants that it shall not discriminate against any employee or applicant for employment relating to this Contract with respect to the hire, tenure, terms, conditions or privileges of employment or any matter directly or indirectly related to employment, because of the employee's or applicant's race, color, national origin, religion, sex, age, disability, ancestry, status as a veteran, or any other characteristic protected by federal, state, or local law ("Protected Characteristics"). Contractor certifies compliance with applicable federal laws, regulations, and executive orders prohibiting discrimination based on the Protected Characteristics in the provision of services. Breach of this paragraph may be regarded as a material breach of this Contract, but nothing in this paragraph shall be construed to imply or establish an employment relationship between the State and any applicant or employee of the Contractor or any subcontractor.

The State is a recipient of federal funds, and therefore, where applicable, Contractor and any subcontractors shall comply with requisite affirmative action requirements, including reporting, pursuant to 41 CFR Chapter 60, as amended, and Section 202 of Executive Order 11246 as amended by Executive Order 13672.

38. Notice to Parties. Whenever any notice, statement or other communication is required under this Contract, it shall be sent to the following addresses, unless otherwise specifically advised.

A. Notices to the State shall be sent to: Public Works Divisions, Director
Indiana Department of Administration
402 W Washington St Room W467
Indianapolis, IN 46204

B. Notices to the Contractor shall be sent to: **[INSERT CONTRACTOR NAME]**
[INSERT CONTRACTOR ADDRESS]

C. As required by IC 4-13-2-14.8, payments to the Contractor shall be made via electronic funds transfer in accordance with instructions filed by the Contractor with the Indiana Auditor of State.

39. Order of Precedence; Incorporation by Reference. Any inconsistency or ambiguity in this Contract shall be resolved by giving precedence in the following order: (1) this Contract, (2) the Project Bid Package, (3) attachments prepared by the State; (4) Contractor's Proposal; and (5) attachments prepared by the Contractor. All of the foregoing are incorporated fully by reference. All attachments, and all documents referred to in this paragraph are hereby incorporated fully by reference.

40. Ownership of Documents and Materials.

A. All documents, records, programs, applications, data, algorithms, film, tape, articles, memoranda, and other materials (the "Materials") not developed or licensed by the Contractor prior to execution of this Contract, but specifically developed under this Contract shall be considered "work for hire" and the Contractor hereby transfers and assigns any ownership claims to the State so that all Materials will be the property of the State. If ownership interest in the Materials cannot be assigned to the State, the Contractor grants the State a non-exclusive, non-cancelable, perpetual, worldwide royalty-free license to use the Materials and to use, modify, copy and create derivative works of the Materials.

B. Use of the Materials, other than related to contract performance by the Contractor, without the prior written consent of the State, is prohibited. During the performance of this Contract, the Contractor shall be responsible for any loss of or damage to the Materials developed for or supplied by the State and used to develop or assist in the services provided while the Materials are in the possession of the Contractor. Any loss or damage thereto shall be restored at the Contractor's expense. The Contractor shall provide the State full, immediate, and unrestricted access to the Materials and to Contractor's work product during the term of this Contract.

41. Payments.

A. All payments shall be made 35 days in arrears in conformance with State fiscal policies and procedures and, as required by IC §4-13-2-14.8, the direct deposit by electronic funds transfer to the financial institution designated by the Contractor in writing unless a specific waiver has been obtained from the Indiana Auditor of State. No payments will be made in advance of receipt of the goods or services that are the subject of this Contract except as permitted by IC §4-13-2-20.

B. The State Budget Agency and the Contractor acknowledge that Contractor is being paid in advance for the maintenance of equipment and / or software. Pursuant to IC §4-13-2-20(b)(14), Contractor agrees that if it fails to perform the maintenance required under this Contract, upon receipt of written notice from the State, it shall promptly refund the consideration paid, pro-rated through the date of non-performance.

42. Penalties/Interest/Attorney's Fees. The State will in good faith perform its required obligations hereunder and does not agree to pay any penalties, liquidated damages, interest or attorney's fees, except as permitted by Indiana law, in part, IC §5-17-5, IC §34-54-8, IC §34-13-1 and IC § 34-52-2-3.

Notwithstanding the provisions contained in IC §5-17-5, any liability resulting from the State's failure to make prompt payment shall be based solely on the amount of funding originating from the State and shall not be based on funding from federal or other sources.

43. Progress Reports. The Contractor shall submit progress reports to the State upon request. The report shall be oral, unless the State, upon receipt of the oral report, should deem it necessary to have it in written form. The progress reports shall serve the purpose of assuring the State that work is progressing in line with the schedule, and that completion can be reasonably assured on the scheduled date.

44. Public Record. The Contractor acknowledges that the State will not treat this Contract as containing confidential information, and will post this Contract on its website as required by Executive Order 05-07. Use by the public of the information contained in this Contract shall not be considered an act of the State.

45. Renewal Option. This Contract may be renewed under the same terms and conditions, subject to the approval of the Commissioner of the Department of Administration and the State Budget Director in compliance with IC §5-22-17-4. The term of the renewed contract may not be longer than the term of the original contract.

46. Severability. The invalidity of any section, subsection, clause or provision of this Contract shall not affect the validity of the remaining sections, subsections, clauses or provisions of this Contract.

47. Substantial Performance. This Contract shall be deemed to be substantially performed only when fully performed according to its terms and conditions and any written amendments or supplements.

48. Taxes. The State is exempt from most state and local taxes and many federal taxes. The State will not be responsible for any taxes levied on the Contractor as a result of this Contract.

49. Termination for Convenience. This Contract may be terminated, in whole or in part, by the State, which shall include and is not limited to the Indiana Department of Administration and the State Budget Agency whenever, for any reason, the State determines that such termination is in its best interest. Termination of services shall be effected by delivery to the Contractor of a Termination Notice at least thirty (30) days prior to the termination effective date, specifying the extent to which performance of services under such termination becomes effective. The Contractor shall be compensated for services properly rendered prior to the effective date of termination. The State will not be liable for services performed after the effective date of termination. The Contractor shall be compensated for services herein provided but in no case shall total payment made to the Contractor exceed the original contract price or shall any price increase be allowed on individual line items if canceled only in part prior to the original termination date. For the purposes of this paragraph, the parties stipulate and agree that the Indiana Department of Administration shall be deemed to be a party to this agreement with authority to terminate

the same for convenience when such termination is determined by the Commissioner of IDOA to be in the best interests of the State.

50. Termination for Default.

A. With the provision of thirty (30) days notice to the Contractor, the State may terminate this Contract in whole or in part if the Contractor fails to:

1. Correct or cure any breach of this Contract; the time to correct or cure the breach may be extended beyond thirty (30) days if the State determines progress is being made and the extension is agreed to by the parties;
2. Deliver the supplies or perform the services within the time specified in this Contract or any extension;
3. Make progress so as to endanger performance of this Contract; or
4. Perform any of the other provisions of this Contract.

B. If the State terminates this Contract in whole or in part, it may acquire, under the terms and in the manner the State considers appropriate, supplies or services similar to those terminated, and the Contractor will be liable to the State for any excess costs for those supplies or services. However, the Contractor shall continue the work not terminated.

C. The State shall pay the contract price for completed supplies delivered and services accepted. The Contractor and the State shall agree on the amount of payment for manufacturing materials delivered and accepted and for the protection and preservation of the property. Failure to agree will be a dispute under the Disputes clause. The State may withhold from these amounts any sum the State determines to be necessary to protect the State against loss because of outstanding liens or claims of former lien holders.

D. The rights and remedies of the State in this clause are in addition to any other rights and remedies provided by law or equity or under this Contract.

51. Travel. No expenses for travel will be reimbursed unless specifically permitted under the scope of services or consideration provisions. Expenditures made by the Contractor for travel will be reimbursed at the current rate paid by the State and in accordance with the State Travel Policies and Procedures as specified in the current Financial Management Circular. Out-of-state travel requests must be reviewed by the State for availability of funds and for appropriateness per Circular guidelines.

52. Indiana Veteran's Business Enterprise Compliance. Award of this Contract was based, in part, on the Indiana Veteran's Business Enterprise ("IVBE") participation plan. The following IVBE subcontractors will be participating in this Contract:

VBE	PHONE	COMPANY NAME	SCOPE OF PRODUCTS and/or SERVICES	UTILIZATION	DATE	PERCENT

N/A

A copy of each subcontractor agreement must be submitted to IDOA within thirty (30) days of the effective date of this Contract. Failure to provide any subcontractor agreement may also be considered a material breach of this Contract. The Contractor must obtain approval from IDOA's MBE/WBE Division before changing the participation plan submitted in connection with this Contract.

The Contractor shall report payments made to IVBE subcontractors under this Contract on a monthly basis. Monthly reports shall be made using the online audit tool, commonly referred to as "Pay Audit." IVBE subcontractor payments shall also be reported to IDOA as reasonably requested and in a format to be determined by IDOA.

53. Waiver of Rights. No right conferred on either party under this Contract shall be deemed waived, and no breach of this Contract excused, unless such waiver is in writing and signed by the party claimed to have waived such right. Neither the State's review, approval or acceptance of, nor payment for, the services required under this Contract shall be construed to operate as a waiver of any rights under this Contract or of any cause of action arising out of the performance of this Contract, and the Contractor shall be and remain liable to the State in accordance with applicable law for all damages to the State caused by the Contractor's negligent performance of any of the services furnished under this Contract.

54. Work Standards. The Contractor shall execute its responsibilities by following and applying at all times the highest professional and technical guidelines and standards. If the State becomes dissatisfied with the work product of or the working relationship with those individuals assigned to work on this Contract, the State may request in writing the replacement of any or all such individuals, and the Contractor shall grant such reques

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Non-Collusion and Acceptance

The undersigned attests, subject to the penalties for perjury, that the undersigned is the Contractor, or that the undersigned is the properly authorized representative, agent, member or officer of the Contractor. Further, to the undersigned's knowledge, neither the undersigned nor any other member, employee, representative, agent or officer of the Contractor, directly or indirectly, has entered into or been offered any sum of money or other consideration for the execution of this Contract other than that which appears upon the face hereof. **Furthermore, if the undersigned has knowledge that a state officer, employee, or special state appointee, as those terms are defined in IC 4-2-6-1, has a financial interest in the Contract, the Contractor attests to compliance with the disclosure requirements in IC 4-2-6-10.5.**

IN WITNESS WHEREOF, the Contractor and the State have, through their duly authorized representatives, entered into this Contract for Public Works Project Number **XXXXX**. The parties, having read and understood the foregoing terms of this Contract, do by their respective signatures dated below agree to the terms thereof.

XXXXXXXXXX
[Contractor]

By: _____
Printed Name: _____
Title: _____

Date: _____

Department of Administration
Public Works Division

By: _____
Director, DAPW
For IDOA Commissioner if less than $1,000,000

Date: _____

Approved by:
Department of Administration

By: _____
Jessica Robertson, Commissioner

Date: _____

Approved by:
State Budget Agency

By: _____
Brian E. Bailey, Director

Date: _____

Approved as to Form and Legality:
Form approval has been granted by the Office of the Attorney General pursuant to IC 4-13-2-14.3(e) on August 15, 2016.
FA 16-28

This Instrument was prepared by: **[INSERT NAME]** on **XX/XX/XXXX**

Legal counsel: _____ (initials)

PART B
LIST OF DRAWINGS

LIST OF DRAWINGS

Page No.	Drawing Description
01	Title Sheet
02	Drawing Index Sheet, Legends, Symbols, and Project Notes
03	Site Survey
04	Site Plan
05	Existing Principal Spillway Channel Improvements
06	Principal Spillway Articulated Concrete Block Overflow Line 'P' Plan, Profile and Details
07	Principal Spillway Wall Line 'W' Plan and Profile
08	Access Drive & Typical Principal Spillway Details
09	Emergency Spillway Line 'E' Plan and Profile
10	Lake Drawdown Plan and Profile
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16	Hydrologic and Hydraulics Data
17	Dam Centerline Profile – Line 'A'
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21	General Structural Notes
22	Typical Structural Details - Concrete
23	Overall Foundation Plan and Retaining Wall Profile
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PART C
SPECIFICATIONS

PART C
DETAILED SPECIFICATIONS

PART C

DETAILED SPECIFICATIONS

INDIANA DEPARTMENT OF NATURAL RESOURCES

CROSLEY FISH & WILDLIFE AREA – DAM IMPROVEMENTS PROJECT

TABLE OF CONTENTS

Notes:

1. Detailed specifications herein are certified by the plan sheet noted electrical, mechanical, instrumentation and control, structural and process engineers for which work is applicable.

2. Appendix “A” – The attached reports of explorations and tests of subsurface conditions at or adjacent to the site, have been included to aid Contractor in development of bids. The Technical Data in such reports upon whose accuracy Contractor may rely are the boring logs.

SECTION 01010

GENERAL REQUIREMENTS

PART I - GENERAL

1.01 DESCRIPTION

A. This project consists of the reconstruction of Crosley Lake Dam in the Crosley Fish and Wildlife Area. The Crosley Lake Dam will be reconstructed/raised to a uniform 12 ft. wide crest at elev. 702.00 MSL, NAVD 88, the exist. principal spillway will be upgraded, two new emergency spillways will be added; in combination, these structures will allow the dam to safely pass the 50% Probable Maximum Precipitation (PMP) storm event. Normal pool will remain at elev. 695.65 MSL, NAVD 88. The principal spillway channel will have a reinforced concrete training wall and large precast block wall to contain the peak 100-year storm event and will serve to direct repetitive discharges from the dam embankment and protect the toe of dam from eroding. For larger storm events, two new 40 ft. wide trapezoidal channels, with articulated concrete block (ACB) and/or Hydroturf, will engage simultaneously at elev. 697.70 MSL, NAVD 88. The spillways will have 3:1 side slopes and are proposed to be installed at 3.5-3.25:1 slope. The north principal spillway overflow will discharge over the top of a notched area in the reinforced concrete training wall. The south emergency spillway discharges into 6 rows of A-Jacks energy dissipators and Class II riprap outlet protection (42" thick). In addition, the dam will be provided with an 8 inch lake drawdown facility (siphon, the upstream embankment will be stabilized with class I riprap on filter fabric to uniform 2:1 slope or flatter, 150 ft. of 8 inch two stage embankment filter drains will be installed, nearly 0.75 acres of brush and tree clearing/grubbing, grout injection for seepage control at principal spillway crest and various concrete placement to protect existing rock principal spillway.

The project is located at Crosley Fish and Wildlife Area, approximately 2.3 miles south of Vernon, Indiana, off of Indiana 3 South.

B. The Contractor shall perform all work required to complete the project in accordance with the contract documents.

1.02 BASE BID AND ALTERNATES:

BASE BID

A. The Base Bid shall include all work and requirements indicated by the Bidding Documents.

1. The Contractor shall not be allowed extra compensation by reason of any matter or thing concerning which the Contractor could have fully informed their self prior to bidding. No verbal agreement, understanding or conversation with an agent or employee of the Owner, either before or after the execution of this contract, shall affect or modify the terms or obligations herein contained.

ALTERNATES

B. Indicate on Bid Form (DAPW 13) the amount to be added or deducted from the Base Bid for each Alternate.

C. ALTERNATE DESCRIPTIONS

PROJECT ALTERNATES FOR RE-BID:

THE PROJECT CONSIST OF FIVE ALTERNATES DISCUSSED IN DETAIL HERE.

ALTERNATE 1: ADD LAKE DRAWDOWN FACILITY

•**LOCATION:** THROUGH DAM EMBANKMENT - LINE 'D', CROSSING AT DAM CENTERLINE LINE 'A' APPROXIMATE STATION 12+61 (JUST NORTH OF EMERGENCY SPILLWAY)
•**SHEET REFERENCES:** GENERAL LOCATION SHEET 04, WORK ON SHEETS 10 AND 11
•**SPECIFICATION REFERENCE:** DETAIL SPECIFICATION SECTION 06 EXCAVATION AND EMBANKMENT, SECTION 08 RIPRAP, SECTION 12 LAKE DRAWDOWN PRECAST STRUCTURES, PIPE AND APPURTENANCES
•**WORK DETAIL:** INSTALL STR. 101 LAKE DRAWDOWN INTAKE & CONCRETE ANCHOR, REVETMENT RIPRAP LEVELING PAD, NEW STR. 102 60" DIAMETER MH WITH FILLER PIPE AND VALVE, NEW STR. 103 48" DIA. MH WITH VALVE, AND 8" PIPE WITH COLLARS AND INLET SCREEN. NOTE: NEW STR. 104 OUTLET HEADWALL SHALL REMAIN PART OF THE BASE BID, WHICH SHALL INCLUDE A FOUR (4) FOOT 8" DUCTILE IRON PIPE STUBBED AND CAPPED BEHIND WALL FOR FUTURE CONNECTION. DUCTILE IRON PIPE SHALL MEET LAKE DRAWDOWN PIPE MATERIAL SPECIFICATIONS.

ALTERNATE 2: ADD EMERGENCY SPILLWAY UTILIZING HYDROTURF CS SYSTEM
•**LOCATION:** DOWNSTREAM DAM EMBANKMENT ON THE SOUTH END OF DAM; CENTERLINE OF EMERGENCY SPILLWAY AT DAM CENTERLINE LINE 'A' APPROXIMATE STATION 13+18.
•**SHEET REFERENCES:** GENERAL LOCATION SHEET 04, WORK ON SHEETS 09, 12, 15 AND 17. NOTE: ARTICULATED CONCRETE BLOCK MATS ARE SHOWN IN THE ACTUAL PLAN SET. WITHIN DETAILED SPECIFICATION SECTION 19, HYDROTURF CS SYSTEM PRODUCT INSTALLATION DETAILS AND REQUIREMENTS ARE PROVIDED. IN ADDITION, THE HYDROTURF CS SYSTEM EXTENDS BEYOND THE TOE OF THE DAM (WHICH DIFFERS FROM THE ARTICULATED CONCRETE BLOCK MAT INSTALLATION SHOWN ON SHEET 09). FOR THAT REASON, THE HYDROTURF CS SYSTEM, SUBSEQUENTLY SHIFTS THE CONCRETE ARMOR UNIT INSTALLATION DOWNSTREAM AND LESS RIPRAP WILL BE UTILIZED. THE END OF THE RIPRAP SHALL REMAIN AT LINE 'E' STATION 32+15 (AS SHOWN ON SHEET 09).
•**SPECIFICATION REFERENCE:** DETAIL SPECIFICATION SECTION 06 EXCAVATION AND EMBANKMENT, SECTION 08 RIPRAP, SECTION 10 CONCRETE ARMOR UNITS, SECTION 17 PERMANENT SEEDING AND SECTION19 HYDROTURF CS SYSTEM
•**WORK DETAIL:** INSTALL EMERGENCY SPILLWAY WITH HYDROTURF CS HARD ARMOR PROTECTION, CONCRETE ARMOR UNITS ENERGY DISSIPATORS AND 42" THICKNESS OF CLASS II RIPRAP. NOTE: BASE BID SHALL INLCUDE PROVIDING A POSITIVE DRAINAGE FOR TWO STAGE FILTER DRAINS FROM NEW STR. 104 TO OUTLET CHANNEL AS SHOWN

ON SHEET 09. BASE BID SHALL MAINTAIN NEW 12'-0" DAM CREST TO ELEV. 702.00.

ALTERNATE 3: ADD ARTICULATED CONCRETE BLOCK MATS IN-LIEU OF HYDROTURF CS SYSTEM FOR EMERGENCY SPILLWAY

•**LOCATION:** DOWNSTREAM DAM EMBANKMENT ON THE SOUTH END OF DAM; CENTERLINE OF EMERGENCY SPILLWAY AT DAM CENTERLINE LINE 'A' APPROXIMATE STATION 13+18.

•**SHEET REFERENCES:** GENERAL LOCATION SHEET 04, WORK ON SHEETS 09, 12, 15 AND 17.

•**SPECIFICATION REFERENCE:** DETAIL SPECIFICATION SECTION 06 EXCAVATION AND EMBANKMENT, SECTION 08 RIPRAP, SECTION 09 ARTICULATED CONCRETE BLOCK MATS, SECTION 10 CONCRETE ARMOR UNITS AND SECTION 17 PERMANENT SEEDING

•**WORK DETAIL:** THIS ALTERNATE SUBSTITUTES ARTICULATED CONCRETE BLOCK MATS HARD ARMOR IN-LIEU OF THE HYDROTURF CS SYSTEM, AS GENERALLY SHOWN WITHIN THIS PLAN SET. THE TOTAL COST DIFFERENCE, MATERIAL AND INSTALLATION SHOULD BE INCLUDED WITHIN THIS ALTERNATE.

ALTERNATE 4: ADD RIPRAP ON FILTER FABRIC

•**LOCATION:** ADD UPSTREAM DAM EMBANKMENT, EAST OFFSETS GIVEN; DAM CENTERLINE LINE 'A', FROM APPROX. STATION 10+75, APPROX. 27 FEET LEFT; TO APPROX. STATION 11+00, APPROX. 23 FEET LEFT; TO APPROX. STATION 12+95 APPROX. 23 FEET LEFT; TO APPROX. STATION ENDING AT APPROX. 13+42 STATION 37 FEET LEFT.

•**SHEET REFERENCES:** GENERAL LOCATION SHEET 04, WORK ON SHEETS 12, 14, 18, 19 AND 20.

•**SPECIFICATION REFERENCE:** DETAIL SPECIFICATION SECTION 08 RIPRAP

•**WORK DETAIL:** INSTALLATION OF RIPRAP (APPROX. 330 SYS PLAN VIEW 2D SCALE), FROM TWO (2) FEET BELOW NORMAL POOL (ELEV.693.65). CONTINUING DOWN THE DOWNSTREAM EMABKMENT AS REQUIRED TO PROVIDE MIN. 2:1 SLOPE. NOTE: BASE BID SHALL BE FOR RIPRAP FROM ELEV. 700.50 TO ELEV. 693.65 (APPROX. 555 SYS PLAN VIEW 2D SCALE).

ALTERNATE 5: ADD PRESSURE GROUTING

•**LOCATION:** AT PRINCIPAL SPILLWAY CREST AND DAM CREST; DAM CENTERLINE LINE 'A' APPROXIMATE STATION 10+00 TO APPROXIMATE STATION 11+40

•**SHEET REFERENCES:** GENERAL LOCATION SHEET 04, WORK ON SHEETS 05 AND 17.

•**SPECIFICATION REFERENCE:** DETAIL SPECIFICATION SECTION 13 PRESSURE GROUTING

•**WORK DETAIL:** INSTALLATION OF ALL PRESSURE GROUTING.

1.03 COMMENCEMENT AND COMPLETION OF WORK:

A. The Contractor shall commence work within 10 days after the date of the execution of the Contract.

B. The Contractor shall begin work within 10 days after the date of the execution of the Contract, except that no work on the site will begin until after

C. All work required by the Contract Documents shall be completed within 180 calendar days after the commencement of the work. This shall consist of 150 calendar days to reach substantial completion (when the project is completed and ready for full use by the Owner). An additional 30 calendar days shall be provided for final completion after the date of substantial completion in order to complete any punch list items or items of work found to be incomplete.

D. This project, or portion thereof, will not be ready for substantial completion review until test and performance evaluations are completed, all items are installed, proper paint is dry, and area is clear of construction rubbish and debris.

1.04 BUILDER'S RISK INSURANCE:

A. The Builder's Risk insurance requirements as specified in the General Conditions (11.2.5) are waived for this project.

1.06 SUBMISSION OF POST-BID INFORMATION: Submit the following information within ten days of receipt of Notice to Proceed.

A. Designation of the work to be performed by the Contractor with his own forces.

B. A list of Subcontractors.

C. A list of manufacturers and suppliers.

D. Designation of location of disposal site for all project debris and excavated material. If the location is anything other than a certified landfill, the submittal shall include a map (United States Geological Survey topographic map preferred) showing the location. This submittal must be received at least 10 days prior to the beginning of the disposal at said site.

E. Designation of the source of any fill material for the project. If the source is anything other than a pre-existing borrow pit, the submittal shall include a map (United States Geological Survey topographic map preferred) showing the location. This submittal must be received at least 21 days prior to any excavation occurring at the fill material site.

1.07 REMEDIATION ALLOWANCE

Detailed Specification Section 18 Remediation Allowance, contains information which will directly affect the amount of the contractors bid. The amount of any such allowances must be added to the contractor's determined cost for performing the work, and included in the bid price for the project. **If any portion of the allowance is not used during the project, that portion will revert to the owner and will not be included in the contractor's final payment.**

1.08 WORKING HOURS:

A. Contractor shall perform all construction activity on Monday thru Friday, excluding state holidays, between the hours of 7:30 a.m. and 5:00 p.m., unless previous

arrangements are made with the Owner.

B. All work performed at other times shall be only by approval from the Owner, confirmed in writing, and shall not constitute a change in the contract amount.

1.09 EXISTING SITE CONDITIONS:

A. Data on the drawings pertaining to present conditions, dimensions, type of construction, obstructions on or near site, location of utilities, etc. have been obtained from sources believed reliable, but accuracy of such data is not guaranteed and is furnished solely for accommodation of the Contractor.

B. The Contractor shall, prior to excavating, verify the location of all buried utilities, including buried power lines.

1.10 CONSTRUCTION AND STORAGE AREA:

A. The Contractor shall confine the construction operations and storage of materials within an area approved by the Designer.

1.11 ROADWAY PROTECTION:

A. The Contractor shall, at his expense, be responsible to repair any and all damage to the property's roads and drainage structures caused by his equipment and/or personnel.

B. The ingress and egress to the project site shall be approved by the Designer.

1.12 SUBSTITUTIONS:

A. Substitutions shall be made in accordance with the requirements of Article 7 of the General Conditions.

1.13 ARCHEOLOGICAL AND HISTORICAL ARTIFACTS:

A. If any objects are uncovered during construction which could possibly be of archeological or historical importance, this shall be immediately reported to the Owner. Work at that spot shall not proceed further until the Owner has evaluated the object and the area where it was found and approved continuation of the work.

B. If any construction time is lost due to such objects being found, an equal number of calendar days will be added to the project completion time given in the specifications.

1.14 PROTECTION OF FACILITIES AND PREMISES:

A. The Contractor shall be responsible for the protection of all existing facilities during the entire period of construction. Any damage to the existing facilities caused by the Contractor shall be repaired by the Contractor at his expense and in a manner approved by the Designer.

B. The Contractor shall confine his construction operations and storage of materials within an area approved by the Designer.

C. The Contractor shall, at all times, keep the premises free from accumulation of waste materials or rubbish caused by his employees or work. At the completion of the work, he shall remove all the accumulated rubbish, tools and surplus materials from and about the job site, and shall leave the premises in a neat, clean and orderly condition.

D. Debris and rubbish from the construction operations shall not be dumped on the Owner's property but shall be removed from the site by the Contractor.

E. **The Contractor Shall power wash any mechanical equipment or vehicle to be used on the job site to remove all mud and debris prior to unloading on the site.** This is necessary to prevent contamination by invasive species that may be attached to the equipment. The Contractor SHALL NOT unload the equipment on site without prior visual inspection by the Property Manager. No other vehicles/machines shall be permitted in the project area. All other equipment or project related vehicles must be parked in specified parking areas.

1.15 SITE ACCESS PRIOR TO BIDDING:

A. Bidders may obtain access to the construction site, for on site inspection prior to bidding, by making arrangements with the following Department of Natural Resources Personnel.

Contact: Chad Springer, Property Manager
Telephone No: 812-346-5596

Address: IDNR Crosley Fish and Wildlife
2010 S. State Highway 3
North Vernon, IN 47265

1.16 CONFINED SPACE ENTRY:

A. Written permit is required prior to entry into areas meeting the OSHA definition of a "permit required confined space". Areas meeting this definition and which are known or presumed to require access for this project are as follows:

B. Non-listing of a confined space requiring access does not relieve the Contractor of responsibility for obtaining a permit if required by OSHA Regulations.

C. Confined space definition (all of the following):

1. Is large enough and so configured that an employee can bodily enter and perform assigned work.
2. Has limited or restricted means for entry or exit.
3. Is not designed for continuous occupancy.

D. Permit required confined space (any of the following):

1. Contains or has the potential to contain a hazardous atmosphere.
2. Contains a material that has the potential for engulfing an entrant.
3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross section.

4. Contains any other recognized serious safety or health hazard.

E. Contractor to provide copy of "confined space entry" plan and permit proposed to be used at the preconstruction meeting. It will be the Contractor's responsibility to abide by all requirements of OSHA.

F. Contractor shall provide for rescue services during work in permit required confined spaces.

G. Contractor to provide copy of issued permits at the beginning of each days work to the Property Manager.

1.17 SAFETY RAILING AND SIGNAGE:

A. All permanent safety railing and signage around the spillway areas shall be the responsibility of the Owner and will not be part of this contract.

1.18 U.S. FISH & WILDLIFE SERVICE ENVIROMENTAL REQUIREMENTS; Endangered Bat Species Habitat:

A. No tree larger than three (3) inches diameter at breast height shall be removed during the period between April 1 and September 30 without prior approval of the Owner or designated representative. In the event an endangered species is found during cutting, then the construction shall be delayed until clearance is obtained. If any construction time is lost due to the delay then an equal number of calendar days shall be added to the project completion time.

1.19 Applicability of the Detailed Specifications

A. The Detailed Specifications are part of the Contract which describes equipment, material, labor, services, and other provisions. This section states what must be provided and met by the Contractor. The Detailed Specifications supersede the Workmanship and Materials Specifications of the Contract where the provisions of these Parts are in conflict.

PART 2 – PLAN OF OPERATION

2.01 General

A. The Contractor shall provide a Plan of Operation within thirty (30) days of the execution of the Agreement. This Plan of Operation shall generally describe the scheduling and phasing of all work, shall describe the means and methods anticipated to be utilized in completing each section of the work, Contractor’s quality control and testing to be utilized for the project, and shall describe in detail; (i) the safety measures to be used to protect the public from Contractor's work, (ii) include provisions to maintain drainage during construction, including procedures for handling high intensity storm events (100-year or 1% annual occurrence) and (iii) ensuring compliance with all project permit requirements. Work details shall include all temporary construction structures, such as coffer dams and temporary bypass pumping facilities. The Engineer and Owner shall review and determine acceptable procedure and development of the Plan of Operation has been established, prior to Contractor commencing work.

B. Due to the nature of the work requiring existing facilities to remain in operation during construction, until start-up of new or temporary facilities is completed, the Contractor must fully coordinate and cooperate with the Owner and Engineer in developing a Plan of Operation for the phasing of construction. This Plan of Operation, which may be amended by the Engineer in discussions with the Owner and the Contractor, shall designate a logical order of task completion for the purpose of maintaining service to the existing utility. The Contractor shall include in his/her plans for phasing of construction the coordination of all disposal requirements.

C. Contractor is responsible for protection of existing facilities and embankments, including temporary work/excavations necessary for permanent improvements. Contractor shall protect existing embankment or make necessary repairs for any said damaged embankment.

2.02 Public Safety

A. Public Safety shall be included in Plan of Operation. Contractor shall secure the site prior to start of construction. Barricades (non-moveable) shall be provided at the parking lot at Crosley Lake or at archery range, prior to gravel road entrance to the lake. This shall be subject to Crosley lake Property Manager on where to close access. Barricades may include a lockable gate and barricades along the edge of the roadway to ensure cars cannot drive around the edge of pavement. Contractor shall also be responsible for protection of existing utilities, storage of equipment and materials, and protection of excavations from public access. Contractor shall be responsible for all site safety measures.

2.03 Contractor's Responsibility

A. Prior to commencing any construction activities, Contractor shall field verify elevations and measurements of all points, where new construction is to match existing conditions. Contractor shall report any errors or discrepancies to Engineer or assume responsibility to ensure new work will meet existing equipment, structures, facilities, pipe, etc. If such new parts do not fit properly to existing, at Contractor's expense, shall make such alterations to new parts to ensure proper fits and connections can be attained. Such work shall meet the approval of Engineer. No direct payment shall be made for this work but the cost thereof shall be included in the costs of the other items of the contract.

B. The Contractor shall be responsible for all construction staking and As-Built plan information.

C. The Contractor shall be responsible to attend all project coordination meetings with the Owner, Engineer, and Resident Project Representative as scheduled by the Engineer. At these meetings, the Contractor shall submit an updated project schedule and a detailed listing of the next two weeks work activities.

D. Under each Item, the Contractor shall include the cost of all materials, equipment, labor, transportation, construction, equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water and sanitary facilities, taxes, cost of insurance and bonds together with all the work specifically described and included under the Contract Items and the component parts of the Contract.

E. It shall be the responsibility of the Contractor to complete all work in accordance with these plans and specifications, provide all applicable permits and accesses, and prevent unlawful discharges to the area streams and drains. The Contractor shall perform all work in such a manner to provide continuous wastewater service to on-site construction workers and prevent spills or discharges of raw or inadequately treated sewage to the area streams, lakes and/or drains. The Contractor shall be fully responsible for providing all temporary piping, pumping, controls, electrical, containment and transportation equipment, and other equipment and work so as to maintain service.

F. The Contractor shall prevent spills, discharges or soil erosion runoff to area streams and drains. All construction activities, any land disturbing activity, must contain temporary site erosion control measures. These site erosion and control measures shall be checked weekly and after each ½" rain event. Contractor shall be responsible for maintaining the temporary erosion and control measures until Owner or Engineer provide in writing to the Contractor that such items can be removed.

G. The Contractor shall comply with all local, state, and federal agency requirements relative to the control of erosion during and immediately following construction and containment of siltation in adjacent streams, lakes and ditches. Any in-stream silt traps as may be required by the Indiana Department of Natural Resources or Indiana Department of Environmental Management shall be installed and maintained by the Contractor.

H. Soil investigation work was conducted as part of this project and included within the project manual. Any additional soils work shall be at Contractor's expense.

2.04 Certificate of Substantial Completion

It shall be noted that only ONE (1) CERTIFICATE OF SUBSTANTIAL COMPLETION will be issued.

2.05 Warranty Period

A. The warranty period for the equipment shall begin with final approval of all equipment and work associated with the project (i.e., upon the issuance of the Certificate of Substantial Completion).

B. It shall be noted, that the warranty period for equipment used initially in temporary service shall only begin with final approval of all equipment associated with said certificate and only after final and permanent installation.

2.06 Notice of Street Closings

A. Contractor shall give Notice to Proper Authorities (Refer to Traffic Control Detailed Specifications, when applicable), to Engineer and Owner and the respective utility or authority notice at least seven (7) days prior to the temporary discontinuation of service, or temporary closing of all or parts of trails, drives, parking areas, shoulders, roads, and streets. Such notice shall specify the locations of temporary service discontinuation or street work, the estimated time that the work will require to complete, and the extent, whether partial or complete, that any streets are anticipated to be closed.

2.07 Use of Easements and/or Construction Limits

A. Notwithstanding, anything to the contrary in these Contract Documents, the Contractor shall limit its work in and around easements and/or construction limits. In the event Owner or the owner of the land on which the easement and/or construction limit exists is damaged by Contractor's work in or around such land, Contractor shall be fully responsible for restitution for the damage.

2.08 All temporary power, water, telephone service, internet service, portable toilets, etc.

A. The Contractor shall be responsible for furnishing and payment of all temporary power, water, telephone service, internet service, portable toilets etc. required for construction.

2.09 Removal of Materials

A. The Contractor shall be responsible for the removal and lawful disposal of all materials, debris, etc. resulting from or required due to construction activities.

2.10 Conflict with Existing Underground Utilities

A. As specified in Section WM 2 and by Indiana Law, the Contractor shall be responsible for locating and protecting all existing underground utilities. All existing underground telephone, cable TV, electrical, water, gas, and sanitary sewer service laterals shall be located and protected by the Contractor. Although not specifically shown on the plans for the location of such individual services, such as water and gas service lines and sewer laterals; Contractor shall anticipate and verify all such facilities. It is the Contractor’s responsibility to contact the subject utility to locate these services and no additional costs will be paid for damage to service lines not shown.

B. Work shall include contacting existing utilities known to be in the area, reviewing available utility mapping, utility locates, and potholing. The Contractor shall be responsible to locate all existing underground utilities in advance of performing work that may present a conflict prior to installing those facilities. Contractor shall give sufficient time to Engineer to determine the extent, if any, of change that is necessary. No additional cost or time will be allowed for rework due to conflicts where the general location of utilities are shown or otherwise known to exist.

C. If an underground utility main or service lateral is damaged, the Contractor shall immediately notify the respective utility and repair the damaged utility main or service lateral in accordance with their requirements and at the Contractor’s own expense. If a minor conflict occurs with an existing underground storm sewer, telephone, cable TV, electrical, water or gas main or service lateral, the proposed facilities shall be adjusted, if possible, to avoid the conflict in accordance with the requirements of the respective utility and with Engineer approval. No extra compensation shall be given to Contractor for minor alignment adjustments.

D. Contractor shall protect all utility poles and/or street lighting in a manner approved by the Utility Company.

2.11 Incidental Construction

A. The Contractor shall remove and reset existing items found within the project limits as necessary for construction unless directly denoted as being permanently removed on the plans or within a specific Detailed Specification Section. All damaged items shall be replaced by the Contractor, at no additional cost to the Owner.

B. Items to be removed and reset may include, but not limited to: exist metal post and metal swing gate.

2.12 Dust and Mud Control

A. Contractor shall use measures and methods to minimize raising dust from construction operations. Contractor shall keep roads clean at the end of each working day.

2.13 Backfilling

A. If backfilling, fills and embankment cannot be completed with materials excavated as part of this project, suitable materials shall be obtained offsite. All borrow pit sites to be utilized by the Contractor shall be approved by the Engineer.

2.14 Testing

A. All equipment and materials incorporated into the work will be tested by the Contractor in accordance with the recommendations of the manufacturer in addition to those tests specified under this Contract. Certified results of all of these tests shall be provided to the Engineer.

2.15 Installation and Testing Instruction

A. Contractor shall provide with submittals two (2) copies of the installation and testing instructions as well as the operation and maintenance manuals of the manufacturer for all equipment and materials to be incorporated into the work.

2.16 Security

A. Contractor shall protect existing work premises. Contractor shall protect any new or Owner salvageable equipment from theft or vandalism. Any stolen or vandalized salvaged equipment, shall be replaced at the Contractor's expense.

2.17 Site Access and Staging

A. Contractor shall work with IDNR Crosley Fish & Wildlife Property Manager for suitable staging locations that are required beyond the Dam project site, including the existing parking lot area south of the dam.

2.18 As-Builts

A. Contractor shall maintain construction As-Builts throughout the project. Contractor shall provide coordinates and/or measurements of all new piping (elevation and location), top of concrete/precast wall, structures, existing pipe removal limit and location, wall elevations and locations, hard armor limits, grout injection depths and locations, grade work cross sections (min. 25 foot intervals) and all other critical work completed during construction. No separate payment shall be provided to the

Contractor for providing construction As-Builts. The cost shall be spread over the unit price work.

B. As-Built information shall be provided in the horizontal and vertical datum, as provided in the Contract Drawings.

C. Final as-builts and/or construction documents shall be submitted electronically, along with 24”x36” hard copy plan sets. Number of copies shall be per the Owner’s request, but shall not exceed three (3) final sets.

PART 3 – SUBMITTAL PROCEDURES

3.01 Work Included

A. The Contractor shall transmit each submittal, Project Name, Contractor, subcontractor and supplier; pertinent drawing and detail number and specification section number appropriate for each submittal item. Submittal shall bear Contractor’s stamp or specific written certification that Contractor has satisfied Contractor’s obligations under the Contract Documents with respect to Contractor’s review and that the Contractor approves the submittal.

B. Information to be submitted includes, product data, shop drawings, installation procedures, samples, testing reports, certificates, Manufacturer’s instructions, Manufacturer’s field reports, pre-construction video, etc.

C. Administrative submittals include, but are not limited to: Performance and Payment Bonds, Insurance Certificates, List of Subcontractors and Payment Application.

END OF SECTION

SECTION 01

MOBILIZATION, BOND, AND STARTUP

PART 1 – GENERAL

1.01 Scope

A. The Contractor shall furnish all material, labor and equipment to perform all work necessary to move onto the project site and start construction. Work shall include, but not limited to: purchase of required insurance and bonds, cost for pre-construction audio-video survey and the cost for all work items not specifically included under other work tasks, shall be included in this item. This work shall also include demobilizing all equipment and materials from the site after project completion and miscellaneous or incidental work task to close the project out.

PART 2 – INSURANCE AND BONDS

2.01 Required Insurance and Bonds

A. Required Insurance and Bonds shall be as set forth in the "Instructions to Bidders" and “Standard General Conditions of the Construction Contract”.

PART 3 – PRE-CONSTRUCTION AUDIO-VIDEO SURVEY

3.01 General

A. Prior to construction, the Contractor shall video record the construction area to document the condition of the area. The purpose is to establish conditions prior to construction.

B. The product shall be high quality audio digital compact disk (DVD). The video portion shall present bright, sharp, clear pictures with accurate colors. The picture shall be free from distortion, tearing, rolls, or other picture imperfection. The audio portion shall be proper volume, clarity and free of distortion. The audio commentary shall be precise and concise explanatory notes.

3.02 Camera

A. Where the area, to be videotaped, is accessible by conventional wheeled vehicles, the video camera shall have a horizontal resolution of 500 lines at center. For areas non-accessible by conventional vehicles, the color video camera shall have a horizontal resolution of at least 300 lines at center. The recordings shall be high quality color DVD. The Contractor shall provide the Owner with three (3) sets of DVD’s.

3.03 Audio

A. The audio part of the tape shall provide a precise and concise summary. An audio summary shall be provided at the beginning of each DVD and at intervals

of not more than 50 lineal feet. Audio summary shall include DVD number, job title, job location, positional location, date and time, weather and any other notable condition.

3.04 Coverage

A. The recordings shall include coverage of all surface features located along the routes, including service lines. The coverage shall include all existing cross streets, driveways, sidewalks, curbs, ditches, shrubbery or other structures located along the routes.

3.05 Recording Procedures

A. The rate of speed of the vehicle used for recording shall not exceed 48 feet per minute.

B. Recording shall only be done during periods of sufficient sunlight. No recording shall be done during periods of significant precipitation, mist, fog or snow.

C. The recording shall be completed prior to the start of construction and the placement of any construction materials or equipment on the proposed site. However, the audio-video survey shall not precede the start of construction by more than seven days.

3.06 Delivery

A. The DVD's shall be delivered to the Engineer prior to the start of construction. Any recordings not conforming to the specifications may be rejected with rerecording to be done at no additional cost to the Owner.

B. The DVD's shall be delivered in storage cases. Each DVD shall be properly labeled. An index shall describe the contents of each recording.

PART 4 – SUBMITTALS

4.01 Submit the following information within ten days of receipt of Notice to Proceed:

A. Preliminary project schedule

B. Designation of the work to be performed by the Contractor with his own forces

C. List of Subcontractors and the work to be performed by each

D. List of manufacturers and suppliers of equipment and products to be incorporated into the work

E. Name and contact phone number(s) of resident superintendent to be Contractor's representative on-site during all work with authority to act on behalf of Contractor.

F. Designation of location of disposal site for all project debris and excavated material and written authorization by the landowner for use of the property for disposal. If the location is anything other than a certified landfill, the submittal shall include a map (United States Geological Survey topographic map preferred) showing the location. This submittal must be received at least 10 days prior to the beginning of the disposal at said site.

G. Designation of the source of any fill material for the project and written authorization by the landowner for removal of fill from the property. If the source is anything other than a pre-existing borrow pit, the submittal shall include a map (United States Geological Survey topographic map preferred) showing the location. This submittal must be received at least 21 days prior to any excavation occurring at the fill material site.

H. Preliminary schedule of shop drawing and sample submittals, O&M submittals, and spare parts submittals.

I. Preliminary schedule of values.

J. List and schedule of proposed start-up and follow-up training.

K. Three copies of the Pre-Construction videos.

END OF SECTION 01

SECTION 02

ACCESS AND STAGING

1. GENERAL

1.01 Scope

A. The Contractor shall furnish all material, labor, equipment and services necessary to provide access and temporary staging area(s) for the project work as shown on the Plans, specified herein or as ordered by Engineer or Owner. Work shall include but not limited to: provide any related power, maintenance and furnishings, staging area or parking areas, (including excavation, placement and compaction of the subgrade and aggregate, backfill, miscellaneous grading and temporary drainage structures, whenever required), provide construction barricades, ongoing maintenance during construction to existing access drives, removal of all temporary facilities upon project completion and all other miscellaneous or incidental work required for complete installation.

B. All new roadways shall be constructed in accordance with these specifications and Section WM 22 of the Workmanship and Materials Specifications. All existing roadways shall be repaired or replaced in accordance with Section WM 4 of the Workmanship and Materials Specifications and these specifications.

C. All staging areas shall be re-graded and seeded to original or better conditions prior to demobilization in accordance with WM-4 Restoration of Surfaces. The Contractor may use (1) existing parking lot south of the dam, for staging and storage of equipment and materials. The Contractor shall barricade the lake access drive near the archery range to keep eliminate public access. The Contractor shall barricade equipment and materials from public access with temporary chain link fence and gate as needed.

1.02 Submittals

A. Submit aggregate gradation for any temporary compacted aggregate drive for temporary construction entrances.

B. Submit barricades and keys to Owner, Crosley Fish & Wildlife personnel and Engineer.

1.03 Related Specifications

Comply with applicable portions of the following WM Specifications:

A.	WM-2	Excavation
B.	WM-3	Backfill, Fills and Embankments
C.	WM-4	Restoration of Surfaces
D.	WM-22	Roadways and Parking Areas

2. PRODUCTS

2.01 General

A. Compacted Aggregate Surface and Base

Compacted aggregate surface and base for staging and other access drives and parking areas shall consist of providing no less than 8 inches of compacted aggregate base #53 crushed stone. Compacted Aggregate provided under riprap shall be in accordance with Section 904.03 of the latest INDOT SS. Gradation shall be in accordance with INDOT SS Section 904.03 (e) Sizes of Coarse Aggregates.

B. Barricades

Barricades shall be per INDOT Section 800, latest edition. Concrete barriers or chain link fence shall be installed as necessary to keep traffic from general construction limits.

3. EXECUTION

3.01 Installation

A. All compacted aggregate base shall be placed in accordance with Workmanship and Materials Specifications WM 22, Roadways and Parking Areas with the latest edition of the Standard Specifications and all supplemental specifications of the Indiana Department of Transportation.

B. Contractor may elect to expand the existing compacted crushed stone access parking lot and drive open areas, subject to approval of the Property Manager.

C. Install construction barricades as required to keep general public traffic restricted. Location of barricade shall be subject to Owner.

END OF SECTION 02

SECTION 03

EXISTING STRUCTURE REMOVAL AND SALVAGE

1. GENERAL

1.01 Scope

A. The Contractor shall furnish all material, labor, and equipment and do all work necessary to complete existing structure removal and salvage for the project as shown on the Plans, as specified herein and as ordered by the Engineer or Owner. Work shall include, but not limited to: excavation, cutting and removing pipe to specified limits, backfilling, coordination with Owner and Engineer, removal of concrete, hauling and disposal, salvage of existing gate system, storing gate, reset of gate and cable system, clean up and all other miscellaneous or incidental work for demolition, removal and salvage.

B. Primary applicable structures for removal include (but are not limited to): (1) existing principal spillway pipe and appurtenances and any other items as shown on the plans and as directed by the Engineer. Primary applicable structure for salvage (remove and reset) include: exist metal post and swing gate across the crest of the dam at the boat ramp. Contractor shall coordinate all items to be salvaged with Owner.

1.02 Continuation of Drainage

A. The Contractor shall take special care to keep upstream portions of the existing lake in service as re-construction of the principal spillway and related downstream sections are accepted for carrying flows. The existing drainage system shall not be out of service for any length of time than is absolutely necessary.

1.03 Submittals

1. A Demolition plan shall be provided and include procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress, a disconnection schedule of utility services, a detailed description of methods and equipment to be used for each operation and of the sequence of operations. Include statements affirming Contractor inspection of the existing structure and its suitability to perform or if inspection reveals a safety hazard to workers, state provisions for securing the safety of the workers throughout the performance of the work.

1.04 Related Specifications

Comply with applicable portions of the following WM Specifications:

A.	WM-2	Excavation
B.	WM-3	Backfill, Fills and Embankments
C.	WM-4	Restoration of Surfaces

2. WORKMANSHIP AND MATERIALS

2.01 Under this section, the Contractor shall be responsible for furnishing all materials, labor, tools and equipment necessary to complete the basic tasks of demolition, removal, salvage and renovation on the equipment, items, and/or structures specified herein.

A. Basic Tasks

1. Demolition

(a) Items to be demolished, where shown on the plans, shall be demolished to the limits expressed within these specifications. Demolition on any item shall be complete unless otherwise agreed to by the Owner.

(b) The Contractor shall be responsible so that demolitions take place in the safest possible environment. No demolition shall occur which would present a potential hazard to the existing dam and/or personnel safety. The Contractor shall be fully liable to the Owner complete restoration to the Owner for any damages that occur due to Contractor negligence of potential problems. Demolition procedures on any such item or associated item that is to be reused under this project shall be agreed upon by the Owner prior to the start of unit demolition.

(c) The Contractor shall be responsible for keeping an accurate record of all demolition performed, noting which items were removed from the site as fill material and which salvage items were stored at the designated site; the quantity, size and quality of the salvaged items and the Owner's indication that said items have been inspected.

(d) The Contractor shall perform demolition work as described herein and as indicated on the drawings. The items noted on the plans to be included in the demolition work shall be limited to the extent as shown on the plans, described elsewhere in these specifications, and as necessary to complete the intended construction, modifications, and installations.

2. Salvage

(a) It is the responsibility of the Contractor to store salvageable items on a site selected by the Owner. Salvageable items shall be as noted on the plans, as specified herein, or as directed by the Owner. Any items to be salvaged and re-used for project, shall be stored and protected by the Contractor until such items are re-

sued for the project. Such salvageable items damaged by Contractor, shall be replaced by Contractor as not cost to the Owner.

(b) The Contractor shall consider all items as salvageable and shall realize that all items belong to the Owner. Any items deemed not salvageable by the Owner shall be removed from the site and disposed of at the Contractor's expense.

3. Removal

(a) The Contractor shall be responsible for coordinating with the Owner which items shall be removed from location or from the site. The Contractor shall be responsible for transportation of removed items.

(b) Except for salvageable items, all items removed, including demolition drainage pipe, bituminous material, concrete or other debris that has no reuse value, shall be removed from the site and be disposed of in a proper manner.

(c) The Contractor shall remove unsalvageable debris and other unusable materials as described herein and as indicated on the drawings. The items noted on the plans to be included in the removal work shall be limited to the extent as shown on the plans, described elsewhere in these specifications, and as necessary to complete the intended construction, modifications, and installations.

3. REMOVAL AND DISPOSAL

3.01 The Contractor shall remove and dispose of all existing pipe, bituminous material, concrete and all other objectionable material from the project. Any broken concrete from removed concrete structures may be reused as foundation material under the new riprap outlet at the emergency spillway, but material shall be approved by Engineer and Owner prior to using.

3.02 All materials removed by the Contractor shall be disposed of in a lawful manner in complete accordance with all local, state and/or federal regulations. Any and all permits required for the hauling and disposal of these materials shall be obtained by the Contractor at his expense.

4. EXECUTION

4.01 Removal Items

A. Existing Facilities to Be Removed. Existing principal spillway pipe and appurtenances. There is indication that an existing 24" corrugated metal principal spillway pipe may be located through the embankment near the proposed emergency spillway. Contractor shall carefully expose the potential

grout plug area on the downstream embankment to verify pipe existence. Contractor shall inform Engineer and Owner of findings prior to proceeding with any work. If pipe is found, intentions would be to expose pipe at the removal limits, then provide a clean cut to eliminate fracturing the grout annulus or disrupting the pipe soil envelop for the remainder of the pipe to remain within the embankment. Contractor shall provide method to terminate such pipe removal limit. Contractor shall give Engineer and Owner time to review the interior of the existing pipe to ensure no voids are present or created which could cause unintended seepage. Engineer and Owner at this time may also make the determination to completely remove such pipe. Once Engineer and Owner review and make determinations, Contractor shall be instructed by Engineer and Owner to backfill the removed pipe with either compacted soils or filter drain materials.

B. Paving and Slabs. Provide neat sawcuts at limits of pavement removal as indicated.

C. Concrete. Saw concrete along straight lines to a depth of not less than 2 inches. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder.

D. Disposition of Material. Property of the Owner unless otherwise indicated.

E. Debris and Rubbish. Debris shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

F. Existing Work. Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The Contractor shall take necessary precautions to avoid damage to existing utilities and other items to remain in place, to be reused, or to remain the property of the Owner; any damaged items shall be repaired or replaced as approved by the Engineer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition or removal work. Repairs, reinforcement, or structural replacement must have Engineer approval.

G. Weather Protection. For portions of the Structure to remain, protect Structure from the weather at all times.

H. Trees within the project area which may be damaged during demolition, and which are indicated to be left in place, shall be protected by orange safety fence. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the work under this contract shall be replaced in kind or as approved by the Engineer.

I. Facilities. Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical utilities. Structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, shall remain standing without additional bracing, shoring, of lateral support until demolished, unless directed otherwise by the Engineer. The Contractor shall ensure that no elements determined to be unstable are left unsupported and shall be responsible for placing and securing bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

J. Protection of Personnel. During the demolition work the Contractor shall continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site. No area, section or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

K. Burning. The use of burning at the project site for the disposal of refuse and debris will not be permitted.

4.02 Salvaged Items

A. Salvaged Items. Contractor shall carefully remove existing metal post and swing gate off the dam. Any concrete shall be removed from the base of the post. Materials shall be safely stored by Contractor until the Contractor re-installs the facility. Contractor shall coordinate the exact location of the gate post and gate that shall be re-installed. For re-installation, metal post shall be set plumb and placed on 8" of compacted aggregate No. 53 (to allow for drainage). Concrete (min. 4000 psi), shall be installed a minimum of 8" beyond outside edge of each post. Contractor shall re-install gate and ensure operations of gate. Lubricate hinges as needed.

END OF SECTION 03

SECTION 04

CLEARING AND GRUBBING

1. GENERAL

1.01 Scope

A. The Contractor shall furnish all materials, labor, and equipment necessary to remove all large vegetation, brush and trees, for the project as shown on the Plans, as specified here-in and as ordered by the Engineer or Owner. Work shall include, but not limited to: tree removal, removing rootballs, backfilling rootballs, disposal or hauling, tree protection or complete work designated or encountered or as ordered by the Owner as needed to complete construction of the improvements. Refer to the plans and associated permits for clearing limits, tree removal details, and any tree clearing timelines.

B. Note: Tree cutting shall be prohibited from April 1st to September 30th for protection of bad habitats.

C. NOTE: OWNER HAS CUT ALL LARGE DIAMETER TREES WITHIN THE SPECIFIED CLEAR LIMITS. Contractor shall remove and dispose of all downed trees, brush, stumps and rootballs or chip material on-site. Wood chip material has been deemed acceptable for use for silt fence. Trees that were indicated on the plans as "Cut" was felled by the Owner; however, these stumps shall remain. Contractor shall be responsible for applying herbicide on those stumps, where trees are indicated as "Cut" on the plans.

1.02 Submittals

A. Submit a tree and brush removal plan to the Owner and include details on restoring the remaining areas.

1.03 Related Specifications

Comply with applicable portions of the following WM Specifications:

A. WM-2 Excavation
B. WM-3 Backfill, Fills and Embankments
C. WM-4 Restoration of Surfaces

2. EXECUTION

2.01 Protection

A. Trees, Shrubs, and Existing Facilities. Trees and vegetation, to be left standing, shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers (orange safety fence) or by such other means as the circumstances require.

B. Clearing. Prior to clearing, the Contractor shall have clearing limits marked. Contractor shall then meet and walk site with either property owner of such property or Owner and/or Owner's representative. At that time, such Owner's may discuss protection of trees to remain.

C. Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within the areas to be cleared. OWNER HAS CUT TREES, CONSIDERED THE FELLING WORK TASK. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation as may be indicated or directed to be left standing. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 1-1/2 inches or more in diameter and shall be trimmed of all branches the heights indicated or directed. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 1-1/2 inches in diameter shall be painted with an approved tree-wound paint. Apply herbicide in accordance with the manufacturer's label to the top surface of stumps.

D. Tree Removal. Where indicated or directed, trees and stumps that are designated as trees, shall be removed from areas outside those areas designated for clearing and grubbing. This work shall include the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING. Trees shall be disposed of as specified in paragraph WASTE MATERALS.

E. Tree Cutting. Where indicated or directed on the plans, shown as "Cut", Contractor shall cut tree at existing grade and leave the rootball, so not to disturb the soil. A suitable selective herbicide shall be applied to the stump to ensure growth does not redevelop. OWNER HAS CUT TREES, CONTRACTOR SHALL APPLY HERBICIDE ON STUMPS AND LEAVE THOSE ROOT BALLS IN PLACE.

F. Pruning. Trim trees designated to be left standing within the cleared areas of dead branches 1 1/2 inches or more in diameter; and trim branches to heights and in a manner as indicated. Neatly cut limbs and branches to be trimmed close to the bole of the tree or main branches. Paint cuts more than1 1/4 inches in diameter with an approved tree wound paint. Vertical clearance above trail, including two (2) ft. clear zone on either side shall be ten (10) feet.

G. Grubbing. Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas. Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of

the ground. All voids created by the removal of rootballs shall be appropriately filled with compacted clay or as approved by Engineer / Owner.

H. Waste Materials. Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations, shall be disposed of in the designated waste disposal area except when otherwise directed in writing. Such directive will state the conditions covering the disposal of such products and will also state the areas in which they may be placed. Burning will not be allowed. It has been deemed acceptable to entirely haul materials offsite or chip material to be utilized for silt fence (not check dams).

I. Protection of Waterways. Contractor shall maintain drainage to waterways. Trees necessary to be felled in waterways shall be immediately moved as to not interfere with channel flows and create erosion.

END OF SECTION 04

SECTION 05

LAKE DRAWDOWN AND SITE DEWATERING

1. GENERAL

1.01 Scope

A. The Contractor shall furnish all material, labor, and equipment necessary to dewater the project site and lower and maintain existing lake levels as shown on the Plans, as specified herein and as ordered by the Engineer or Owner. Work shall include, but not limited to: sequentially lowering and maintaining the existing lake level below the project work limits; dewater all excavations or foundations as required; dewater general excavations or swale construction areas; dewater shoreline construction areas; maintain storm discharges during the project; all other dewatering mechanisms to allow installation of new facilities; cleanup; and all other miscellaneous or incidental work required for complete installation for the lift of the project.

B. Surface and groundwater controls shall be accomplished in coordination with the required excavation and embankment construction. Surface and/or groundwater controls may necessitate the use of temporary diversion ditches, cofferdams and/or dewatering by the use of pumping. Methods for care of surface water and for controlling the surface and groundwater levels shall be subject to approval of the Engineer. Discharge water must filter through an approved erosion control measure prior to leaving the project site or entering another waterway, refer to Temporary Erosion and Sediment Control Specifications for details.

C. Once work on the dam is completed and accepted by the Owner, the Contractor shall allow the lake to refill using natural, upstream channel flows. Filling the lake should be accomplished at a gradual pace so as not to erode the upstream embankments or cause undue stresses to the dam. Contractor shall monitor the dam embankments, shorelines and other structures during this time period and report any concerns to the Engineer or Owner.

1.02 Continuation of Drainage

A. The Contractor shall take special care to maintain upstream drainage as construction of the new structures progress and until downstream work items are completed and accepted for carrying drainage.

1.03 Submittals

A. Submit an operations and phasing plan to maintain drainage during construction. This plan shall include provisions for handling high intensity storm events, including 100-year (1% annual occurrence) storm event flows (approximately 750 cfs).

1.04 Related Specifications

Comply with applicable portions of the following WM Specifications:

A.	WM-2	Excavation
B.	WM-3	Backfill, Fills and Embankments
C.	WM-4	Restoration of Surfaces

2. PRODUCT

2.01 General

Since this is a performance specification, all materials to be provided for this work shall be submitted to the Owner for review.

3. EXECUTION

Rapid draw down of the lake can result in a build-up of hydrostatic pressures in the upstream slope of the dam which can lead to slope failure. Lowering the lake water level slowly allows these pressures to dissipate gradually. Also, as the elevation of the lake is lowered, the volume of water per inch may also decrease resulting in a greater lowering rate. Contractor shall continuously monitor the lake levels and surrounding embankment conditions.

3.01 Lake Drawdown

A. Lake Drawdown:

1. The lake may be drawn down as follows:

(a) Drawdown of the lake shall be no more than six (6) inches per day to elevation **684.00** or (11.65 feet below normal pool), unless the Owner allows the Contractor to lower it further or at a faster rate (no guarantees). Contractor shall continuously monitor the upstream sideslopes for sloughing during the drawdown period.

(b) The Contractor shall continuously monitor and keep a daily field record of the drawdown, including rise and fall during rainfall events.

B. Should rainfalls bring lake levels back up, Contractor shall use extreme caution to again lower the lake. Contractor may request additional time, without compensation, for delays due to lake drawdown impacts.

C. The drawdown may be accomplished using a siphon sized accordingly for this project and in order to minimize flooding and sedimentation downstream.

D. The existing sideslopes of the dam shall be protected from possible erosion and sloughing to downstream areas. Erosion control silt fences shall also be placed below all areas that are disturbed during construction and that drain to waterways.

E. Install rock riprap check dams or sediment basins or filtering devices as required to control sediments from the project site to areas downstream of the lake.

3.02 General Site Dewatering

A. For general construction dewatering, for excavations, trench excavations, structure placement, etc., discharging of ground or surface water shall be filtered prior to leaving project site or entering another waterway.

B. Refer to Detailed Specification Temporary and Erosion and Sediment Control for additional sedimentation measures.

END OF SECTION 05

SECTION 06

EXCAVATION AND EMBANKMENT

1. GENERAL

1.01 Scope

A. The Contractor shall furnish all material, labor, equipment and do all work necessary for completing all excavations and embankments for the project as shown on the Plans, as specified herein or as ordered by Engineer or Owner. Work shall include but not limited to: construction staking, construction engineering, stripping top soil, stockpiling, hauling and disposal, removing debris and rubbish from fills, all rock excavation, rock removal, rock channel improvements and grading, subgrade preparations, placement, backfilling (includes structures), compacting, soil testing or foundation reviews by Contractor hired geotechnical engineer in State of Indiana, final grading, excess material placement and hauling, clean up and all other miscellaneous or incidental work required for complete installation for general site construction of raising the dam, spillway wall foundations, spillway channel subgrade preparations for channel armoring, excavations and soil backfill for structures and piping, embankment materials for raising dam and new grade, excavation or backfill for riprap or other erosion control devices, and rock removal and re-grading existing rock principal spillway.

B. **Excavation and Embankment associated with the emergency spillway shall be work associated with Alternate 2: Add Emergency Spillway Utilizing Hydroturf CS System and Alternate 3: Add Articulated Concrete Block Mats In-Lieu of Hydroturf CS System for Emergency Spillway. Base Bid work shall maintain positive drainage for the embankment two stage filter drains to the outlet channel and raising the dam to Elev. 702.00 across the crest of the dam where the emergency spillway would be located.**

C. Work shall also include for the treatment of existing principal spillway rock fissures, including, but not limited to: all materials, labor and equipment, for temporary bulkhead installation, preparation of surfaces (including cleaning and removal of loose rock and debris), installation of concrete and/or reinforcement, when required, and all other work necessary for filling rock fissures within the existing principal spillway channel. **Thin surface treatments shall be considered work with Alternate 5 Pressure Grouting.**

D. Contractor shall be responsible for providing geotechnical engineer (licensed in State of Indiana) to provide all necessary soil testing, reporting, for compaction of embankments, foundations and structure backfill.

E. Construction operations shall be carried out in such a manner and sequence that erosion and air and water pollution will be minimized and held within acceptable limits. It is important that material excavated from this project be contained.

F. The completed job shall present a workmanlike appearance and in reasonable conformance to the line, grades, and elevations shown on the drawings.

G. All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used.

H. No borrow work areas are expected. Project is expected to have a new waste of materials. Soil can be placed on the downstream embankment, near the toe of the dam, between Str. 104 and principal spillway wall. Benching and compaction of those soil will be required. Owner may elect to utilize excess material at archery range. Intent is to keep all materials on the property and not have to haul off-site.

1.02 Submittals

A. Contractor shall submit excavation and embankment details as required within the Plan of Operation (per Detailed Specification Section 00 General). This Plan of Operation shall be approved prior to starting work.

B. Submit soil proctors along with Unified Soil Classification System (USCS) soil material symbol and compaction test reports, as performed by a licensed geotechnical engineer (State of Indiana).

C. Soil compaction tests will be required for each 150 linear feet per lift of any embankment or subgrade constructed. The licensed geotechnical engineer or professional geologist making these tests shall provide written reports with these tests. Report shall include the approximate location (Station) and approximate elevation taken. The contractor may only reduce the number of tests required based on a written quality control plan and performance-based test results from the geotechnical engineer or professional geologist who will also provide recommendations for the frequency of tests needed.

D. For rock excavation, NO BLASTING will be allowed within this project. Within the plan of operations, Contractor must submit equipment type for excavating rock encountered. Rock Excavation is defined in Workmanship and Material Section 2.

E. Contractor shall submit construction as-builts. Cross sections of the dam shall be at no less than 25-foot intervals, including any intermediate points to accurately define the complete improvement. The as-builts shall include the top and bottom elevations of all critical structures (top and bottom of walls, inverts of structures or gates, etc.). This information shall be submitted to the Owner with a layout plan identifying the grid layout and tied to the original GPS coordinates for the project (vertical and horizontal). The cost of this work shall be spread within the respective pay item.

1.03 Related Specifications

Comply with applicable portions of the following WM Specifications:

A. WM-2 Excavation
B. WM-3 Backfill, Fills and Embankments
C. WM-4 Restoration of Surfaces
D. WM-22 Roadways and Parking Areas

1.04 Soil Borings

A. Soil borings have been included herein for this project. Read and study this information carefully and do not rely on scaling any soils boring logs or profiles that are provided for this project. The information given in these logs applies only to conditions encountered at the indicated locations and to the depths shown. The Contractor shall examine the site personally and make such additional investigations, as he/she may deem necessary for estimating costs, planning and execution of the work.

2. EXCAVATION AND EMBANKMENT FOR EARTHEN DAM AND SPILLWAY CONSTRUCTION – GENERAL PROVISIONS AND DEFINITIONS

2.01 Work covered under this subsection includes that for earthen dam, existing rock principal spillway reconstruction, new principal spillway overflow, new emergency spillway construction, structure and pipe excavation and backfilling, structure foundation preparations, general site work and all other work for complete installation. Work includes all site preparation, stripping topsoil, hauling handling (disposal of water, refer to Lake Drawdown and Dewatering for details), excavation and embankment for the earthen dam, reconstruction of the principal spillway and new emergency spillway. Work under this item also includes subsoil and topsoil stockpiling, draining, hauling, handling, (disposal of water from the excavations, refer to Lake Drawdown and Dewatering), foundation and earthen subgrade preparation for spillway structures (walls and articulated concrete blocks), backfilling; final grading; providing topsoil over final graded areas; and other operations as specified and required to complete the earthwork.

2.02 Prior to initiating construction of the site, erosion control measures shall be installed to minimize erosion and prevent sediment-laden water from exiting the site. This shall include, but not be limited to, the installations of temporary earthen berms, silt fences, filter curtains, riprap, rock check dams, drainage piping, catch basins, and other items that are needed to control sediment.

2.03 Contractor shall refer to Clearing and Grubbing Detailed Specification. Clearing limits shall be marked and reviewed with Owner. All trees to remain, shall be protected.

2.04 Prior to excavation, topsoil, suitable for replacement, shall be stripped and placed in stockpiles for later usage. Excavated materials, that are not used immediately for embankment or backfill, shall be stockpiled until such time that they can be placed as required or as shown on the plans and in compliance with Section WM-3 of the Workmanship and Materials Specifications. Backfilling shall be done in a manner to avoid any undue structural loading on structures. Stockpiles shall be located away from waterways, out of high construction traffic areas to avoid interference with access to project areas and area of least interfere.

2.05 When rock is encountered, as described in WM-2 Excavation, Contractor shall remove rock to the required elevations as shown on the plans. This shall include removing excess rock to allow for any bedding materials for structures and piping, wall foundations, riprap placement and keyways and spillway channel relocation. Contractor must submit in writing and have Engineer approval for adjusting any structure or pipe elevations.

2.06 Lines and Grades. The embankment shall be constructed to the lines, grades and cross sections indicated unless otherwise directed. The Owner reserves the right to increase or decrease the foundation widths or the embankment slopes or make such other changes in the embankment sections as may be deemed necessary to produce a safe structure. Increases in height of section, made to compensate for shrinkage or consolidation of the embankment material subsequent to the completion of the embankment, will not exceed five (5) percent of the height above the foundation indicated. The end slopes and side slopes of partial fill sections shall not be steeper than one vertical on 3 horizontal and as those shown.

2.07 Conduct on the Work. The Contractor shall maintain and protect the embankment in a satisfactory condition at all times until final completion and acceptance of all work under the contract. If in the opinion of the Engineer the hauling equipment causes horizontal shears or slick sides, rutting, quaking, heaving, cracking or excessive deformation of the embankment, the Contractor shall limit the type, load or travel speed of the hauling equipment on the embankment. Any approved embankment material which is lost in transit or rendered unsuitable after being placed in the embankment and before final acceptance of the work, shall be replaced by the Contractor in a satisfactory manner and no additional payment will be made therefore. The Contractor shall excavate and remove from the embankment any material which the Engineer considers objectionable and shall also dispose of such material and refill the excavated area as directed, all at no cost to the Owner. The Contractor may be required to remove, at his own expense, any embankment material placed outside of prescribed slope lines.

2.08 Haul Roads. Haul roads shall be located and constructed as approved. They shall be designed to maintain the intended traffic, to be free draining and shall be maintained in good condition throughout the contract period, unless otherwise directed. Haul roads within the area of contact between the embankment and its foundation and abutments shall be removed and the area shall be treated as specified.

2.09 Stockpiles shall <u>NOT</u> be located immediately adjacent to the top of the principal spillway or lake drain headwall at any time. Nor should equipment be allowed to operate too closely to the open excavation or while the principal spillway walls or headwall structure is curing.

2.10 Stockpiling from Approved Borrow Sources. – Not Applicable, Contractor is expected to use on-site materials excavated from the principal spillway overflow, emergency spillway and other structure installations.

2.11 In the event of a surplus of excavated material that is not needed for backfilling, grading or filling, the Contractor shall discuss surplus material options, including approximate quantities. If Owner wishes to save any excess materials, Contractor shall stockpile materials away from critical structures at an agreed upon location. If Owner does not want any excess materials, surplus materials may be stored in two locations near the toe of the dam: 1. approximate Station 12+00 to 12+50 (120 feet right), between Str. 104 Reinforced Concrete Headwall and Principal Spillway Wall to form a berm or constant grade and 2. Approximate Station 13+60 (120 feet right), south emergency spillway exit channel to form a small berm. Dependent upon amounts, Contractor may be required to distribute between two locations. Topsoil shall be placed over this material and subsequently graded and seeded.

2.12 Prior to final grading and seeding, all areas shall be covered with a minimum four (4) inches of compacted, clean top soil regardless of top soil thicknesses prior to construction. Topsoil shall be brought to the proper final grades and cleared of all stones, boulders, and debris. Note Well: All top soil shall be free of construction debris and related backfill stone or rocks.

2.13 Final grade work shall include placement of additional fill (surplus materials) additional swales for drainage if required, compaction, and other activities required to restore and prepare turf areas for all facets of the project. The Contractor shall furnish all labor and materials, equipment, tools, pumps, and other equipment necessary for all final grading.

2.14 Vegetation shall be established on all disturbed areas such as channel slopes, berms, spoil, placement and other areas except when bank materials or land use conditions are such that vegetation is impractical and authorized by the Owner. Disturbed areas are to be final graded and seeded as soon as possible after exposure. Gullied and uneven areas will be smoothed before attempting to prepare seedbed. Upon finish grading of work area, the Contractor shall permanently seed and stabilize all final grade areas.

2.15 **Definitions**. The term "embankment" as used in these specifications is defined as the earth fill portions of the dam structure and includes all types of earth fill and filter materials for the dam and cut-off or core trench, and all other specified or directed earth fills within the limits of the dam, excepting those stone and filter materials used for slope protection, which are described in other Sections. "Compacted fill" includes all fill, except backfill, deposited in layers and compacted by rolling or tamping. The types of compacted earth fill are:

A. "Impervious fill" for the cut-off trench, horizontal and inclined impervious blankets, and impervious section of the embankment;

B. "Random fill" adjacent to the impervious section and blankets;

C. "Pervious fill" forming the upstream and downstream sections of the embankment, and

D. "Uncompacted fill" includes all fill, deposited in layers but not compacted except by the controlled movement of hauling and spreading equipment.

"Backfill," as used in these specifications, is defined as that excavation refill which cannot be placed around or adjacent to a structure until the structure is completed or until a specified time interval has elapsed after completion. "Spalls" are stone fragments placed as transition between rock fill and earth fill. "Rock Fill" consists of those portions of the embankment where rock is used for purposes other than slope protection.

3. PRODUCTS

3.01 Embankment Materials

A. General. The origin of any fill material in no way determines where it may be used in the embankment. Materials for embankment fills shall be secured from required excavations (principal spillway overflow, emergency spillway and other structures). The intention is to use the most suitable materials obtained from these sources. Material to be wasted will be specifically designated at the time the material is excavated. Materials containing brush, roots, sod or other perishable materials will not be considered suitable for embankment or backfill. The suitability of the materials shall be subject to approval and their disposition in the embankment will be as directed.

B. Impervious Fill. Material for compacted impervious fill shall consist of clays, silty clays, or clayey silts obtained from the project site. Silts and clays containing sand may be used, if such materials are sufficiently impermeable and suitable for compacting with a tamping or rubber-tired roller.

An alternative may be submitted to the Owner/Engineer for review based on recommendations of the Contractor’s hired geotechnical engineer.

C. Random Fill. Material for compacted random fill shall consist of any or all types of material which, from the standpoint of compacted stability, are suitable for use in the dam embankment.

D. Pervious Fill. Material for compacted pervious fill shall be clean, free draining sand or sand and gravel obtained from natural deposits within borrow areas and from designated excavations or from sources designated. Particles of material shall be free from any objectionable coating and not more than 5 percent of the material, by weight, shall pass a Standard No. 200 sieve.

E. Uncompacted Fill. Except as otherwise required, material for uncompacted fill may consist of any or all types of material available from required excavations and designated borrow areas.

F. Backfill. Backfill shall consist of material of a type and quality conforming to that specified for the contiguous embankment fills materials, unless otherwise directed.

G. Rock mixtures. Rock mixtures shall not be permitted within the dam embankment.

3.02 Exist Rock Fissure & Dental Concrete Mix

A. Concrete mix for filling the existing rock fissure within the existing principal spillway shall be per the requirements of the Detailed Specification Reinforced Concrete Structures section. Concrete Mix shall be lean Class D (exterior), 4500 psi per WM 5.2 Cast-In-Place Concrete.

4. EXECUTION

4.01 Preparation of Foundation, Partial Fill Surfaces, Abutments and Subsequent Fill Lifts

A. **Earth**. After excavation or stripping of the embankment foundation, embankment side slope, abutment, or groin area, to the extent indicated or otherwise required, any depression, stump holes, test pits or other similar cavity, shall be broken down, and filled with either random or impervious material dependent upon the type of material which is to be placed immediately above the foundation. Loosened soils, which may turn up debris, including roots or large rocks shall be removed prior to compacting or fill building or preparation of foundation for spillway armoring materials. All soft or loose material, materials containing cracks or gullies, and all material that does not conform with the specified zoning of the embankment shall be removed. Prior to placement of new compacted fill (or subgrade materials for spillway armoring materials) in any section of the surfaces of the embankment benching, abutments, groin areas, or the existing foundation, the existing underlying soils shall be loosened thoroughly by scarifying, plowing, disking or harrowing to a minimum depth of 6 inches, and the moisture content shall be adjusted to the amount specified in paragraph MOISTURE CONTROL for the appropriate type of material, except in areas where this requirement is waived by the Engineer. Intent is to provide bond between the new fill and existing soil material. The existing soil materials shall be compacted per applicable provisions of COMPACTION paragraph. All existing subgrade (cut soils) for spillway armoring materials, shall be compacted and approved prior to proceeding with associated armoring device installations (per those applicable Detailed Specification Sections). New fill shall be placed in layers, moistened, and compacted in accordance with the applicable provisions of paragraphs PLACEMENT, MOISTURE CONTROL, and COMPACTION. Materials which cannot be compacted by roller equipment because of inadequate clearances shall be spread in 6-inch layers and compacted with power tampers to an extent equal to that of the contiguous embankment fill material. Upon approved lift installation, subsequent fill materials shall be placed. When required, existing underlying fill materials may require the scarifying, plowing, disking or harrowing as noted above to bond subsequent lifts. Benches shall be excavated into slopes (generally 10 feet horizontally into the existing slope) to create a stepped benched condition and vertical step shall not typically exceed four (4) feet unless otherwise approved by Contractor's hired geotechnical engineer.

B. **Rock**. All rock surfaces upon which or against which embankment materials are to be placed or foundations shall be constructed, shall be cleaned in accordance with the applicable provisions. Prior to the placement of embankment or foundation or concrete material upon or against a rock surface, all open joints and cracks in that surface shall be filled with dental concrete to the depths cleaned. Those portions of such rock surfaces where, in the opinion of the Engineer, the compaction of the embankment materials cannot be accomplished satisfactorily with power tampers or other specified compaction equipment shall be filled with dental concrete as directed to the extent necessary to permit satisfactory use of the compaction equipment. In no case shall a thin coat of dental concrete be left on smooth, intact rock surfaces. Large rock overhangs and protrusions shall be removed by the use of pre-splitting or line drilling techniques in such a manner as to minimize damage to the underlying rock, or the spaces beneath overhangs and around protrusions shall be filled with tamped concrete so that satisfactory compaction of embankment materials can be accomplished. Vertical surfaces shall not be more than five (5) feet in height, and benches of sufficient width shall be provided as necessary so that the average slope of any rock face is not steeper than 1 vertical on 1 ½ horizontal. Dental concrete, including forming as necessary, shall conform with the applicable specifications.

4.02 Placement

A. General. No fill shall be placed on any part of the embankment foundation until such areas have been inspected and approved. Lifts shall generally be horizontally built up, with enough slope to provide drainage only. The gradation and distribution of materials throughout the compacted earth fill section of the dam shall be such that the embankment will be free from lenses, pockets, streaks, and layers of material differing substantially in texture or gradation from surrounding material of the same class. Successive loads of material shall be dumped at locations on the fill as directed or approved. No fill shall be placed upon a frozen surface, nor shall snow, ice, or frozen earth be incorporated in the embankment.

B. Frozen Material. Embankment shall not be placed on a foundation which contains frozen material, or which has been subjected to freeze-thaw action. This prohibition encompasses all foundation types, including the natural ground, all prepared subgrades, whether in an excavation or on an embankment, and all layers of previously placed and compacted earth fill which become the foundations for successive layers of earthfill. All material that freezes or has been subjected to freeze-thaw action during the construction work, or during periods of temporary shutdowns, such as, but not limited to, nights, holidays, weekends, or winter shutdowns or earthwork operations, shall be removed to a depth that is acceptable to the Engineer and replaced with new material. Alternatively, the material shall be thawed, dried, reworked, and recompacted to the specified criteria before additional material is placed. The Engineer will determine when placement of fill shall cease due to cold weather. The Contracting officer may elect to use average daily air temperatures, and/or physical observation of the soils for his determination. Dam embankment material shall not contain frozen clumps of soil, snow, or ice.

C. Impervious Fill:. In general dam embankment installation, the more impervious materials shall be placed towards the center of the impervious section and the less impervious materials toward the pervious sections so that a transition in permeability is effected from the core to the pervious sections.

D. Random Fill. Random fill shall be placed in the random sections of the embankment. Except as specified below, limits of random sections shown indicate the maximum extent of random material. When approved, pervious material may be substituted for random material in areas where random sections adjoin pervious sections. In general, the more impervious of the random material shall be placed toward the impervious section or blanket and the more pervious of the random material shall be towards the outer edge of the random section so that a transition in permeability is effected from the impervious section to the pervious section, outer portions of the embankment. Where random materials are shown, in the upper portion of the central core, the more impervious of available random materials shall be placed to the full core lines and no substitution with pervious material shall be made.

E. Pervious Fill. Pervious fill shall be placed in the pervious sections of the embankment. In general, the pervious sections of embankment shall be placed with the less pervious material near the impervious sections of the embankment and the more pervious materials near the outer slopes of the embankment.

F. Spreading. After dumping, the materials shall be spread by bulldozers or other approved means in approximately horizontal layers over the entire fill areas. Unless otherwise directed, the thickness of these layers, before compaction with tamping type rollers, shall not be more than 6 inches for impervious materials nor more than 6 inches for other embankment materials, except backfill, which shall be spread in accordance with paragraph BACKFILL. Unless otherwise directed, the thickness of layers before compaction with rubber-tired rollers shall not be more than 6 inches for impervious materials, nor more than 6 inches for other embankment materials except backfill. Pervious fill and filters, including spalls, shall be spread in layers not more than 6 inches in thickness. Shale or shale and soft rock mixtures (where allowed to be installed), thickness prior to compaction shall not exceed 6 inches maximum loose lifts and maximum rock size cannot exceed the thickness of the lift. As soon as practicable after commencement of construction of any section of the embankment, the central portion thereof shall be raised or crowned with grades not to exceed 2 percent so that the surface of the fill will drain freely and shall be so maintained throughout construction. If the compacted surface of any layer of material, exclusive of filter material, is determined to be too smooth to bond properly with the succeeding layers, it shall be loosened by harrowing, or by any other approved method, before the succeeding layer is placed. At all times during the dumping and spreading processes, the Contractor shall maintain a force of men adequate to remove all roots and debris from all embankment materials and all stones of greater than ¼ inches in maximum dimension from impervious materials and greater than ½ inches in maximum dimension from pervious materials, except filters. Stone, when

allowed, shall be placed in the outer slopes of the fill or removed as required by Engineer or Owner. Roots and debris shall be removed from the embankment and disposed of in an approved manner. The entire surface of any section of the embankment under construction shall be maintained in such condition that construction equipment can travel on any part of any one section. Ruts in the surface of any layer shall be removed by scarifying before placing and compacting additional material.

G. Moisture Control. The materials in each layer of the fill shall contain the amount of moisture, within the limits, specified below or as directed, necessary to obtain the specified compaction. Material that is not within the specified limits after compaction shall be reworked, regardless of density.

H. Impervious Sections. The moisture content after compaction shall be as uniform as practicable throughout any one layer of impervious materials. The moisture content after compaction shall be within the limits of 2 percentage points above optimum and 2 percentage points below optimum moisture content. Material that is too wet shall be spread on the embankment and permitted to dry, assisted by disking or harrowing, if necessary, until the moisture content is reduced to an amount within the specified limits. When the material is too dry, the Contractor will be required to sprinkle each layer on the fill. Harrowing or other approved methods will be required to work the moisture into the material until a uniform distribution of moisture is obtained. Water applied on a layer of fill shall be accurately controlled in amount so that free water will not appear on the surface during or subsequent to rolling. Should too much water be added to any part of the embankment, so that the material is too wet to obtain the desired compaction, the rolling on that section of the embankment shall be delayed until the moisture content of the material is reduced to an amount within the specified limits. If it is impracticable to obtain the specified moisture content by wetting or drying the material on the fill, the Contractor may be required to pre-wet or dry back the material at the sources of excavation. If, in the opinion of the Engineer, the top or contact surfaces of the partial fill section become too dry to permit suitable bond between these surfaces and the additional fill to be placed thereon, the Contractor shall loosen the dried materials by scarifying or discing to such depths as may be directed; he shall dampen the loosened material to an acceptable moisture content; and he shall compact this layer in accordance with the applicable requirements of paragraph COMPACTION, subparagraph IMPERVIOUS FILL, to densities comparable to the underlying embankment.

I. Random Sections. The upper and lower limits of moisture content, and the moisture control procedures for random materials shall be the same as that specified for impervious material, or pervious material, dependent upon which of these types it most nearly resembles.

J. Pervious Section. The moisture content after compaction shall be as uniform as practicable throughout any one layer of pervious materials. The moisture content after compaction shall be within the limits of 2 percentage points above optimum and 2 percentage points below optimum moisture content. The Pervious material shall be wetted by sprinkling after spreading on the

embankment and the moisture content of each layer shall be maintained at the optimum for compaction during rolling. Pre-wetting of pervious material at the sources of excavation or borrow will not be required. Sprinkling shall be done with hoses connected to header pipes along the faces of the embankment, by water trucks with pressure spray bars, or by any other approved method. All connections in the water supply system, including the hose connections to the header pipes, shall be watertight. Jets shall not be directed at the embankment with such force that the finer materials will be washed out. The capacities of pumps and sizes of header pipes shall be sufficient to supply the required amount of water at all times.

4.03 Compaction

A. Equipment. Compaction equipment shall conform to the following requirements and shall be used as prescribed in subsequent paragraphs.

B. Tamping Rollers

1. Towed - Tamping rollers shall consist of two or more non-vibratory roller drums mounted side-by-side in a suitable frame and towed by either a crawler-type or rubber tired tractor having sufficient power to pull the roller satisfactorily when the drums are fully ballasted. Each drum shall be free to pivot about an axis parallel to the direction of travel. Rollers operated in tandem sets shall be controlled in a manner such that the prints produced by the tamping feet of the tandem units are staggered. Each drum of a roller shall have an outside diameter of not less than 5 feet and shall be not less than 5 feet in length. The space between two adjacent drums, when on a level surface, shall not be less than 12 inches nor more than 15 inches. At least one tamping foot shall be provided for each 2 square feet of drum surface. The length of each tamping foot from the outside surface of the drum shall be not more than 11 inches and shall be maintained at not less than 9 inches. The bearing surface of each tamping foot shall be flat with a surface area not less than 7 square inches nor more than 10 square inches. During the operation of rolling, the spaces between the tamping feet shall be maintained clear of materials which would impair the effectiveness of the tampering rollers. The weight of a roller when fully loaded shall be not less than 4,000 pounds per foot of drum length, and the weight of a roller empty shall be not more than 2,500 pounds per foot of drum length. The bearing surface, tamping foot size, the drum loading, and the operation of the rollers shall be as required to obtain the desired compaction. If more than one roller is used on any one layer of fill, all rollers so used shall be of the same type and essentially of the same dimensions. Rollers shall be drawn by crawler-type or rubber-tired tractors at a speed not to exceed 5.0 mph. The use of rubber-tired towing equipment shall be discontinued if the tires leave ruts that prevent uniform compaction by the tamping roller, and the substitution of crawler-type towing equipment may be directed.

2. Self-propelled - The use of self-propelled non-vibratory tamping rollers conforming with the following specification will be permitted, and their design and operation shall be subject to approval, and subject to the right, at any time during the prosecution of the work, to direct such modifications to the tamping feet or variations in roller drum weight where applicable, as may be found necessary to secure optimum compaction of the earth fill materials. If use of self-propelled tamping rollers causes shearing of the fill, laminations in the fill, or results in inadequate compaction, the Engineer may direct that such rollers be removed from the fill and that appropriate towed tamping rollers be used. Two-or three-drum side-by-side units that are either in drive position or drawn by separate power equipment shall have a clearance between adjacent drums not less than 12 inches nor more than 15 inches. Two-drum or four-drum equipment separated by cab and differential and arranged in tandem must have its static weight equally distributed to all compaction drums and must have the tandem drums positioned such that the prints of the tamping feet produced by the tandem drums are staggered. The surface on which the tamping feet are mounted shall have a minimum outside diameter of 4 feet and at least one tamping foot for each 2 square feet of drum surface. The distance between the centers of any two adjacent tamping feet shall be not less than 9 inches. The length of each tamping foot from the outside mounting surface of the drum shall be not more than 11 inches and shall be maintained at not less than 9 inches. The bearing surface of each tamping foot shall be flat and have a surface area not less than 7 square inches nor more than 14 square inches. Cupped recesses within the bearing surface of each tamping foot will be permitted but shall not exceed 0.5 inches in depth. During rolling operations, the spaces between the tamping feet shall be maintained clear of materials which would impair the effectiveness of the tamping roller. The weight of all roller drums during compaction of fill materials shall be maintained uniform and with the weight per foot of drum length not less than 4,300 pounds.

   For self-propelled rollers in which steering is accomplished through the use of rubber-tired wheels, the tire pressure shall not exceed 40 psi. The use of the compactor shall be discontinued if the tires leave ruts that prevent uniform compaction by the tamping roller and the substitution of appropriate towed tamping rollers may be directed. When a self-propelled roller is provided with a dozer blade, coverages made with the blade in operation shall not be counted as compaction coverages. Self-propelled rollers shall be operated at a speed not to exceed 5.0 mph.

C. Vibratory Rollers. Vibratory rollers for compacting rock fills, pervious sand and gravel fills, or filter and transition drainage layers shall be equipped with a smooth steel compaction drum and shall be operated at a frequency of vibration during compaction operations between 1100 and 1500 vpm. Vibratory rollers may be either towed or self-propelled and shall have an unsprung drum weight that is a minimum of 60 percent of the rollers' static weight. Towed rollers shall have at least 90 percent of their weight transmitted to the ground through the compaction drum when the roller is standing in a level position hitched to the towing vehicle. Rollers for compacting sand and

gravel fills or filter and drainage layers shall have a minimum static weight of 8,000 pounds, a minimum dynamic force of 16,000 pounds when operating at 1400 vpm, and an applied force not less than 5,000 pounds nor greater than 9,000 pounds per foot of compaction drum length. For shale or shale and soft rock mixtures, the minimum total compactive effort for the vibratory tamping-foot roller shall be 27.5 tons. Total compactive effort is defined as that portion of the static weight acting upon the unsprung compaction drum added to the centrifugal force provided by the drum. If the manufacturer's charts do not list the static weight acting on the compaction drum, the roller shall be satisfactorily weighed, the weight shall be added to the centrifugal force, and the roller rated in accordance with the Construction Industry Manufacturer's Association, CIMA. Each tamping-foot on the vibratory tamping-foot roller shall project from the drum a minimum of 6 inches. The surface area of the end of each foot shall be no less than 5 ½ square inches. The level of amplitude and vibration frequency during compaction will be maintained uniform throughout the embankment zone within which it is operating. Rollers shall be operated at speeds not to exceed 1.5 mph. The equipment manufacturer shall furnish sufficient data, drawings, and computation for verification of the above specifications, and the character and efficiency of this equipment shall be subject to approval.

D. Rubber-tired Rollers. Rubber-tired rollers shall have a minimum of four wheels equipped with pneumatic tires. The tires shall be of such size and ply as can be maintained at tire pressures between 80 and 100 psi for a 25,000 pound wheel load during rolling operations. The roller wheels shall be located abreast and be so designed that each wheel will carry approximately equal load in traversing uneven ground. The spacing of the wheels will be such that the distance between the nearest edges of adjacent tires will be greater than 50 percent of the tire width of a single tire at the operating pressure for a 25,000 pound wheel load. The roller shall be provided with a body suitable for ballast loading such that the load per wheel may be varied, from 18,000 to 25,000 pounds. The roller shall be towed at speeds not to exceed 5 mph. The character and efficiency of this equipment shall be subject to approval.

E. Power Tampers. Compaction of material, in areas where it is impracticable to use a roller or tractor, as provided herein, shall be performed by the use of approved power tampers. This work may be within confines of pipe trenches, behind walls of structures or around structures themselves.

F. Impervious, Pervious and Random Fill. After a layer of impervious or random fill material has been dumped and spread, it shall be harrowed if required, to break up and blend the fill materials, unless harrowing, as specified herein, is performed to obtain uniform moisture distribution. Harrowing shall be performed with a heavy disc plow, or other approved harrow, to the full depth of the layer. If one pass of the harrow does not accomplish the breaking up and blending of the materials, additional passes of the harrow may be required, but in no case will more than three passes of the harrow on any one layer be required for this purpose. When the moisture content and the condition of the layer is satisfactory, the lift shall be compacted to at least 100 percent of maximum density as determined by ASTM D 698, prior to placement of the

next layer. Determination of in-place density shall be in accordance with ASTM D 1556, ASTM D 2167, and ASTM D 2922.by not less than 3 complete coverages of the tampering roller 3 complete coverages of the rubber-tired roller. A complete coverage shall consist of the coverage of the entire lift to be compacted with the roller specified. A complete coverage shall consist of the application of compactive effort to the entire lift to be compacted with a single roller drum having the characteristics as specified in paragraph SELF-PROPELLED. The use of four-drum self-propelled equipment that is laterally separated by operator's cab and differential may be used; however, two complete coverages of the lift to be compacted will be achieved by a subsequent offset trip of the roller for coverage of the previously uncompacted central portion of the roller path. Portions of the fill which are not accessible to the roller shall be placed in 6 inch layers loose measurement and compacted with power tampers to a degree equal to that obtained on the other portions of the compacted fill by rolling as specified. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously.

G. Pervious Fill. After each layer of pervious material has been dumped and spread, and the moisture content is in accordance with the specifications, the entire surface of the layer shall be compacted to an average of 95 percent minimum relative density by not less than 3 complete coverages of the vibratory roller.

H. Additional Rolling for Compaction. If, in the opinion of the Engineer, the desired compaction of any portion of the embankment is not secured by the minimum number of coverages specified, additional complete coverages shall be made over the surface area of such designated portion until the desired compaction has been obtained.

I. Filter and Transition Drainage Layers. The requirements for compacted pervious fills will apply to these materials except for bedding layers under dumped riprap. Bedding layers under dumped riprap will require no special compaction other than controlled movement of dumping and spreading equipment.

J. Uncompacted Fill. Material from required excavations and from the designated borrow areas shall be placed in the berms upstream and downstream from the dam embankment, as indicated or otherwise required. The fill shall be dumped and spread in horizontal layers not to exceed 6 inches in thickness. Compaction other than that obtained by the controlled movement of the hauling and spreading equipment over the area will not be required.

K. SLIDES. In the event of slides in any part of the embankment prior to final acceptance of the work the Contractor shall remove material from the slide area, as directed, and shall rebuild such portion of the embankment.

4.04 Principal Spillway Rock Procedures for Treatments, Excavation, Preparation and Removal

A. The principal spillway walls will be founded within or at or near bedrock or rock outcroppings. Prior to placing fill against rock, rock walls will be required to be "squared up" to facilitate concrete placement or placement of backfill. Earth fill shall meet compaction requirements for cohesive soils against rock surfaces. Refer to section 4.01 B, Preparation of Foundation, Partial Fill Surfaces, Abutments and Groin Areas for further instruction. Dental concrete, provided in this section may be required prior to placing such soil materials against rock.

B. Within the existing principal spillway, existing rock work details have generally been identified on the plans. Work details noted below:

1. Relocate or Remove From Channel: Displaced solid rock slabs shall be removed as shown on the drawings, specified here-in or as required by Engineer or Owner. Displaced rock slabs may be relocated within the existing principal spillway channel or at the emergency spillway. Within the existing principal spillway, rocks may be allowed to be neatly stacked, with Engineer or Owner approval, without being broken down. However, there is no guarantee. Rocks may be broken to Class II riprap size, for utilization in select locations of the principal spillway channel (per plan) or emergency spillway, with Engineer or Owner approval. This work would not preclude Contractor from installing grout, filter fabric or keyway.

2. Break Projecting Rock to Exist Grade: Rock, projecting into the channel from existing natural embankment, shall be broken off at existing grade (without disrupting surrounding existing grade). The broken rock shall be removed or relocated from channel as noted above.

3. Existing Channel – Install V-Swale to re-direct low flows: Contractor shall mechanically chip layered stone to from a small 6" depth swale to re-direct low flows to the center of the swale (and away from new principal spillway wall). Contractor shall not break large layered fragments or sheets off. Contractor shall provide specific equipment to complete such work to minimize unnecessary rock removal or damage to existing rock.

4. Rock Preparation for thin surface cracks, fissures or channels:

   Note: Thin surface crack treatment is only required for **Pressure Grouting Alternate 5 Work as identified under Detailed Specification Section 13**, and only if grout operations yield the necessity to plug seepage.

   1. After excavation of the overburden has been completed, the rock surfaces shall be thoroughly cleaned and dewatered. All loose rock, ledges, and overhangs exposed during preparation of the rock surfaces shall be removed or squared up. Dental excavation shall consist of the removal of all soil and soft or loose rock from cracks, fissures, holes, and solution channels exposed during excavation activities. The extent of the dental excavation shall be as shown on the drawings with onsite adjustments as determined by the Owner or

Engineer.

b. Rock surfaces shall be cleaned by air-water cutting, water jetting, wire brush scrubbing, or other suitable methods determined necessary to obtain an acceptable surface to ensure bonding of surface material. No surface treatment material shall be applied until rock surfaces have been inspected and approved.

c. Rock surfaces shall be free of standing or running water during the placement of surface treatment material. Surface shall be kept moist before treatment. Lake shall be drawdown to lowest elevation as allowed under Lake Drawdown and Dewater Detailed Specification for Principal Spillway Rock Treatment Item F. Fissure.

d. Material placed in cracks, fissures, channels shall be consolidated by vibration, spading, tamping as necessary to completely fill the void.

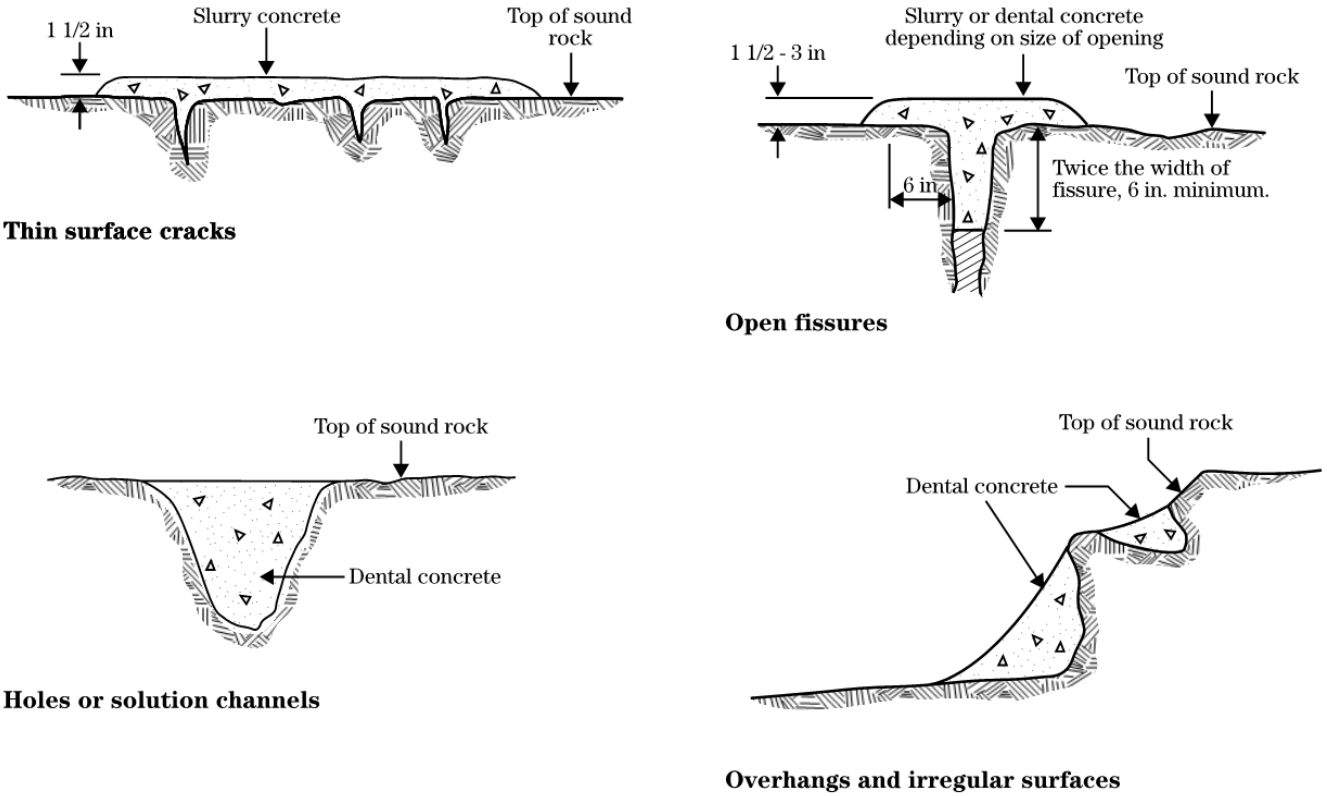
e. The surface treatment shall remain in a moist condition for 7-day curing period. Curing compound may be used as an alternative to maintaining continuous moisture.

f. Surface treatment material shall not be placed when the daily minimum temperature is less than 40 degrees Fahrenheit unless facilities are provided to ensure that the temperature of the material is maintained at a minimum temperature of 50 degrees Fahrenheit and not greater than 90 degrees Fahrenheit during placement and the curing period. Concrete treatment material shall not be placed on a frozen surface. When freezing conditions prevail, rock surfaces to be treated must be covered and heated to within a range of 50 to 90 degrees Fahrenheit for a minimum period of 24 hours before placing concrete treatment material.

g. For Principal Spillway Rock Treatment Item E – Fissure/Channel, care shall be taken not to displace Rock #1 to remain in place. Furthermore, this fissure/channel shall be filled with dental concrete (flush with existing rock grade), during the concrete placement for the access drive and foundation pour to form a continuous concrete pour. The Fissure/channel shall have two No. 4 bars installed the length of the fissure/channel and tied into the access drive pour. Rock #1, shall be locked in place with excess concrete on the south side, at the access drive, to form a smooth and stable transition.

h. For Principal Spillway Rock Treatment Item F – Fissure, Contractor thoroughly clean the fissure, including base of all loose materials. Rock shall be squared up as required. Contractor shall install bulkhead at the downstream side of the fissure, to form a concrete wall, even with the surrounding rock interface. Contractor shall provide a continuous pour of concrete, installation by tremie pipe method. The top of the new concrete, within the fissure, shall be three (3) inches lower than the existing surrounding rock. of the

fissure, shall be within three inches of the top of the existing surrounding rock.



Typical Rock Treatment
(From Part 642 of National Engineering Handbook, from Figure 63-1)

C. Rock; Excavation and Preparation for Principal Spillway Walls, All other Structures/Piping and Riprap:

1. After excavation of the overburden has been completed, the rock surfaces shall be exposed. Contractor shall use suitable mechanical equipment to remove rock to the limits specified. Contractor shall not break large layered fragments or sheets off. Contractor shall provide specific equipment to complete such work to minimize unnecessary rock removal or damage to existing rock to remain. All loose rock, ledges, and overhangs exposed during preparation of the rock surfaces shall be removed or squared up. Exposed large voids in existing rock may require to be filled with dental concrete prior to pouring foundations or pads. All riprap shall be keyed and anchored along channel toe of slopes, including within existing rock surfaces.

2. Rock surfaces, to be poured against, shall be cleaned by air-water cutting, water jetting, wire brush scrubbing, or other suitable methods determined necessary to obtain an acceptable surface to ensure bonding

of surface material. No surface treatment material shall be applied until rock surfaces have been inspected and approved.

3. Rock surfaces shall be free of standing or running water during the placement of surface treatment material. Surface shall be kept moist before placement of new concrete.

4.05 Backfill

A. General. Backfill work for piping structures or behind concrete shall generally follow the provisions noted above. Type of fill, where specifically noted on the plans, shall consist of acceptable materials required here in or as specifically indicated on the plans.

B. Concrete Structure Backfill: No backfill or other load shall be placed on or against concrete surfaces before expiration of the minimum period after placing the concrete as indicated in the specifications or structural drawings.

1. Walls and Vertical Faces 28 days
2. Headwall 28 days

C. Subsequent to 7 days but prior to 28 days after pouring the principal spillway walls or lake drain headwall, backfill operations may be initiated but no rolling or hauling equipment will be permitted within 10 feet of any part of the walls. During this period, backfill may be placed against the exterior walls, if compaction is accomplished by power tampers as specified in paragraph POWER TAMPERS. Before passage of hauling and rolling equipment over the top of the conduit or other structure will be permitted, the depth of fill over the concrete shall be sufficient to permit such passage without inducing harmful stresses or vibrations in the structure.

D. Placement. Backfill shall be placed in 6 inch layers and thoroughly compacted. Unless otherwise directed, the placing and compacting of all backfill material and the control of its moisture content shall conform to the applicable provisions. Fill in back of wingwalls shall be kept at approximately the same elevations of the backfill, gravel blankets, or riprap on the opposite side of the wall until placement has reached the maximum elevation of the materials to be placed on the toe of the wall. Drainage openings (weep holes, if provided) through walls shall be kept open at all times.

END OF SECTION 06

SECTION 07

TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 – GENERAL INFORMATION

1.01 DESCRIPTION

A. The Contractor shall furnish all material, labor and equipment and do all work necessary to complete and provide temporary erosion and sediment control barrier for the lift of the project, as shown on the plans, as specified herein and as ordered by the Engineer or Owner. Work shall include, but not limited to: project site and/or all disturbed areas; to provide all erosion and sediment control barriers prior to commencing construction; ongoing maintenance; temporary seeding; temporary restroom facilities; hauling and disposal of materials; concrete washout areas; rock check dams; rolled erosion control products for steep embankments; silt fence; weekly or incident reports as required; installation of any additional erosion and sediment control measures as necessary to eliminate sediment transport; compliance with the Contract Documents and all other Federal, State, and Local requirements or permits; clean up and removal of erosion control items at project completion; and all other miscellaneous or incidental work necessary. Work shall also include the installation of temporary erosion control blankets and temporary turf reinforcements mats prior to final seeding.

B. All work shall comply with the requirements set forth in 327 IAC 15-1 and 327 IAC-15-5.

1.02 PRODUCT HANDLING

A. Store and protect miscellaneous erosion control items at the Project site as required by the manufacturer.

1.03 SUBMITTALS AND PROJECT NOTIFICATION

A. Submit shop drawings on temporary seed mixtures, silt fence, temporary erosion control blankets and permanent turf reinforcement mats, temporary in-channel pump around plan and details and all other material specifications normally provided from the manufacturer. Provide performance data and manufacturer's installation details as required.

B. **Contractor shall submit weekly stormwater pollution prevention inspection reports and event inspection reports as required within 24 hours of every ½" rain event.**

C. Contractor shall contact all appropriate regulatory agencies, per Erosion Control Permit requirements, typically 48 hours prior to the commencement of any work.

1.04 RELATED SPECIFICATIONS

A. All work shall comply with the requirements set forth in Rule 327 IAC-15-1 and 327 IAC-15-5 and any and all subsequent additions and revisions.

1. PRODUCTS

2.01 General

A. All products shall generally be in accordance with the INDOTSS. Silt fence, silt fence filters and rock check dams shall be provided in lieu of straw bales. Wood chips (utilized from on-site tree disposal, refer to Detail Specification Section 4 Clearing and Grubbing for additional details) may be utilized for silt fence. Shop drawings shall be submitted for all items covered in this specification.

B. Temporary Erosion Control Blankets shall be Tensar International Corporation's North American Green SC150BN, 18 month or approved equivalent (contains coconut fiber matrix). Design permissible shear stress shall be minimum of 2.10 lbs/ft^2 and design permissible velocity shall be a minimum 8.00 ft/s for unvegetated conditions.

C. Permanent Turf Reinforcement Mats shall be Tensar International Corporation's North American Green P300, Design permissible shear stress shall be minimum of 3.0 lbs/ft^2 and design permissible velocity shall be a minimum 9.0 ft/s, both for unvegetated conditions.

D. Dewatering bag shall be either single-usage or reusable. Bag shall be constructed of a non-woven geotextile, non-biodegradable material able to handle varying flow rates. Material shall be 8 oz/per square yard and have the following material properties: tensile strength of 205 lbs. and elongation of 50% per ASTM D 4632, trapezoidal teat of 85 lbs per ASTM D 4533, CBR Puncture strength of 535 lbs. per ASTM D 6241, apparent opening size (AOS) of 80 sieve per ASTM D 4751, permittivity of 1.35 sec-1 per ASTM D 4491 and UV resistance of 70% per 500 hours per ASM D 4533.

E. Rolled erosion control products (fiber wattle) shall consist of a minimum 8-inch diameter with a minimum 5 lbs per cubic ft. non-woven coir fiber with a polypropylene net exterior, D2 Land & Water Resource, North American Green or approved equivalent for downstream embankment protection as shown on the plans.

2. EXECUTION

3.01 Installation and Maintenance

A. Prior to any land disturbing activities taking place, the erosion and sediment control plan shall be implemented. The Contractor shall review existing site conditions and install appropriate storm water pollution prevention measures as detailed in this plan. This plan is to be used as a general guide with the intention of protecting water resources from potential pollutants from construction activities. This plan shall be allowed to change as field conditions

warrant or construction progresses. Contractor shall be responsible for the continual maintenance and providing project updates as necessary.

B. All materials provided under this Specification shall meet the requirements of the applicable sections of the Indiana Department of Transportation Standard Specifications (INDOTSS), latest edition. Certification of such compliance shall be provided with the cost for such testing the Contractor's responsibility.

C. All erosion and sediment control items shall be installed in strict conformance with the manufacturer's instructions. Said instructions shall be included with the shop drawings.

D. A stable construction entrance shall be provided where construction traffic will enter and exit the construction areas onto an existing roadway. The actual number and location for the construction entrance, shall be dependent upon construction phasing, techniques and accessibility.

E. Prior to construction or any lake drawdown work, erosion control measures shall be installed to control erosion and prevent sediment-laden water from exiting the site. This shall include, but not be limited to, the installations of rock check dams, temporary earthen berms, silt fences, filter curtains, riprap, drainage piping, catch basins, and other items that are needed to control sediment.

F. The facility shall be inspected no less than once per week and after every rainfall event and shall be maintained on a bi-monthly basis for erosion control measures during construction. Both temporary and final seeding is required. Should any areas outside of the basin remain inactive for a period of 15 days or more, they shall be seeded with a temporary vegetative cover such as oats, wheat or rye.

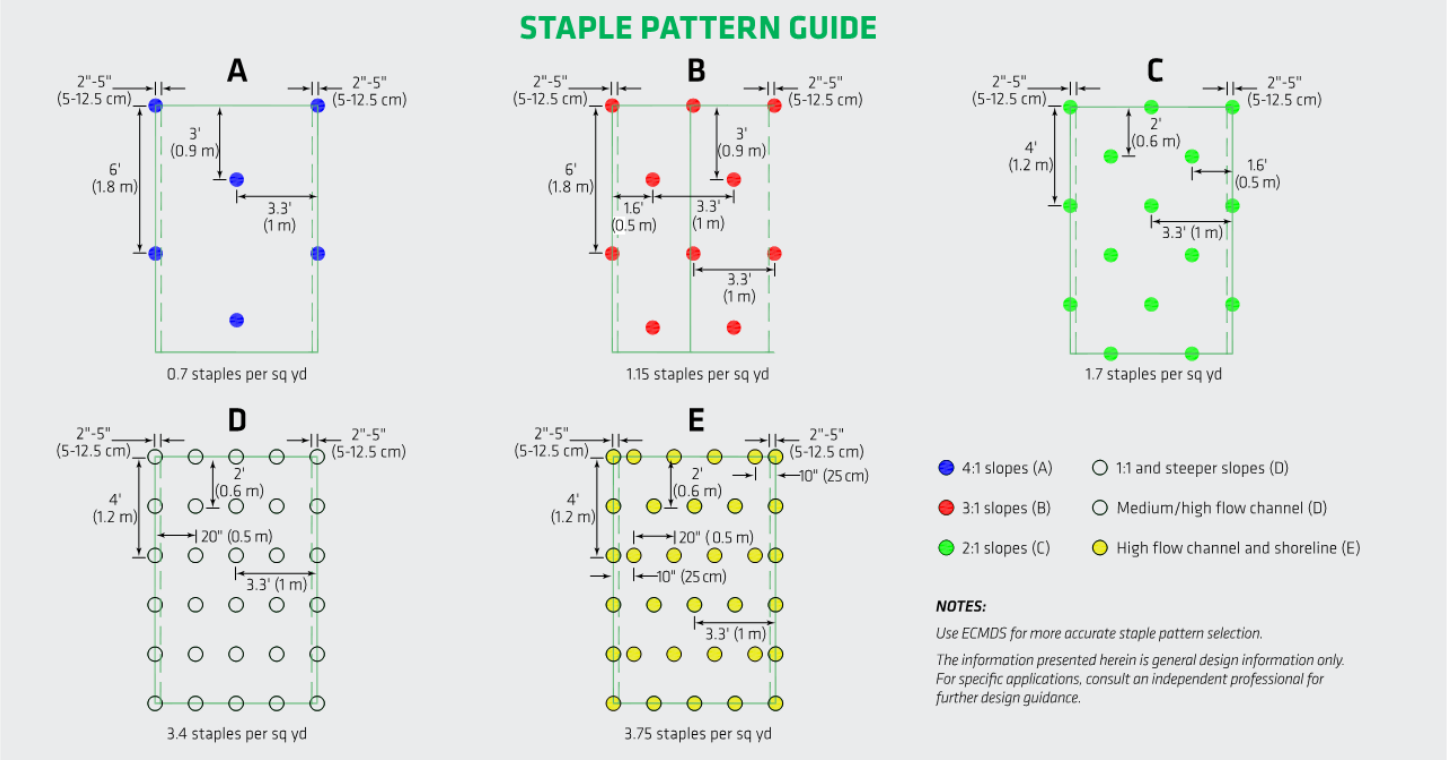
G. Silt fences shall be installed by the Contractor to retain sediment from disturbed areas. Fence shall approximately follow the contour of the land and be located at least ten (10) feet from toe of slope to provide broad, shallow sediment pool. Access to the area shall be provided for sediment clean-out. 2 x 2 in. hardwood posts (or steel fence posts) with a maximum of eight (8) foot spacing shall be used. Support wire (if needed) shall be 14 gauge, six (6) inch mesh wire fence. Fence fabric shall be either woven or non-woven, geotextile fabric with minimum 85% filtering efficiency. The fence fabric shall contain UV inhibitors and stabilizers to insure six (6) month minimum life at temperatures between 0º-120º F. The fence shall be installed per the manufacturer's recommendations to insure acceptable performance. When work is completed with an acceptable ground cover, the silt fence may be removed.

H. Rock check dams shall be used below construction activities above critical ditches, principal spillway channel and emergency spillway channel.

I. Temporary Erosion Control Blankets shall be installed where specifically shown on the plans and for disturbed embankments, between 4:1 to 2:1 in slope steepness. The blankets shall also be installed for all slopes steeper than 4:1.

Installation shall be per manufacturer's recommendation, which includes all mat anchoring, staple requirements (see Staple Pattern Guide) and patterns and mat overlaps. Install key trenches as recommended by manufacturer for embankments.

J. Permanent Turf Reinforcement Mats shall be installed where specifically shown on the plans, generally concentrated flow areas (ditches and channels) and soil embankments, 2:1 or steeper. Installation shall be per manufacturer's recommendation, which includes all mat anchoring, staple requirements (see Staple Pattern Guide and patterns and mat overlaps. Note, longer anchors may be required in soft soils. Hard soils may require heavy duty anchor pins or rebar to ensure minimum anchor depths are attained. For spillway and lake drawdown outlets, high flow staple pattern guide shall be utilized. Contractor shall install all permanent turf reinforcement mats with key trenches (for side embankments and all channel termination areas), as recommended by manufacturer.



Staple Pattern Guide
for Temproary Erosion Control Blankets and Permanent Turf Reinforcements Mats
From North American Green

K. If necessary, Temporary In-Channel Pump Around shall be utilized. Thiswork shall stay within the limits of the disturbance as shown on the plans and minimize disturbances within the work area whenever possible. Upon installation of all sediment control measures, Contractor shall begin work on the upstream cofferdam and work downstream. Sandbags or other approved non-erodible materials, shall be used for the cofferdam. Cofferdams shall be

installed at the upstream and downstream ends of the work area, with channel flow being bypass pumped around the work area. Pumps/generators, left overnight within neighborhoods, shall have noise attenuation devices. The pump intake, shall wither be "floated", installed within a casing or other approved filtering device to ensure sediment is not being pumped. The pump should discharge onto a stable velocity dissipater made of riprap or sandbags. Water pumped from the work area should be pumped to a sediment filtering measure such as a sediment filter bag, dewatering basin or other approved source. The measure should be located such that the water drains back into the channel below the downstream cofferdam. Traversing a channel reach with equipment in the work area where no work is proposed should be avoided. All channel restoration measures shall be installed as indicated by the plans and all banks graded in accordance with the grading plans and typical cross sections. After an area is completed and stabilized, the cofferdams shall be removed. If necessary, due to disturbance of the upstream cofferdam, the upstream cofferdam shall be removed to allow for a first flush, then reinstall a new cofferdam above the old upstream cofferdam to allow for restoration of the sump and cofferdam. The Temporary In-Channel Pump Around shall be installed on any tributary or channel or storm drain outfall that contributes baseflow within the work area. After construction, all disturbed areas shall be regraded and revegetated per the plans or within applicable Detailed Specification or as specified within the Temporary Erosion and Sediment Control specification or permit. Note, for temporary pump around installations that may last more than one day, Contractor may be required to temporarily remove cofferdams, prior to rain events, to allow channel to adequately convey the surface waters, to reduce flooding, eliminate property damage or increase site safety. Contractor is responsible for temporary pump around facilities for 24 hours, 7 days a week. If work is expected to take one day, work shall be conducted during low flow conditions, when rain is not forecasted.

L. Dewatering Filter Bags, where utilized or specified, shall be securely connected to the end of the discharge hose. Dewatering bags shall be installed per manufacturer's requirements. General instructions are provided here-in: Lay bad flat in designated area. Securely fasten bag to pump discharge hose, with the use of wire, clamps or another securing device. Contractor may place the bag on aggregate or straw bales to improve performance. Pump into the bad and monitor to ensure pump is working and filtering effectively at rates and levels the bag can handle. The bad will be filled when it stops filtering or no longer able to pass water at a reasonable rate. When dewatering process is complete or bag is full, remove the hose and allow bag to dry. Remove the bag and material in an upland area or per specific project requirements.

M. Where equipment has to traverse a stream/channel for access to another area, timber mats or similar measures should be used to minimize disturbances to the stream/channel. Temporary stream/channel crossings should be used only when necessary and only where noted on the plans or as specified. Crossing the stream or channel during rain events or high flow times shall be avoided.

N. The Contractor shall also prevent any wind-borne soil particles, which could create a health and/or visibility hazard from leaving the disposal sites. The

Contractor shall apply an approved dust preventative, as necessary, to avoid and eliminate a health and/or visibility hazard due to wind-borne soil particles. The dust preventative must be approved by the Owner prior to use.

O. Construction operations shall be carried out in such a manner and sequence that erosion and air and water pollution will be minimized and held within acceptable limits. It is important that material excavated from this project be contained.

P. Temporary seeding shall be applied immediately after grading (or after 15 days of soil work inactivity) at the following rates:

General Temporary Seeding Recommendations			
Seed Species *	**Rate/Acre**	**Planting Depth**	**Optimum Dates ****
Wheat or Rye Spring Oats Annual Ryegrass	150 lbs. 100 lbs. 40 lbs.	1 to 1-1/2 in. 1 in. 1/4 in.	9/15 to 10/30 3/1 to 4/15 3/1 to 5/1 8/1 to 9/1
German Millet Sudangrass	40 lbs. 35 lbs.	1 to 2 in. 1 to 2 in.	5/1 to 6/1 5/1 to 7/30

* Perennial species may be used as a temporary cover, especially if the area to be seeded will remain idle for more than a year.

** Seeding done outside the optimum dates increases the changes of seeding failure.

Temporary Seeding Areas for Embankment Dams

Temporary Vegetative Cover		
Early Spring to Mid Spring (2/15-6/15)	**Seed Species**	**Rates (Lbs. Per Acre)**
	Perennial Ryegrass	10
	Annual Ryegrass	5
	Weeping Lovegrass	2
Mid Spring to Mid Summer (6/15-8/15)		
	Sudangrass	10
	Pearl Millet	6
	Foxtail Millet	8
	Red Clover	4

Mid Summer to Early Fall (8/15-11/15)		
	Rye	45
	Winter Wheat	45
	Annual Ryegrass	4
	Perennial Ryegrass	5
	Crimson Clover	10

*For best results: (a) legume seed should be inoculated; (b) seeding mixtures containing legumes should preferably be spring seeded, although the grass may be fall seeded and the legume frost seeded; (c) and if legumes are fall seeded do so in early fall.

Q. The following Erosion Control Schedule shall be used for this project:

Erosion Control Schedule

Control Measure	Maintenance	Installation Sequence
Stone Entrance	• Inspect entrance pad and sediment disposal area weekly and after storm events or heavy use. • Reshape pad as needed for drainage and runoff control. • Top dress with clean stone as needed. • Immediately remove mud and sediment tracked or washed onto public roads by brushing or sweeping. Flushing should only be used if the water is conveyed into a sediment trap or basin. • Repair any broken road pavement immediately.	Prior to clearing and grading
Silt Fence	• Inspect the silt fence periodically and after each storm event. • If fence fabric tears, starts to decompose, or in any way becomes ineffective, replace the affected portion immediately. • Remove deposited sediment when it reaches half the height of the fence at its lowest point or is causing the fabric to bulge. • Take care to avoid undermining the fence during the clean out. • After the contributing drainage area has been stabilized, remove the fence and sediment deposits, bring the distributed area to grade, and stabilize.	Prior to clearing and grading

Control Measure	Maintenance	Installation Sequence
Existing Inlet / Drain Pipe Protection	• Inspect the structure after each storm event. • Remove accumulated sediment and make needed repairs immediately. • When the contributing drainage area has been stabilized, remove and properly dispose of all construction material and sediment and stabilize.	Prior to clearing and grading
Tree Protection	• Weekly, after storm events and as needed.	Prior to clearing and grading
Temporary Diversions	• Inspect weekly and following each storm event. • Remove sediment from the channel and reinforce the ridge as needed. • Check outlets and make necessary repairs immediately. • Remove sediment from traps when they are 50% full. • When the work area has been stabilized, remove the ridge, fill the channel to blend with the natural ground, remove temporary drains, and stabilize all disturbed slope areas.	Along with rough grading
Temporary Seeding	• Water as needed. • Inspect periodically after planting to see that vegetative stands are adequately established; re-seed if necessary. • Check for erosion damage after storm events and repair; re-seed and mulch if necessary. • Topdress fall seeded wheat or rye seedings with 50 lbs./acre of nitrogen in February or March if nitrogen deficiency is apparent.	After rough grading

Control Measure	Maintenance	Installation Sequence
Permanent Seeding	• Water as needed. • Inspect periodically, especially after storm events, until the stand is successfully established. (Characteristics of a successful stand include: vigorous dark green or bluish-green seedings; uniform density with nurse plants, legumes, and grasses well inter-mixed; green leaves; and the perennials remaining green throughout the summer, at least at the plant base.) • Plan to add fertilizer the following growing season according to soil test recommendations. • Repair damaged, bare, or sparse areas by filling any gullies, re-fertilizing, over- or re-seeding, and mulching. • If plant cover is sparse or patchy, review the plant materials chosen, soil fertility, moisture condition, and mulching; then repair the affected area either by over-seeding or by re-seeding and mulching after re-preparing the seedbed. • If vegetation fails to grow, consider soil testing to determine acidity or nutrient deficiency problems. • If additional fertilization is needed to get a satisfactory stand, do so according to soil test recommendations.	After finish grading
Erosion Control Matting	• During vegetative establishment, inspect after storm events for any erosion below the blanket. • If any area shows erosion, pull back that portion of the blanket covering it, add soil, re-seed the area, and re-lay and staple the blanket. • After vegetative establishment, check the treated area periodically.	After finish grading
Inlet Protection	• Inspect the structure after each storm event. • Remove accumulated sediment and make needed repairs immediately. • When the contributing drainage area has been stabilized, remove and properly dispose of all construction material and sediment and stabilize.	After each inlet is placed
Seed, Sod & Landscape Around Inlets Completed	• Water as needed. • Keep sod moist until fully rooted. • After it is well-rooted (2-3 wks.) mow to a height of 2-3 in. • Do not remove more than one-third of the shoot in any mowing. • Fertilize permanent fine turf areas annually – warm-season grass, cool-season grass in later winter and again in early fall.	After finish grading around finished inlets
Removal of Inlet Protection	• N/A	After all areas draining to these areas are stabilized

Control Measure	Maintenance	Installation Sequence
Removal of Silt Fence	• N/A	After all areas draining to these areas are stabilized
Riprap	• Inspect periodically for displaced rock material, slumping, and erosion at edges, especially downstream or downslope. (Properly designed and installed riprap usually requires very little maintenance if promptly repaired.)	After grading

3.02 Section B: Storm Water Pollution Prevention Plan – Construction Component

B.1 Description Of Potential Pollutant Sources

POTENTIAL POLLUTANT LIST: sediment from exposed soil, paints and coatings, fuel, diesel fuel, equipment lubricating oil, grease, concrete

1. The excavation and clearing activities may allow sediment to enter the storm water runoff. The construction activities include site grading, general excavation, trench excavation, underground pipe installation, aggregate backfilling, and precast concrete installation. Runoff from these activities is generally controlled by perimeter storm water quality controls and stabilization techniques.

2. Large machinery used for construction is a potential source of pollutants due to the possibility of leaking fuels, miscellaneous lubricating oils, grease, and antifreeze. The equipment is usually parked in a central location, and serviced at that location by a service truck each morning prior to start up. The machinery is greased and checked daily prior to use. Activities to minimize the likelihood of pollutant discharge include locating the central parking area away from storm water conveyances and inspecting equipment daily for leaks. Service trucks shall be equipped with spill containment kits in the event of an oil spill. Any spillage of fuel or maintenance oils shall be promptly cleaned up. If a fuel tank is located on site, appropriate secondary containment will be provided.

3. Other ancillary practices have the potential to impact storm water quality. The following measures shall be followed to minimize their impact.

(a) Temporary Restroom Facilities

Temporary restroom facilities shall be provided as required and shall be located to minimize the likelihood of a spill from exiting the site. These facilities shall not be located within 100 feet or directly up gradient from a storm sewer conveyance or additional controls may be necessary. Any spillage shall be promptly contained, cleaned-up and disposed of properly.

(b) Unused Building Materials

Unused building materials that may contribute pollutants to storm water shall be promptly disposed of or removed from the site.

(c) Garbage, Debris and General Solid Waste Maintenance

The Contractor shall maintain good housekeeping practices. All trash and debris shall be placed in appropriate leak-proof trash containers to prevent contamination of storm water. No debris shall be dispose of in the construction trench. Trash containers shall not be located on steep slopes or adjacent to any storm water conveyance.

(d) Sediment Clearing and Disposal

Sediment clearing involves the removal of sediment contained by a storm water quality measure, or sediment that has been discharged into roads or other areas. Bulk clearing of sediment shall **NOT** include flushing the area with water. Large amounts shall be shoveled or scraped, followed by sweeping and brushing. Any roads or other structures damaged by the clearing shall be repaired immediately. Cleared sediment shall be redistributed or disposed properly.

B.13 Material Handling And Spill Prevention Plan

1. List of Expected materials

- Pipe
- Pipe Fittings & Appurtenances
- Aggregate backfill
- Sand bedding
- Diesel fuel
- Lubricating oils
- Grease
- Steel
- Concrete (Cast-In-Place)
- Paint, Coatings

2. Pipe, Pipe Fittings & Appurtenances

Materials such as pipe, pipe fittings, and pre-cast concrete structures are not foreseen to contribute pollutants to storm water runoff.

3. Stockpiles (aggregate backfill, sand bedding)

Sediment could be released form stockpiles of stone, granular backfill, and sand. To minimize the potential for these materials to enter the storm water runoff, the following measures shall be taken:

(a) Stockpile volumes shall be limited to the amount expected to be used in three (3) days. Maintaining larger stockpiles is

discouraged and may require additional erosion controls for adequate protection.

(b) Stockpiles shall not be located on a slope steeper than 2:1 and shall be positioned a minimum of fifty (50) feet away from storm water conveyances.

(c) Silt fencing shall be placed down gradient of stockpiles as necessary to prevent sediment transport.

4. Fuel, Lubricating Oils, Grease

There is a potential for a release of fuel, lubricating oils, and grease from on-site machinery due to leaks and during routine maintenance activities. To minimize the potential for these materials to enter the storm water runoff, the following measures shall be taken:

(a) Routine equipment maintenance and fueling activities shall be conducted at locations that minimize the impact of a potential spill.

(b) Equipment shall be positioned within the serviceable area of nearby storm water quality controls and away from storm water conveyances during routine maintenance.

(c) Equipment shall be checked daily for leaks and repaired immediately.

(d) Spill control kits consisting of the appropriate oil sorbent socks, boom, and mats shall be provided at all fueling and maintenance areas.

(e) Any leakage or spilled oil shall be cleaned up immediately and properly disposed of in accordance with applicable laws.

(f) If a temporary oil or fuel storage tank is located on site, appropriate secondary containment shall be provided to prevent the off-site release of a spill.

5. Steel

Structural steel to be used on this project is not anticipated to contribute pollutants to storm water runoff.

6. Cast-in-Place Concrete

If there is excess concrete during placement, it can be discarded on-site, away from storm water conveyances and allowed to set-up. It shall be then disposed of or utilized elsewhere.

7. Paint, Coatings

There is a potential for a release of paint or other coatings due to leaks, or spills and during transfer. To minimize the potential for these materials to enter the storm water runoff, the following measures shall be taken:

(a) Containers and application equipment shall be positioned within the serviceable area of nearby storm water quality controls and away from storm water conveyances.

(b) Containers shall be checked daily for leaks and repaired immediately.

(c) Any leakage or spilled materials shall be cleaned up immediately and properly disposed of in accordance with applicable laws.

B.16 Construction Sign And Project Notification

1. A notice shall be posted at a publicly accessible location near the field office. The notice shall include:

   (a) A copy of the NOI letter and the NPDES number

   (b) Name, company name, telephone number, e-mail address (if applicable), and address of the project site owner.

   (c) Location of the construction plans

B.17 Project Notification

1. At least weekly and within 24 hours of every ½ inch rain event, the contractor shall inspect the site for stormwater pollution prevention deficiencies. An inspection report shall be filed with the Owner after every ½ inch rain event.

3.03 Section C: Storm Water Pollution Prevention Plan – Post Construction Component

C.1 Description Of Potential Pollutants and their Sources

POTENTIAL POLLUTANT LIST: sediment from exposed soil, paints and coatings, fuel, diesel fuel, equipment lubricating oil, grease, and concrete normally found along public facilities, farms and town streets.

1. The normal rainfall events should not allow any significant sediment or other constituents to enter the storm water runoff. Runoff from the town site is generally controlled by surface and subsurface drainage.

END OF SECTION 07

SECTION 08

RIPRAP

1. GENERAL

1.01 Scope

A. The Contractor shall furnish all material, labor, equipment and do all work necessary for installing riprap for the project as shown on the Plans, as specified herein or as ordered by Engineer or Owner. Work shall include but not limited to: layout, hauling and stockpiling materials, underlying separation materials (filter fabrics or compacted aggregate base No. 53 stone), placement to the lines and grades shown, clean-up and all other miscellaneous or incidental work for complete installation. Excavation, including rock removal, and subgrade preparation work is detailed under the Excavation and Embankment Detailed Specification.

B. For this project, Revetment, Class I and Class 2 riprap, grouted riprap shall be furnished and installed for the project.

C. Alternate 1: Revetment Riprap associated with Lake Drawdown Facility. Alternate 2 and 3: Class II Riprap associated with Emergency Spillway. Alternate 4: Class I Riprap on Upstream Dam embankment, below elevation 693.65. Base bid is Class I riprap from Elev. 700.50 to 693.65 on upstream embankment.

2. PRODUCT

2.01 Riprap

A. All riprap provided for this project shall be provided in accordance with Section 616 and 904.04, of the Indiana Department of Transportation Standard Specification, (i.e. latest edition) (INDOTSS). The material shall be coarse aggregate, Class F or higher. Gradation shall be in accordance with 904.04(f).

GRADATION REQUIREMENTS					
Percent Smaller					
Size, in. (mm)	Revetment	Class 1	Class 2	Uniform A	Uniform B
30 (750)			100		
24 (600)		100	85-100		
18 (450)	100	85-100	60-80		
12 (300)	90-100	35-50	20-40		
8 (200)				100	
6 (150)	20-40	10-30	0-20	35-80	95-100
3 (75)	0-10	0-10	0-10		35-80
1 (25)				0-20	0-20
Depth of Riprap, minimum	18 in. (450 mm)	24 in. (600 mm)	30 in. (750 mm)		

The maximum dimension of individual pieces shall not be greater than three times the minimum dimension. The riprap will be visually inspected for size, shape, and consistency.

Minimum riprap thickness shall be as specified here-in, per plan or table, whichever is greater.

2.02 Geotextile

A. Geotextile membranes shall be provided per the table below and installed under riprap where shown on the plans (except for specific identified underwater installation applications or where Compacted Aggregate No. 53 material is specified) in accordance with Section 918.02 of the INDOTSS.

B. The material used shall consist of a non-woven geotextile consisting of strong, rot resistant, chemically stable long-chain synthetic polymer material dimensionally stable with distinct and measurable openings. The plastic yarn or fibers used in the geotextile, shall consist of any long-chain synthetic polymer composed of at least 85% by weight of polyolefins, polyesters, or polyamides, and shall contain stabilizers and inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultraviolet and heat exposure. The geotextile shall be calendared or otherwise finished so that the yarns or fibers will retain their relative position with respect to each other. Silt film geotextiles will not be allowed unless approved.

GEOTEXTILE MATERIAL PROPERTIES

TEST	METHOD	REQUIREMENTS*
Tensile Strength	Grab Tensile Strength, ASTM D 4632	200 lb
Elongation	Grab Tensile Strength, ASTM D 4632	15%
Seam Strength	Grab Tensile Strength, ASTM D 4632	180 lb
Puncture Strength	ASTM D 4833	80 lb
Trapezoid Tear	ASTM C 4533	50 lb
Ultraviolet Degradation at 150 h	ASTM D 4355	70% strength retained
Apparent Opening Size, AOS	ASTM D 4751	AOS shall be No. 50 standard sieve or filter
Permeability**	ASTM D 4491 (Permittivity)	0.01 cm/sec or >

* Use value in weaker principal direction. All numerical values represent minimum average roll value and test results from any sampled roll in a lot shall meet or exceed the minimum values in the table. Lots shall be sampled according to ASTM D 4354.

** The nominal coefficient of permeability shall be determined by multiplying permittivity value by nominal thickness. The nominal thickness is measured under a normal load of 280 psi.

2.03 Compacted Aggregate Base No. 53

A. Compacted Aggregate provided under riprap shall be in accordance with Section 904.03 of the latest INDOT SS. Gradation shall be in accordance with INDOT SS Section 904.03 (e) Sizes of Coarse Aggregates.

2.04 Grout for Riprap

A. The grout shall be composed of one (1) part Portland cement to four (4) parts of No. 23 fine aggregate. Water is added during mixing until the grout attains a consistency that allows the material to flow into the interspaces.

3. EXECUTION

3.01 Installation

A. Contractor shall excavate to the grades required per the plan. Subgrade shall be smooth to ensure intimate contact is achieved between the filter fabric and soil. When placing underwater, Contractor shall ensure that the bed is free from logs, large rocks or other blocky materials. Geotextiles shall be installed and anchored as recommended by the manufacturer.

B. All riprap installed at the emergency spillway outfall channel shall be 42-inches or more thickness of Class 2 Riprap. Riprap along the upstream face of the dam shall be no less than 24 inches of Class I riprap. Riprap at the outfall of the lake drawdown headwall shall be no less than 24 inches of Class 1 riprap. Riprap for the lake drawdown intake anchor, shall be a minimum of 30 inches of revetment riprap. Riprap along principal spillway overflow top of slope and principal spillway wall shall be 24-inches or more of Class I Riprap. Riprap within the principal spillway, shall be 42-inches or more thickness of Class 2 Riprap. Where indicated within the principal spillway, riprap shall be grouted.

C. All riprap shall be mechanically placed to the depths required. Contractor shall ensure the geotextile filter fabric is not stretched, torn, punctured or repositioned during installation. Equipment shall minimize riprap drop height of the stone, generally less than one (1) foot. The finished surface shall be free from clusters of small stones or of large ones. The finished surface shall vary from a true plane no more than 12 in. for class 2 riprap but shall not be less than the minimum depth specified. Class I riprap shall be placed to produce a surface of approximate regularity with edges having projection no more than 3 in. above the required cross section. For the revetment riprap, Contractor shall ensure pad is level and stable for the installation of the intake anchor to reside on.

D. Riprap installed in or along existing rock surface. Riprap installed within principal spillway channel shall have a keyway installed, extending 1.5 times the specified minimum depth and extend a horizontal distance equal to the specified thickness.

E. Grouted Riprap Installation. Riprap shall be installed as required above. Grouted riprap shall generally be installed within the principal spillway channel where riprap will be keyed into rock. In general, after the aggregate has been placed and accepted, all interspaces are filled with a cement grout. Interspaces are the small spaces between the spalls and the larger aggregate. In general, all voids shall be filled with cement grout with the surface being moderately smooth, solid and true to line, grade and section.

F. Installation of Compacted Aggregate No. 53 under Riprap. Compacted Aggregate shall be installed in no less than 6” of total compacted thickness under riprap. Contractor shall minimize drop height to ensure 6” of compacted aggregate base no. 53 is not diminished.

G. Installation of Geotextile Under Riprap. Storage and handling of geotextiles shall be in accordance with the manufacturer’s recommendations, except that the geotextile shall not be exposed to direct sunlight, ultraviolet rays, water, temperature greater than 60° C (140° F), mud, dirt, dust, and debris, to the extent that its strength, toughness or permeability requirements are diminished. Each geotextile roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes. Exposure of geotextiles to the elements between lay down and cover shall be a maximum of 14 days. At the time of installation, the geotextile shall be rejected and replaced with no additional payment if defects, rips. Flaws, deterioration or

damage incurred during manufacture, transportation, storage or construction is evident.

H. The surface to receive the geotextile shall be prepared to a relatively smooth condition free of obstruction, depressions and debris within the limits indicated on the plans.

I. Geotextiles used along channels shall be placed with the machine direction of the geotextile parallel to the channel. Successive geotextile sheets shall be overlapped in such a manner that the upstream sheet is placed over the downstream sheet and the upslope sheet over downslope sheet.

J. Geotextiles used for 2:1 slopes or greater shall be placed with the machine direction of the geotextile sheets perpendicular to the toe of slope. The geotextile sheets shall be overlapped in the direction of the anticipated movement of the water.

K. Adjacent pieces of geotextile may be joined by sewing if approved, or by overlapping and pinning. The minimum overlap shall be 460 mm (18 in.) except when placed under water. When placed under water the overlap shall be a minimum of one meter (3 ft.). Securing pins shall be steel, 5 mm (3/16 in.) in diameter, 460 mm (18 in.) long, pointed at one end and fabricated with a head to retain a steel washer having an outside diameter of no less than 38 mm (1.5 in.). Securing pins with washers shall be inserted through both strips of overlapped geotextile at spacing intervals in Table 1 along a line through the midpoint of the overlap. The geotextile strip shall be placed so that the lower strip will be overlapped by the next higher strip. Pins shall be driven until the washer bears against the geotextile and secures it firmly to the ground.

L. Whether the fabric is joined by sewing or pinning, additional pins shall be installed as necessary to prevent any slippage of the fabric regardless of location.

TABLE 1

Slope	Pin Spacing
Steeper than 3:1	2 ft.
3:1 to 4:1	3 ft.
4:1 or flatter	5 ft.

M. The geotextile shall be placed in such a manner that placement of the overlying materials will not excessively stretch or tear the geotextile and will not pull the required overlap or seam apart. Construction equipment will not be allowed on the exposed geotextile. Placement of riprap or stone shall start from the base of the slope, moving upslope and from the center outward. Riprap shall not be allowed to roll downslope and the height drop for riprap shall be kept to less than 2 ft.

END OF SECTION 08

SECTION 09

ARTICULATED CONCRETE BLOCK MATS

1. GENERAL

1.01 Scope of Work

A. The Contractor shall furnish all material, labor, equipment and do all work necessary to complete the Articulated Concrete Block Mat installation for the Principal Spillway Overflow (Line 'P') as shown on the plans, specified herein and as ordered by the Engineer or Owner. Work shall include, but not limited to: layout; subgrade preparation; subgrade review and compaction testing by Contractor's hired geotechnical engineer; installation of filter fabric; stone; geogrid; block mats; all perimeter anchoring; all testing; Manufacturer's technical representative installation assistance; backfilling mats; cleanup and all other miscellaneous or incidental work for complete installation. Contractor shall provide smooth driving approach along dam embankment consisting of #73 compacted stone as necessary.

B. **Alternate 3: Add Articulated Concrete Block Mats In-Lieu of Hydroturf CS System; Line 'E' as shown on the plans, specified herein or as ordered by the Engineer or Owner. This alternate cost shall be total cost difference only (materials, labor and equipment), to install the articulated concrete blocks vs. HydroTurf. Work shall consist of Scope of Work Item A and additional percussion anchoring as shown on the plans. Note, this Alternative does include additional riprap, as the HydroTurf option material extends ten (10) feet beyond the toe of the dam, whereas the Articulated Concrete Block Mat terminates at the toe of the dam.**

1.02 Submittal

A. The Contractor shall submit to the Engineer all manufacturers' hydraulic testing and calculations in support of the proposed cellular concrete mat system and geotextile. Contractor shall submit granular material gradation (sieve analysis) when required for subgrade.

B. The Contractor shall furnish the manufacturer's certificates of compliance for cellular concrete blocks/mats, revetment cable, and any revetment cable fittings and connectors. The Contractor shall also furnish the manufacturer's specifications, literature, shop drawings for the layout of the mats, and any recommendations, if applicable, that are specifically related to the project.

C. Contractor shall submit a Final Report, from Manufacturer's technical representative, indicating Contractor installed material in conformance with Manufacturer's recommendations. This report shall be provided prior to Contractor receiving final payment. Refer to paragraph 6.01 for details.

2. PRODUCTS

2.01 General

A. All cellular concrete mats shall be prefabricated as an assembly of concrete blocks, with specific hydraulic capacities, laced with revetment cables. Cellular concrete mats may be assembled on-site by hand-placing the individual units either with or without subsequent insertion of cables.

B. Individual units in the system shall be staggered and interlocked for enhanced stability. The mats shall be constructed of open and/or closed cell units as shown on the contract drawings. The open cell units have two (2) vertical openings of rectangular cross section with sufficient wall thickness to resist breakage during shipping and installation. Parallel strands of cable shall extend through two (2) cable ducts in each block allowing for longitudinal binding of the units within a mat. Each row of units shall be laterally offset by one-half of a block width from the adjacent row so that any given block is cabled to four other blocks (two in the row above and two in the row below).

C. Each block shall incorporate interlocking surfaces that minimize lateral displacement of the blocks within the mats when they are lifted by the longitudinal revetment cables. The interlocking surfaces must not protrude beyond the perimeter of the blocks to such an extent that they reduce the flexibility or articulation capability of the cellular mats or become damaged or broken when the mats are lifted during shipment or placement. Once the mats are in place, the interlocking surfaces shall minimize the lateral displacement of the blocks even if the cables should become damaged or removed. The mats must be able to flex a minimum of 18° between any given row or column of blocks in the uplift direction and a minimum of 45° in the downward direction.

D. The cables inserted into the mats shall form lifting loops at one end of the mat with the corresponding cable ends spliced together to form a lifting loop at the other end of the mat. The Engineer shall approve appropriate sleeves for use in order to splice the lifting loop. The cables shall be inserted after sufficient time has been allowed for the concrete to complete the curing process.

1. Certification (Open-Channel Flow) – Product Data: Manufacturer's Data Sheets

   (a) Certification of successful completion of full-scale laboratory testing in accordance with the current version of ASTM D 7277, Standard Test Method for Performance Testing of Articulating Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open Channel Flow. This certification shall comprise a final test report from the testing facility, or a summary test report from the testing facility providing the test procedure and the obtained Critical Shear Stress parameters of the tested block. Third-party testimonies of compliance shall not be sufficient to satisfy this requirement.

(b) Certified analysis and interpretation of the test data shall conform to the guidance contained in the current version of ASTM D 7276, *Standard Guide for Analysis and Interpretation of Test Data for Articulating Concrete Block (ACB) Revetment Systems in Open Channel Flow*.

(c) The following information obtained from the above testing, analysis, and interpretation:
   a. Tested bed slope
   b. Maximum discharge attained prior to failure
   c. Measured water surface elevation
   d. Calculated energy grade line (EGL)
   e. Plot of the applied shear and velocity by station
   f. An illustration of the selected control volume on a profile of the test slope
   g. Calculated design Manning's n
   h. Calculated block system coefficient of Lift
   i. Characteristic block properties including weight and moment arms
   j. Extrapolation of tested values to thicker block (if required)

2. Performance (Open-Channel Flow) – Factor of Safety (FoS) Calculations in Support of the Proposed ACB System (By manufacturer)

(a) Design shall be in accordance with the Factor-of-Safety design methodology as described in *"Moment Stability Analysis Method for Determining Safety Factors for Articulated Concrete Blocks"*, by Amanda L. Cox, 2010.

(b) Stamped and signed by a Professional Engineer licensed to practice in the state where the project is located.

(c) The following project specific hydraulic requirements are to be utilized:

HYDRAULIC INFORMATION
EMERGENCY SPILLWAY

Velocity (ft/sec)	27.0
Shear Stress (lb/ft^2)	15.1
Friction or Bed Slope (ft/ft)	0.308
Side Slope (_H:1V)	3:1
Allowable Unit Protrusion (in)	0.0 FOR 0.5 INCH

HYDRAULIC INFORMATION
PRINCIPAL SPILLWAY OVERFLOW

Velocity (ft/sec)	26.0

Shear Stress (lb/ft^2)	14.0
Friction or Bed Slope (ft/ft)	0.286
Side Slope (_H:1V)	3:1
Allowable Unit Protrusion (in)	0.0 FOR 0.5 INCH

(d) The analysis shall be performed based upon the stability of the ACBs due to gravity alone, conservatively neglecting any stabilizing forces potentially provided by cabling, mechanical anchorage, contact with adjacent blocks, or other restraints not attributable to gravity alone.

(e) The analysis must account for a 0.5-inch block projection, in accordance with *ASTM D 6884, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems,* Section 6.3.3. Site grading requirements may not be used to omit this requirement for standard (non-tapered) block. For block that is tapered (i.e., the block thickness is greater on the downstream edge than on the upstream edge, by at least 0.5"), this block projection value may be 0 inches for analysis purposes.

2.02 Cellular Concrete Blocks

A. Scope

1. This specification covers concrete blocks for erosion control mats used in revetments, storm channels, etc. and for soil stabilization.

Note 1 - Concrete units covered by this specification are made from lightweight or normal weight aggregates, or both.

Note 2 - The values stated in U.S. customary units are to be regarded as the standard.

C. Materials

1. Cementitious Materials - Materials shall conform to the following applicable ASTM specifications and INDOT Approved aggregate source:

(a) Portland Cements - Specification C 150, for Portland Cement.

(b) Blended Cements - Specification C 595, for Blended Hydraulic Cements.

(c) Hydrated Lime Types - Specification C 207, for Hydrated Lime Types.

(d) Pozzolans - Specification C 618, for Fly Ash and Raw or Calcined Natural Pozzolans for use in Portland Cement Concrete.

2. Aggregates shall conform to the following ASTM specifications, except that grading requirements shall not necessarily apply:

   (a) Normal Weight - Specification C 33, for Concrete Aggregates.

D. Casting

1. The concrete units shall be produced by a dry cast method. The dry cast units obtain strength in a shorter duration as well as an increase in the durability and overall quality of product.

E. Physical Requirements

1. At the time of delivery to the work site, the units shall conform to the physical requirements prescribed in Table 1 below.

TABLE 1 - PHYSICAL REQUIREMENTS

Compressive Strength Net Area Min. psi (mPa)		Water Absorption Max., lb/ft^3 (kg/m^3)	
Avg. of 3 units	Individual Unit	Avg. of 3 units	Individual Unit
4,000 (27.6)	3,500 (24.1)	10 (160)	12 (192)

2. Durability. The manufacturer shall meet all requirements pertaining to a concrete unit's durability pertaining to freeze-thaw environment.

3. Sample and test units in accordance with ASTM D 6684-01, Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems.

4. For ACB system testing and analysis, current standards for ACB systems include ASTM D7276 & ASTM D7277 for testing and data interpretation. These design standards are intended to be coupled with ASTM D6684 and D6884 which speak to manufacturing and construction for all ACB systems. The ASTM design/analysis protocol shall be utilized.

E. Visual Inspection

1. All units shall be sound and free of defects that would interfere with the proper placing of the unit or impair the strength or permanence of the construction. Surface cracks incidental to the usual methods of manufacture, or surface chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.

2. Cracks exceeding 0.25 inches (.635 cm) in width and/or 1.0 inch (2.54 cm) in depth shall be deemed grounds for rejection.

3. Chipping resulting in a weight loss exceeding 10% of the average weight of the blocks shall be deemed grounds for rejection.

4. Blocks rejected prior to delivery from the point of manufacture shall be replaced at the manufacturer's expense. Blocks rejected at the job site shall be repaired with structural grout at the expense of the contractor.

2.03 Revetment Cable and Fittings

A. Galvanized Steel Revetment Cable and Fittings

1. Revetment cable shall be constructed of preformed galvanized aircraft cable. The cables shall be made from individual wires and strands that have been formed during the manufacture into the shape they have in finished cable.

2. Cable shall consist of a core construction comprised of six (6) or seven (7) wires wrapped within seven (7) or nineteen (19) wire strands. The revetment cable shall have the following physical properties:

Nominal Cable Diam	Approx. Avg. Strength		Lbs./100 ft (kg/m)			
	Lbs.	(kN)	Min. Lbs.	Min (kg)	Max Lbs.	Max (kg)
1/8"	1,700	(7.5)	2.8	(.04)	2.9	(.04)
3/16"	3,700	(16.4)	6.2	(.09)	6.5	(.10)
1/4"	6,100	(27.1)	10.6	(.16)	11.0	(.16)
3/8"	13,300	(59.2)	23.6	(.35)	24.3	(.36)

3. The revetment cable shall exhibit resistance to mild concentrations of acids, alkalis, and solvents. Fittings such as sleeves and stops shall be aluminum, and the washers shall be galvanized steel.

4. Selection of cable and fittings shall be made in a manner that insures a safe design factor for mats being lifted from both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Revetment cable splicing fittings shall be selected so that the resultant splice shall provide a minimum of 75% of the minimum rated cable strength.

2.04 Anchors

A. Where permanent anchoring is required, e.g. hanging mats on steep slopes without toe construction, the cables (polyester or steel) shall be attached to the anchoring system as indicated on the Contract Drawings.

B. Permanent anchoring, percussive driven earth anchor, is required on the Emergency Spillway. A minimum of four total rows shall be installed near the base of the spillway. Rows shall generally be installed across the bottom channel elevation of: 672, 673.5, 675 and 679. Each row shall have a minimum of 9 (nine) anchors equally spaced along the base of the channel and 2 anchors (per each side) of the channel side slope. Rows shall be staggered and offset. Anchors shall not be driven into undisturbed soil of the filter drain. Design life for anchors shall be 100 years. Anchors shall be installed at minimum of 3.5 feet in undisturbed soil. Maximum pull-out shall be 5,000 lbs.

2.05 Filter Fabric

A. The geotextile filter shall meet the minimum physical requirements listed in Table No. 3 of these Specifications. Consultation with the manufacturer is recommended. Fabric shall be Geotex ® Woven Filtration / Monofilament Geotextile type 104F as manufactured by Propex Geosynthetics or approved equivalent.

B. The geotextile must be permitted to function properly by allowing relief of hydrostatic pressure; therefore concrete shall not be allowed to clog the filter fabric.

C. The geotextile fiber shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic, if necessary, to make the filaments resistant to deterioration due to ultraviolet and heat exposure. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile.

D. The Contractor shall furnish the Engineer, in duplicate, manufacturer's certified test results showing actual test values obtained when the physical properties are tested for compliance with the specifications.

E. During all periods of shipment and storage, the filter fabric shall be protected from direct sunlight, ultraviolet rays and temperatures greater than 140 degrees Fahrenheit. To the extent possible, the fabric shall be maintained wrapped in its protective covering. The geotextile shall not be exposed to sunlight, ultraviolet rays until the installation process begins.

TABLE 3 – PHYSICAL REQUIREMENTS

Physical Property	Test Procedure	Minimum Value
Grab Tensile Strength (Unaged Geotextile MD x XD)	ASTM D4632	370 x 250 lbs.
Breaking Elongation (Unaged Geotextile MD x XD)	ASTM D4632	24 x 24
Burst Strength	ASTM D3786	480 psi
Puncture Strength	ASTM D4833	130 lbs.
Trapezoidal Tear (MD x XD)	ASTM D4533	100 x 70 lbs.
A.O.S., U.S. Std. Sieve	ASTM D4751	70 or 0.212 mm
% Open Area	CWO-22125-86	4%
Permittivity	ASTM D4491	0.28 sec^{-1}

MD = Machine Direction XD = Cross Direction

F. Final acceptance of the filtration geotextile by the Engineer shall be dependent upon the geotextile performance when tested in accordance with ASTM D5101, Standard Test Method for Measuring the Soil-Geotextile System Clogging by the Gradient Ratio test or the Hydraulic Conductivity Ratio test. Soil characteristics such as grain size analysis, and plasticity shall be determined for every 200,000 square feet of geotextile installed, or for each source of borrow material used during construction. Significant differences in soil characteristics shall require further performance testing by either the Gradient Ratio or the Hydraulic Conductivity Ratio tests at the discretion of the Engineer. The locations for which the material to be tested is extracted shall be approved by the Engineer. The Contractor shall provide the site-specific soil and modified proctor curves for the site-soil, at his own expense, to the manufacturer. The contractor shall be responsible for the performance of the test by a certified independent laboratory experienced in performing such test. The test shall be performed under the actual field soil conditions or as otherwise required by the Engineer.

G. At the time of installation, the filter fabric shall be rejected if it has been removed from its protective cover for over 72 hours or has defects, tears, punctures, flow deterioration, or damage incurred during manufacture, transportation or storage. With the acceptance of the Engineer, placing a filter fabric patch over the damaged area prior to placing the mats shall repair a torn

or punctured section of fabric. The patch shall be large enough to overlap a minimum of three (3) feet in all directions.

H. In the event pre-assembled panels of fabric are required, the panels of filter fabric shall be sewn together at the manufacturer or another approved location.

2.06 Size of Cellular Concrete Mats

A. General

1. The cellular concrete blocks, cables and fittings shall be fabricated at the manufacturer or another approved location into mats with a width of up to eight (8) feet and a length up to forty (40) feet, which is approved by the Engineer.

B. Mat Length

1. The cellular concrete mats shall have the ability for fabrication in various lengths, widths, and in combinations of length and/or widths. Special mats are a combination of two opposing dimensions either in the longitudinal or transverse direction of the mats. The special mats are available in various dimensions that allow for a custom fit to a site-specific project.

2.07 Coarse Aggregate

A. Coarse Aggregate provided under articulated concrete block mats shall be INDOT No. 5 and in accordance with Section 904.03 of the latest INDOT SS. Gradation shall be in accordance with INDOT SS Section 904.03 (e) Sizes of Coarse Aggregates.

Sieve Sizes	**Nominal Sizes and Percent Passing**
	No. 5
2 in. (50 mm)	
1-1/2 in. (37.5 mm)	100
1 in (25 mm)	85-98
3/4 in (19 mm)	60-85
1/2 in. (12.5 mm)	30-60
3/8 in. (9.5 mm)	15-45
No. 4 (4.75 mm)	0-15

Sieve Sizes	Nominal Sizes and Percent Passing
	No. 5
No. 8 (2.36 mm)	0-10
No. 16 (1.19 mm)	

2.08 Geogrid

A. Geogrid shall be integrally formed biaxial geogrid made from polypropylene. Geogrid shall transfer loads by positive mechanical interlock with the primary application of base reinforcement. Geogrid shall be Biaxial Geogrid BX 1100 by Tensar International Corporation or approved equivalent. Geogrid shall meet minimum specific properties:

Index Properties	Units	MD Values[1]	XMD Values[1]
▪ Aperture Dimensions[2]	mm (in)	25 (1.0)	33 (1.3)
▪ Minimum Rib Thickness[2]	mm (in)	0.76 (0.03)	0.76 (0.03)
▪ Tensile Strength @ 2% Strain[3]	kN/m (lb/ft)	4.1 (280)	6.6 (450)
▪ Tensile Strength @ 5% Strain[3]	kN/m (lb/ft)	8.5 (580)	13.4 (920)
▪ Ultimate Tensile Strength[3]	kN/m (lb/ft)	12.4 (850)	19.0 (1,300)
Structural Integrity			
▪ Junction Efficiency[4]	%	93	
▪ Flexural Stiffness[5]	mg-cm	250,000	
▪ Aperture Stability[6]	m-N/deg	0.32	
Durability			
▪ Resistance to Installation Damage[7]	%SC / %SW / %GP	95 / 93 / 90	
▪ Resistance to Long Term Degradation[8]	%	100	
▪ Resistance to UV Degradation[9]	%	100	

Dimensions and Delivery

The biaxial geogrid shall be delivered to the jobsite in roll form with each roll individually identified and nominally measuring 3.0 meters (9.8 feet) or 4.0 meters (13.1 feet) in width and 75.0 meters (246 feet) in length.

Notes

1. Unless indicated otherwise, values shown are minimum average roll values determined in accordance with ASTM D4759-02. Brief descriptions of test procedures are given in the following notes.
2. Nominal dimensions.
3. Determined in accordance with ASTM D6637-10 Method A.
4. Load transfer capability determined in accordance with ASTM D7737-11.
5. Resistance to bending force determined in accordance with ASTM D7748-12, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs, and of length sufficiently long to enable measurement of the overhang dimension.

6. Resistance to in-plane rotational movement measured by applying a 20 kg-cm (2 m-N) moment to the central junction of a 9 inch x 9 inch specimen restrained at its perimeter in accordance with GRI GG9.
7. Resistance to loss of load capacity or structural integrity when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW), and crushed stone classified as poorly graded gravel (GP). The geogrid shall be sampled in accordance with ASTM D5818 and load capacity shall be determined in accordance with ASTM D6637.
8. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090 immersion testing.
9. Resistance to loss of load capacity or structural integrity when subjected to 500 hours of ultraviolet light and aggressive weathering in accordance with ASTM D4355-05.

2.09 Compacted Aggregate Base No.73

A. Compacted Aggregate Base No. 73 shall be provided at the base of the emergency spillway and side slope, at the crest of the dam, to ease site access by creating a rounded access drive. Likewise, the principal spillway overflow shall have compacted aggregate base on the south side of the bottom of the channel. Compacted aggregate base No. 73 shall be in accordance with Section 904.03 of the latest INDOT SS. Gradation shall be in accordance with INDOT SS Section 904.03 (e) Sizes of Coarse Aggregates.

3. SAMPLING AND TESTING

3.01 The purchaser or his authorized representative shall be accorded proper access to facilities to inspect and sample the units at the place of manufacture from lots ready for delivery.

4. EXPENSE OF TESTS

4.01 Additional testing, other than that provided by the manufacturer, shall be borne by the Contractor.

5. MANUFACTURER

5.01 Contractor shall submit geotextile fabric, geogrid and stone shop drawings prior to ordering materials. Alternative materials may be considered. Such materials must be pre-approved in writing by the Engineer. Alternative submittal packages must include, as a minimum, the following:

A. Full-scale laboratory testing performed by the submitting manufacturer and associated engineered calculations quantifying the hydraulic capacity of the proposed cellular concrete mat system in similar conditions to the specific project.

B. A list of 5 comparable projects, in terms of size and applications, in the United States, where the results of the specific alternate revetment system use can be verified after a minimum of one (5) year of service life.

5.02 The individual blocks comprising the mat shall have the nominal characteristics, such as the open area, that are presented in Table 2. Acceptable manufacturer includes Armortec, a subsidiary of Contech, (800) 338-1122 or Shoretec, LLC (225) 408-1444 or approved equal.

6. WORK PLANNING, TEMPORARY EROSION AND SEDIMENT CONTROL, FOUNDATION PREPARATION, GEOTEXTILE AND MAT PLACEMENT

6.01 Manufacturer's Representative

A. General

1. Contractor shall coordinate installation with Manufacturer of articulated block system such that a representative is available for the installation; discuss and review pertinent installation details and ensure compliance with Manufacturer's installation recommendations.

2. At least seven (7) days prior to any placement of the Articulated Concrete Block System, a technical representative (not a sales representative), from manufacturer shall conduct a pre-installation meeting with the Contractor. Contractor shall notify Engineer and Owner of such meeting to allow for attendance. Intent of meeting is to ensure Contractor installs the components in strict conformance with manufacturer's recommendations. Manufacturer's representative may make additional site visits, as needed, to verify installation was complete per manufacturer's requirements. Contractor may provide photo documentation of all installation steps to assist with manufacturer's verification. Manufacturer's technical representative shall provide a written report, with photo documentation, indicating Contractor completed installation in conformance with manufacturer's recommendations. If work was not complete per Manufacturer's requirements, Manufacturer shall provide reasoning and recommendations for Contractor to meet requirements. Engineer and Owner shall be given 72 hours to review Manufacturer's recommendations, prior to Contractor making revisions. Contractor shall then complete necessary work to ensure compliance with Manufacturer's product. Manufacturer shall provide final report indicating Contractor's installation was in conformance with Manufacturer's recommendations. The Manufacturer's final report shall be submitted to Engineer and Owner for review within one week of the final installation of such product and prior to Contractor receiving final payment.

6.02 Foundation Preparation

A. General

1. Areas on which coarse aggregate, filter fabric, geogrid and cellular concrete blocks are to be placed shall be constructed to the lines and grades shown on the Contract Drawings and to the tolerances specified in the Contract Documents, and approved by the Engineer.

B. Grading

1. The slope shall be graded to a smooth plane surface to ensure that intimate contact is achieved between the slope face and the geotextile (filter fabric), and between the geotextile and the entire bottom surface of the cellular concrete blocks. All slope deformities, roots, grade stakes, and stones which project normal to the local slope face must be re-graded or removed. No holes, "pockmarks", slope board teeth marks, footprints, or other voids greater than 1.0 inch in depth normal to the local slope face shall be permitted. No grooves or depressions greater than 0.5 inches in depth normal to the local slope face with a dimension exceeding 1.0 foot in any direction shall be permitted. Where such areas are evident, they shall be brought to grade by placing compacted homogeneous material. The slope and slope face shall be uniformly compacted, and the depth of layers, homogeneity of soil, and compacted to minimum 100% maximum dry density as determined by ASTM D-698 (Standard Proctor). Refer to Detailed Specification Excavation and Embankment for additional requirements and details.

2. Excavation and preparation for anchor trenches, side trenches, and toe trenches or aprons shall be done in accordance to the lines, grades and dimensions shown in the Contract Drawings. The anchor trench hinge-point at the top of the slope shall be uniformly graded so that no dips or bumps greater than 0.5 inches over or under the local grade occur. The width of the anchor trench hinge-point shall also be graded uniformly to assure intimate contact between all cellular concrete blocks and the underlying grade at the hinge-point.

C. Inspection

1. Immediately prior to placing the filter fabric, coarse aggregate, geogrid and cellular concrete blocks, the prepared subgrade shall be inspected by the Owner or Engineer or by Contractor’s on-site geotechnical engineer. No fabric or blocks shall be placed thereon until that area has been approved by each of these parties. Subgrade shall be tested by geotechnical engineer at Contractor’s expense (No less than four passing test over the area receiving block mats).

6.03 Placement of Geotextile Filter Fabric, Coarse Aggregate and Geogrid

A. General

1. Filter Fabric, coarse aggregate and geogrid, as specified elsewhere, shall be placed within the limits shown on the Contract Drawings.

B. Placement

1. Upon completion of the subgrade, Contractor shall install approved filter fabric. Filter Fabric shall be placed directly on the prepared area, in intimate contact with the subgrade soils. The geotextile shall be free of folds or wrinkles. Install pins to hold the filter fabric down as required. The geotextile shall not be walked on or disturbed when the result is a loss of intimate contact between the subgrade soils or cellular concrete block and the geotextile or between the geotextile and the subgrade or drainage medium. The geotextile filter fabric shall be placed so that the upstream strip of fabric overlaps the downstream strip. The longitudinal and transverse joints shall be overlapped at least two (2) feet and pinned per manufacturer's recommendation. The geotextile shall extend at least one foot beyond the top and bottom termination points. If cellular concrete blocks are assembled and placed as large mattresses, the top lap edge of the geotextile should not occur in the same location as a space between cellular concrete mats unless the space is concrete filled. Coarse aggregate drainage medium shall be installed in one lift, with final thickness no less than 4 inches. The crushed rock surface shall be smooth. Geogrid shall be installed over the coarse aggregate in strict conformance with manufacturer's installation recommendations. Minimum of 2 ft. overlaps shall be provided or as specified per manufacturer.

6.04 Placement of Cellular Concrete Blocks/Mats

A. General

1. Cellular concrete block/mats, as specified in Part 2 of these Specifications, shall be constructed within the specified lines and grades shown on the Contract Drawings.

B. Placement

1. The cellular concrete blocks shall be placed on top of approved geogrid on a minimum 4-inch thick granular drainage layer consisting of coarse aggregate INDOT No. 5 angular crushed rock followed by the geosynthetic, in such a manner as to produce a smooth plane surface in intimate contact with the concrete unit. No individual block within the plane of placed cellular concrete blocks shall protrude more than one inch or as otherwise specified by the Engineer. To ensure that the cellular concrete blocks are flush and develop intimate contact with the subgrade, the blocks shall be "seated" with a roller or other means as approved by the Engineer.

2. If assembled and placed as large mattresses, the cellular concrete mats shall be attached to a spreader bar or other approved device to aid in the

lifting and placing of the mats in their proper position by the use of a crane or other approved equipment. The equipment used should have adequate capacity to place the mats without bumping, dragging, tearing or otherwise damaging the underlying fabric. The mats shall be placed side-by-side and/or end-to-end, so that the mats abut each other. Mat seams or openings between mats greater than one (1) inch shall be filled with 4000 psi grout. Whether placed by hand or in large mattresses, distinct changes in grade that results in a discontinuous revetment surface in the direction of flow shall require a grout seam at the grade change location so as to produce a continuous surface.

3. Anchor trenches, including side trenches, upstream and downstream terminations, shall be backfilled with grout/concrete, filled flush with the top of the blocks and surrounding finish grade. Finish grade soil shall be tapered away from the edge of the concrete, to prevent drainage from running along the edge of the concrete and creating erosion. Anchor trenches shall be poured at the time of articulated concrete block mat installation for each spillway. Minimum 4000 psi Concrete (INDOT Class A or approved equivalent) shall be utilized for said concrete trenches. Concrete shall be installed at the time of the Articulated Concrete Block Mats (do not pour on frozen, saturated conditions and protect concrete against weather conditions).

4. It is the intent that all articulated concrete block systems shall be keyed in the sideslopes according to the plans and in accordance with the manufacturer's instructions. All such materials shall blend in smoothly to adjacent land areas. Add additional topsoil within the edges of articulated concrete block mat areas where a transition to seeded areas begin in order to account for settlement of soil.

C. Finishing

1. The cells or openings in the cellular concrete blocks shall be backfilled with No.5 stone and compacted immediately to assure there are no voids and so that compacted material extends from the filter fabric to one-inch above the surface of the cellular concrete block. Backfilling and compaction shall be completed in a timely manner so that no more than 500 feet of exposed mats exist at any time.

D. Consultation

1. The manufacturer of the cellular concrete blocks/mats shall provide design and construction advice during the design and initial installation phases of the project when requested.

2. Contractor must have a representative from the manufacturer on-site during the first day of block installation.

6.05 Placement of Compacted Aggregate Base No. 53

A. Upon completion of the articulated concrete block mats, including filling all voids with stone as specified, Contractor shall install compacted aggregate base No. 53 within the base of the emergency spillway and principal spillway overflow, side slope transition area, to form a smooth drive across the crest of the dam. Contractor shall be carefully not to damage blocks by overcompacting.

END OF SECTION 09

SECTION 10

CONCRETE ARMOR UNITS

1. GENERAL

1.01 Scope

A. The Contractor shall furnish all material, labor, equipment and do all work necessary to complete the Concrete Armor Unit installation for the project as shown on the plans, as specified herein and as ordered by the Engineer or Owner. Work shall include, but not limited to: subgrade preparation, filter fabric installation, rock foundation and bedding, concrete armor unit installation, anchoring concrete armor units together, clean up and all other miscellaneous or incidental work required for complete installation. The concrete armor units shall be designed specifically for erosion control, toe and slope protection, and energy dissipation.

B. Concrete Armor Units is considered work associated with Alternate 2 and Alternate 3.

1.02 Submittal

A. The Contractor shall submit to the Engineer all manufacturers' hydraulic testing and calculations in support of the proposed hard armor unit and geotextile.

B. The Contractor shall furnish the manufacturer's certificates of compliance for the concrete hard armor units. The Contractor shall also furnish the manufacturer's specifications, literature, shop drawings for the layout of the concrete armor units, and any recommendations, if applicable, that are specifically related to the project. Manufacturer shall verify acceptable bedding material and installation procedures.

C. Contractor shall submit a Final Report, from Manufacturer's technical representative, indicating Contractor installed material in conformance with Manufacturer's recommendations. This report shall be provided prior to Contractor receiving final payment. Refer to paragraph 3.01.D. for details.

2. PRODUCT

2.01 General

A. The geometry of the concrete armor unit shall consist of six arms extending from a central hub. A complete unit is made up of two identical halves, with each half consisting of a central core with three legs radiating outward at equal spacing. On each half, two fillets are located between adjacent arms. These fillets provide additional structural strength and aid in the proper placement of the armor units.

B. When the symmetrical halves are interlocked, the resultant unit will have geometry, which exhibits six equally spaced arms, with each arm spaced at 90 degrees from the four adjacent arms. When placed in the most stable configuration, each unit will rest on three of the six arms.

2.02 Concrete Armor Units

A. The concrete armor units, shall be two (2) feet, produced on a pre-determined concrete block machine and conform to ASTM D 6684-04, Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems.

B. Cementitious Materials – Materials shall conform to the following applicable ASTM specifications:

- Portland Cements - Specification C 150, for Portland Cement.
- Blended Cements - Specification C 595, for Blended Hydraulic Cements.
- Hydrated Lime Types - Specification C 207, for Hydrated Lime Types.
- Pozzolans - Specification C 618, for Fly Ash and Raw or Calcined Natural Pozzolans for use in Portland Cement Concrete.

C. Aggregates shall conform to the following ASTM specifications, except that grading requirements shall not necessarily apply:

- Normal Weight - Specification C 33, for Concrete Aggregates.

D. Casting. The concrete units will be produced by a dry cast method. The dry cast units obtain strength in a shorter duration as well as an increase in the durability and overall quality of product. Material and manufacture standards will be compliant with ASTM D6684-04.

E. Physical Requirements. At the time of delivery to the work site, the units shall conform to the following physical requirements:

TABLE 1. PHYSICAL REQUIREMENTS

Compressive Strength Net Area Min. psi		**Water Absorption Max., lb/ft^3**	
Avg. of 3 units	Individual Unit (min. required)	Avg. of 3 units	Individual Unit
4000	3,500	9.1	11.7

Units shall be sampled and tested in accordance with ASTM C 140, Standard Test Methods of Sampling and Testing Concrete Masonry Units.

F. Visual Inspection. All units shall be sound and free of defects that would interfere with either the proper placement of the unit or impair the performance of the system. Surface cracks incidental to the usual methods of manufacture, or surface chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.

Cracks exceeding 0.25 inches (.635 cm) in width and/or 1.0 inch (2.54 cm) in depth shall be deemed grounds for rejection.

Chipping resulting in a weight loss exceeding 10% of the average weight of a concrete unit shall be deemed grounds for rejection.

Concrete armor units rejected at the job site shall be repaired with structural grout (only under strict guidance from the manufacturer's representative, which shall be available to review, inspect and approve each individual repair) or replaced at the expense of the Contractor.

G. Sampling and Testing. The Owner or Engineer, shall be accorded proper access to the suppliers facilities to inspect and sample the units at the place of manufacture from lots, ready for delivery.

Field installation procedures shall comply with the procedures utilized during the hydraulic testing procedures of the recommended system. All system restraints and ancillary components (such as synthetic drainage mediums) shall be employed as they were during testing. For example, if the hydraulic testing installations utilize a drainage layer then the field installation must utilize a drainage layer; an installation without the drainage layer would not be permitted.

Critical Testing requirements for concrete armor units shall be provided. These tests shall include Dynamic Impact Testing and Lateral Load testing to ensure the units meet the necessary structural demand they will encounter for use as dissipators at the toe of a spillway. A Dynamic Factor of 1.75 (min.) shall be used to ensure the proper units are specified in order to avoid failure of the units.

Additional testing, other than that provided by the manufacturer, shall be borne by the purchaser.

H. Manufacturer. The concrete armor units shall have the following nominal characteristics:

A-JACK Model	Total Length (in)	Arm Length (in)	Fillet Length (in)	Arm Width (in)	Volume (ft^3)	Weight (lbs)
AJ-24	24	8.30	1.85	4.00	0.59	76-82

The concrete armor units shall be A-JACKS® as manufactured by: Armortec, A Contech Company of West Chester, Ohio.

2.03 Geotextile Filter Fabric

A. The geotextile filter shall meet the minimum physical requirements listed in Table No. 2 of these Specifications. Consultation with the manufacturer is recommended. Fabric shall be Geotex ® Woven Filtration / Monofilament Geotextile type 104F as manufactured by Propex Geosynthetics or approved equivalent.

B. The geotextile must be permitted to function properly by allowing relief of hydrostatic pressure; therefore concrete shall not be allowed to clog the filter fabric.

C. The geotextile fiber shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic, if necessary, to make the filaments resistant to deterioration due to ultraviolet and heat exposure. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile.

D. The Contractor shall furnish the Engineer, in duplicate, manufacturer's certified test results showing actual test values obtained when the physical properties are tested for compliance with the specifications.

E. During all periods of shipment and storage, the filter fabric shall be protected from direct sunlight, ultraviolet rays and temperatures greater than 140 degrees Fahrenheit. To the extent possible, the fabric shall be maintained wrapped in its protective covering. The geotextile shall not be exposed to sunlight, ultraviolet rays until the installation process begins.

TABLE 2 – PHYSICAL REQUIREMENTS

Physical Property	Test Procedure	Minimum Value
Grab Tensile Strength (Unaged Geotextile MD x XD)	ASTM D4632	370 x 250 lbs.
Breaking Elongation (Unaged Geotextile MD x XD)	ASTM D4632	24 x 24
Burst Strength	ASTM D3786	480 psi
Puncture Strength	ASTM D4833	130 lbs.
Trapezoidal Tear (MD x XD)	ASTM D4533	100 x 70 lbs.
A.O.S., U.S. Std. Sieve	ASTM D4751	70 or 0.212 mm
% Open Area	CWO-22125-86	4%
Permittivity	ASTM D4491	0.28 sec^{-1}

MD = Machine Direction XD = Cross Direction

F. Final acceptance of the filtration geotextile by the Engineer shall be dependent upon the geotextile performance when tested in accordance with ASTM D5101, Standard Test Method for Measuring the Soil-Geotextile System Clogging by the Gradient Ratio test or the Hydraulic Conductivity Ratio test. Soil characteristics such as grain size analysis, and plasticity shall be determined for every 200,000 square feet of geotextile installed, or for each source of borrow material used during construction. Significant differences in soil characteristics shall require further performance testing by either the Gradient Ratio or the Hydraulic Conductivity Ratio tests at the discretion of the Engineer. The locations for which the material to be tested is extracted shall be approved by the Engineer. The Contractor shall provide the site-specific soil and modified proctor curves for the site-soil, at his own expense, to the manufacturer. The contractor shall be responsible for the performance of the test by a certified independent laboratory experienced in performing such test. The test shall be performed under the actual field soil conditions or as otherwise required by the Engineer.

G. At the time of installation, the filter fabric shall be rejected if it has been removed from its protective cover for over 72 hours or has defects, tears, punctures, flow deterioration, or damage incurred during manufacture, transportation or storage. With the acceptance of the Engineer, placing a filter fabric patch over the damaged area prior to placing the mats shall repair a torn or punctured section of fabric. The patch shall be large enough to overlap a minimum of three (3) feet in all directions.

H. In the event pre-assembled panels of fabric are required, the panels of filter fabric shall be sewn together at the manufacturer or another approved location.

2.04 Cabling

A. Termination or transition of the concrete armor units, as identified in the submittal and contract drawings, shall have field cabling provided. Cable type will be minimum 1/4” stainless steel, as approved by the Engineer.

Field cabling is done to mitigate unexpected local toe scour or to add redundancy at the termination and transition points. Three strands minimum of cable will be placed around the mid-section of the exterior perimeter, hand tightened and connected using standard cable hardware supplied by the manufacturer. Splicing will only be allowed at the connection point. Connection shall be made with an approved stainless steel hardware clamp, capable of withstanding forces of impact and tensional pulls.

Cable orientation shall be perpendicular/parallel to the bottom channel, and shall be identified and agreed upon in the field by the Contractor and Engineer’s representative. Ensure practical placement of additional cabling to minimize unreasonable effort by Contractor. Prior to field cabling work means and methods will be discussed to establish a typical configuration for the

previously identified areas. Final orientation, and additional cable strand placement if deemed necessary, shall be per Owner and Engineer.

2.05 Concrete Armor Unit Performance Specification – Channel Bed and Bank Protection

A. The concrete armor unit should provide sufficient hydraulic stability under the design conditions specified above.

The Factor-of-Safety (FOS) Method should be used in evaluating the hydraulic stability of the chosen armor units.

The FOS for shear stress, SF_τ, should be greater than 2, where SF_τ is defined in the following:

$$SF_\tau = \tau_p/\tau_o$$

where τ_p is the permissible stress for the armor unit accounting for the appropriate side slope correction factor, and τ_o is the maximum bed shear stress corresponding to the design condition.

The FOS for velocity, SF_v, should be greater that *2*, where SF_v is defined in the following:

$$SF_v = V_p/V$$

where V_p is the permissible velocity for the armor unit accounting for the appropriate side slope correction factor, and V is the design velocity.

3. EXECUTION

3.01 Installation

A. Foundation Preparation

General. All subgrade preparation should be performed in accordance with *ASTMD6884-03, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems*.

Areas on which filter fabric and the Hard Armor Units are to be placed will be constructed to the lines and grades shown on the Contract Drawings and to the tolerances specified in the Contract Documents, and approved by the Engineer.

Grading. The slope will be graded to a smooth plane surface to ensure that intimate contact is achieved between the slope face and the geotextile (filter fabric). All slope deformities, roots, grade stakes, and stones which project normal to the local slope face must be re-graded or removed. Where such areas are evident, they will be brought to grade by placing compacted homogeneous material. The slope and slope face will be uniformly compacted, and the depth of layers, homogeneity of soil and amount of compaction will be as required by the Engineer.

Inspection. Immediately prior to placing the filter fabric and remaining subgrade components, the prepared subgrade shall be inspected by the Engineer or Owner. No fabric, subgrade section or Hard Armor Unit will be placed thereon until that area has been approved by each of these parties. "Rules of thumb" may be established during the initial inspection of each product type with regard to foundation preparation to facilitate efficiency in future project preparation areas.

B. Placement of Geotextile Filter Fabric

General.
All placement and preparation should be performed in accordance with *ASTM D6884-03, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems*. Filter Fabric, or filtration geotextile, as specified elsewhere, will be placed within the limits shown on the Contract Drawings or specified here-in.

Placement. The filtration geotextile will be placed directly on the prepared area, in intimate contact with the subgrade, and free of folds or wrinkles. The geotextile will not be walked on or disturbed when the result is a loss of intimate contact between the geotextile and the subgrade. The geotextile filter fabric will be placed so that the upstream strip of fabric overlaps the downstream strip. The longitudinal and transverse joints will be overlapped at least two (2) feet. The geotextile will extend at least one (1) foot beyond the top and bottom revetment termination points, or as required by the Engineer.

C. Placement of Concrete Armor Unit System

The proposed concrete armor units, shall be constructed per Manufacturer's recommendations, these plans and as specified here-in.

Placement (No. 5 Stone) – For 24" Concrete Armor Unit
If applicable, to mitigate subgrade inconsistencies, a minimum thickness of 6" of No. 5 stone is required prior to installing the 24" units. The stone and desired thickness will be placed directly on the specified geotextile as shown on the plans, directed by Engineer or Owner or as specified here-in.

Bedding – For 24" Concrete Armor Unit
A bedding layer of clean stone is to be placed in conjunction with the subgrade section for backfilling purposes to achieve necessary bearing and/or setback tolerances. The recommended bedding layer size (D_{50}) is 2-3"; alternate D_{50} size for bedding layer will be defined by local aggregate availability, as shown on the plans, directed by Engineer or Owner or as specified here-in.

Placement – For 24" Concrete Armor Unit
Concrete armor units can be installed individually or in bundles at the discretion of the Contractor.

Placed individually, the concrete armor unit shall be placed with uniform spacing. For a specified area receiving the 24" units, spacing between unit center in both the x and y dimension shall be 9.6" to 12" (maximum), which represents a 0.4 to 0.5 packing ratio. Standard installation includes placing the units in a consistent repeatable fashion to aid in efficiency. Recommended in-place orientation of the unit(s) emphasizes pointing exposed projecting unit arm (vertical or horizontal) downstream whenever practical during construction. Subsequent cabling of outer units shall be as specified here-in.

Placed in bundles, the concrete armor units shall be placed into a pre-determined matrix, spacing them as closely as possible, approximating the maximum packing ratio of 0.4 (9.6" center spacing in x and y directions). Cable will be placed around the pre-determined matrix (around mid-section) with cable; hand tightened and connected using standard cable hardware supplied by the manufacturer. Bundles are to be placed as closely as possible, with recommended tolerance requirement of 4" between bundles. If the bundling method is employed by the Contractor, tolerances between bundles will be discussed and agreed upon prior to commencing work, with Engineer and Owner. Spacing shall be measured from center of bundle to middle of installed bundle, in the horizontal plane, before additional (stacked) units are placed. Subsequent cabling (around entire perimeter), beyond what is necessary to install bundles, still will be required as specified here-in.

Bedding stone material can be utilized, subject to Engineer or Owner review and approval, for bridging interior voids and establishing consistent bedding layer for additional lifts of unit(s), whether hand placed or bundles. Vertical fluctuations occurring from unit to unit or bundle to bundle will be compensated for by utilizing bedding.

D. Manufacturer's Representation

1. Contractor shall coordinate installation with Manufacturer of concrete armor units such that a representative is available for the installation; discuss and review pertinent installation details and ensure compliance with Manufacturer's installation recommendations.

2. At least seven (7) days prior to any placement of the Concrete Armor Units, a technical representative (not a sales representative), from manufacturer shall conduct a pre-installation meeting with the Contractor. Contractor shall notify Engineer and Owner of such meeting to allow for attendance. Intent of meeting is to ensure Contractor installs the components in strict conformance with manufacturer's recommendations. Manufacturer's representative may make additional site visits, as needed, to verify installation was complete per manufacturer's requirements. Contractor may provide photo documentation of all installation steps to assist with manufacturer's verification. Manufacturer's technical representative shall provide a written report, with photo documentation, indicating Contractor completed installation in conformance with manufacturer's recommendations. If work was not complete per Manufacturer's requirements, Manufacturer shall provide reasoning and

recommendations for Contractor to meet requirements. Engineer and Owner shall be given 72 hours to review Manufacturer's recommendations, prior to Contractor making revisions. Contractor shall then complete necessary work to ensure compliance with Manufacturer's product. Manufacturer shall provide final report indicating Contractor's installation was in conformance with Manufacturer's recommendations. The Manufacturer's final report shall be submitted to Engineer and Owner for review within one week of the final installation of such product and prior to Contractor receiving final payment.

END OF SECTION 10

SECTION 11

FILTER DRAINS

1. GENERAL

1.01 Scope

A. The Contractor shall furnish all material, labor, equipment and do all work necessary to complete the filter drain installation for the project as shown on the plans, as specified herein and as ordered by the Engineer or Owner. Work shall include but not limited to: hauling and stockpiling of materials, installation of fine and coarse aggregates, compaction of said aggregates, testing of aggregates (by Contractor's hired geotechnical engineer), installation of drain pipe, clean outs, connections through wall or structures, flap gates, clean up and all other miscellaneous or incidental work required for complete installation. Excavation, including rock removal, and subgrade/foundation preparation work, and soil backfill is included under the Excavation and Embankment Detailed Specification.

1.02 Submittals

A. Submit shop drawings for all collector pipe, connections, and other appurtenances.

B. Include all performance data such as strengths for all pipe and fitting material items. Provide maximum pipe deflections for pipe joints.

C. Submit flexible flap gate. Contractor shall provide installation drawings of all details of construction, details required for installation, dimensions and anchor bolt locations. Manufacturer shall provide maximum bending stress and deflection of the flap under the maximum design head.

D. Submit samples and gradation of fine and coarse aggregate material to be used for this item.

E. Submit compaction test or geotechnical reporting or observation as required.

F. Include within quality control plan, details on how to limit segregation of fine and coarse aggregates and installation procedure of filter drain.

1.03 Related Specifications

Comply with applicable portions of the following WM Specifications:

A. WM-2 Excavation
B. WM-3 Backfill, Fills and Embankments
C. WM-5.2 Cast-In-Place Concrete
D. WM-12 Storm Sewer Structures

E. WM-13 Storm Sewer Pipe
F. WM-14 Pressure Pipe – Water
G. WM-16 Valves, Gates and Hydrants
H. WM-17 Miscellaneous Pipe and Fittings

2. PRODUCT

2.01 Collector Pipe Materials

The following collector pipes shall be used for this project:

A. Drain Pipe

1. Dual Wall HDPE pipe shall be Type 'N-12' as manufactured by Advanced Drainage Systems, Inc. or approved equivalent. Pipe shall have a smooth interior and annular exterior corrugations. Pipe shall meet requirements of ASTM D-F2648 and pipe joint shall be soil tight. Fittings shall conform to ASTM F-2306.

2. Perforations shall conform to AASHTO Class II Perforation, M252. Perforation pattern shall be at 45- or 60-degree pattern (8 or 6 equally spaced perforations around the entire collector pipe circumference). Minimum water inlet area shall be 0.945 in^2/foot or per AASHTO M252. Perforations shall be installed on the outside valley of the corrugations.

3. Ductile iron pipe shall generally be per Detailed Specification Section Lake Drawdown Precast Structures, Pipe and Appurtenances. Joints can either be push on or mechanical joint. Flanged pipe (on downstream end only) shall be provided for retaining wall drain pipe outlet. Polyethylene encasement shall be provided.

4. HDPE to Ductile Iron pipe shall be made with shear resistant flexible coupling specific to fitting outside diameters of the differing pipe materials.

2.02 Clean-Out

A. 8" Clean-Out

1. 8" Ductile Iron Grate rated for heavy duty wheel load traffic. Material shall conform to ASTM A48 – Class 30B. Concrete collar shall be installed around casting as shown on the plans; however, minimum requirements are: greater of min. thickness of 18-inches or to pipe adapter and min. width of 32" or 12-inches beyond the outside surface edge of the casting.

2.03 Flap Gates

A. Flexible Flap Gate for 8" Two-Stage Embankment Drain Collector Pipe Mounted to Str. 104

1. Flap Gate shall be installed (attached) directly to poured-in-place concrete headwall (Str. 104) for each 8" two-stage filter drain pipe outlet. Flap gate shall be flexible type, manufactured with stainless steel frame and Neoprene or EPDM flexible flap. Contractor shall provide rectangular gate, sized to account for pipe opening (including skew angle). Contractor shall mount to the wall per manufacturer's recommendations. These recommendations and installation instruction shall be provided with the submittal. Gate shall be designed to accommodate a minimum of 10 feet of head.

2. Acceptable model and manufacturers include: Series 451 Rubber Flap Gate as manufactured by Whipps, Inc. of Athol, Massachusetts and Flexible (Rubber) Flap Gate by Hydro Gate 3888 E. 45th Ave. #120 Denver CO, 80216.

3. Frame shall be fabricated from stainless steel type 304. All structural components of the frame and reinforcing stiffeners on the flap shall be fabricates of steel having a minimum thickness of ¼" or more and shall have adequate strength to prevent distortion during normal handling, during installation and while in service.

4. The Cover shall be fabricated from neoprene or EPDM rubber and Type 304 stainless steel reinforcing angles or stiffeners attached to the rubber sheet with stainless steel through bolts and backing bars. Seals shall be Neoprene or EPDM. Anchor studs, fasteners and nuts shall be stainless steel Type 316 and provided by the flap gate manufacturer. Quantity and location shall be determined by the gate manufacturer.

5. The flap rubber cover shall be one piece without seams and be of sufficient thickness to prevent ballooning under hydrostatic pressures. The flap cover shall have lifting lugs or handles made from stainless steel. The hinge shall be flexible type integral with the flexible rubber cover.

B. Flap Gate for 8" Retaining Wall Drain Pipe

1. Flap Gate shall be installed (attached) directly to ductile iron outlet pipe. Flap gate shall be cast in one piece with necessary reinforcing ribs, lifting eye for manual operation and with bosses to provide a pivot point connection with the links. Gate shall be rated for minimum of 20 feet of head.

2. Acceptable model and manufacturers include: Series 452 Stainless Steel or Cast Iron Flange Mounted Flap Gate as manufactured by Whipps, Inc. of Athol, Massachusetts and Model 50C Cast Iron Flap Gate by Hydro Gate 3888 E. 45th Ave. #120 Denver CO, 80216.

3. Seat and Cover shall be Cast Iron or Stainless Steel. Seating faces shall be silicone bronze. Pivot lugs shall be ductile iron or stainless steel. Links shall be ductile iron. Bushings shall be self-lubricating bronze or stainless steel. Fasteners shall be stainless steel. All cast iron shall be pained ith water-resistant rust preventative compounds.

3. EXECUTION

3.01 General Filter Drain Installation

A. Collector pipe shall be laid and tested in accordance with the Workmanship and Materials Specifications, Section WM 13, "Storm Sewer Pipe".

B. Fine (filter) and Coarse (drain) aggregate shall meet the gradation and requirements as specified and shown on the plans.

C. Care shall be taken to prevent contamination of drains and filters by runoff containing sediment, dust, construction traffic, and mixing with nearby fine-grained materials during placement and compaction. Contaminated filters shall be removed and replaced at the Contractor's expense.

D. Construction traffic shall be minimized to only that needed to properly construct the filter drains. Haul roads shall NOT be constructed over the filter drain. Any damage to the filter drains shall be repaired at the Contractor's expense.

E. Contractor shall minimize and prevent aggregate segregation, with particular attention for the coarse filter, during handling and placement. Material handling shall be minimized. Filter and drain material shall be placed or stockpiled in a manner that limits the "free fall" of materials onto the site and filter installation. Max, acceptable "free fall" shall be 3 feet.

F. Fine and coarse aggregate shall be compacted to a minimum of 70 percent relative density. Observational testing and reporting shall be completed under the direction of the Contractor's hired geotechnical engineer. Observation and reporting shall be completed to review soil subgrade and subsequent aggregate installations. Contractor's hired geotechnical engineer, may make recommendations on procedural compaction changes, for Engineer and Owner review, during installation.

G. Fine Aggregate shall be placed uniformly in layers not to exceed 6 inches thick before compaction. Each layer shall have sufficient moisture to limit "bulking" during compaction. Each layer of fine aggregate shall be compacted by a mechanical compactor having a plate width of 17 in. or larger that delivers 3,000 to 9,000 lb per blow. Each lift shall be compacted with minimum of six passes of the compactor.

H. Coarse aggregate shall be placed uniformly in layers not to exceed 12 inches loose measurement (prior to compaction). Each layer of coarse aggregate shall be compacted by a mechanical compactor having a plate width of 17 in.

or larger that delivers 3,000 to 9,000 lb per blow. Each lift shall be compacted with minimum of two passes of the compactor.

I. Placed fine and coarse aggregates shall be clean, washed aggregate without clay and silt coatings and no clay ball inclusions or organics. Unacceptable filter materials shall be removed from the filter drain system.

J. Contractor shall maintain alignment and grade of collector pipes. Contractor shall take care to maintain the continuity and separation of the filter and drain. At no point shall the filter (fine aggregate) be less than 6-inches in thickness.

K. Ductile iron pipe and fittings shall be installed from the headwall to first upstream cleanout. Connection shall be made with a flexible coupling or approved equivalent. Impervious pipe bedding and backfill, utilizing clay and bentonite, 1-2% by weight, shall be installed for the ductile iron pipe. Minimum of two compaction test shall be completed, by Contractor's hired geotechnical engineer, per each ductile iron pipe run from headwall to first cleanout structure. Bedding and backfill, shall be compacted to minimum of 100% of optimum moisture and density per ASTM D 698 Standard Proctor.

3.02 Flap Gate

A. Flexible Flap Gate for 8" Two-Stage Embankment Drain Collector Pipe Mounted to Str. 104

1. Installation of all parts shall be done by the Contractor in a workmanlike manner and in accordance with the manufacturer's instructions. Contractor shall ensure minimum clearance is provided below the bottom of the pipe and poured in place headwall floor prior to constructing headwall. Adjustments, if necessary, must be approved by Engineer prior to construction. It shall be the Contractor's responsibility to handle, store and install the gate in strict accord with the manufacturer's drawings and recommendations. Gates assemblies shall be installed in a true vertical plan, square and plumb. The Contractor shall fill the void in between the gate frame and the wall with non-shrink grout as shown on the manufacturer's installation drawing and in accordance with manufacturer's recommendations. Gates shall be watertight and visually inspected to confirm that the flap seats against the frame tightly.

B. Flap Gate for 8" Retaining Wall Drain Pipe

1. Installation of all parts shall be done by the Contractor in a workmanlike manner and in accordance with the manufacturer's instructions. Contractor shall provide a minimum of 6" directly below the flap and a minimum of one (1) foot above lowest point in channel. Grouted Class II Riprap shall be securely anchored and lugged in place to keep riprap from rolling onto flap gate. Gate and pipe shall be protected from concrete. Extra concrete may be required to secure pipe. It shall be the Contractor's responsibility to handle, store and install the gate in strict accord with the manufacturer's

drawings and recommendations. Gates assemblies shall be installed in a true vertical plan, square and plumb. Contractor shall install as shown on the manufacturer's installation drawing and in accordance with manufacturer's recommendations. Gates shall be watertight and visually inspected to confirm that the flap seats against the frame tightly.

END OF SECTION 11

SECTION 12

LAKE DRAWDOWN PRECAST STRUCTURES, PIPE AND APPURTENANCES

1. GENERAL

1.01 Scope

A. The Contractor shall furnish all material, labor and equipment and do all work necessary to construct lake drawdown facility as shown on the plans, as specified herein and as ordered by the Engineer or Owner. Work shall include but not limited to: installation of precast manhole structures, valves, pipes, fittings and appurtenances, ball valve, lake drawdown anchor, pipe collars and associated drawdown piping. Contractor test the facility to demonstrate facility will work as intended and provide Standard Operating Procedure and Operation and Maintenance Manuals. Excavation, including rock removal, and subgrade/foundation preparation work, and soil backfill is included under the Excavation and Embankment Detailed Specification.

B. In general, the structures and installation shall be in accordance with the Workmanship and Materials Specifications, Section 9, “Standard Manholes” and Section 16, "Valves, Gates, and Hydrants". This Section shall address only revisions, additions or clarifications.

C. The Lake Drawdown Facility is considered work associated with Alternate 1. **For Base Bid, Contractor shall stub and cab 8” ductile iron pipe four (4) feet behind the headwall structure. All other work shall be considered Alternate 1.**

1.02 Standard Operating Procedure and Operation and Maintenance Manual

A. The Contractor shall provide a step by step Standard Operating Procedure to detail the operation of the lake drawdown facility.

B. Contractor shall provide Operation and Maintenance Manuals for the Gate Valves.

1.03 Submit

A. The Contractor shall provide installation procedures and quality control plan to ensure pipe deflections are not exceeded within lake and downstream embankment.

B. Contractor shall submit shop drawings on all structures, pipe and valving.

2. PRODUCTS

2.01 Reinforced Concrete Manhole Structure

A. Reinforced concreted manholes shall conform to the Workmanship and Materials Specifications, Section 9, "Standard Manholes".

B. The pre-cast concrete manhole, including base, barrel sections, flat tops or concentric cones and adjusting rings shall have, Xypex Admix C-Series or approved equivalent, added to the concrete at the time of batching for concrete waterproofing by crystallization. All manufacturer's recommendations for concrete waterproofing by crystallization products shall be followed. A pink dye shall be added to any concrete mix that has the Xypex additive.

C. Structure 103 manhole frame and cover shall East Jordan model V-1800-4 (30" clear opening and min. 4" frame height) or approved equal. Casting shall have Heavy Duty frame and solid cover meeting requirements of AASHTO M306. Casting shall be watertight assembly with dual hinges, locking device and spring assist. Casting shall be bolted to concrete manhole structure.

D. Structure 102 manhole frame and cover shall be East Jordan model V-1600-5 (36" clear opening and 6" frame height) or approved equal, Heavy Duty frame and cover (min. 36" clear opening) meeting requirements of AASHTO M306. Casting shall be provided with dual hinges, locking device and spring assist. Casting shall be bolted to concrete manhole structure.

2.02 Gate Valve

A. Gate Valve shall generally conform to the Workmanship and Materials Specifications, Section 16, "Valves, Gates, and Hydrants" except where specifically indicated here-in. Gate Valve shall have full body consisting of ductile iron. Wedge shall be made from ductile iron. Wedge shall be totally encapsulated rubber wedge. O-ring seals shall be provided at all pressure retaining joints. Interior coating shall comply with AWWA C550. Exterior coating shall be NSF61 certified fusion-bonded epoxy. A non-rising operating stem shall be located to 6" below the structure to allow the owner to operate the valve with a T-handle above grade. Contractor to provide Owner a T-handle (for each valve) for operation of the gate valves.

2.03 Ductile Iron Drawdown Pipe

1. Mechanical joint pipe

    a. Mechanical joint pipe shall be installed in buried applications. All mechanical joint piping shall be restrained with EBAA Iron Sale, Inc. Megalug or approved equivalent.

    b. Ductile Iron Pipe shall meet all standards of AWWA C151, with bolt holes in bell. Ductile Iron Pipe shall be 350 psi pressure class with gasket joints. Rubber-gasket joints shall be per AWWA C111. Pipe and fittings shall have exterior coated with an asphaltic coating approximately 1 mil thick. Provide interior lining for all pipe and fittings, consisting of ceramic epoxy.

c. Standard Fittings shall meet all standards of AWWA C110, ductile iron with bolt holes in bell.

d. Compact Fittings shall meet all standards of AWWA C153, with bolt holes in bells.

e. Provide polyethylene encasement.

2. Ball and Socket Type Joint

a. Ductile Iron ball and socket type restrained locking joint, shall be installed in the lake. Pipe pressure shall be minimum 350 psi.

3. Flanged Pipe

a. Flanged pipe shall be installed in all exposed applications (structures), unless specifically noted on the plans.

b. Ductile Iron Pipe shall meet all standards of AWWA C151 with bolt hole aligned per AWWA C115 conforming to the drilling and facing of ANSI B16.1 Class 125 flanges. Ductile Iron Pipe shall be provided with minimum 1/8" thick gaskets with three (3) bulb type rings. Flat rubber gaskets are not considered equal in performance. Rubber-gasket joints shall be per AWWA C111. Pipe and fittings shall have exterior coated with an asphaltic coating approximately 1 mil thick. Provide interior lining for all pipe and fittings, consisting of ceramic epoxy.

c. Exterior Coating for Ductile Iron Pipe and Fittings (Within Structures)

- Refer to Workmanship and Material Section 25.1 for coating materials, requirements and preparation. Refer to Section 2.02 Coating Requirement per paragraph F. Ductile Iron Pipe for Submerged Applications.

- DO NOT paint over bituminous shop coating.

d. Provide polyethylene encasement for retaining wall drain pipe.

e. Standard Fittings shall meet all standards of AWWA C110, ductile iron with bolt holes in bell.

f. Compact Fittings shall meet all standards of AWWA C153, with bolt holes in bells.

3. Interior Lining for Ductile Iron Pipe and Fittings

a. Lining material of quality is Protecto 401™ Ceramic Epoxy. The material shall be an amine cured novolac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining pipe and fittings for sewer service, a test report verifying the following properties, and a certification of the test results.

b. A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.

c. The following test must be run on coupons from factory lined ductile iron pipe:

1. ASTM B-117 Salt Spray (scribed panel) - Results to equal 0.0 undercutting after two years.

2. ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F. Results to equal no more than 0.5 mm undercutting after 30 days.

3. Immersion testing rated using ASTM D-714-87.
   A. 20% Sulfuric acid—No effect after two years.
   B. 140°F 25% Sodium Hydroxide—No effect after two years.
   C. 160°F Distilled Water—No effect after two years.
   D. 120°F Tap Water (scribed panel)—0.0 undercutting after two years with no effect.

4. ASTM G-22 90 Standard practice for determining resistance of Synthetic Polymeric materials to bacteria. The test should determine the resistance to growth of Acidithiobacillus Bacteria and should be conducted at 30 degrees centigrade for a period of 7 days on a minimum of 4 panels. The growth must be limited only to trace amounts of bacteria.

d. An abrasion resistance of no more than 3 mils (.075 mm) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.

e. Condition of Ductile Iron Pipe Prior to Surface Preparation

1. All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first six inches of the exterior

of the spigot ends.

f. Application

1. Applicator

The lining shall be applied by a certified firm with a successful history of applying linings to the interior of ductile iron pipe and fittings. All applicators must be independently inspected at least two times per year to insure compliance with the requirements of this specification. This inspection must be coordinated and reviewed by the manufacturer of the lining material and any deviation from the application and/or quality requirements shall be corrected by the applicator. All inspections shall be in writing and a permanent record maintained.

2. Surface Preparation

Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas with oil, grease, or any substance that can be removed by solvent, shall be solvent cleaned to remove those substances. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compounds shall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering oxide may be left on the surface. Any area where rust reappears before lining must be re-blasted.

3. Lining

After surface preparation and within 12 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness. No lining shall take place when the substrate or ambient temperature is below 40°F. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

4. Coating of Bell Sockets and Spigot Ends

Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto 401™ Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be

taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

5. Number of Coats

   The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. To prevent delamination between coats, no material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.

6. Touch-Up and Repair

   Protecto 401™ Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

g. Inspection

1. All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC PA-2 Film Thickness Rating.

2. The interior lining of all pipe barrels and fittings shall be tested for pinholes with a non-destructive 2,500 volt test. Any defects found shall be repaired prior to shipment.

3. Each pipe joint and fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified.

h. Handling

1. Lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying. The pipe shall not be dropped or unloaded by rolling.

2. Care should be taken not to let the pipe strike sharp objects while swinging or being off loaded. Ductile iron pipe should

never be placed on grade by use of hydraulic pressure from an excavator bucket or by banging with heavy hammers.

2.04 Fusible HDPE Drawdown Pipe

A. HDPE shall generally be per Workmanship and Material Section 14 Pressure Pipe – Water. HDPE pipe shall be per PE 4710, DR 11 200 psi (Ductile Iron Pipe Size) pressure pipe. HDPE shall be butt fused.

2.05 Flexible Expansion Joint

A. Install flexible expansion joint where shown on the plans. Flexible expansion joint shall be manufactured of ductile iron conforming to the material requirements of ASTM A536 and AWWA C153. Flexible Expansion Joints shall not be utilized for grade changes, fittings shall be utilized.

B. Flexible expansion joint shall be pressure tested prior to shipment against its own restraint to a minimum of 350 psi. A minimum 2:1 safety factor, determined from the published pressure rating, shall apply.

C. Each flexible expansion joint shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 20° and 4-inches minimum expansion. Additional expansion sleeves shall be available and easily added or removed at the factory or in the field. Both standardized mechanical joint end connections shall be available.

D. Provide restrained mechanical joint restraint on each end.

E. All internal surface (wetted parts) shall be lined with a minimum of 15 mils of fusion boded epoxy conforming to the applicable requirements of AWWA C213. Sealing gaskets shall be constructed of EPDM. The coating and gaskets shall meet ANSI/NSF-61.

F. Exterior surfaces shall be coated with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C 116.

G. Appropriately sized polyethylene sleeves, meeting AWWA C105 shall be included for direct bury application.

H. Flexible expansion joints shall be Flex-Tend as manufactured by EBAA Iron, Inc or approved equivalent.

2.06 Stainless Steel Screen

A. Stainless steel drum screen shall be joined to the ductile iron pipe via flanged connection. Bolts for flange shall be stainless steel. Stainless steel screen shall be a minimum of 16” in diameter and 18” in screen length. Mesh shall be 1.5” x 1.5”.

2.07 Ball Valve

A. Ball Valve shall be 1-1/2” in diameter, made from 316 stainless steel. Body shall be inline with min. 250 psi working pressure with FNPT x FNPT connections.

2.08 Concrete Pipe Collar and Lake Drawdown and Intake Concrete Anchor

A. Concrete and reinforcement shall be per Detailed Specification Section Reinforced Concrete Structures. Lake Drawdown and Intake Concrete Anchor shall be Revetment Riprap per Detailed Specification Section Riprap, minimum thickness of 30”. Pipe collar connections shall be made with stainless steel straps and hardware.

3. EXECUTION

3.01 Installation

A. The manholes shall be installed in accordance with the Workmanship and Materials Specifications, WM-9, "Standard Manholes". The structures shall be installed so that the top of the structure lid and frame is set one inch above final grade.

B. Contractor shall provide a removable support or blocking under valves and tees.

C. Gate Valve nut shall be located to the edge of the manhole frame lid to allow operation from above and to maintain man access to the valve. Stem shall be securely anchored or fastened to the manhole structure as required or necessary per manufacturer’s recommendation. Valves, provided with fusion bond epoxy, may not require field coat painting.

D. Pipe collars shall be installed at minimum intervals and minimum amount of total collar required as shown on the plans.

E. Lake Drawdown Anchor shall be installed plumb on revetment riprap foundation as required to create a firm, stable base.

F. Ductile Iron Drawdown pipe, ball and socket within lake, shall not exceed pipe deflection (12 degrees maximum). No joints shall be installed in a final position in a fully deflected state. Fittings shall be utilized where necessary. Contractor install a laying chute if required to maintain such alignment. Chute shall require Engineer or Owner approval and shall not consist of excavating into embankment – only adding approved materials.

G. Ductile Iron Drawdown pipe, mechanical joint with restraints on downstream embankment shall not exceed pipe deflection (4 degrees maximum). No joints

shall be installed in a final position in a fully deflected state. Fittings shall be utilized where necessary.

H. If fusible HDPE is installed on downstream embankment, Contractor shall provide pressure rated restrained coupling for specific outside pipe diameter differences. Coupling shall be installed approximately 15 feet downstream of New Str. 102 and 5 feet prior to New Str. 103. Pipe shall not exceed allowable tolerances or restrained fittings shall be provided.

I. Restrained joint mechanical joint ductile iron pipe shall be installed from New Str. 103 to the New Str. 104 Headwall.

J. Drawdown pipe through the embankment shall be installed with compacted impervious pipe bedding and backfill, utilizing clay and bentonite, 1-2% by weight.

3.02 Testing

A. Once Contractor deems the facility is ready for operation, Contractor shall test, with Owner and Engineer present to ensure the facility works as intended. Contractor shall make all necessary repairs or adjustments, if required, and re-test until operations are deemed satisfactory by Owner and Engineer.

END OF SECTION 12

SECTION 13

PRESSURE GROUTING

1. GENERAL

1.01 Scope

A. The Contractor shall furnish all material, labor, equipment and do all work necessary to complete the pressure grouting for the project as shown on the Plans, as specified herein and as order by Engineer or Owner. Work shall include, but not limited to: drilling (soil and rock); washing and pressure testing grout holes; verification holes; grout materials, including, transporting, storing, mixing, testing and injecting; making grout connections; care and disposal of drill cuttings; surface crack treatments; waste water and waste grout; clean up, and all other miscellaneous or incidental work to pressure injecting grout.

B. **All work contained within this specification shall pertain to Alternate 5.**

C. The Contractor's methods shall safely treat the rock and foundation soils, particularly the soil and rock interface areas. The Contractor shall take all the necessary precautions to prevent hydrofracturing or jacking or uplifting of the existing exposed rock spillway chute due to back pressures.

D. During grouting operations, the Owner reserves the right to direct the grouting operation when deemed necessary to maintain dam safety.

1.02 Quality Assurance and Qualifications

A. The pressure grouting shall be performed by a specialist Grouting Contractor with a minimum of five (5) continuous years of documented experience in pressure grouting. Evidence of previous grouting project experience shall be provided.

B. The Grouting Contractor shall provide evidence of experienced management, supervisory and key personnel as required to implement the grouting program, as follows:

1. Project Manager shall have a minimum of five (5) year of continuous experience in grouting, with a minimum of the past two (2) years being fully employed by said Grouting Contractor.

2. Project superintendent shall have at least two (2) years of experience in grouting.

C. The Contractor shall use an automated grouting recording and control system to record, display and control the grouting and water pressure testing of this contract. The Contractor shall take all necessary precautions to prevent hydrofracturing or jacking due to back pressure. The operator of the automated recording and control systems shall have at least one (1) year of

experience operating the equipment and three (3) years of foundation grouting experience.

1.03 Submittals

A. The Contractor shall provide a detailed working plan describing all operations and phases of said work, including, but not limited to: site preparation; equipment details; drilling procedures; flushing details; water pressure testing; grouting; grout mixes; quality control; grouting pressures to safely treat the rock and foundation soils; schedule and emergency procedures. This method shall be fully understood by the Owner before the work begins. During construction, Owner shall monitor the working plan to ensure it complies with the agreed methodology.

A pattern of primary drilling holes has been provided in the drawings and described in this section. Any proposed changes to grout hole orientations shall be described in work plan.

Work Plan shall include details of the sequence of overburden casing, coring and drilling of verification and grout holes, anticipated staffing and shifts, identification of key milestones and a list of assumptions and a discussion of their potential impacts on the course of work.

Work plan shall include general guidelines and procedures for identifying and isolating zones of grout take and procedures to be followed in the event of communication in grout holes, thickening and thinning expeditiously to the grout hole, the procedures used to minimize wasted grout and testing procedures.

B. If work is scheduled to take place during winter weather or during high temperatures of the summer months, Contractor shall submit detailed working procedures to ensure quality of the project is maintained.

C. Grouting Contractor shall submit how equipment delivery and flow and pressure equipment will be verified on a routine basis. Contractor shall provide weekly calibration reports on the automated grout recording and collection system equipment. The reports shall give order or accuracy and frequency of calibration.

A. Grouting Contractor shall submit Marsh funnel and specific gravity test during construction operation. Flow cone, may be required for apparent viscosity where thicker grouter is used (flow time exceeds 60 to 70 seconds).

D. Grouting Contractor shall submit Grout Hole Drilling Logs, Pressure Testing and Grouting Logs, Grouting and Field Testing Reports.

E. Contractor shall submit test results prior to starting grout work demonstrating the water source has no deleterious effect on the grout quality. These tests shall be in accordance with ASTM C1602/C1602M for non-potable water only.

F. Contractor shall submit daily, weekly, monthly Contractor quality control grout tests.

2. MATERIALS

2.01 Equipment

B. General

All grouting equipment shall be of a type, capacity and mechanical capability suitable for performing all said work. The equipment shall be maintained in a first class operating conditions. Any grout hole that is lost or damaged due to mechanical failure of equipment's, inadequacy of grout supply, or improper injection procedure shall be properly filled and replaced by another hole, drilled by the Contractor, at Contractor's expense.

Contractor shall provide a list, details and data on the drilling, pressure washing, pressure testing and grouting equipment. Equipment details shall include, but not limited to: instrumented packers, gages, transducers, borehole deviation survey equipment, pumps, hoses, drills, drill bit size and type, stabilizers, and any equipment that impact the quality of work, calibrations methods for gages, flow meters, head loss plots at various pressures, and flow rates for the grouting system, and any additional equipment details as requested by Owner or Engineer.

C. Drill Rig

The drilling rig shall be able to give appropriate thrust during drilling and sufficient pull back from the maximum drilling depth, bearing in mind the potential for hole instability and rod jamming. The rig must permit the holes to be drilled at every specified angle and azimuth. The mast must remain constant in orientation during drilling, with minimal vibration and drift. All the major components, especially the mast, must be able to resist, without damage, the various combinations of thrust, torque and vibration created by the drilling method. The rig must permit access to all hole locations, even on steep slopes.

D. Grout Mixing Equipment

High-speed, high shear mixer shall be utilized to obtain a uniformly mixed and dispersed grout and the agitating equipment shall be used to maintain the grout in a uniformly blended suspension. Equipment shall be operated at appropriate speeds and length of time to obtain the best result. Agitators, unless fully automated, shall be located within 100 feet of the hole being grouted. Agitators, shall discharge by pumping rather than gravity. Equipment shall have all oversized grout materials removed, including grout scales, or contaminants that may otherwise prematurely clog the hole.

2.02 Grout Mixes

A. Contractor shall submit and provide details of several grout design mixes, including all components, proportions, mixing procedures and sequence of additives and admixtures of all mixes. The goal of the varying mix designs shall be of bringing each stage to a full and natural refusal, avoiding premature refusal and lack of refusal. Contractor shall provide test results for viscosity, specific gravity, set times (initial and final), strength (at 3, 7, 14 and 28 days), bleed shrinkage, and other testing results as required.

B. The use of cementitious grout shall be a high mobility-grout (HMG) type, balanced and stable, designed for zero bleed and a pressure filtration resistance of less than 0.5 $min^{-1/2}$.

C. Contractor shall submit and provide detailed grout designs for: void filling of karstic features (which may include the use of a low mobility-grout (LMG)), for grouts installations below water table (which may consider water repellent characteristic such as modified cellulose admixture) and for grout placements with minimal or high groundwater flow rates (antiwashout additive or other).

3. EXECUTION

3.01 General Installation

A. The Contractor shall drawdown the lake to elevation 684.00, prior to initiating grouting to reduce the reservoir head. refer to the Lake Drawdown and Dewatering Detailed Specification for details.

B. Prior to initiating any grouting work, Contractor shall have an approved working plan detailing all work procedures, materials, equipment, testing procedures, etc. Contractor shall identify or detail proposed variations or changes that may differ from what is detailed here-in.

C. Contractor shall seal any existing rock seepage pathway (fissures or cracks) with dental concrete, to plug any voids. Refer to Detailed Specification Section Excavation and Embankment for details or requirements.

D. The drilling, water pressure testing and grouting shall follow the sequence of the work presented in the Contractor's working plan.

3.02 Drilling

A. Air flush drilling, shall not be permitted for fissure grouting operations or for karstic treatments under structures, which includes air-water mists using conventional air-powered, direct circulation (DC) down-the-hole (DTH) hammers.

B. When drilling through the existing dam embankment, neither air nor water, under pressure, and at anything other than minimal amounts, is permissible for fear of pneumatic or hydraulic fracture. USACE Guideline "Engineering and Design Procedures for Drilling Earth Embankments" should be observed.

C. General project installation shall consist of two rows of primary grout holes being provided. The holes for each row shall be installed at an inclined 15º angle (in opposing directions) to form a crisscross. The primary holes shall be spaced ten (10) feet maximum, with the rows being offset and staggered. Primary grout holes shall be drilled to minimum elevation of 665.0.

D. The Grouting Contractor shall field mark all planned hole locations before drilling begins and allow Owner and Engineer to review locations. The Contractor shall be responsible for setting up the proper holes and drilling in an approved manner to the appropriate depth, at the correct angle and correct direction.

E. Exploratory holes or superprimaries, and verification holes can be drilled by coring methods.

F. The Contractor shall start with the downstream row. Within any row and within any area being grouted, drilling should start with a primary hole and end with a primary hole. No secondary hole should be drilled until the primary holes on both sides have been drilled and grouted and until the grout injected has taken an initial set. This shall allow evaluation and basis for assessing whether there is interaction between the grout holes and whether there is a progressive reduction in grout take as the hole spacing is reduced.

G. Secondary holes installation shall require Engineer and Owner approval prior to proceeding. Holes that that have above-standard grout takes, or drilling, water testing, and grouting data, may make some holes be determined a “hot spot” which higher order priority shall take precedence.

H. Grout nipples shall be set to a tolerance of no greater than 1.5º± and wedged in place. The Contractor shall replace, at no expense to the Owner, any hole that is drilled out of sequence, any nipple that is found not to have been installed at the correct orientation or angle.

I. Furthermore, no drilling shall be permitted at any location that is covered with water or loose material. Water and cuttings shall be directed away from the drill hole, loose material or water shall not be allowed to re-enter the drill hole.

J. Drilling parameters shall be measured and documented during drilling (every 3 min. max.), including: penetration rate, thrust or hold-back pressure, torque pressure, speed of rotation (revolutions per minute), flush return characteristics (nature of cuttings or loss of flush), drill and rod action (wobbling, chattering, binding), interconnection between hole or surface leakage and indication of hole instability.

K. Contractor shall provide specific detail and provide potential solutions for drilling operations that may require drill stop and the hole being grouted for any of the following circumstances:

1. within one (1) foot of losing 50% or more of the circulating fluid;

2. encountering artesian flow from the hole;
3. within five (5) feet of encountering loose, caving conditions; and
4. within one (1) foot if surface leaking is observed during drilling.

L. The use of grease ("rod dope") on the rods is not allowable due to grease preventing grout from adhering to the rock. (Use of grease, in limited quantities, on the threads is essential and permissible.)

M. The use of conventional clay-based drilling mud as a circulating fluid is non-permissible due to mud clogging fine fractures and mud coating preventing grout from adhering to rock surfaces in larger openings.

N. After drilling any hole interval for grouting, drill fluid circulation should be maintained until all cuttings have been removed from the hole. If there is communication of drilling fluid to nearby hole or to the surface, the Contractor shall wash the hole until only clear water returns to the surface. This step may require washing through a packer, using both air and water if satisfactory results are not achieved by washing through the drill rods.

O. Drilling, water pressure testing and grouting of initial primary holes shall not be performed within 50 feet of other open grout holes or grout holes in the process of being drilled, water pressure tested or grouted. This approach can be re-examined with actual field observations and shall not apply to later primary, secondary or higher order holes if grout travel distances are not occurring and hole to hole connections are infrequent.

P. For remedial grouting under existing embankments, Contractor shall install and seal a standpipe through the embankment into the existing rock. Standpipe shall be installed within the previously installed, temporary drill casing which shall be withdrawn as, or before, the standpipe is sealed into the formations and embankment via annular grouting. End of casing grouting and rock socket shall be used. Contractor shall install an inflatable barrier bag or swell seal around the standpipe, similar to the Multiple Packer Sleeved Pipe System (MPSP) and develop a very clear method statement detailing how the standpipe sealing operation is to be conducted and verified.

3.03 Hole Flushing and Water Pressure Testing

A. Contractor shall provide details and specifics for flushing and water pressure testing. Contractor shall provide and submit all associated water pressure results electronically.

B. Contractor shall flush or wash to clear the entrance into fractures for water and grout. Washing incidental to, and concurrent with, the drilling operation is not sufficient to clean the hole prior to water testing and grouting. Flushing and washing shall clear the entrance into the fractures for water and grout, but removal of substantial clay infilling shall not be considered the goal of the hole washing operation.

C. Water-pressure (permeability) test of the multi-pressure “Houlsby” type shall be performed for all stages in exploratory holes, superprimaries and verification holes.

D. Residual permeability, shall be no greater than 3 Lugeons, as calculated by the actual Lugeon value (actual rock mass permeability). Apparent Lugeon values, shall be generated and provided within drilling reports, by the automated grouting and data collection system, but the actual final Lugeon value shall be verified through water testing results.

3.04 Grouting

A. Contractor grouting method shall be selected to ensure the existing dam embankment is protected from erosion, hydrofracturing or jacking or uplifting of the existing exposed rock spillway chute due to back pressures. Downstage grouting (descending) grouting techniques shall be implemented for all drilling and remedial grouting through the existing dam embankment, unless otherwise approved by the Owner. Contractor may elect to use practical downstage grouting techniques for all other areas, to verify hole stability exist. Practical downstage procedure shall continue until such time Contractor shall determine if water losses and hole stability are such that upstage (ascending) grouting techniques, drilling and grouting is clearly possible.

B. Grout acceptance rate, indicating refusal, should be measured over a period of at least 10 min to allow time to verify the apparent slow rate of take is not due to extraneous factors. Once refusal criterion has been met, the header valve should be closed and the packer shall be left in place until the grout sets in holes from which seepage has occurred, or the hole shall be capped.

C. Site specific data relevant to the identification of the maximum safe injection pressure has not been conducted prior to initiating this grouting program. Contractor shall provide specific details within the detailed working plan on grout pressure to be utilized to protect the embankment from hydrofracturing, or jacking or uplifting of the existing rock spillway chute due to back pressures. Pressure consideration shall be closely monitored during the early stage of the project, utilizing automatic recording system data, which may lead to the modification of the injection pressure criteria. Contractor shall ensure no uplift or permanent displacement (large increase in flow rate of grout or drop in injection pressure) occurs at the existing rock spillway surface. Furthermore, Contractor shall ensure closely bedded or fissile rock foundations, hydraulically fracturing rock, lest impermeable planar fractures are not opened unnecessarily. Special consideration will be warranted at the existing rock spillway and dam embankment (left side of spillway looking downstream) which the existing rock may have a steep drop off and grouting may cause a lateral displacement.

D. Refusal criterion, injection rate at which grouting on a stage is stopped, shall be considered less than 0.1 gallons per minute (gpm) in 10 minutes.

E. Surface leakage, in fine fractures of hard rock shall be plugged, refer to Detailed Specification Section Excavation and Embankment for details.

F. Artesian flow, if encountered, shall be treated separately from the remainder of the flow. The artesian flow shall be treated prior to drilling to the planned depth. Drilling operation shall be stopped, and allow the hole to drain the maximum amount of time before attempting to inject grout. Injection of the water-producing zone shall be accomplished with the highest safe pressure. The hole shall be plugged or packer remained in place to allow the grout to be sufficiently set to stop the tendency of water.

G. Grouting shall not take place in rock that is below freezing temperatures. US Army Corps of Engineers, (1984) *Grouting Technology Engineer Manual* 1110-2-3506 procedures shall be followed for winter grouting. Basic winter grouting procedures from the manual include: "For winter grouting, all grout shall be maintained at temperatures above 50º F until injected. The temperatures of mixing water range from 50º F to 100º F when added to the grout mixer. Storage of grouting materials is at temperatures above freezing. In addition, the grouted rock should be no colder than 40 º F when grout is injected and for a period of five (5) days thereafter. It shall be up to Contractor on how to accomplish the work. Insulation, heated enclosures, and water heaters are frequently necessary.

H. For Hot-weather grouting, Contractor should avoid high mixing water temperatures to the extent feasible to reduce the acceleration of the set time of grout. Grout scale and build up in mixers and agitators shall be removed. Grout, grouting materials and equipment, shall be protected, which includes removal of all items from direct sunlight during extreme hot weather. Grout hoses should be covered with wet burlap to keep temperatures of the grout below 90º F. If necessary, grout operations, with Owner approval, may take place during night, adding ice to the water supply tank used by the grout mixers, running grout lines through ice baths.

END OF SECTION 13

SECTION 14

REINFORCED CONCRETE STRUCTURES

1. GENERAL

1.01 Scope of Work

The Contractor shall furnish all material, labor, equipment, and do all work necessary to complete the installation of Reinforced Concrete Structures as shown on the plans, specified herein and as ordered by Engineer or Owner. Work shall include, but not limited to: layout; subgrade preparation; subgrade review and compaction testing (for soil and for compacted aggregate base 53 stone when wall in founded on soils) by Contractor's hired geotechnical engineer; reinforcement; all formwork; all expansion and construction joints; water stops; grout fills; curing materials; waterproofing materials; rubbed finish work; floor hardening materials; concrete and placement; finishing; anchor bolts; bulkheads; bracing; conduits required to be embedded in the concrete; weep hole filter; all testing; cleanup and all other miscellaneous or incidental work for complete installation.

The Contractor shall be responsible for installing the reinforced concrete structures within the work limits indicated on the plans, which generally consist of the reinforced concrete spillway walls and foundations, reinforced concrete large precast block foundation, New Str. 104 – Lake Drawdown Outlet Headwall, all work associated with the access drive and or miscellaneous structures referenced from other Detailed Specification sections.

1.02 Submittals

The Contractor shall submit to the Engineer plans and details describing the materials and methods which he proposes to use. No work shall proceed until such plans and methods have been reviewed for conformity with the approved permit by the Engineer. The review by the Engineer of any plans or methods shall not relieve the Contractor of his responsibility in any way.

Contractor shall submit per all requirements of WM 5.2 "Cast-In-Place Concrete" including a quality control plan.

2. PRODUCTS

2.01 POURED-IN-PLACE STRUCTURES

A. All reinforced concrete structures formed and poured in place shall be constructed with Class A concrete as specified herein unless otherwise indicated in these specifications or on the drawings. The concrete and concrete forms shall be furnished and installed as described in WM 5.1, WM 5.2, and WM 21 of the Workmanship and Materials Specifications.

B. In addition to the finishing requirements described in WM 5.2, the Contractor shall provide a “Smooth Rubbed Finish” to all exposed concrete and from 8-inches below finished grade. The procedures for a smooth rubbed finish are described in WM 5.2.

C. Submittals: In addition to the provisions required in Specification Section WM 5.2 “Cast-in-Place Concrete”, submit a detailed joint plan and all associated waterstop details.

D. Exposed Edges: All edges of exposed concrete are to have ¾-inch chamfers unless noted otherwise on the Drawings.

E. Waterstops - Extruded Polyvinyl Chloride (PVC)

1. At least 6" wide X 3/8" thick with longitudinal ribs and hollow centerbulb.
2. Split-fin waterstops may be used for vertical wall joints.

2.02 CONCRETE MIX CLASSES

A. Class A Concrete (Footings and Retaining Walls):

1.	Compressive strength at 28 days:	4500 psi.
2.	Portland Cement:	ASTM C150, Type II
3.	Minimum cement content:	611 lb/cu yd.
4.	Maximum water-cement ratio:	0.45.
5.	Air content:	6% +/- 1%

B. Non-Shrink Grout

1. Grout shall be a high early strength, non-metallic, shrinkage resistant (when tested in accordance with the latest edition of ASTM C827 or CRD-C621), premixed, non-corrosive, non-staining, synthetic fiber reinforced product conforming to the requirements of the latest edition of ASTM C1107 and containing Portland Cement, silica sands, shrinkage compensating agents and fluidity improving compounds.

2. Synthetic fibers shall be virgin (non-recycled) nylon or polypropylene fibers conforming to ASTM C1116, Type III. Fibers shall be introduced into the mix at the plant in accordance with the manufacturer's recommendations. The Contractor shall submit the mix design, including the fiber size and quantity, to the Structural Engineer for approval prior to construction. The Contractor shall take adequate measures to manage any difficulty in concrete finishing associated with the use of the fibers. Apply at a rate of 1.5-LBS/CYD.

3. Grout compressive strength tests shall be performed in accordance with the latest edition of ASTM C109, with a restraining plate placed over the molds.

4. Grout shall be installed in accordance with the manufacturer's instructions.

5. Grout shall be placed in a non-sag, flowable state. Grout shall be cured according to manufacturer's recommendations.

6. Strength shall be a minimum of 6,500-PSI in twenty-eight (28) days.

3. EXECUTION

A pre-pour meeting shall be scheduled with the Owner, Contractor, Testing Company and the Engineer at least seven (7) days prior to any placement of concrete on this project.

In general, the products and methods of execution are presented in WM 5.1 “Concrete Formwork”, WM 5.2 “Cast-In-Place Concrete”, and WM 21 “Expansion and Construction Joints and Waterstops”. Provide all materials and equipment as specified herein, as shown on the drawings, and as necessary.

Contractor shall provide construction schedule and give 48 hours notice prior to concrete pours to allow Engineer and Owner time to review reinforcement, joints, etc. Any deficiencies shall be repaired by Contractor.

Contractor shall provide all concrete testing as required for the project.

END OF SECTION 14

SECTION 15

LARGE PRECAST BLOCK RETAINING WALL

1. GENERAL

1.01 Scope

A. The Contractor shall furnish all material, labor, equipment and do all work necessary to complete the large precast concrete modular block units for the project as shown on the Plans, as specified herein and as ordered by Engineer or Owner. Work shall include, but not limited to: layout, foundation support, leveling pad (including reinforced concrete), installation of block, weep holes and drainage, free draining backfill and pipe, and filter fabrics placement to the lines and grades shown, clean-up and all other miscellaneous or incidental work for complete installation. Excavation, including rock removal, and subgrade/foundation preparation work is included under the Excavation and Embankment Detailed Specification.

B. Contractor and Manufacturer shall design wall system. All drawings shall be signed and sealed by a Professional Engineer who is licensed in the State of Indiana. Do not sign over engineer's seal. Each bidder is required to identify their intended block supplier as part of their bid submittal. Qualified suppliers must have at least 10 years' experience in fabricating these types of structures.

1.02 Product Handling

A. Contractor shall store and protect miscellaneous items at the project site above ground on platforms, skid or other supports and in accordance with manufacturer's recommendations. Contractor shall check for damaged materials and shall not incorporate any product damage into the project.

B. Contractor responsible for verifying proper material has been provided at delivery.

1.03 Submittals

A. Submit all product data: including fabrication drawings, manufacturer's installation instructions, shop or forming details showing exact dimensions of the units, concrete mix design, all pertinent performance data for concrete (28-day compressive strength, air content and slump), drainage pipe, drainage materials and geotextiles. Contractor shall provide Statement of Experience as detailed under section 1.04.

B. Submit Retaining Wall Design Calculations and Construction Shop Drawings. This shall include signed, sealed and dated drawings and engineering calculations for design of the wall system. Manufacturer shall provide Statement of Experience as detailed under section 1.04.

C. Submit proposed layout drawing, block finish and colors.

D. Contractor shall submit a Final Report, from Manufacturer's technical representative, indicating Contractor installed material in conformance with Manufacturer's recommendations. This report shall be provided prior to Contractor receiving final payment. Refer to paragraph 3.01 for details.

1.04 Quality Assurance

A. Retaining Wall Installation Contractor Qualifications. In order to demonstrate basic competence in the construction of precast modular block walls, the Retaining Wall Installation Contractor shall document compliance with the following:

1. Experience.

   a. Construction experience with a minimum of 30,000 square feet (2,800 square meters) of the proposed precast modular block retaining wall system.
   b. Construction of at least ten (10) precast modular block (large block) retaining wall structures within the past three (3) years.
   c. Construction of at least 50,000 square feet (4,650 square meters) of precast modular block (large block) retaining walls within the past three (3) years.

2. Retaining Wall Installation Contractor experience documentation for each qualifying project shall include:
   a. Project name and location
   b. Date (month and year) of construction completion
   c. Contact information of Owner or General Contractor
   d. Type (trade name) of precast modular block system built
   e. Maximum height of the wall constructed
   f. Face area of the wall constructed

3. In lieu of the requirements set forth in items 1 and 2 above, the Retaining Wall Installation Contractor must be a certified Precast Modular Block Retaining Wall Installation Contractor as demonstrated by satisfactory completion of a certified precast modular block retaining wall installation training program administered by the precast modular block manufacturer.

B. Retaining Wall Design Engineer Qualifications and Statement of Experience. The Retaining Wall Design Engineer shall submit a written statement affirming that he or she has the following minimum qualifications and experience.

1. The Retaining Wall Design Engineer shall be licensed to practice in the jurisdiction of the project location.

2. The Retaining Wall Design Engineer shall be independently capable of performing all internal and external stability analyses, including those for seismic loading, compound stability, rapid draw-down and deep-seated, global modes of failure.

3. The Retaining Wall Design Engineer shall affirm in writing that he or she has personally supervised the design of the retaining walls for the project, that the design considers all the requirements listed in paragraph 1.06 and that he or she accepts responsibility as the design engineer of record for the retaining walls constructed on the project.

4. The Retaining Wall Design Engineer shall affirm in writing that he or she has personally designed in excess of 100,000 face square feet (9,000 face square meters) of modular block earth retaining walls within the previous three (3) years.

5. In lieu of these specific requirements, the engineer may submit alternate documentation demonstrating competency in Precast Modular Block retaining wall design.

C. The Owner reserves the right to reject the design services of any engineer or engineering firm who, in the sole opinion of the Owner, does not possess the requisite experience or qualifications.

D. Manufacturer's representative shall be available and on-site during the first day of block installation to verify installation procedures.

1.05 Shop Drawing Preparation

A. The Retaining Wall Design Engineer shall coordinate the retaining wall construction shop drawing preparation with the project Civil Engineer, project Geotechnical Engineer and Owner's Representatives. The General Contractor shall furnish the Retaining Wall Design Engineer the following project information required to prepare the construction shop drawings. This information shall include, but is not limited to, the following:

1. Current versions of the site, grading, drainage, utility, erosion control, landscape, and irrigation plans;
2. electronic CAD file of the civil site plans listed in (1);
3. report of geotechnical investigation and all addenda and supplemental reports;
4. recommendations of the project Geotechnical Engineer regarding effective stress shear strength and total stress shear strength (when applicable) parameters for in-situ soils in the vicinity of the proposed retaining wall(s) and for any fill soil that may potentially be used as backfill in retained and/or foundation zones of the retaining wall.

B. The Retaining Wall Design Engineer shall provide the Owner with a certificate of professional liability insurance verifying the minimum coverage limits of $1 million per claim and $1 million aggregate.

C. Design of the precast modular block retaining wall shall satisfy the requirements of this section. Where local design or building code requirements exceed these specifications, the local requirements shall also be satisfied.

D. The Retaining Wall Design Engineer shall note any exceptions to the requirements of this section by listing them at the bottom right corner of the first page of the construction shop drawings.

E. Approval or rejection of the exceptions taken by the Retaining Wall Engineer will be made in writing as directed by the Owner.

F. The precast modular block design, except as noted herein, shall be based upon:
1. AASHTO Load and Resistance Factor Design (LRFD) methodology as referenced in paragraph 1.06., or
2. NCMA, Design of Segmental Retaining Walls, referenced in Section 1.06

G. In the event that a conflict is discovered between these specifications and a reasonable interpretation of the design specifications and methods referenced in paragraph F above, these specifications shall prevail. If a reasonable interpretation is not possible, the conflict shall be resolved per the requirements in paragraph 1.06.

H. Soil Parameters for Design. The Retaining Wall Design Engineer shall prepare the construction shop drawings based upon soil parameters shown on sheet S1-1. The parameters for global stability are provided in the geotechnical report. If insufficient data exists to develop the retaining wall design, the Retaining Wall Design Engineer shall communicate the specific deficiency of the project information or data to the Owner in writing.

I. Allowable bearing pressure requirements for each retaining wall shall be clearly shown on the construction drawings.

J. Global Stability. Overall (global) stability shall be evaluated in accordance with the principals of limit equilibrium analysis as set forth approved standards as referenced in paragraph 1.06. The minimum factors of safety shall be as follows:

Normal Service (Static)	1.5
Seismic	1.1
Rapid Drawdown (if applicable)	1.2

K. Seismic Stability. Seismic loading shall be evaluated in accordance with one of the two previous code requirements.

1.06 Related Specifications

Where the specification and reference documents conflict, the Owner's designated representative will make the final determination of the applicable document.

Comply with applicable portions of the following WM Specifications:

A.	WM-2	Excavation
B.	WM-3	Backfill, Fills and Embankments
C.	WM-5.1	Concrete Formwork
D.	WM-5.2	Cast-In-Place Concrete
E.	WM-6	Concrete Reinforcement

Other Reference Standards:

A. Design
1. Minimum Design Loads for Buildings and Other Structures – ASCE/SEI 7-10.
2. International Building Code, 2012 Edition.
3. Design Manual for Segmental Retaining Walls, National Concrete Masonry Association, 3rd Edition, 2010

B. Precast Modular Block Units
1. ASTM C94 – Standard Specification for Ready-Mixed Concrete.
2. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
3. ASTM C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete.
4. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
5. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete.
6. ASTM C666 – Standard Test Method for Concrete Resistance to Rapid Freezing and Thawing.
7. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
8. ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete.
9. ASTM C1611 – Standard Test Method for Slump Flow of Self-Consolidating Concrete.
10. ASTM C1776 – Standard Specification for Wet-Cast Precast Modular Retaining Wall Units.
11. ASTM D6916 – Standard Test Method for Determining Shear Strength Between Segmental Concrete Units (Modular Concrete Blocks).

2. PRODUCTS

2.01 General

A. All units shall be wet-cast precast modular retaining wall units conforming to ASTM C1776.

B. All units for the project shall be obtained from the same manufacturer. The manufacturer shall be licensed and authorized to produce the retaining wall units by the precast modular block system patent holder/licensor and shall document compliance with the published quality control standards of the proprietary precast modular block system licensor for the previous three (3) years, or the total time the manufacturer has been licensed, whichever is less.

C. Concrete used in the production of the precast modular block units shall be first-purpose, fresh concrete. It shall not consist of returned, reconstituted, surplus or

waste concrete. It shall be an original production mix meeting the requirements of ASTM C94 and exhibit the following:

1. Minimum 28-day compressive strength of 4,000 psi (27.6 MPa).
2. Shall be free of water soluble chlorides and chloride based accelerator admixtures.
3. 6% +/- 1½% air-entrainment in conformance ASTM C94.
4. Maximum slump of 5 inches +/- 1½ inches (125 mm +/- 40 mm) per ASTM C143 for conventional concrete mix designs.
5. Slump Flow for Self-Consolidating Concrete (SCC) mix designs shall be between 18 inches and 32 inches (450 mm and 800 mm) as tested in accordance with ASTM C1611.

D. Each concrete block shall be cast in a single continuous pour without cold joints. With the exception of half-block units, corner units and other special application units, the precast modular block units shall conform to the nominal dimensions listed in the table below and be produced to the dimensional tolerances shown.

Block Type	Dimension	Nominal Value	Tolerance
28” (710 mm) Block	Height	18” (457 mm)	+/- 3/16” (5 mm)
	Length	46-1/8” (1172 mm)	+/- 1/2” (13 mm)
	Width*	28” (710 mm)	+/- 1/2” (13 mm)
41” (1030 mm) Block	Height	18” (457 mm)	+/- 3/16” (5 mm)
	Length	46-1/8” (1172 mm)	+/- 1/2” (13 mm)
	Width*	40-1/2” (1030 mm)	+/- 1/2” (13 mm)
60” (1520 mm) Block	Height	18” (457 mm)	+/- 3/16” (5 mm)
	Length	46-1/8” (1172 mm)	+/- 1/2” (13 mm)
	Width*	60” (1520 mm)	+/- 1/2” (13 mm)

* Block tolerance measurements shall exclude variable face texture
*Block dimensions shown on the plans are approximate only and Manufacturer shall provide sizes of block necessary to accommodate all loading conditions.
*Contractor shall provide 6” thick cap block.

E. Individual block units shall have a nominal height of 18 inches (457 mm).

F. With the exception of half-block units, corner units and other special application units, the precast modular block units shall have two (2), circular dome shear knobs that are 10 inches (254 mm), 7.5 inches (190 mm), or 6.75 inches (171 mm) in diameter and 4 inches (102 mm) or 2 inches (51 mm) in height. The shear knobs shall fully index into a continuous semi-cylindrical shear channel in the bottom of the block course above. The peak interlock shear between any two (2) vertically stacked precast modular block units, with 10 inch (254 mm) diameter shear knobs, measured in accordance with ASTM D6916 shall exceed 6,500 lb/ft (95 kN/m) at a minimum normal load of 500 lb/ft (7kN/m). as well as an ultimate peak interface shear capacity in excess of 11,000 lb/ft (160 kN/m). The peak interlock shear between any two (2) vertically stacked precast modular block units, with 7.5 inch (190 mm) or 6.75 inch (171 mm) diameter shear knobs, measured in accordance with ASTM D6916 shall exceed 1,850 lb/ft (27 kN/m) at a minimum normal load of 500 lb/ft (7kN/m) as well as an ultimate peak interface shear capacity in excess of 10,000 lb/ft (146 kN/m).Test specimen blocks tested under ASTM D6916 shall be

actual, full-scale production blocks of known compressive strength. The interface shear capacity reported shall be corrected for a 4,000 psi (27.6 MPa) concrete compressive strength. Regardless of precast modular block configuration, interface shear testing shall be completed without the inclusion of unit core infill aggregate.

G. The 28" (710 mm) and 41" (1030 mm) precast modular block units may be cast with a 13" (330 mm) wide, continuous vertical core slot completely through the block, or solid concrete.

H. Without field cutting or special modification, the precast modular block units shall be capable of achieving a minimum radius of 14 ft 6 in (4.42 m).

I. The precast modular block units shall be manufactured with an integrally cast shear knobs that establishes a standard horizontal set-back for subsequent block courses. The precast modular block system shall have the following standard horizontal set-back facing batter options listed below:

Horizontal Set-Back/Blk. Course	Max. Facing Batter
3/8" (10 mm)	1.2˚

The precast modular block units shall be furnished with the required shear knobs that provide the facing batter required that will all the precast block manufacturer to tie into the poured-in-place reinforced concrete wall.

J. The precast modular block unit face texture shall be split limestone face of a brown, buff color. Each textured block facing unit shall be a minimum of 5.76 square feet (0.54 square meters) with a unique texture pattern that repeats with a maximum frequency of once in any 15 square feet (1.4 square meters) of wall face. The top two rows shall have both sides textured and colored as noted above.

K. All precast modular block units shall be sound and free of cracks or other defects that would interfere with the proper installation of the unit, impair the strength or performance of the constructed wall. PMB units to be used in exposed wall construction shall not exhibit chips or cracks in the exposed face or faces of the unit that are not otherwise permitted. Chips smaller than 1.5" (38 mm) in its largest dimension and cracks not wider than 0.012" (0.3 mm) and not longer than 25% of the nominal height of the PMB unit shall be permitted. PMB units with bug holes in the exposed architectural face smaller than 0.75" (19 mm) in its largest dimension shall be permitted. Bug holes, water marks, and color variation on non-architectural faces are acceptable. PMB units that exhibit cracks that are continuous through any solid element of the PMB unit shall not be incorporated in the work regardless of the width or length of the crack.

L. Contractor shall provide wall outlets as required in Structural Drawings. Each wall outlet shall have a weep hole filter installed per Structural Drawings.

M. Preapproved Manufacturers.
Manufacturers of Redi-Rock Retaining Wall Systems as licensed by Redi-Rock International, LLC, 05481 US 31 South, Charlevoix, MI 49720 USA; telephone (866) 222-8400; website www.redi-rock.com.

Conditionally Approved Manufacturers.
ReCon Retaining Wall Systems by Reading Roaack Inc., 3370 Port Union Road, Fairfield, OH 45014 USA; telephone (513) 860-3593; website www.reading rock.com. Also, telephone (317) 913-9442.

The design, plans and specifications are based on the use of (18 in. nominal height) Redi-Rock type/size block. The use of the (16 in. nominal height) ReCon block will be considered under the submittal process, but the wall and structural foundation design shall require a professional engineer (in State of Indiana) that will visit the site and provide complete structural re-designs as part of the submittal process. The design shall also consider impacts on the backfill behind the wall, proper drainage of the adjacent dam embankment and must meet the minimum height requirements of the wall as shown on the plans.

2.02 Leveling Pad

A. Leveling pad shall be reinforced concrete foundation in rock. The leveling pad shall be constructed to dimensions and limits shown on the Structural Drawings and verified for usage by Retaining Wall Designer Engineer.

B. Concrete shall meet the requirements of Detailed Specification Section Reinforced Concrete Structures. The concrete should be cured a minimum of 12 hours prior to placement of the precast modular block wall retaining units and exhibit a minimum 28-day compressive strength of 2,500 psi (17.2 MPa) or as required by Structural Engineer. Non-shrink grout (min. 2” thick) shall be installed as required in Structural Drawings to fill top front face of reinforced concrete leveling pad (slope water away from the wall)

2.03 Free Draining Backfill and Retaining Wall Drain Pipe

A. Free Draining Backfill material shall consist of coarse gravel, washed river run gravel and fine aggregate, sand meeting specifications of the embankment filter drain per Detailed Specification Filter Drains.

B. An 8” perforated pipe, shall meet the requirements of the drain collector pipe materials, Dual Wall HDPE, per Detailed Specification Filter Drain. At the outlet, the retaining wall drain pipe shall transition to ductile iron and have a flap gate per Detailed Specifications Filter Drains.

C. Wall outlets shall be provided meeting the requirements shown in the Structural Drawings. Each wall outlet shall have a weep hole filter installed per Structural Drawings.

2.04 Filter Fabric

A. The geotextile filter shall meet the minimum physical requirements listed in Table No. 1 of these Specifications. Consultation with the manufacturer is recommended. Fabric shall be Geotex ® Woven Filtration / Monofilament Geotextile type 111F as manufactured by Propex Geosynthetics or approved equivalent.

B. The geotextile must be permitted to function properly by allowing relief of hydrostatic pressure; therefore concrete shall not be allowed to clog the filter fabric.

C. The geotextile fiber shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic, if necessary, to make the filaments resistant to deterioration due to ultraviolet and heat exposure. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile.

D. The Contractor shall furnish the Engineer, in duplicate, manufacturer's certified test results showing actual test values obtained when the physical properties are tested for compliance with the specifications.

E. During all periods of shipment and storage, the filter fabric shall be protected from direct sunlight, ultraviolet rays and temperatures greater than 140 degrees Fahrenheit. To the extent possible, the fabric shall be maintained wrapped in its protective covering. The geotextile shall not be exposed to sunlight, ultraviolet rays until the installation process begins.

TABLE 1 – PHYSICAL REQUIREMENTS

Physical Property	Test Procedure	Minimum Value
Grab Tensile Strength (Unaged Geotextile)	ASTM D4632	370 x 220 Lbs.
Breaking Elongation (Unaged Geotextile)	ASTM D4632	25 x 15
Burst Strength	ASTM D3786	450 psi
Puncture Strength	ASTM D4833	115 lbs.
A.O.S., U.S. Std. Sieve	ASTM D4751	30 or 0.6 mm
% Open Area	CWO-22125-86	8%
Permittivity	ASTM D4491	1.10 sec^{-1}

3. EXECUTION

3.01 Manufacturer's Representative

A. Contractor shall coordinate installation with Manufacturer of large precast block retaining wall system such that a representative is available for the installation; discuss and review pertinent installation details and ensure compliance with Manufacturer's installation recommendations.

B. At least seven (7) days prior to any placement of the large precast block retaining wall system, a technical representative (not a sales representative), from manufacturer shall conduct a pre-installation meeting with the Contractor. Contractor shall notify Engineer and Owner of such meeting to allow for attendance. Intent of meeting is to ensure Contractor installs the components in strict conformance with manufacturer's recommendations. Manufacturer's representative may make additional site visits, as needed, to verify installation was complete per manufacturer's requirements. Contractor may provide photo documentation of all installation steps to assist with manufacturer's verification. Manufacturer's technical representative shall provide a written report, with photo documentation, indicating Contractor completed installation in conformance with manufacturer's recommendations. If work was not complete per Manufacturer's requirements, Manufacturer shall provide reasoning and recommendations for Contractor to meet requirements. Engineer and Owner shall be given 72 hours to review Manufacturer's recommendations, prior to Contractor making revisions. Contractor shall then complete necessary work to ensure compliance with Manufacturer's product. Manufacturer shall provide final report indicating Contractor's installation was in conformance with Manufacturer's recommendations. The Manufacturer's final report shall be submitted to Engineer and Owner for review within one week of the final installation of such product and prior to Contractor receiving final payment

3.02 Excavation

A. Contractor shall excavate to the lines and grades shown on the construction drawings. In general foundation soil and rock foundation work shall comply with Detailed Specification Section Excavation and Embankment.

3.03 Foundation Soil Preparation

A. Where native foundation soil is found, materials shall be compacted prior to placement of the leveling pad material.

B. In-situ foundation soil shall be examined and tested by Contractor's hired geotechnical engineer to ensure that the actual foundation soil strength meets or exceeds assumed design strength. Soil not meeting the required strength shall be removed and replaced with acceptable, compacted material.

3.04 Foundation Rock Preparation

A. Where native foundation rock is encountered, which is anticipated for entire wall installation, Contractor shall excavate a minimum of 26 inches below the approximate flow line of the channel or per construction drawing requirements. The rock shall be squared up to allow concrete to be poured directly against the existing rock. All loose materials shall be removed or chipped away. Do

not pour concrete where flowing or standing water is encountered. Engineer shall review inspection prior to installation of leveling pad.

3.05 Leveling Pad Placement

A. Leveling Pad shall be placed as shown on the construction drawings or as specified here-in.

B. Leveling Pad shall be placed on rock cut.

C. Leveling Pad shall be reinforced concrete leveling pad within existing rock. Pad shall be constructed level and to the proper elevation to ensure the final elevation shown on the plans.

3.06 Grout Placement

A. Non-shrink grout, minimum of 2-inches thick, shall be installed on top of the Concrete leveling pad along the front face of the wall. This non-shrink grout shall be utilized to keep standing water from the wall and shall be per the drawings.

3.07 Unit Installation

A. The precast modular block structure shall be installed in accordance with the construction drawings, these specifications and the recommendations of the retaining wall system component manufacturers. Where the specification and reference documents conflict, the Owner's designated representative will make the final determination of the applicable document.

B. The first course of block units shall be placed with the front face edges tightly abutted together on adjacent blocks, on the prepared leveling pad at the locations and elevations shown on the construction drawings. The Retaining Wall Installation Contractor shall take special care to ensure that the bottom course of block units are in full contact with the leveling pad, are set level and true and are properly aligned according to the locations shown on the construction drawings.

C. Backfill shall be placed in front of the bottom course of blocks prior to placement of subsequent block courses. Filter fabric shall be placed in the V-shaped joints between adjacent blocks. Filter Drain aggregate shall be placed in the V-shaped joints between adjacent blocks, and extend to distances as shown on the plans. Installation of Filter drain aggregates shall be per Detailed Specification Section Filter Drains.

D. Unit core fill shall be placed in the precast modular block unit vertical core slot. The core fill shall completely fill the slot to the level of the top of the block unit. The top of the block unit shall be broom-cleaned prior to placement of subsequent block courses. No additional courses of precast modular blocks may be stacked before the unit core fill is installed in the blocks on the course below.

E. Base course blocks for gravity wall designs (without geosynthetic soil reinforcement) may be furnished without vertical core slots. If so, disregard item D. above, for the base course blocks in this application.

F. Subsequent courses of block units shall be installed with a running bond (half block horizontal course-to-course offset). With the exception of 90 degree corner units, the shear channel of the upper block shall be fully engaged with the shear knobs of the block course below. The upper block course shall be pushed forward to fully engage the interface shear key between the blocks and to ensure consistent face batter and wall alignment. Drainage aggregate, unit core fill, geotextile and properly compacted backfill shall be complete and in-place for each course of block units before the next course of blocks is stacked.

G. The elevation of retained soil fill shall not be less than 1 block course (18") below the elevation of the retained backfill throughout the construction of the retaining wall.

H. Cap units shall be secured with an adhesive in accordance with the precast modular block manufacturer's recommendation.

3.08 Construction Tolerance.

Allowable construction tolerance of the retaining wall shall be as follows:

A. Deviation from the design batter and horizontal alignment, when measured along a 10' straight wall section, shall not exceed 3/4".

B. Deviation from the overall design batter shall not exceed 1/2" per 10' of wall height.

C. The maximum allowable offset (horizontal bulge) of the face in any precast modular block joint shall be 1/2".

D. The base of the precast modular block wall excavation shall be within 2" of the staked elevations, unless otherwise approved by the Inspection Engineer.

E. Differential vertical settlement of the face shall not exceed 1' along any 200' of wall length.

F. The maximum allowable vertical displacement of the face in any precast modular block joint shall be 1/2".

G. The wall face shall be placed within 2" of the horizontal location staked.

3.09 Free Draining Backfill, Retaining Wall Drain Pipe and Filter Fabric

A. Installation shall be per Detailed Specification Section Filter Drains and per construction drawings. Filter fabric shall be installed to isolate the river run gravel materials from the concrete foundation, precast block wall and the top of the filter drain materials, below the riprap. The filter fabric shall be overlapped a minimum of two (2) feet. Any tears or punctures or damage to existing fabric, shall require filter fabric replacement. Weep holes shall be provided per drawings.

END OF SECTION 15

SECTION 16

FENCE

1. GENERAL

1.01 Scope

A. Contractor shall furnish all materials, labor and equipment necessary for complete fence installations for the project as shown on the plans, as specified here-in and as ordered by Engineer or Owner. Work shall include, but not limited to: layout and locations of post, post installations and anchoring device or materials, rail, bracing or support material installations, mesh installation, clean up and all other miscellaneous or incidental work required for complete installation.

B. Fence Locations, but not limited to:
(1) Chain link fence around the perimeter of the principal spillway large precast block area.
(2) Chain link fence on top of Str. 104 Reinforced Concrete Outlet Headwall.
(3) Chain link fence on top of principal spillway wall (poured-in-place concrete).

1.02 Product Handling

A. Store and protect miscellaneous fence and related metal and wood items at the project site as recommended by the manufacturer and the specifications.

1.03 Submittals

A. Submit shop drawing for all chain link fence materials, including but not limited to: woven wire fabric, gates, posts and other related anchors and fasteners.

B. Do not fabricate until shop drawings are approved.

C. Include all performance data such as strengths for concrete and metal items.

1.04 Related Specifications

Comply with applicable portions of the following WM Specifications:

A. WM-5.2 Cast-In-Place Concrete
B. WM-19 Miscellaneous Metal and Aluminum
C. WM-23 Chain Link Fence and Gates
D. WM-25 Painting

2. PRODUCT

2.01 Chain Link Fence

A. Chain link fence materials shall be per Workmanship and Material Section 23 Chain Link Fence and Gate with exceptions or additions contained here-in. All materials shall be new and unused.

B. Chain Link Type Fence (CLTF) shall be 48" in height (min.). Material product shall be per Workmanship and Material Section 23 Chain Link Fence and Gate Section 2.02 PVC Coated Steel Chain Fence. The PVC coated Wire can be Class 1, 2a or 2b. Diameter of the wire mesh and fabric shall be 0.148". The color of the fabric and posts shall be black. PVC coated tension wire shall be heavy duty gauge 7 metallic coated wire. No barb wire is required. Type II round posts shall be used. Terminal or corner pull post shall be min. 2 ½" in diameter with intermediate post min. 2" in diameter. Top and intermediate brace rails (min. 1 ½" diameter) shall be provided.

C. All mounting hardware to aluminum or concrete shall be stainless steel.

D. A protective (bituminous) coating shall be applied between all aluminum and concrete.

2.02 Concrete

A. Concrete for corner posts (which includes directional changes greater than 30 degrees), terminal posts, shall be a minimum strength of 4,000 psi at 28 days and shall be air entrained. The top of the concrete shall be convex shaped at the surface for drainage. Concrete shall be a minimum of 12" in diameter.

3. EXECUTION

3.01 Refer to Workmanship and Material Section 23 Chain Link Fence and Gates for installation of CLTF and other installation specifications.

3.02 Chain link posts shall be mounted on the top wall of concrete structures (including reinforced concrete outlet headwall or principal spillway wall). Posts on concrete shall be mounted with a malleable or adjustable (for sloping walls) floor flanges with concrete stainless steel anchor screws that will support the dynamic weight of persons who may lean over the fence.

3.03 Fence posts and railing shall be erected in such a manner that they will follow a straight line along the ground. Fence post shall be installed vertically plumb on sloped locations.

3.04 Holes made for concrete footings shall be vertically drilled. "Sono-tube" or approved equivalent (preformed, waxed cardboard tube forms) is to be placed in the hole when the ground conditions are such that the excavated walls cannot stabilize before pouring the concrete.

END OF SECTION 16

SECTION 17

PERMANENT SEEDING

1. GENERAL

1.01 Scope

A. The Contractor shall furnish all material, labor, equipment and do all work necessary to complete the Permanent Seeding and Mulching for the project site as shown on the Plans, as specified herein and as ordered by the Engineer or Owner. Permanent seeding shall include all disturbed areas, which may include, but not limited to access and staging areas, temporary construction access drives, or borrow sites when required. Work shall include, but not limited to: any soil preparation, top soil placement, seeding, lime installation, fertilizing, and mulching, special seed mixtures, clean up and all other miscellaneous or incidental work required for complete installation.

1.02 Quality Control

A. All permanent seeding shall be in accordance with this detailed specification and Workmanship and Materials Section 24 Seeding and Sodding. **SUBMIT** seed mixtures certifications prepared by manufacturer to certify materials furnished are in accordance with the specifications.

B. Any disturbed property which will not have construction activities on for 15 days shall be temporarily graded and seeded per Temporary Erosion and Sediment Control Specification Section.

2. MATERIALS AND SPECIFICATIONS

All seeded areas shall be mulched or have erosion control blankets or turf reinforcement mats installed. Refer to the plans and Temporary Erosion and Sediment Control Specification for temporary vegetation cover requirements, blanket and mat locations and requirements.

2.01 Lime, Fertilizer and Mulch

Refer to Workmanship and Materials Section 24 Seeding and Sodding.

2.02 Permanent Seeding for Embankment Dams

The following seed combination will be permissible for applications within optimum soil pH of 5.5-7.5.

DAM EMBANKMENT & GENERAL SEEDING AREAS – TYPE 1

Seed Species	Rates (Lbs. Per Acre)
Orchard Grass	5
Perennial Ryegrass	8
Redtop	3
Switchgrass	5
Timothy	4
Alfalfa	5
Red Clover	8

NATIVE SEED MIXTURE – TYPE 2

(TO BE INSTALLED BELOW TOE OF DAM EMBANKMENT AND NORTH SIDE OF EXIST. ROCK SPILLWAY AS SHOWN ON STROMWATER POLLUTION PREVENTION PLANS)

PERMANENT GRASSES/SEDGE MUST HAVE 10 of 12 SPECIES

Botanical Name	Common Name	PLS Oz./Acre
Andropogon gerardii	Big Bluestem	4.00
Carex comosa	Bristly Sedge	2.50
Carex cristatella	Crested Oval Sedge	2.00
Carex lurida	Bottlebrush Sedge	2.50
Carex sup.	Prairie Sedge Mix	8.00
Carex vulpinoidea	Brown Fox Sedge	4.00
Elymus virginicus	Virginia Wild Rye	8.00
Glyceria striata	Fowl Manna Grass	1.00
Panicum virgatum	Switch Grass	2.00
Scirpus atrovirens	Dark Green Rush	2.00

Scirpus cyperinus	Wool Grass	1.00
Spartina pectinata	Prairie Cord Grass	3.00
	TOTAL	40.00

FORBS MUST HAVE 12 of 17 SPECIES

Botanical Name	Common Name	PLS Oz./Acre
Alisma sup.	Water Plantain (Various Mix)	1.00
Asclepias incarnate	Swamp Milkweed	2.00
Aster novae-angliae	New England Aster	1.00
Coreopsis tripteris	Tall Coreopsis	1.00
Eupatorium maculatum	Spotted Joe-Pye Weed	0.25
Iris virginica	Blue Flag	4.00
Liatris spicata	Marsh Blazing Star	1.00
Lobella cardinalis	Cardinal Flower	0.25
Lobella siphilitica	Great Blue Lobelia	0.50
Lycopus americanus	Common Water Horehound	0.25
Pycanthemum virginianum	Common Mountain Mint	0.50
Rudbeckia triloba	Brown-eyed Susan	0.50
Sagittaria latifolia	Common Arrowhead	0.25
Senna hebecarpa	Wild Senna	1.00
Silphium terebinthinaceum	Prairie Dock	1.00
Verbena hastate	Blue Vervain	1.50
Zizia aurea	Golden Alexanders	0.75
	TOTAL	**16.75**

TEMPORARY COVER

Botanical Name	Common Name	PLS Oz./Acre
Avena sativa	Common Oat	360.00
Lolium multiflorum	Annual Rye	100.00
	TOTAL	**460.00**

3. EXECUTION

3.01 Prior to excavation, top soil suitable for replacement, shall be removed and stockpiled per Detailed Specification Section 6, Excavation and Embankment.

3.02 Upon finish grading of work area the CONTRACTOR shall permanently stabilize all finished grade areas with mulch, seed, and fertilizer. Contractor shall ensure the final grade is clear of all stones, boulders and debris; the area shall be thoroughly tilled to a depth of three (3) inches by disking, harrowing, or other approved methods, until the condition of the soil is acceptable to the Engineer. If as a result of a rain, a crust is formed over the prepared surface, the surface shall again be placed in a suitable condition for planting.

3.03 Commercial fertilizer or equal shall be uniformly spread over the top soil by a mechanical spreader and mixed into the soil for a depth of two (2) inches on areas to be seeded. This shall be done at least 48 hours before the sowing of any seed at the rate of 35 pounds per thousand square feet. The area shall then be lightly raked or harrowed until the surface of the finish grade is smooth, loose and pulverized.

3.04 All seeding shall be performed in accordance with this item specification and Workmanship and Material Section 24 Seeding and Sodding. Grass seed shall be sown at a rate of not less than three (3) pounds per thousand square feet.

3.05 No seed shall be sown during high winds or when the ground is not in a proper condition for seeding. Equipment shall be operated in a manner to insure complete coverage of the entire area to be seeded.

3.06 At Contractor's option, hydro-seeding method may be utilized. Hydro-seeding shall be done in accordance with the Indiana Department of Transportation Standard Specifications, latest edition.

3.07 Following final grading, fertilizing and seeding, the Contractor shall apply mulch to all newly seeded areas and crimp into the soil. Mulch shall consist of:

1. Dry straw or hay of good quality at the rate of two and one-half (2-1/2) tons per acre; or

2. Wood cellulose or cane fiber mulch at a rate of one thousand (1,000) pounds per acre; or

3. A combination of good quality dry straw, or hay free of seeds of competing plants, at a rate of two and one-half (2-1/2) tons per acre and wood cellulose or cane fiber mulch at a rate of five hundred (500) pounds per acre; or

4. Manufactured mulch materials such as soil retention blankets, erosion control netting, or others which may be required on special areas of high water concentration or unstable soils. When these materials are used, follow the manufacturer's recommendation for installation. Cost for erosion control blankets and mats shall be as specified in Temporary Erosion and Sediment Control Detailed Specification.

3.08 The seeded areas shall be watered, maintained and patched as directed by the Engineer until the Contractor's work is completed and accepted. Within three (3) months after completion of work, the Contractor shall be required to correct any defective work, such as bare spots in grass coverage, erosion, gullies, etc.

END OF SECTION 17

SECTION 18

REMEDIATION ALLOWANCE

1. GENERAL

A. RELATED DOCUMENTS
- A.1 DAPW 13 Contractor's Bid Form
- A.2 DAPW 26 General Conditions of the Contract
- A.3 DAPW 33 Standard Agreement for Construction Projects

B. SUMMARY – An allowance required by Public Works Division, Department of Administration, acting, as Owner shall be included in the base bid.

C. REMEDIATION ALLOWANCE

A.1. Contractor shall include an allowance of $ 15,000.00 in the Base Bid for Owner directed remediation of unforeseen constraints. **This amount shall be included as a separate item in the Schedule of Values, adding up to the total bid price.**

A.2. Such constraints may include but are not necessarily limited to unforeseen subsurface conditions particular to this construction site; improperly recorded or unrecorded physical properties and conditions at the site; obstruction of or delays to reasonable work sequences by the Owner; uncommon adverse weather or site conditions; and conflict within or omissions from the Contract Documents.

A.3. Such remediation work shall be proposed to and authorized by the Owner prior to execution, jointly documented by Contractor and Designer, and recorded in Contractor's as-builts and Designer's project record documents. Proposed work must be accompanied with full documentation, and if authorized, shall be billed against, and paid under the remediation allowance line item on the Schedule of Values.

A.4. **If any portion of the remediation allowance is not used during the project, that portion will revert to the Owner, and will not be included in the Contractor's final payment.**

2. PRODUCTS (Not Applicable)

3. EXECUTION (Not Applicable)

4. PAYMENT (As Authorized)

DETAIL SPECIFICATION
SECTION 19

CROSLEY LAKE DAM IMPROVEMENTS PROJECT

HYDROTURF® CS ENGINEERED TURF

Work associated within this specification is considered part of ALTERNATE 2: Add Emergency Spillway Utilizing Hydroturf CS System.

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LIST OF FIGURES

Work shall include all labor, equipment and materials for complete installation of the HydroTurf CS Emergency Spillway (Line 'E') as shown on the plans, specified here-in or as ordered by the Engineer or Owner. Work shall include subgrade preparation, compaction testing and foundation review by Contractor hired geotechnical engineer, geosynthetic and geomembrane installations, hydrobinder installation, colloidal concrete treatment, all perimeter anchoring, weep holes, all testing, reports, as-built data and manufacturer's site review and final inspection, clean-up, and all other miscellaneous or incidental work required for complete installation. Contractor shall provide smooth driving approach along dam embankment consisting of 2" of lime or sand padding on HydroTurf CS, then No. 73 crushed aggregate stone as necessary.

Note, on the Plans, Articulated Concrete Block Mats are shown and are considered Alternate 3 for bidding purposes. No percussion anchors, as shown on the plans are required for this system, unless specifically indicated within this Detailed Specification Section 19. Note, the HydroTurf CS system extends beyond the toe of the dam, subsequently the Concrete Armor Units installation will be shifted and less Riprap will be utilized. The end of the riprap shall remain at Station 32+15 (or as shown on Plan Sheet 09).

SUBMIT
Contractor shall submit a Final Report, from Manufacturer's technical representative, indicating Contractor installed product system in conformance with Manufacturer's recommendations. This report shall be provided prior to Contractor receiving final payment.

At least seven (7) days prior to any placement of the Hydroturf CS System, a technical representative (not a sales representative), from manufacturer shall conduct a pre-installation meeting with the Contractor. Contractor shall notify Engineer and Owner of such meeting to allow for attendance. Intent of meeting is to ensure Contractor installs the components in strict conformance with manufacturer's recommendations. Manufacturer's representative may make additional site visits, as needed, to verify installation was complete per manufacturer's requirements. Contractor may provide photo documentation of all installation steps to assist with manufacturer's verification. Manufacturer's technical representative shall provide a written report, with photo documentation, indicating Contractor completed installation in conformance with manufacturer's recommendations. If work was not complete per Manufacturer's requirements, Manufacturer shall provide reasoning and recommendations for Contractor to meet requirements. Engineer and Owner shall be given 72 hours to review Manufacturer's recommendations, prior to Contractor making revisions. Contractor shall then complete necessary work to ensure compliance with Manufacturer's product. Manufacturer shall provide final report indicating Contractor's installation was in conformance with Manufacturer's recommendations. The Manufacturer's final report shall be submitted to Engineer and Owner for review within one week of the final installation of such product and prior to Contractor receiving final payment.

SECTION 01 01 01

HYDROTURF® CS ENGINEERED TURF SPECIFICATION

PART 1: GENERAL

1.01 SUMMARY

A. Section Includes:
1. Specifications for the Engineered Turf component (Turf Type 2) of the HydroTurf® CS System.

1.02 RELATED SECTIONS

Section 31 23 13 - Subgrade Preparation
Section 01 42 00 - HydroTurf CS References and Definitions
Section 01 73 19 - HydroTurf CS MicroSpike Geomembrane Specification
Section 03 49 01 - HydroBinder® Infill Specification
Section 03 05 59 - Penetrating Catalyzed Colloidal Silicate Concrete Treatment for HydroTurf

1.03 REFERENCES

A. See Section 01 42 00 - References and Definitions

1.04 SUBMITTALS

A. MANUFACTURER
1. MQC Testing – Engineered Turf Component
a. Certificate of Compliance: Certificate of Compliance shall indicate that the engineered turf meets or exceeds the property values in Table 1. Also, the turf fiber color / blend shall be indicated.
a. Provide inspection records of the tufting procedures for every 300,000 sq.ft. of Engineered Turf, including:
1.) Inspection records that indicate the following properties as they relate to Section 2.01 – Engineered Turf:
a.) Tufting Gauge;
b.) Pile height;
c.) Roll length and roll numbers;
d.) Total product weight;

e.) Tensile Strength Product (lbs./ft.) (MARV) ASTM D 4595; and

f.) Tensile Strength of Yarn (lbs.) (MARV) ASTM D 2256.

B. GEOSYNTHETICS INSTALLER

1. Prior to beginning the installation of the HydroTurf CS System, GEOSYNTHETICS INSTALLER shall submit the following to the OWNER'S REPRESENTATIVE for Engineered Turf component:
   a. Verify in writing that GEOSYNTHETICS INSTALLER'S PERSONNEL have the following experience:
      1.) GEOTEXTILE SEAMERS
         i. Shall have installed at least 1,000,000 square feet of like materials.
   b. OWNER'S REPRESENTATIVE shall be responsible for approving resumes and qualifications of GEOSYNTHETICS INSTALLER PERSONNEL; and
   c. GEOSYNTHETICS INSTALLER PERSONNEL shall attend HydroTurf CS orientation prior to starting the work.

C. PRODUCT DATA

1. Refer to Section 2.0 for the Engineered Turf specifications applicable to this project and integral part of the product specifications.

PART 2: PRODUCTS

2.01 ENGINEERED TURF – HYDROTURF CS

A. Manufacturer: Shaw Industries, Inc.

1. The engineered turf component shall meet or exceed property values listed in Table 1 as an individual component and as the performance property for the HydroTurf CS system.

2. Engineered synthetic turf shall be supplied by Watershed Geosynthetics as a component of the HydroTurf CS Revetment System.

B. Substitutions

   a. None

C. The engineered synthetic turf shall be comprised of the following components:
   a. Polyethylene monofilament yarn fibers; and
   b. Two polypropylene backing geotextiles.

D. The polyethylene yarn shall conform to the color selected by the Owner per color coding provided under Section 1.04(A)(1).

Table 1 – Property Values for Engineered Turf Component (Turf Type 2) of HydroTurf CS System

Property	Test Method	Value
Engineered Turf Component		
Tufted Pile Height (inches)	ASTM D 5823	2.25 ± 0.25
CBR Puncture, lbs	ASTM D6241	800 (MARV)
Tensile Strength, MD/XMD, lbs/ft	ASTM D4595	1000 (MARV)
Pile Weight	ASTM D5848	34 ± 2.0 oz./sq. yd
Yarn	ASTM D 1577	Polyethylene Monofilament
Tensile Strength of Yarn	ASTM D2256	15 lbs min
Aerodynamic Evaluation	GTRI Wind Tunnel	120 mph with max. uplift of 0.12 lb/sf
UV Resistance and Stability of Synthetic Turf	ASTM G147 ASTM G7	>60% Retained Tensile Strength at 100-year exposure (projected)
Standard Roll Dimensions	12-ft (3.66-m) Wide x 300-ft (91.4-m) Long	
Roll Area (approximate)	3600 ft^2 (334.5-m^2)	
HydroTurf CS System Performance Properties		
Full-Scale Steady State Overtop Test	ASTM D7277 / ASTM D7276	40 ft/s of velocity
Manning's N Value	ASTM D7277 / ASTM D7276	0.018 – 0.025
Full-Scale Steady State Hydraulic Jump Test	Colorado State University (CSU)	Dissipates 30 horsepower per ft (min)
Full-Scale Wave Overtopping Test – Cumulative Volume	CSU Wave Simulator	165,000 ft^3/ft (min)
Full-Scale Wave Overtopping Test – Maximum Average Wave Discharge	CSU Wave Simulator	4.0 cfs/ft
Internal Friction of Combined Components (Low Confining Stress)	ASTM D 5321	23° min (peak) MicroSpike 33° min (peak) Super GripNet

PART 3: EXECUTION:

3.01 INSTALLERS

A. Installer shall be trained by Watershed Geosynthetics, LLC.

3.02 INSTALLATION

A. ENGINEERED TURF COMPONENT:
   1. Contractor shall ensure that:
      a. Engineered Turf tufts are not excessively pulled out by the installation process; and
      b. After the first panel is deployed, all subsequent panels are deployed on top of the previous panel, seamed, and then flipped into position.

3.03 ENGINEERED TURF COMPONENT DEPLOYMENT

A. Prior to installation of Engineered Turf Component, the Contractor shall review work with CQA PERSONNEL and provide all testing reports demonstrating work was installed per manufacturer's requirements (if test failed, Contractor shall provide documentation showing test passed):
   1. HydroTurf CS geomembrane component has been seamed, tested, approved; and
   2. The supporting surface (e.g., the geomembrane) is substantially free of debris or large scraps.

B. During deployment of Engineered Turf, Contractor shall be responsible for the following: (Contractor shall review work with CQA personnel and give CQA personnel opportunity to observe all installations)
   1. Observe the turf as it is deployed and record defects and disposition of the defects (i.e., panel rejected, patch installed, etc.);
   2. That repairs are made in accordance with Section 3.05 and the HydroTurf Installation Guidelines; (Contractor shall document defect locations and repairs made)
   3. Equipment used does not damage the turf or underlying geomembrane;
   4. That all panels are deployed from the top of the slope in a way that the Engineered Turf filaments are pointing upslope after deployment is complete;

5. That the turf is anchored to prevent movement by the wind (the GEOSYNTHETICS INSTALLER is responsible for any damage resulting to or from windblown Engineered Turf);
6. That the turf remains substantially free of contaminants;
7. That the turf is laid substantially smooth;
8. That on slopes, the turf is secured with sandbag anchoring at the top of the slope after deployment;
9. Fusion Seaming Method
    a. Engineered Turf fusion seaming device will be a DemTech VM20/4/A (Model No. VM-20/4/A Pro-Wedge Welder 120V, VM20 Outfitted with 100-KIT/4S/VC/A.2 Welding Kit, 4-in, 220V, S.S.) fusion welder only.
    b. Fusion seams require a minimum of 5 inches of overlap.
    c. Demonstrate the preparation methods and equipment utilized for removal of the salvage from the outside edge of the rolls of turf (i.e. trimming & cutting devices). Mechanical trimming and cutting devices will be utilized for salvage trimming. Box blades and knives shall not be utilized for salvage preparations. Fraying of geotextile strands when performing the removal of salvage is not acceptable.
    d. Frayed or loose edges and/or geotextile strands shall be cut off or removed.
    e. Since the temperature and speed controls of the DemTech VM-20 wedge welder are variable and can be increased / decreased depending on weather and environment conditions, the temperature and speed shall be confirmed with a trial seam. This trial seam shall be field tested. Trial seams shall be performed at the being of each day and during the day when the weather (i.e., temperature, humidity, etc.) conditions change.
    f. Trial seams shall be performed as outlined in the HydroTurf Installation Guidelines (most recent revision).
    g. Production fusion seams shall be continuous and have no gaps.
    h. Any damage and defects (including burnouts) that occur during production seaming will be repaired as outlined in Section 3.05 and HydroTurf

Installation Guidelines (most recent revision).

i. All seams not passing the visual inspection shall be repaired.

j. After seaming operations, the edges of the synthetic turf panels shall be sufficiently anchored with sandbags in the top of slope perimeter anchor trenches unless otherwise noted on the construction drawings.

3.04 EQUIPMENT ON THE TURF:

A. Construction equipment on the deployed synthetic turf shall be minimized to reduce the potential for synthetic turf material puncture. Small equipment such as generators shall be placed on scrap synthetic turf / geosynthetic material (rub sheets) above engineered synthetic turf.

B. During Construction:
   1. On slopes exceeding 15%
      a. No equipment will be allowed until HydroBinder Infill is in place.
   2. On slopes less than 15%
      a. ATV type vehicles and/or rubber tracked skid steer machines will be allowed prior to infill placement if the tire / track ground pressure is less than 5 psi.
   3. Equipment operators shall inspect equipment rubber tires or tracks for sharp protrusions from foreign matter or tire/track damage, embedded rocks, or other foreign materials protruding from tires/track prior to driving on the synthetic turf. Equipment travel paths driven on synthetic turf shall be as straight as possible with no sharp turns, sudden stops or quick starts.
   4. Damage caused by having equipment on the engineered synthetic turf (i.e., tears, rips, punctures, wrinkles, ripples, movement, etc.) shall be the responsibility of the installer to repair.

C. Post installation, no equipment shall be allowed on the HydroTurf until HydroBinder Infill is fully cured for 28 days:
   1. Driving should be limited and only in areas where the subgrade under the HydroTurf is well-compacted, firm and unyielding.
   2. Drivability tire / track (ground) pressures should be limited to less than 35 psi.

Rubber tire and/or tracked vehicles or equipment only.

3. On slopes flatter than 10%, allowable ground pressures may only be increased with the written approval of the Engineer or Owner.

D. Any activity that may be identified during the course of construction by the Engineer or Owner, OWNER'S REPRESENTATIVE, or CQA PERSONNEL as being a possible danger to the integrity of the HydroTurf CS system will prohibited regardless of any prior approval.

3.05 REPAIR AND TIE-IN PROCEDURES

A. ENGINEERED TURF COMPONENT:
   1. When Repairs and Tie-Ins of Engineered Turf occur, Contractor shall document locations and Contractor shall review work with CQA personnel and give CQA personnel opportunity to observe all said installations:
      a. Repairs to Engineered Turf are completed by using a 4-in overlapped heat-bonded seam;
      b. All tie-in seams along flatter slopes (i.e. 15% or less) with length greater than 25 feet will use an approved fusion welding machine so that consistent pressure is achieved throughout the seam; and
      c. A hand-held heat gun or leister with hand pressure will be used in smaller/concentrated areas. Passing trial seams using the hand-held heat gun shall be performed prior to production seaming. Trial seams shall be performed as outlined in the HydroTurf Installation Guidelines (most recent revision).
   2. GEOSYNTHETICS INSTALLER may also demonstrate techniques and practices as follows:
      a. Field demonstration and approval by the OWNER'S REPRESENTATIVE is required before incorporating any alternative technique. OWNER may require Contractor to request approval from Manufacturer prior to proceeding.

3.06 FINAL COMPLETION

A. Once work is complete, Geosynthetics Installer shall allow Engineer and Owner opportunity to review the following:

1. After HydroTurf CS components are deployed, seamed, has passed required testing successfully, and any repairs are made;
    a. The completed installation will be inspected by the OWNER'S REPRESENTATIVE and the GEOSYNTHETICS INSTALLER'S CONSTRUCTION QUALITY CONTROL SUPERVISOR (Contractor shall schedule meeting to ensure Owner is available during time Geosynthetic Installer is at site);
    b. Damage and/or defects found during this inspection will be repaired by the GEOSYNTHETICS INSTALLER;
    c. The installation will not be accepted until it meets the requirements of these specifications and any applicable State, Federal or Local Regulations.

B. Contractor shall supply the following information upon Installation of the HydroTurf CS system:
    1. The installation dates when each key work task was complete.
    2. Required independent testing laboratory and field test reports; any failed test shall be provided documentation by Contractor of additional test to result in successful test.
    3. Required GEOSYNTHETICS INSTALLER supplied documentation, including defect locations, repairs and all As-Built Record Drawings.

END OF SECTION

SECTION 31 23 13

HYDROTURF® SUBGRADE PREPARATION

PART 1: GENERAL

1.01 SUMMARY

A. Section Includes:

1. Specifications for approved subgrade below the HydroTurf System.

1.02 RELATED SECTIONS

Section 01 42 00 - HydroTurf CS References and Definitions
Section 01 73 19 - HydroTurf CS MicroSpike Geomembrane Specification
Section 01 01 01 - HydroTurf CS Engineered Turf Specification
Section 03 49 01 - HydroBinder® Infill
Section 03 05 59 - Penetrating Catalyzed Colloidal Silicate Concrete Treatment for HydroTurf

1.03 REFERENCES

A. See Section 01 42 00 - References and Definitions

PART 2: PRODUCTS

Not Used

PART 3: EXECUTION:

3.01 EXAMINATION

A. Evaluation and Assessment:

1. Responsibilities for the approval and maintenance of the subgrade are as follows:
   a. CONTRACTOR:
      1.) Contractor shall provide necessary passing compaction reports (minimum of four passing test conducted by Contractor's hired geotechnical engineer, over the area to be provided Hydro Turf) and verification on grades and elevations. Contractor shall give Engineer 48 hours notice, to allow Engineer time to review and

inspect subgrade for general conformance. Any deficiencies shall be repaired by Contractor. The prepared subgrade shall be inspected by the Owner, Engineer or by Contractor's geotechnical engineer and no additional material shall be placed until all parties has approved.

b. INSTALLER:

1.) Keep the accepted subgrade surface in a condition conducive to the deployment of all HydroTurf components.

2.) Subgrade acceptance is determined when the deployment of the product, or its components, begins.

3.) Maintain the previously accepted subgrade at or above the accepted condition.

4.) Identify any part of the subgrade that becomes non-compliant to the specifications during the course of construction.

3.02 PREPARATION

A. Surface Preparation:

2. Subgrade shall be smooth (free from ruts, depressions, etc.), uniform, firm and unyielding, and free from rocks, roots or other debris.
3. No rocks or protrusions greater than 0.75 inch in diameter will be exposed at the subgrade surface.
4. Approved subgrade shall be capable of supporting the weight of the product, installation equipment, and maintenance equipment.
5. Daily evaluation shall be performed to show that no changes have occurred that would render the subgrade unacceptable.
6. Compaction requirements shall be per Detailed Specification Section 06 Excavation and Embankment. Contractor shall compact existing cut / fill soils as specified within those sections, including providing all required testing (by Contractor's hired Geotechnical Engineer) to verify acceptable compaction efforts were met. No less than four tests shall be taken.

B. Anchor Trench Preparation

1. Anchor trenches shall be excavated to the grades and dimensions as specified

on the construction plans and/or Detailed Specification Section 19 FIGURES.

2. Anchor trenches shall be straight and uniform with no rough edges.
3. The inside edge of the anchor trench shall be rounded and smooth.
4. Anchor trenches shall be free of sharp objects and other deleterious material.

C. Non-Conforming Work

1. Subgrade not meeting specifications either before or during deployment of the HydroTurf, or its components, will be reported to the OWNER'S REPRESENTATIVE and corrected as required.

END OF SECTION

SECTION 01 42 00

HYDROTURF® CS REFERENCES AND DEFINITIONS

PART 1: GENERAL

1.01 SUMMARY

Section Includes References and Definitions related to the HydroTurf® CS product.

1.02 RELATED SECTIONS

Section 31 23 13 - Subgrade Preparation

Section 01 73 19 - HydroTurf CS MicroSpike Geomembrane Specification

Section 01 01 01 - HydroTurf CS Engineered Turf Specification

Section 03 49 01 - HydroBinder Infill

Section 03 05 59 - Penetrating Catalyzed Colloidal Silicate Concrete Treatment for HydroTurf

1.03 REFERENCES

A. Latest Version of American Society for Testing and Materials (ASTM) standards:

ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)

ASTM C150 - Standard Specification for Portland Cement

ASTM C387 - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar ASTM D792 – Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement

ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting

ASTM D1204 - Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature

ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

ASTM D1505 - Standard Test Method for Density of Plastics by Density-Gradient Technique

ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics

ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics

ASTM D1907 - Standard Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method

ASTM D2256 - Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method

ASTM D3218 - Standard Specification for Polyolefin Monofilaments

ASTM D3895 – Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry.

ASTM D4218 - Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique.

ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products

ASTM D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles

ASTM D5321 - Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

ASTM D5323 – Standard Test Method for Determination of 2% Secant Modulus for Polyethylene Geomembranes

ASTM D5397 – Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test

ASTM D5596 - Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

ASTM D5617 – Standard Test Method for Multi-Axial Tension Test for Geosynthetics

ASTM D5721 – Standard Practice for Air-Oven Aging of Polyolefin Geomembranes

ASTM D5885 – Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry

ASTM D5994 – Standard Test Method for Measuring Core Thickness of Textured Geomembrane

ASTM D6392 – Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

ASTM D6693 – Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

ASTM D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

ASTM D7007 – Standard Practices for Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earth Materials

ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)

ASTM C150 - Standard Specification for Portland Cement

ASTM C387 - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar

ASTM D1335 - Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings

ASTM D1577 - Standard Test Methods for Linear Density of Textile Fibers

ASTM D4595 - Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method

ASTM D5793 - Standard Test Method for Binding Sites per Unit Length or Width of Pile Yarn Floor Coverings

ASTM D5823 - Standard Test Method for Tuft Height of Pile Floor Coverings

ASTM D5848 - Standard Test Method for Mass per Unit Area of Pile Yarn Floor Coverings

ASTM D6241 - Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

B. American Concrete Institute (ACI) - 306R-10 Guide to Cold Weather Concreting

C. Latest version of Geosynthetics Research Institute (GRI) testing methods:

GRI-GM11– Accelerated Weathering of Geomembranes Using a Fluorescent UVA Device.

GRI-GM12 –Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage

GRI-GM13 – Test Methods, Test Properties, and Testing Frequency and for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes

GRI-GM19 - Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

1.04 DEFINITIONS

The definitions below are as related to the HydroTurf® Product and the Construction Quality Assurance (CQA) Plan definitions for the product. Whenever the terms listed below are used, the intent and meaning will be interpreted as indicated.

Acclimation

Physiological/thermal adjustment. Required in the geomembrane deployment process.

ASTM

ASTM International, known until 2001 as the American Society for Testing and Materials, is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

HydroTurf® CS and Manufacturer's Representative

HydroTurf CS is a composite system of a structured geomembrane overlain by an engineered synthetic turf which is infilled with a cementitious mix (HydroBinder). Said HydrTurf CS Manufacturer's representative shall be on-site during the initial installation, or at request of Owner, and for final inspection of mat system. At final inspection, Manufacturer's representative shall provide a final inspection summary.

Construction Quality Assurance (CQA)

Construction Quality Assurance includes but is not limited to observations and

documentation of materials and workmanship necessary to show that a particular project is being constructed according to site-specific specifications and within regulatory guidelines.

Construction Quality Assurance (CQA) Personnel / Owner's or Operators Representative

Construction Quality Assurance (CQA) personnel can be representatives of the Owner or official Owner's representative. The CQA personnel are available for reviewing Contractor's quality assurance monitoring, applicable conformance sampling and performing onsite tests and observations.

Construction Quality Control (CQC) Personnel

CQC Personnel are representatives of the Geosynthetics Installer who work under direct supervision of the Geosynthetics Installer. The Geosynthetics Installers' CQC Personnel are responsible for construction quality control, applicable conformance sampling and performing onsite tests and observations.

Contract Documents

Written, printed, or electronic matter that provides information or evidence that serves as an official record and are issued by the owner or operator. The documents include bidding requirements that include but are not limited to, contract forms, contract conditions, contract specifications, CQA plan, contract drawings, addenda, and contract modifications.

Contract Specifications

The requirements which are to be followed in the construction of the HydroTurf® System. The standard specifications, supplemental specifications, special provisions, and all written or printed agreements and instructions that pertain to the method and manner of performing the work.

Contractor

One that agrees to furnish materials or perform services at a specified price, especially for construction work. Contractor is responsible for planning, organizing, and controlling construction activities. Contractor is responsible for providing and completing necessary testing as required as specified here-in, per plans or as required by Design Engineer or Owner. Contractor is responsible for all installation and work performance.

Design Engineer or Engineer

An individual licensed to practice as a Professional Engineer or a Professional Service Firm that is responsible for the preparation of the project construction drawings and specifications. The Engineer may also be the Owner's

representative for construction activities and allowed to make decisions on behalf of the Owner when such authority is given by the Owner.

Earthwork

A general engineering term relating to the relocation and utilization of soil during the process of construction.

Engineered Turf

Component 3 of the HydroTurf® System. A synthetic structured material consisting of one or more geotextiles tufted with polyethylene yarns that resemble grass blades.

Final Cover System Evaluation Report (FCSER)

Upon substantial completion of closure activities, the POR is responsible for the documentation of construction activities relating to the project, and any other inspections or verifications required by the regulatory authority. The FCSER will be signed and stamped by the POR and include documentation necessary for certification closure.

Fish Mouth

A semi-conical opening of the seam that is formed by an edge wrinkle in one sheet of the geomembrane component.

Geomembrane

A synthetic lining material that is also known as Component 2 and/or Agru Super Gripnet® HDPE Geomembrane Liner as it relates to the HydroTurf® System. Used as the primary barrier to infiltration and exfiltration of covered materials. Also referred to as the geomembrane component throughout this document.

GSI

Geosynthetic Institute
475 Kedron Avenue
Folsom, PA 19033-1208 USA
TEL (610) 522-8440
FAX (610) 522-8441

HydroBinder®

A proprietary cementitious infill utilized as an infill where higher surface water velocities may occur as well as in anchor trenches where specified.

Geosynthetics Contractor / Installer

The entity responsible for geosynthetic installation.

Independent Testing Laboratory

An organization, person, or company that tests products and materials, etc. according to agreed requirements. The entity shall be independent of ownership or control by the Owner or any party to the construction of the final cover or the manufacturer of the final cover products used. The entity shall also have proper legal authority where required to issue opinions and document the results of tests requested by the Owner.

Installation Supervisor

The person on-site who works for the Geosynthetics Installer and is in charge of the Geosynthetics Personnel and following the site specifications for the installation of the geosynthetics.

Manufacturing Quality Control (MQC)

A planned system of inspection and verification to ensure the quality of the final product.

Nonconformance

A deficiency in characteristics, documentation, or procedures that render the quality of an item or activity unacceptable or indeterminate. Examples of non-conformances include, but are not limited to, physical defects, test failures, and inadequate documentation.

Operator

The entity in control and responsible for the facility.

Owner

The entity that owns facility and land.

Panel

A general reference to a unit area of either Component 2 – Agru Super Gripnet® HDPE Geomembrane or Component 3 – Engineered Turf.

Quality Assurance

A planned and systematic pattern of procedures and documentation to ensure that items of work or services meet the requirements of the contract documents.

Quality Control

These actions provide a means to measure and regulate the characteristics of an item or service to comply with the requirements of the contract documents.

Representative Sample

(With respect to geomembrane destructive testing) - A random specimen of either Component 2 – Agru Super Gripnet HDPE Geomembrane or Component 3 – Engineered Turf material consisting of 1 or more cut pieces (commonly referred to as coupons) from the same rectangular portion of material, oriented along a seam that is removed for field or laboratory testing purposes.

Ripple

Smaller in nature than a wrinkle. A result of thermal/or manufacturing that cannot be folded over.

Snapping

A manual method to an open ended seam to remove tenting as a result of the welding of the geomembrane seams.

Spike

A systematic design for interface friction located on the bottom of the Super Gripnet®.

Specimen

(With respect to geomembrane destructive testing) - A specimen is the individual test strip (sometimes called coupon) from a sample location. A sample location can consist of many specimens.

Studs

A systematic design for drainage located on the top side of the Super Gripnet®.

Tenting

A vertical ridge that is caused by wedge welding geomembrane.

Wrinkle

A portion of the geomembrane that does not lay relatively flat and is not a result of subgrade irregularity and which can be folded over.

PART 2: PRODUCTS:

Not Used.

PART 3: EXECUTION:

Not Used.

END OF SECTION

SECTION 01 73 19

HYDROTURF® CS MICROSPIKE GEOMMEMBRANE COMPONENT SPECIFICATION

PART 1: GENERAL

1.01 SUMMARY

A. Section Includes:

Product specifications for geomembrane component (40 mil MicroSpike) of the HydroTurf® CS system

1.02 RELATED SECTIONS

Section 31 23 13 - Subgrade Preparation

Section 01 42 00 - References and Definitions

Section 01 01 01 - HydroTurf CS Engineered Turf Specification

Section 03 49 01 - HydroBinder Infill

Section 03 05 59 - Penetrating Catalyzed Colloidal Silicate Concrete Treatment for HydroTurf

1.03 REFERENCES

A. See Section 01 42 00 - References and Definitions

1.04 SUBMITTALS

A. MANUFACTURER
   1. Pre-Production Manufacturer's Product Data
      a. Submit to the OWNER'S REPRESENTATIVE:
         1.) Certificate of Compliance that shows that the proposed material for this project will meet the project specifications;
         2.) Provide representative Product Data Sheets;
         3.) Provide one (1) representative product sample;
         4.) Provide manufacturer's quality control program, including test procedures and frequencies for this product; and
         5.) Provide installation instructions and procedures on wrinkle control and wrinkle acceptance.

2. Pre-Shipment Manufacturer Quality Control (MQC) Data
    a. Submit to the OWNER'S REPRESENTATIVE prior to shipment:
        1.) A copy of the MQC test results;
        2.) Statement that MQC testing has been done in accordance with manufacturer's quality control program;
        3.) Certificate of Compliance stating;
            a) Production dates and origin of resin;
            b) All resin is from same manufacturer;
            c) Reclaimed resin does not exceed 10 percent by weight; and
            d) Any additional MQC certifications required by the CONTRACT.
        4.) MQC Certifications shall include:
            a) Geomembrane roll numbers and identification;
            b) Sampling procedures; and
            c) Results of MQC tests, and the test methods used.

B. GEOSYNTHETICS INSTALLER

1. Prior to beginning the installation of the HydroTurf CS System and its components, GEOSYNTHETICS INSTALLER shall submit the following to the OWNER'S REPRESENTATIVE as it relates to the Geomembrane Component:
    a. Shop drawings indicating panel layout and field seams 14 calendar days prior to installation of geomembrane component;
    b. HydroTurf CS system, including geomembrane, installation schedule;
    c. Installation capabilities, including:
        1.) Information on equipment proposed for this project; and
        2.) Construction Quality Control (CQC) procedures.
    d. Submit to OWNER'S REPRESENTATIVE:
        1.) Subgrade Acceptance (from Contractor or if required) for each area to be covered by the geomembrane component;
        2.) A flow chart showing GEOSYNTHETICS PERSONNEL responsible positions for this project; and
        3.) Resumes of (Include date hired and duration of employment)

a) Project designated GEOSYNTHETICS SEAMING SUPERVISOR;
b) CQC SUPERVISOR if other than above;
c) All personnel who will perform seaming operations;
d) Verify in writing that GEOSYNTHETICS INSTALLER'S PERSONNEL have the following experience:
    i.) CQC SUPERVISOR and the MASTER GEOMEMBRANE SEAMER;
        i.) Shall have installed at least 5,000,000 square feet of like geosynthetics materials.
    ii.) All other GEOSYNTHETICS INSTALLER SEAMING PERSONNEL:
        i.) Shall have seemed at least 1,000,000 sf of polyethylene geomembrane; and
        ii.) Personnel who have seamed less than 1,000,000 sf of polyethylene geomembrane will be allowed to seam only under the direct supervision of the MASTER GEOMEMBRANE SEAMER or CQC SUPERVISOR.
a) OWNER'S REPRESENTATIVE shall be responsible for approving resumes and qualifications of GEOSYNTHETICS INSTALLER PERSONNEL; and
b) GEOSYNTHETICS INSTALLER PERSONNEL shall attend HydroTurf CS orientation prior to beginning the installation.

C. CLOSEOUT SUBMITTALS:
1. GEOSYNTHETICS INSTALLER shall furnish to the OWNER upon completion of the project:
    a. One year warranty against defects in workmanship;
    b. As-built Geomembrane Panel Drawings; and
    c. As-built Drawings shall include:
        1.) Panel locations,
        2.) Panel identification numbers,

3.) Geomembrane roll numbers for each panel,

4.) Seam caps,

5.) Destructive sample locations, and

6.) Location of large repairs.

1.05 DELIVERY, STORAGE AND HANDLING

A. Conform to the manufacturer's recommendations to prevent damage to the materials;

B. Deliver materials to the site only after the OWNER'S REPRESENTATIVE and the OWNER approve required submittals;

1. Contractor shall observe and document that all rolls of geomembrane delivered to the site have been properly identified (at the manufacturer's location) along with the following:
   a. Manufacturer's name,
   b. Product identification,
   c. Lot number,
   d. Roll number, and
   e. Roll dimensions.
2. Contractor shall observe and document the following:
   a. Rolls are wrapped with protective covering; and
   b. Rolls are protected from any outside source that could degrade or damage the product.

C. Storage and Handling Requirements

1. On-Site Storage
   a. Store in space allocated within the project site and Access and Staging limits;
   b. Store on level prepared surface (not on wooden pallets) graded to drain away from HydroTurf CS components; and
   c. Stack no more than three rolls high.
2. On-Site Handling
   a. The GEOSYNTHETICS INSTALLER is responsible for storage and transporting material from storage area to installation area;
   b. Use appropriate handling equipment as required by Manufacturer's written

instructions;

c. Dragging panels on ground surface will not be permitted; and

d. Do not fold geomembrane component material.

3. Packaging and Waste Management

a. GEOSYNTHETICS INSTALLER shall be responsible for proper containment, collection and disposal of:

1.) Waste and packaging; and

2.) All waste products produced by the installation of the HydroTurf CS System.

1.06 SITE CONDITIONS

A. Ambient Conditions

1. Excessive heat or cold, ambient temperatures less than 35°F and greater than 104°F, will require additional testing as indicated below; and

2. The acceptable ambient temperature range may vary from parameters shown in Article 1.06A-1 only if field test seams can pass at the specific ambient temperature at which welding will take place.

B. Existing Conditions

1. See Section 31 23 13 for Subgrade Preparation Specifications.

PART 2: PRODUCTS

2.01 GEOMEMBRANE COMPONENT OF HYDROTURF CS SYSTEM

A. AGRU 40-mil MicroSpike® HDPE Geomembrane that is Doubled-Sided Textured

1. Manufacturer: AGRU America, Inc.

a. The geomembrane shall meet or exceed the property values listed in Table 1.

b. AGRU MicroSpike HDPE Geomembrane shall be supplied by Watershed Geosynthetics as a component of the HydroTurf CS Revetment System.

B. SUBSTITUTIONS

1. None

Table 1 – HydroTurf CS MicroSpike® Geomembrane Component Properties.

Property	Test Method	HDPE Values
Thickness, (nominal), mil (mm)	ASTM D5994	40 (1.02)
Thickness, (min avg.), mil (mm)		38 (0.95)
Thickness (8 out of 10), mil (mm)		36 (0.90)
Thickness, (lowest individual.), mil (mm)		34 (0.85)
Asperity Height, (min. avg.), mil (mm)	ASTM D7466	20 (0.51)
Density, g/cc	ASTM D792, Method B	0.94 (min)
Tensile Properties, (avg., both directions)	ASTM D6693, Type IV	-
Strength @ Yield, (min. avg.), lb/in (N/mm)		88 (15.4)
Elongation @ Yield, (min. avg.), %, (GL=1.3 in)		13
Strength @ Break, (min. avg.), lb/in (N/mm)		88 (15.4)
Elongation @ Break, (min. avg.), %, (GL=2.0 in)		350
Tear Resistance, (min., avg.), lbs (N)	ASTM D1004	30 (133)
Puncture Resistance, (min. avg.), lbs (N)	ASTM D4833	90 (400)
Carbon Black Content, (range in %)	ASTM D4218	2-3
Carbon Black Dispersion, (Category)	ASTM D5596	Only near spherical agglomerates for 10 views in Cat. 1 or 2
Stress Crack Resistance, (Single Point NCTL), hours	ASTM D5397, Appendix	500
Oxidative Induction (Time), minutes	ASTM D 3895, 200°C, 1 atm O_2	≥140
Standard Roll Dimensions	23-ft (7-m) Wide by 750-ft (229-m) Long	
Roll Area (approximate)	17,250 ft^2 (1603 m^2)	

PART 3: EXECUTION

3.01 INSTALLERS

A. Installer shall be trained by Watershed Geosynthetics, LLC.

3.02 EXAMINATION

A. Verification of Conditions
   1. CONTRACTOR shall:
      a. Verify provisions set forth in Section 31 23 13 – SUBGRADE PREPARATION (including giving Owner notice and time to review); and
      b. Have approved shop drawings from Owner.

B. Pre-Installation Testing
    1. FIELD TRIAL SEAM TESTING – TRIAL WELDS
        a. Prior to geomembrane component welding, Contractor shall ensure the following are tested as required and Contractor shall provide documentation reports:
            1.) Welding apparatus (both wedge and extrusion welder) are tested;
                a) At daily start-up;
                b) Immediately after any break; and
                c) Anytime the machine is turned off for more than 30 minutes.
        b. Procedures
            1.) The trial weld will be completed under conditions similar to those under which the panels that will be welded;
            2.) If at any time, the CQA PERSONNEL believe that an operator or welding apparatus is not functioning properly, a Field Trial Seam Test must be performed;
            3.) Any dispute concerning proper installation techniques or the proper function of welding equipment shall be resolved by the OWNER'S REPRESENTATIVE;
            4.) The trial weld must be allowed to cool to ambient temperature before testing; and
            5.) Trial weld samples must comply with "PASSING CRITERIA FOR WELDS" included in Section 3.07-B.
            6.) Field Seam Test Failure
                a) Unacceptable locus-of-break codes per their description in ASTM D6392:
                    i.) Hot Wedge: AD and AD-Brk>25%
                    ii.) Extrusion Fillet: AD1, AD2, AD-WLD (unless strength is achieved)
                b) There shall be no apparent weld separation (i.e., greater than 1/8 inch); and
                c) The INDEPENDENT TESTING LABORATORY strength tests

must:

i.) Meet the manufacturer's specifications for the sample sheets; or

ii.) Percentage of the manufacturer's parent sheet strength as determined by the manufacturer; and

iii.) For dual-track fusion welds, both sides (the inner and outer weld) must meet the minimum requirements for a satisfactory peel test.

c. Additional Field Seam Testing Requirements:

1.) A trial weld will also be obtained prior to welding tie-ins;

2.) The trial weld sample must be 3 feet long and 12 inches wide, with the seam centered lengthwise;

3.) If a welding apparatus exceeds 5 hours in the second half of the day, another trial seam must be performed;

4.) Required number of specimens per trial weld:

i.) Two coupons for shear and two coupons for peel; and

ii.) Both the inner and outer welds of dual track fusion welds:

i.) Must be tested for each peel test coupon; or

ii.) Additional coupons may be required.

d. Contractor documentation of trial seam procedures will include the following:

1.) The names of the seaming personnel;

2.) The name of the welding technician;

3.) The welding apparatus number, time, date;

4.) Ambient air temperature; and

5.) Welding apparatus temperature.

3.03 INSTALLATION

A. Geomembrane Component will not be deployed under following conditions:

1. During precipitation;
2. In the presence of excessive moisture as determined by the CQA Personnel

onsite;

3. In areas of ponded water; and
4. In the presence of excessive winds (sustained winds greater than 25 MPH) or at the discretion of the Engineer or Owner.

B. Contractor shall ensure the following while the geomembrane component is being deployed:
   1. Use equipment which will not damage geomembrane;
   2. Observe that personnel working on geomembrane do not engage in activities that could damage HydroTurf CS Components;
   3. Smoking on the liner is prohibited;
   4. Clamps and other metal tools are not tossed or thrown;
   5. Geomembrane component has had adequate time to acclimate to ambient temperature prior to welding;
   6. The deployment method will protect both the geomembrane component as well as the underlying subgrade;
   7. Adequate anchoring techniques are placed to prevent uplift by wind;
   8. Anchoring techniques are used that will not damage the geomembrane component;
   9. Continuous anchors are used along leading edges of the geomembrane to reduce wind flow under panels;
   10. Panels will be deployed perpendicular to slope elevation contours;
   11. Generation of seams will be reduced where possible;
   12. Protect geomembrane in heavy traffic areas using methods approved by the Engineer or Owner;
   13. Rubber tired ATV's are acceptable if specified wheel pressure limitation is specifically observed and provided to the Engineer or Owner by the GEOSYNTHETICS INSTALLER in writing;
   14. The bottom and side anchor trenches are left open until the engineered turf and sand infill placement are complete;
   15. Top anchor trenches are backfilled as soon as practical to avoid creeping of the geomembrane;
   16. Verify that the HydroTurf CS system is properly deployed into the anchor

trench prior to backfilling;

17. Where possible, anchor trenches are filled when temperatures are coolest to reduce bridging of the geomembrane component;
18. Soil material placed in anchor trenches are placed in uniform lifts, following procedures in Detailed Specification Section 06 Excavation and embankment, lifts not exceeding 6 inches and compacted to 100 percent maximum density per ASTM D 698 (within +/- 2 percent of optimum moisture). Contractor shall protect underlying materials from compaction equipment damage; Anchor trenches receiving concrete shall have a minimum 4000 psi compressive strength (INDOT Class A or approved equivalent) concrete. Concrete shall be installed at time of Hydro Turf installation (do not pour on frozen, saturated conditions and protect concrete against weather conditions).
19. In-place moisture/density tests in anchor trenches may be taken at the discretion of the Engineer and Owner; and
20. Slightly rounded corners will be provided in anchor trenches.

3.04 WRINKLES

A. The Contractor shall:

1. Reduce geomembrane wrinkles to acceptable requirements of Manufacturer's recommendations;
2. GEOSYNTHETICS INSTALLER shall repair all wrinkles present that are above the maximum tolerance level as described below;
3. Contractor shall document corrective actions taken to reduce the wrinkles;
4. Observe that wrinkles are reduced prior to field seaming; and
5. Observe that snapping procedures described in Article 3.06 SPECIAL TECHNIQUES are followed.
6. Contractor shall give Engineer and Owner 48 hour notice to review installation. Any installation deemed unacceptable by Engineer or Owner shall be repaired by Contractor.

B. Any wrinkles that can fold over must be repaired if:

1. Overnight temperature reduction does not contract the geomembrane to an

acceptable level; and

2. Time constraints do not allow for an overnight wait time to be observed whether wrinkles were reduced adequately.

3.05 HYDROTURF CS GEOMEMBRANE COMPONENT FIELD SEAMING

A. General Work Procedures:

1. Prior to geomembrane seaming operations, Contractor shall verify;
   a. Panel layout drawing has been accepted by the Engineer and Owner;
   b. A seam numbering system (submitted by Contractor, agreed to by Engineer and Owner) has been incorporated by GEOSYNTHETICS INSTALLER prior to the start of seaming operations;
   c. The GEOSYNTHETICS INSTALLER shall have a previously agreed upon number of welding apparatus and spare parts necessary to perform the work;
   d. Verify that equipment used for welding will not damage any HydroTurf CS system components;
   e. The extrusion welding machine is purged to remove heat degraded extrudate;
   f. Seam grinding has been completed less than one hour before seam welding;
   g. The upper sheet is beveled (extrusion welding only);
   h. The ambient temperature requirements (Section 1.06 SITE CONDITIONS), are met;
   i. The contact surfaces of the sheets are clean, free of dust, grease, dirt, debris, and moisture prior to welding;
   j. The weld area is substantially free of dust, rocks, and other debris;
   k. The seams are overlapped a minimum of 3 inches for extrusion and hot wedge welding, or in accordance with manufacturer's recommendations, whichever is more stringent;
   l. Panels will be overlapped (shingled) in the downgrade direction;
   m. No solvents or adhesives are present in the seam area;

n. The procedure used to temporarily hold the panels together does not damage the panels and does not preclude CQA testing;
o. The panels to be welded are in accordance with the plans and site specific specifications;
p. There is no obvious free moisture in the weld area;
q. Measure and document surface sheet temperature every two hours; and
r. At the end of each day or installation segment, un-seamed edges are anchored with sandbags or other approved anchoring device.

2. During Geomembrane Seaming Operations;
   a. At the end of previously placed welds, (with a cooling time longer than 5 minutes), grinding is required to expose new material before restarting a weld (extrusion welding only).

3.06 SPECIAL TECHNIQUES

A. During field seaming operations special attention will be given to the following:
   1. Once two panels have been seamed together or at the approx. 1/3 seaming process, a seam snapping process shall be applied;
      a. Perform with manual labor by utilizing 3-4 technicians on the open side of the panel applying a pulling pressure to snap out the tented welded seam.

3.07 TESTING CONCURRENT WITH INSTALLATION:

A. DESTRUCTIVE AND NON-DESTRUCTIVE TESTING
   1. NON-DESTRUCTIVE SEAM TESTING
      a. GEOSYNTHETICS INSTALLER shall:
         1.) Non-destructively test field welds for continuity over their full length
            a) Perform concurrently with seaming work progress; and
            b) Repair seam defects in accordance with Article 3.07 REPAIR PROCEDURES.
         2.) Non-destructive testing procedures - Vacuum Box Testing for Extrusion Welds
            a) Vacuum box testing equipment for extrusion welds will have:

i.) A rigid housing;

ii.) Transparent viewing window;

iii.) A soft rubber gasket attached to bottom of housing;

iv.) Porthole or valve assembly; and

v.) A vacuum gauge.

iii.) Be capable of applying 5 psi gage pressure of vacuum to the box.

iv.) Have a soapy solution.

b) Vacuum Box testing procedures:

i.) Clean window, gasket surfaces, and check for leaks;

ii.) Energize vacuum pump and reduce tank pressure to approximately 5 psi;

iii.) Wet a strip of geomembrane approximately 12 inches by 30 inches (or length of box) with soapy solution;

iv.) Place box over wetted area and compress;

v.) Close bleed valve and open vacuum valve;

vi.) Ensure that a leak tight seal is created;

vii.) Examine length of weld through viewing window for presence of soap bubbles for a period of not less than 10 seconds; and

viii.) If no bubbles appear after 10 seconds, close vacuum valve and open bleed valve, move box over next adjoining area with minimum three inches overlap and repeat process.

c) Defects:

i.) Mark with a defect code;

ii.) Repair the area in accordance with Section 308 REPAIR PROCEDURES; and

iii.) Retest the repaired area.

3.) Non-destructive testing procedures – Air Pressure Testing for Double Fusion Welds

a) Air Pressure Testing equipment for double fusion seams:
   i.) An air pump, equipped with pressure gauge having an accuracy of 1 psi, capable of generating and sustaining a pressure between 25 to 30 psi and mounted on a cushion;
   ii.) Rubber hose with fittings and connections; and
   iii.) Sharp hollow needle or other pressure feed device approved by the Owner.

b) Air Pressure testing procedures:
   i.) Seal both ends of the seam to be tested;
   ii.) Insert a needle or other approved pressure feed device into tunnel created by double hot wedge seaming and insert a protective cushion between air pump and geomembrane;
   iii.) Energize air pump to 25 to 30 psi, close valve, and sustain pressure for a minimum of five minutes;
   iv.) If loss of pressure exceeds 2 psi or does not stabilize, locate faulty area and repair in accordance with Article 3.08 REPAIR PROCEDURES;
   v.) Release pressure at opposite end of seam from gauge to verify that the seam is not blocked; and
   vi.) Remove approved pressure feed device and seal penetration holes by extrusion welding.

2. DESTRUCTIVE SEAM TESTING Geomembrane Component:
   a. GEOSYNTHETICS INSTALLER shall:
      1.) Cut destructive samples 12 inches wide by 48 inches long with seam centered lengthwise;
      2.) Repair holes in geomembrane resulting from obtaining destructive samples and vacuum test patches;
      3.) Obtain two 1-inch wide specimens from each side of the sample, test for peel and shear in the field;
         i.) Provide OWNER'S REPRESENTATIVE with the following:

i.) One sample per 500 feet of seam length per welding apparatus prior to completion of liner installation.

b. Contractor shall provide the Owner and Engineer the following:
   1.) Mark destructive samples with:
      a) Consecutive numbering;
      b) Location;
      c) Apparatus I.D.;
      d) Technician I.D.;
      e) Engineer I.D.;
      f) Apparatus settings; and
      g) Date;
   2.) Record, in written form:
      a) Weld and test date;
      b) Time;
      c) Location;
      d) Seam number;
      e) Ambient temperatures;
      f) Machine settings;
      g) Technician I.D.;
      h) Apparatus I.D.; and
      i) Pass or fail description.

c. Additional Destructive Testing Procedures:
   1.) Cut ten 1-inch wide specimens from one piece;
   2.) Test five specimens for peel and five for shear;
   3.) Test results will meet requirements of Section 3.07-B.
   4.) Failing Destructive Tests:
      a) GEOSYNTHETICS INSTALLER'S CQC REPRESENTATIVE shall;
         i.) Track the failure immediately; and
         ii.) Cut the remaining sample into three 14-inch long pieces and distribute as follows:

i.) To the Owner's Representative for destructive testing;
ii.) To the Owner's Representative for archive; and
iii.) To the Geosynthetics Installer for their use.

b) In the event of failure, the procedures for failed seam tracking are:
i.) Retrace welding path 10 (ten) feet in both directions from the failed test location and remove (at these locations) a one inch wide specimen for testing;
ii.) Obtain destructive samples from each side of the welding path for Contractor destructive testing, samples shall be given to the OWNER'S REPRESENTATIVE;
iii.) Repeat process if additional tests fail; and
iv.) Reconstruct seam between passing test locations to satisfaction of the OWNER'S REPRESENTATIVE.
v.) Reconstruction may be one of the following:
i.) Cut out old seam, reposition panel and re-seam;
ii.) Add cap strip;
iii.) Cut additional destructive samples from reconstruction at discretion of OWNER'S REPRESENTATIVE; and
iv.) If additional destructive sample results are not acceptable, repeat process until reconstructed seam is judged satisfactory by the OWNER'S REPRESENTATIVE.

5.) Final seaming inspection:
a) Check the seams and surface of geomembrane for:
i.) Defects,
ii.) Holes,
iii.) Blisters,
iv.) Undispersed raw materials, and
v.) Signs of contamination by foreign matter.

b) Brush, blow, or wash geomembrane surface if dirt inhibits observation; and
c) The OWNER'S REPRESENTATIVE shall decide if cleaning of geomembrane surface and welds is needed to facilitate inspection.

B. PASSING CRITERIA FOR WELDS

1. Passing criteria are based on Geosynthetic Institute Test Method GM-19 for geomembrane seams.
   a. An extrusion or fusion-welded seam will pass when the following values are met:
      1.) Shear and peel strengths for 4 out of 5 test specimens (the 5th specimen can be as low as 80 percent of the listed values) for 40-mil HDPE geomembrane:
         a) Shear strength (lb./in) 100
         b) Shear elongation at break (%) 50
         c) Peel strength (lb./in) 75 (65 extrusion weld), and
         d) Peel separation (%) 25
      2.) A geomembrane seam sample passes the field testing when:
         a) The break is a film tear bond (FTB);
         b) The seam strength meets the required strength values for peel and shear given above; and
         c) For dual track welds, both welds pass.
      3.) Elongation measurements should be omitted for field-testing.

3.08 REPAIR PROCEDURES

A. GEOMEMBRANE COMPONENT:
1. The GEOSYNTHETICS INSTALLER shall be responsible for repair of damaged or defective areas;
2. The appropriate repair method shall be decided between the OWNER'S REPRESENTATIVE and the GEOSYNTHETICS INSTALLER.
   a. Procedures available include:

1.) Patching:
   a) Used to repair holes (over 1/4-inch diameter), tears (over 1/4 inch long), undispersed raw materials, and contamination by foreign matter.
2.) Grinding and welding:
   a) Used to repair pinholes, and blemishes.
3.) Capping:
   a) Used to repair large lengths of seams.
4.) Removing the seam and replacing with a strip of new material.

b. Prior to repairing, Contractor shall ensure:
   1.) The surface of the geomembrane component is clean at the time of inspection;
   2.) Non-conforming geomembrane component is removed and replaced;
   3.) Any portion of the geomembrane component exhibiting a flaw identified as defective by the Engineer or Owner is replaced;
   4.) Repair areas are distinctively marked and the required type of repair is indicated.

c. Repair Methods:
   1.) Geomembrane surfaces to be repaired will be abraded (extrusion welds only) no more than 1/2 hour prior to the repair;
   2.) All geomembrane surfaces will be clean and dry at the time of repair;
   3.) The repair procedures, materials, and techniques will be submitted to Engineer and Owner prior to completing;
   4.) Patch Requirements:
      a) Will be a minimum of 12 inches in diameter with all corners rounded;
      b) Will extend at least 6 inches beyond the edge of the defect;
      c) Temporarily bond the patch to the geomembrane with an approved method;
      d) Extrusion weld the patch; and
      e) Vacuum test the repair.

d. Repair Verification:
   1.) Contractor shall number and log each patch repair and give log/samples to Engineer and Owner;
   2.) CQC REPRESENTATIVE shall non-destructively test each repair using methods specified in this Section; and
   3.) Provide daily documentation of non-destructive and destructive testing to the OWNER'S REPRESENTATIVE.
   4.) The documentation will identify;
      a) Seams that initially failed the test; and
      b) Include the evidence that these seams were repaired and retested successfully.

3.09 INSTALLATION ACCEPTANCE

A. Once work is complete, Geosynthetics Installer shall allow Engineer and Owner opportunity to review the following:
   1. After all HydroTurf CS components are deployed, seamed, have passed required testing successfully, and any repairs are made;
      a. The completed installation will be inspected by the Contractor, Engineer, OWNER'S REPRESENTATIVE and the GEOSYNTHETICS INSTALLER'S CONSTRUCTION QUALITY CONTROL SUPERVISOR; (Contractor shall schedule meeting to ensure Owner is available during time Geosynthetic Installer is at site);
      b. GEOSYNTHETICS INSTALLER'S CONSTRUCTION QUALITY CONTROL SUPERVISOR shall provide observation report and documentation for site seam inspection – any repairs shall be documented and repaired within final report;
      c. Damage and/or defects found during this inspection will be repaired by the GEOSYNTHETICS INSTALLER; and
      d. The installation will not be accepted until it meets the requirements of these specifications and any applicable State, Federal or Local Regulations.

B. Contractor shall supply the following information upon installation of the HydroTurf CS system:

1. The installation date when work was complete;
2. Seam observation, review and documentation by Geosynthetic Installer's Construction Quality Control Supervisor has been provided;
3. Required independent testing laboratory and field tests have been completed, reviewed and approved;
4. Required GEOSYNTHETICS INSTALLER supplied documentation has been received, reviewed and approved;
5. As built record drawings have been completed, including defect locations and repairs made.

END OF SECTION

SECTION 03 05 59

PENETRATING CATALYZED COLLOIDAL SILICATE CONCRETE TREATMENT FOR HYDROTURF

PART 1: GENERAL

1.01 SUMMARY

A. Section Includes:

1. Specifications for the spray-applied, Penetrating Catalyzed Colloidal Silicate Concrete Treatment Component of the patented HydroTurf® System.

B. Background:

1. Colloidal Silicate Concrete Treatment is used on HydroTurf in areas prone to potential freeze thaw.

2. Colloidal Silicate Concrete Treatment products are based on catalyzed colloidal silicate technology that penetrates into concrete capillaries and pores to form colloidal silica. The colloidal silica then reacts with free alkali (i.e. – unused calcium hydroxide) to convert it into an insoluble gel within the capillary voids of the concrete, providing a waterproof seal, but uniquely leaving the concrete surface in a condition to receive adhesives, toppings, other finish systems, and coatings.

1.02 RELATED SECTIONS

Section 31 23 13 - Subgrade Preparation
Section 01 42 00 - HydroTurf CS References and Definitions
Section 01 73 19 - HydroTurf CS MicroSpike Geomembrane Specification
Section 01 01 01 - HydroTurf CS Engineered Turf Specifications
Section 03 49 01 - HydroBinder® Infill Specification

1.03 REFERENCES

A. See Section 01 42 00 - References and Definitions

1.04 SUBMITTALS

A. Pre-Production and Pre-Shipment – Submit to the Owner's Representative

1. Provide representative manufacturer Product Data Sheet.

2. Provide Material Safety Data Sheets (MSDS) for the Penetrating Catalyzed Colloidal Silicate Concrete Treatment.

PART 2: MATERIALS

2.01 DELIVERY, STORAGE AND HANDLING

A. Delivery, Storage and Handling:

1. Deliver materials to the site only after the Owner's Representative and the Owner approve required submittals.

2. Delivery, storage, and handling shall be according to the manufacturer's written recommendations, industry guidelines, and/or DIVISION 01 requirements, whichever is more stringent.

3. Store in space allocated by the Owner.

4. Protect from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat or other damage.

5. Store on level prepared surface.

6. The installer is responsible for storage, and transporting material from storage area to installation area.

2.02 MANUFACTURER / PRODUCT

A. Penetrating Catalyzed Colloidal Silicate Concrete Treatment shall be SCP 327 – Time of Placement manufactured by Spray-Lock Concrete Protection and shall be supplied by Watershed Geosynthetics as a component of the HydroTurf Revetment System.

B. Freeze-thaw properties of the HydroTurf system with the HydroBinder infill treated with the SCP 327 shall have been tested in accordance to ASTM C666 with the results of 0.2% loss (avg.) at 100 cycles and <3.0% loss (avg.) at 300 cycles.

C. Substitutions

1. None

2. Source Limitations: Obtain penetrating catalyzed colloidal silicate concrete treatment through one source from a single manufacturer.

2.03 DESCRIPTION

A. SCP 327 – Time of Placement product is a green-tinted (dries clear), odorless, non-toxic, and non-flammable penetrant in a colloidal liquid base.

1. SCP 327 penetrates concrete and masonry substrates to chemically react with free alkali components in the concrete resulting in:

a. Superior cure at time of placement

b. Reduced or eliminated shrinkage cracking

c. Minimizes scaling and spalling

d. Enhanced durability

2.04 ACCESSORIES

A. Large Surface Areas and/or Volumes: 1,500 psi airless sprayer

B. Small to Medium Surface Areas and/or Volumes: Pump sprayer

PART 3: EXECUTION

3.01 FIELD CONDITIONS

A. Environmental Requirements per manufacturer's written recommendations, DIVISION 01, and as follows:

1. Allow surfaces and product to attain a temperature of 36 deg F (2 deg C) and rising before proceeding with product application.

2. Do not apply unprotected during periods of exposure to high winds.

3. Ensure that frost or frozen surfaces are thawed with no standing water.

4. Very Hot Weather and Direct Sunlight Conditions: Apply a fine mist spray of water on the surface after application of SCP treatment to help alleviate premature chemical reaction and/or drying from taking place prior to achieving maximum penetration.

3.02 EXAMINATION, PREPARATION, AND APPLICATION

A. Examination, preparation, and application per Spray-Lock SCP's written instructions, industry guidelines, DIVISION 01, and as follows:

1. Acceptance of Conditions: Carefully examine installation areas with Installer/Applicator present for compliance with requirements affecting Work performance.

    a. Verify that surfaces, substrates, tolerances, levelness, plumbness, temperature, humidity, cleanliness, and other applicable conditions are as required by product manufacturers, and are ready to receive Work.

    b. Test substrates as required by Spray-Lock SCP to verify proper conditions. Catalyzed colloidal silicate technology is dependent upon water penetration/absorption into the concrete. If water does not penetrate the concrete, then treatment will also not penetrate.

    c. Proceed with installation only after unsatisfactory conditions have been corrected.

2. Provide or prepare substrates to ensure proper application of SCP treatment.

    a. Protect in-place assets from overspray.

    b. NEW CONCRETE: As soon after HydroBinder placement (min. 24 hours) and after it is hard enough for foot traffic without causing damage to the surface.

        i. Concrete mixes shall not use internal curing compounds or other membrane forming chemical additives, such as crystalline silicate sealers (i.e. – sodium, potassium, lithium, etc. silicate sealers) that can inhibit penetration of catalyzed colloidal silicate treatment.

        ii. Remove standing water.

        iii. Do not hard trowel or over-float the surface.

3. SCP Application to HydroBinder

    a. Apply SCP treatment as soon as the concrete is hard enough to walk on without damage to the surface (min. 24 hours). Use a 1,500 psi (10 MPa) airless sprayer set at a pressure that will not damage the surface [i.e. – approximately 500 to 1,000 psi (3.5 to 7.0 MPa)]. Apply at a rate of approximately one gallon per140 ft^2 (max). For small to medium surface areas, a pump sprayer may be used.

b. If necessary, spray a second application of SCP on the HydroBinder using a 1,500 psi (10MPa) airless sprayer or a pump sprayer at the rate of one quart per 42 ft^2 (1 liter per 4 m^2).

3.03 FIELD QUALITY CONTROL

A. Site Tests and Inspections per DIVISION 01, and as follows:

1. Inspect substrate for non-conforming work including, but not limited to:

a. Curing compounds

b. Other membrane forming compounds (i.e. – crystalline silicates, epoxies, urethanes, etc.)

c. Excessive or hard troweling

d. Dried SCP treatment material on the concrete substrate due to slab not being wetted during very hot or direct sunlight, and/or windy conditions.

3.04 CLEANING

A. Immediately clean overspray or splash off glass and metal with soap and water, and dry.

B. Waste Management per DIVISION 01, and as follows: Store and recycle shipping cartons and empty bucket containers.

3.05 CLOSEOUT ACTIVITIES

A. Work Completion Requirements per DIVISION 01 and as follows:

1. Perform Closeout Procedures

2. Perform training with Owner's Representative, if needed.

B. Correct non-conforming work in accordance with the General Conditions, and the acceptance of the Owner's Representative.

END OF SECTION

SECTION 03 49 01

HYDROTURF® HYDROBINDER® INFILL SPECIFICATION

PART 1: GENERAL

1.01 SUMMARY

A. Section Includes:
1. Specifications for the HydroBinder® Infill Component of the patented HydroTurf® System.

1.02 RELATED SECTIONS

Section 31 23 13 - Subgrade Preparation
Section 01 42 00 - HydroTurf CS References and Definitions
Section 01 73 19 - HydroTurf CS Structured Geomembrane Specifications
Section 01 73 19 - HydroTurf CS MicroSpike Geomembrane Specification
Section 01 01 01 - HydroTurf CS Engineered Turf Specifications
Section 03 05 59 - Penetrating Catalyzed Colloidal Silicate Concrete Treatment for HydroTurf

1.03 REFERENCES

B. See Section 01 42 00 - References and Definitions

1.04 SUBMITTALS

A. HYDROBINDER INSTALLER
1. HYDROBINDER INSTALLER shall submit a certificate stating that the HydroBinder meets or exceeds the requirements outlined in the project specifications, including:

a. That the type of cement meeting the requirements of ASTM C150 (AASHTO M85) Type I or Type II; and

b. That the cementitious infill mix shall have a minimum 28-day compressive strength of 5000 psi in accordance with ASTM C 387 as tested in accordance with ASTM C 109.

PART 2: PRODUCTS

2.01 HYDROTURF HYDROBINDER INFILL COMPONENT

A. DESCRIPTION

1. HydroBinder is a proprietary cementious product used as the infill component of the HydroTurf system.

2. HydroBinder shall be supplied by Watershed Geosynthetics as a component of the HydroTurf Revetment System.

B. MATERIALS

1. The infill will be HydroBinder Cementitious Infill;

2. The infill material may be delivered in either pallet form of 80 lb. bags or 3000 lb. bulk bag super sacks;

3. Cement, except as otherwise specified herein, will be a brand of Portland Cement, meeting ASTM C 150 and will be Type I or Type II;

4. Only one brand of cement will be used throughout the duration of this Contract;

5. The cementitious infill mix will conform to the requirements of ASTM C 387 for high strength mortars;

6. The cementitious infill mix will have a minimum 28-day compressive strength of 5000 psi as measured in accordance with ASTM C 109; and

7. Freeze-thaw properties of the HydroTurf system with the HydroBinder infill treated with the Catalyzed Colloidal Silicate Concrete Treatment shall have been tested in accordance to ASTM C666 with the results of 0.2% loss (avg.) at 100 cycles and <3.0% loss (avg.) at 300 cycles.

PART 3: EXECUTION:

3.01 INSTALLERS

A. Installer shall be trained by Watershed Geosynthetics, LLC.

3.02 HYDROBINDER PLACEMENT

A. Placement of HydroBinder infill shall be performed as follows:

1. HydroBinder is typically delivered to the jobsite on pallets in either 3000# bulk bags (1 per pallet) or 80# bags (42 per pallet). It is delivered on a flatbed with 16 pallets (typical) per truckload.

2. The HydroBinder shall be installed into the turf while it is in a dry state.

3. Prior to placing the HydroBinder, the engineered turf shall be dry. If the turf is wet from rain or dew, the installer shall wait until it is dry. The installer may attempt to speed up the drying process by using a blower (i.e., leaf blower, industrial blower, etc.).

4. HydroBinder shall not be installed in inclement, wet or rainy weather, or the threat of inclement weather. Also, the HydroBinder shall not be installed in cold weather as defined by American Concrete Institute (ACI) 306.

5. The HydroBinder infill shall be placed at a minimum thickness of 7/8-inch minimum dry thickness and a ¾-inch minimum finished thickness after hydration and curing. This thickness is achieved by placing approximately 7 lbs/sf of the dry HydroBinder over the engineered synthetic turf.

6. The infill is to be placed / spread using a manual drop spreader, top-dresser and/or drop spreader attached to low ground pressure equipment with adequate dust control. Alternative methods can be used to spread and place the infill as approved by the Manufacturer, Owner's Representative and/or Engineer. Contractor shall explain in detail in the pre-construction meeting the method of infill deployment to be used. The Owner's Representative and/or Engineer shall approve the method.

7. Manual hand spreading is acceptable when equipment is not practical.

B. The HydroBinder infill will need to be worked into the turfs of the engineered turf such that the turf fibers are in an upright position. This can be achieved as follows:

1. The infill shall be worked into the tuft fibers so the tuft fibers are in an upright position with the infill at a measurable 7/8-inch minimum depth

in the dry state. This is typically achieved with common mechanical turf broom, power broom, shop broom, yard rakes, or greens groomer rakes.

2. Brushing of the HydroBinder infill shall be performed such that the fibers of the engineered turf are upright and trapped fibers are minimal. This shall be confirmed by visual inspection. Multiple brushing passes in multiple directions may be required to achieve this.

3. The HydroBinder may need to be placed in 2 to 4 lifts with brushing in between lifts to effectively work the material into the tufts and achieve fibers that are upright.

4. Thickness measurements of the HydroBinder infill shall be taken using a caliper or equivalent device. Measurements shall be taken at a minimum frequency of 5 measurements per 1,000 sf (for smaller projects) or 20 per acre (for larger projects) of installed area.

5. The desired HydroBinder infill thickness shall be achieved prior to the hydration process.

C. The HydroBinder infill shall be hydrated in place as follows:

1. The hydration process shall occur on the same day as the HydroBinder infill placement.

2. The infill shall be hydrated thoroughly with a light and consistent spray of water to avoid displacement of the non-hydrated infill. Estimated application rate is between 0.12 and 0.20 gallons per square foot of area. During hot temperatures and/or in dry climates, additional water may be needed.

3. The installer shall not overhydrate the infill so that water begins to runoff and cause loss of cement infill during the process. The general objective is to soak the area to start the hydration process but not to inundate with water beyond saturation of the infill.

4. Contractor shall ensure that the HydroBinder infill has been fully hydrated, and not over hydrated. Visually observe that the top of the HydroBinder has a wet sheen (denoting saturation) but that water is not ponding on top. Also, excavate (with finger or small tool) into the HydroBinder to confirm full hydration of the section has been achieved.

5. To improve curing, the hydrated area may be covered with plastic sheeting and in full conformance of Manufacturer's Recommendations.

6. If cold weather temperatures are expected, the hydrated area should be covered with heated blankets and plastic sheeting. Procedures in ACI 306 shall be followed for cold weather HydroBinder installation.

7. The HydroBinder infill shall harden within 24 hours following hydration, and shall reach its maximum compressive strength at 28 days. If the HydroBinder has not hardened in 24 hours, it will need to be removed and replaced.

8. Personnel access on the HydroTurf shall be prohibited following the hydration of the HydroBinder until it sets up hard.

D. Once hydration is completed and the HydroBinder has set up (min. 24 hours); backfill and compaction of the remaining perimeter anchor trenches may be performed. The HydroBinder infill layer may be placed using appropriate equipment capable of completing the work;

E. Manual hand spreading and raking is acceptable when mechanical equipment is not practical;

F. Once hydration has been completed, and the HydroBinder has cured for a minimum of 24 hours and has fully set up; the HydroBinder Catalyzed Colloidal Silicate Concrete Treatment shall be sprayed onto the HydroTurf System in accordance with Section 03 05 59 of these Specifications.

G. Contractor shall provide and ensure the following installation procedures are followed:

1. INSTALLER shall explain in detail, to Owner, in the pre-construction meeting the method of HydroBinder infill deployment;

2. Installation of HydroBinder infill will only be performed by a Watershed Geosynthetics' trained installer;

3. HydroBinder shall not be installed in inclement, wet or rainy weather, or the threat of inclement weather;

4. The HydroBinder shall not be installed in freezing temperatures;

5. The HydroBinder will be installed into the turf while it is in a dry state;

6. The HydroBinder will be worked into the tufts so the tufts are in an upright position;

7. The HydroBinder infill will be placed dry at a minimum thickness of 7/8 inch;

8. Do not backfill anchor trenches until turf has been infilled with HydroBinder infill;

9. The hydration process must occur the day of the HydroBinder infill placement;

10. The desired HydroBinder infill thickness will be achieved and confirmed by measurements prior to the hydration process;

11. The cemented infill is hydrated thoroughly however care must be taken to avoid displacement of the non-hydrated infill;

12. Hydration shall start at the upstream or upslope portion and move downstream or downslope;

13. The objective is to soak the area to start the hydration process but not to inundate with water beyond saturation;

14. Once hydration is completed as described, backfill and compaction of the anchor trenches should take place;

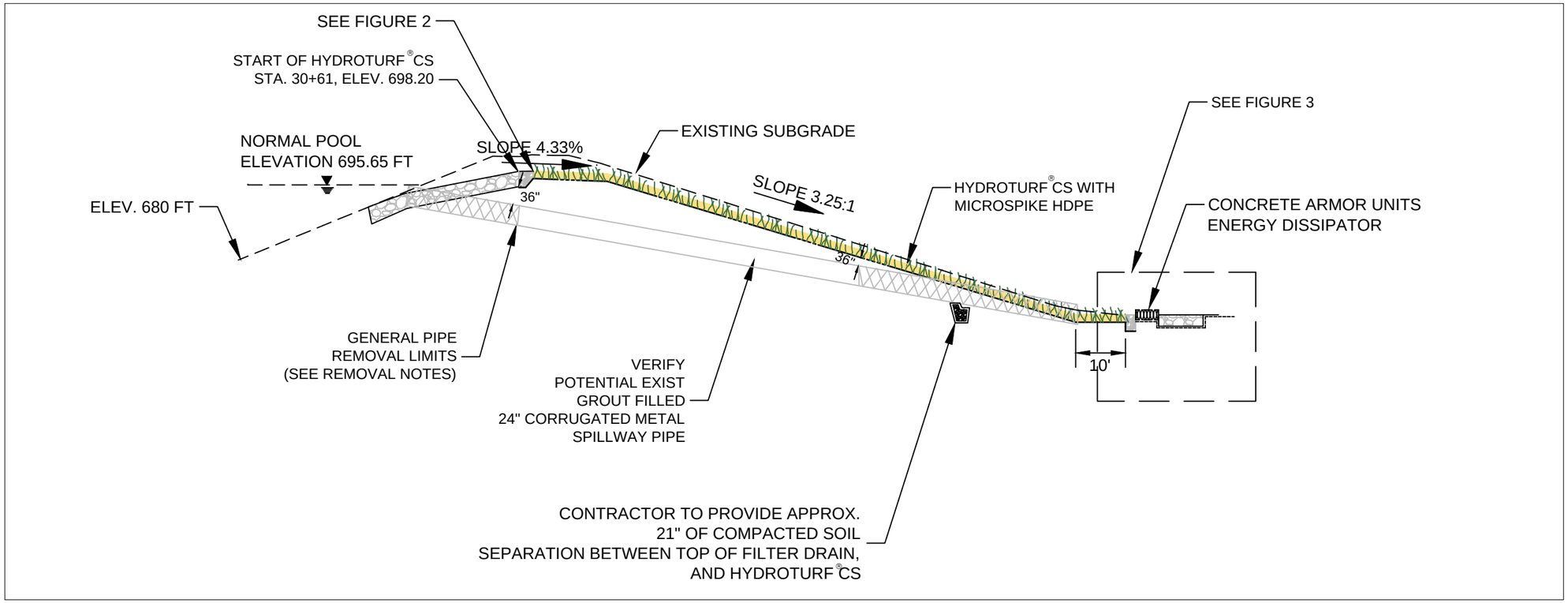
15. HydroBinder that does not set up within 24 hours on account of improper hydration shall be removed and replaced;

16. Cold weather installation of HydroBinder shall be performed in accordance with American Concrete Institute (ACI) - 306R-10 Guide to Cold Weather Concreting; and,

17. Once hydration has been completed, and the HydroBinder has cured for a minimum of 24 hours and has fully set up; the HydroBinder Catalyzed Colloidal Silicate Concrete Treatment shall be sprayed onto the HydroTurf

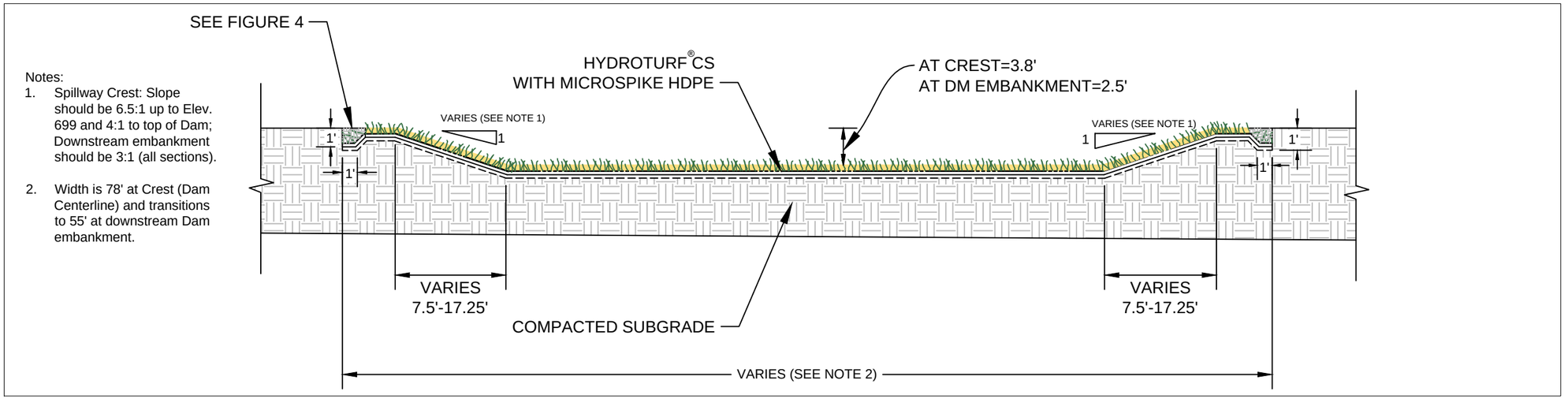
System in accordance with Section 03 05 59 of these Specifications.

END OF SECTION



1/1 SPILLWAY PROFILE

SCALE: 1"= 2'



Notes:

1. Spillway Crest: Slope should be 6.5:1 up to Elev. 699 and 4:1 to top of Dam; Downstream embankment should be 3:1 (all sections).
2. Width is 78' at Crest (Dam Centerline) and transitions to 55' at downstream Dam embankment.

2/1 SPILLWAY SECTION

SCALE: 1 1/2"= 1'

WG WatershedGeo® Unearthing Solutions

HydroTurf®

PRODUCT

TITLE

HYDROTURF® CS SPILLWAY
PROFILE & SECTION
CROSLEY LAKE DAM
IMPROVEMENT PROJECT

FILE No.	DRAWING 1	
REV.	SCALE	DATE
0	NTS	4/5/2018

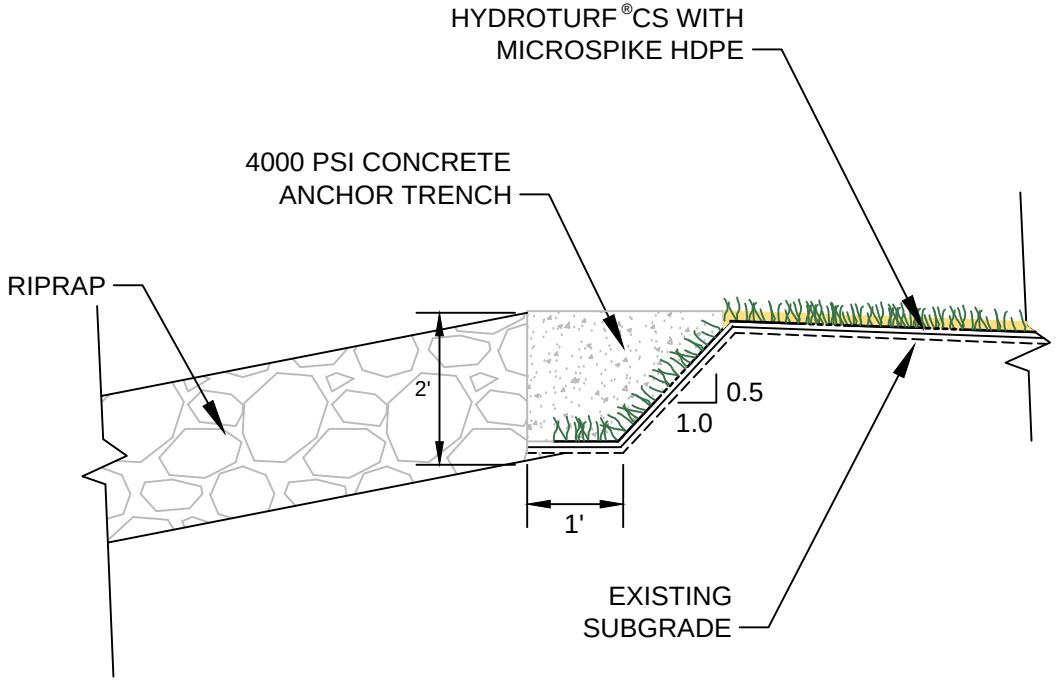
FIGURE 1

Notes:

1. The geomembrane component of HydroTurf®CS shall be in intimate contact with the anchor trench inside wall and bottom. Wrinkles, ripples, fish mouths, and/or bunching shall be removed and properly patched. During filling of the anchor trench with the compacted soil or concrete backfill, the contractor shall maintain that the geomembrane is in intimate contact with the trench wall and bottom. Concrete backfill shall be vibrated in place in accordance with standard industry techniques.

2. The geomembrane shall not extend up the outside wall of the anchor trench. It shall be trimmed short of the outside wall and shall extend a minimum of ¾ of the width of the anchor trench.

3. The engineered turf component of HydroTurf CS shall be in intimate contact with the geomembrane. Wrinkles, ripples, fish mouths, and/or bunching shall be removed and properly patched. The engineered synthetic turf shall be trimmed so that it does not extend onto the bottom of the anchor trench. It shall be trimmed just short of the bottom and shall extend a minimum of ¾ of the depth of the anchor trench.



WG WatershedGeo® Unearthing Solutions

PRODUCT HydroTurf®

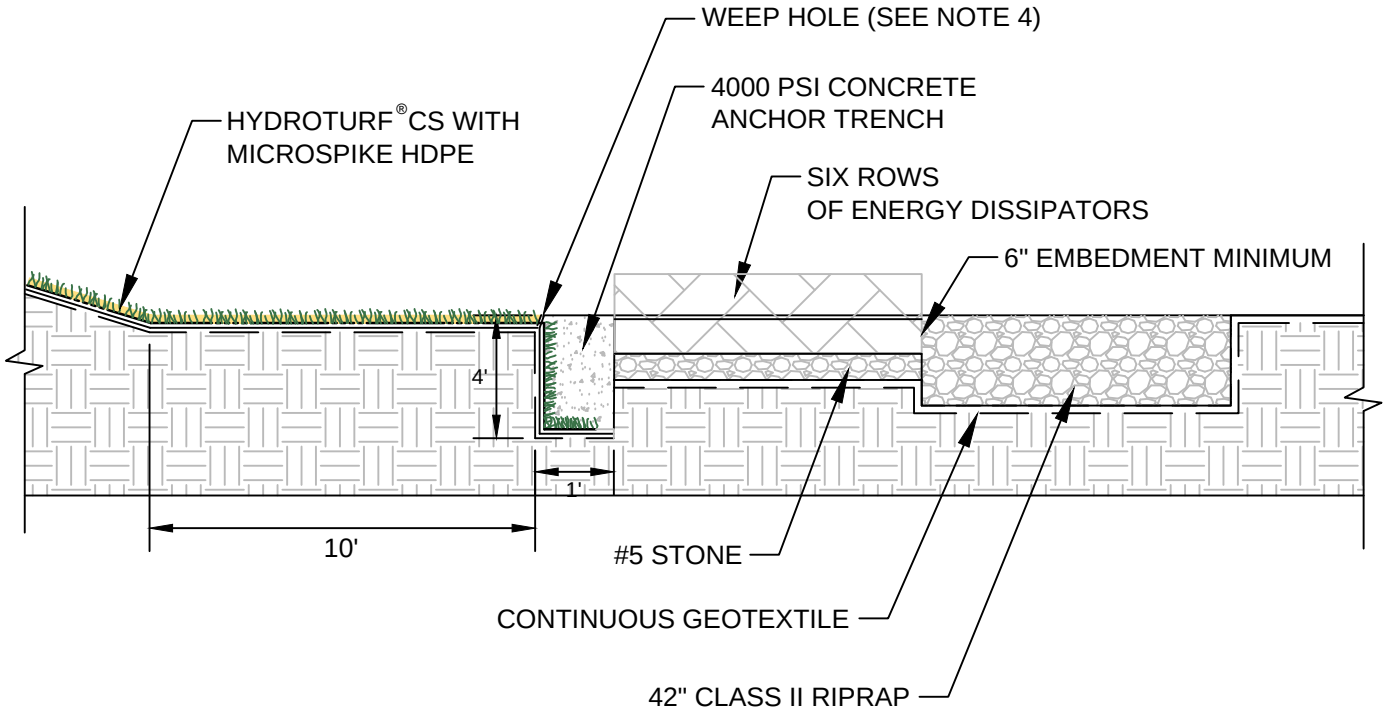
TITLE HYDROTURF®CS CREST ANCHOR TRENCH CROSLEY LAKE

File #	FIGURE 2	
Rev #	Scale	Date
0	NTS	3/23/2018

FIGURE 2

Notes:

1. The geomembrane component of HydroTurf® CS shall be in intimate contact with the anchor trench inside wall and bottom. Wrinkles, ripples, fish mouths, and/or bunching shall be removed and properly patched. During filling of the anchor trench with the compacted soil or concrete backfill, the contractor shall maintain that the geomembrane is in intimate contact with the trench wall and bottom. Concrete backfill shall be vibrated in place in accordance with standard industry techniques.
2. The geomembrane shall not extend up the outside wall of the anchor trench. It shall be trimmed short of the outside wall and shall extend a minimum of ¾ of the width of the anchor trench.
3. The engineered turf component of HydroTurf CS shall be in intimate contact with the geomembrane. Wrinkles, ripples, fish mouths, and/or bunching shall be removed and properly patched. The engineered synthetic turf shall be trimmed so that it does not extend onto the bottom of the anchor trench. It shall be trimmed just short of the bottom and shall extend a minimum of ¾ of the depth of the anchor trench.
4. Install 3/4" Ø PVC pipe through the geomembrane and engineered turf to serve as weep hole. PVC pipe to be placed at 4' on center along the toe trench. Pack HydroBinder® around the PVC pipe.



WG WatershedGeo® Unearthing Solutions

PRODUCT HydroTurf®

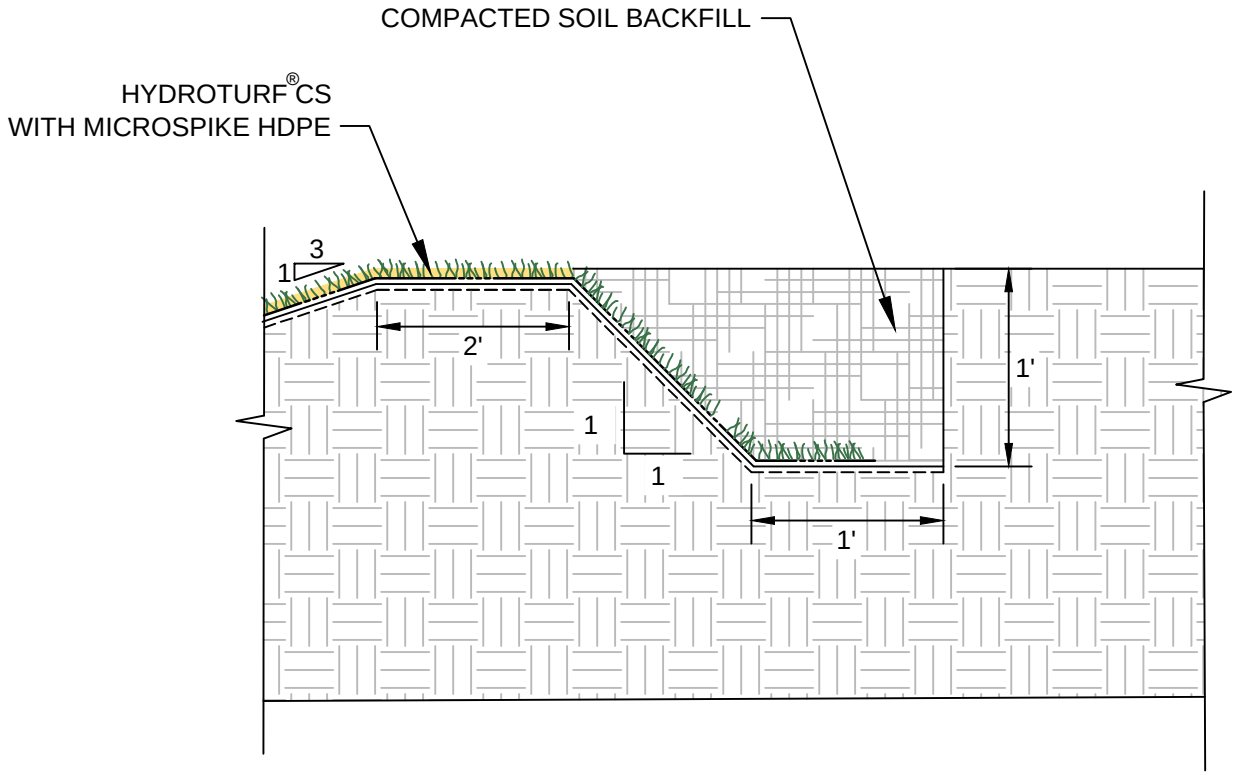
TITLE HYDROTURF® CS DOWNSTREAM ANCHOR TRENCH DETAIL CROSLEY LAKE

File #	FIGURE 3	
Rev #	Scale	Date
0	NTS	4/5/2018

FIGURE 3

Notes:

1. The geomembrane component of HydroTurf® CS shall be in intimate contact with the anchor trench inside wall and bottom. Wrinkles, ripples, fish mouths, and/or bunching shall be removed and properly patched. During filling of the anchor trench with the compacted soil or concrete backfill, the contractor shall maintain that the geomembrane is in intimate contact with the trench wall and bottom. Concrete backfill shall be vibrated in place in accordance with standard industry techniques.
2. The geomembrane shall not extend up the outside wall of the anchor trench. It shall be trimmed short of the outside wall and shall extend a minimum of ¾ of the width of the anchor trench.
3. The engineered turf component of HydroTurf CS shall be in intimate contact with the geomembrane. Wrinkles, ripples, fish mouths, and/or bunching shall be removed and properly patched. The engineered synthetic turf shall be trimmed so that it does not extend onto the bottom of the anchor trench. It shall be trimmed just short of the bottom and shall extend a minimum of ¾ of the depth of the anchor trench.



WG WatershedGeo® Unearthing Solutions

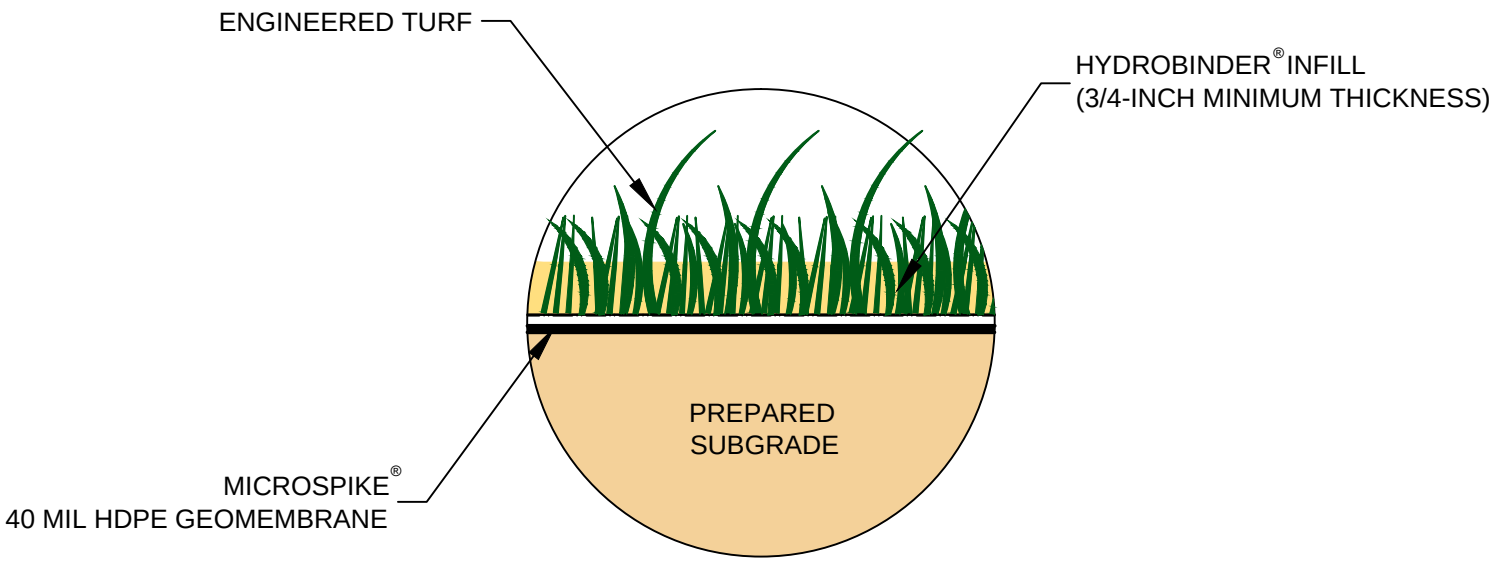
PRODUCT HydroTurf®

TITLE

HYDROTURF® CS DOWNSLOPE ANCHOR TRENCH DETAIL CROSLEY LAKE

File #	FIGURE 4	
Rev #	Scale	Date
0	NTS	3/23/2018

FIGURE 4



WG WatershedGeo® Unearthing Solutions

PRODUCT

HydroTurf®

TITLE

HYDROTURF® CS TYPICAL SECTION WITH MICROSPIKE® HDPE GEOMEMBRANE

File #	HTPD-02-R00	
Rev #	Scale	Date
0	NTS	3/23/2018

FIGURE 5

PART C
DETAILED SPECIFICATIONS

APPENDIX - A

SUPPLEMENTAL GEOTECHNICAL
CONSIDERATIONS

Date: November 22, 2013

Note: The Technical Data contained in such report upon whose accuracy Contractor may rely are the boring logs.

November 22, 2013

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269-262-4320 or 574-233-6820
(FAX) 269-262-4479

Mr. Drew O. Flamion, P.E.
Commonwealth Engineers, Inc.
101 Plaza Blvd., Suite 200
Evansville, IN 47715

Re: Geotechnical Considerations
Schematic Design
Crosley Lake Dam Improvements
Jennings Co., Indiana
EEI Project No. 1-13-215

Dear Drew:

We have reviewed our engineering report dated April 3, 2009 for this facility, and we have reviewed the schematic plans that you have recently prepared. Based on our conversations and the schematic plans, we understand improvements are being planned to correct the ongoing scour/erosion along the toe of the embankment (right side) and mitigate seepage that has been occurring through rock at the right abutment. With regard to the seepage, you requested an exploratory core be performed to better evaluate the characteristics of the rock exposed in the spillway at the right abutment. The exploratory location plan and boring log are attached. As we have discussed, clay-filled voids were observed in the rock near depths of 4 and 15 ft below the surface. Given the geology and our experience in the area, it is likely that open voids, factures, and bedding planes are present in the rock. To correct the seepage, we understand you are evaluating cement grouting options as part of the schematic phase, and we do not take exception to that approach in light of observations of our exploratory core.

With regard to the scour/erosion, the improvements are anticipated to include construction of a hard-armored element (i.e., a segmental concrete block wall) at the toe. From a global stability perspective, we do not have a concern of instability. However, careful attention and detailing will be required for the design of the wall with regard to internal stability and drainage under the anticipated loading conditions. To evaluate internal wall drainage, we have included grain size distributions curves that are representative of the exposed near-vertical scoured face of soil at the toe. Given the proprietary nature of these wall types, it is typically the responsibility of the wall supplier to provide the engineering services of the internal design in conjunction with well-defined expectations to be provided by the owner in the contract documents.

As you are aware, additional geotechnical analysis and input will be required as plans progress. If the project continues beyond the schematic phase, we would be more than happy to assist you through design development.

We appreciate the opportunity to provide our services to you on this project and trust that this information is sufficient for your current needs. Feel free to contact us if you have any questions.

Sincerely,

EARTH EXPLORATION, INC.

Michael S. Wigger, P.E.
Principal Engineer

KPH

Attachments: Exploratory Location Plan (Drawing No. 1-13-215.A1)
Log of Test Boring
Grain Size Distribution Curve (4)

NOTES

1. Base map developed from an aerial image from maps.google.com.
2. Vicinity map generated using commercially-available software by DeLorme (Street Atlas USA ver. 7.0).
3. Borings and soundings were located in the field by Earth Exploration, Inc. on July 18, 2013.
4. Ground surface elevation at the boring location was provided by Commonwealth Engineers, Inc.
5. Exploratory locations are approximate.

LEGEND

B-1 — Test Boring Location and Designation

EXPLORATORY LOCATION PLAN

PROJECT:	Schematic Design - Crosley Lake Dam
LOCATION:	Jennings County, Indiana
CLIENT:	Commonwealth Engineers, Inc.
EEI PROJECT NO.:	1-13-215
SCALE:	1" = 100'

PROJECT ENG: MSW
APPROVED BY: MSW
DRAWN BY: JBF
DATE AND TIME: 8/28/13

EARTH EXPLORATION, Inc.
7770 West New York Street
Indianapolis, IN 46214-2988
317-273-1690
(FAX) 317-273-2250

DRAWING NO.:
1-13-215.A1

LOG OF TEST BORING

Project **Schematic Design - Crosely Lake Dam**
Location **Jennings County, Indiana**
Client **Commonwealth Engineers, Inc.**

7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. **B-1**
Elevation **695.91**
Datum **NAVD 88**
EEI Proj. No. **1-13-215**
Sheet **1** of **1**

Proj. No.	---	Station	---	Weather	**Sunny**	Driller	**C.H.**
Struct. No.	---	Offset	---	Temp.	**90° F**	Inspector	---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
RC-1		88	RQD=88%	0	695								
RC-2		100	RQD=100%	5	690	**LIMESTONE**, low bedding plane angles, hard, fine to medium grained, coarse grained from near 4' to 4½', gray to brownish gray from near 12½' to 16½', with clay seams from near 4' to 4½' and from near 15½' to 16½'							
RC-3		100	RQD=100%	10	685								
RC-4		87	RQD=87%	15	680								
				20		End of Boring at 20 ft During coring, communication of the wash water with the lake water was observed near a depth of 4'. This corresponds with the depth of one of the clay seams observed in the core.							

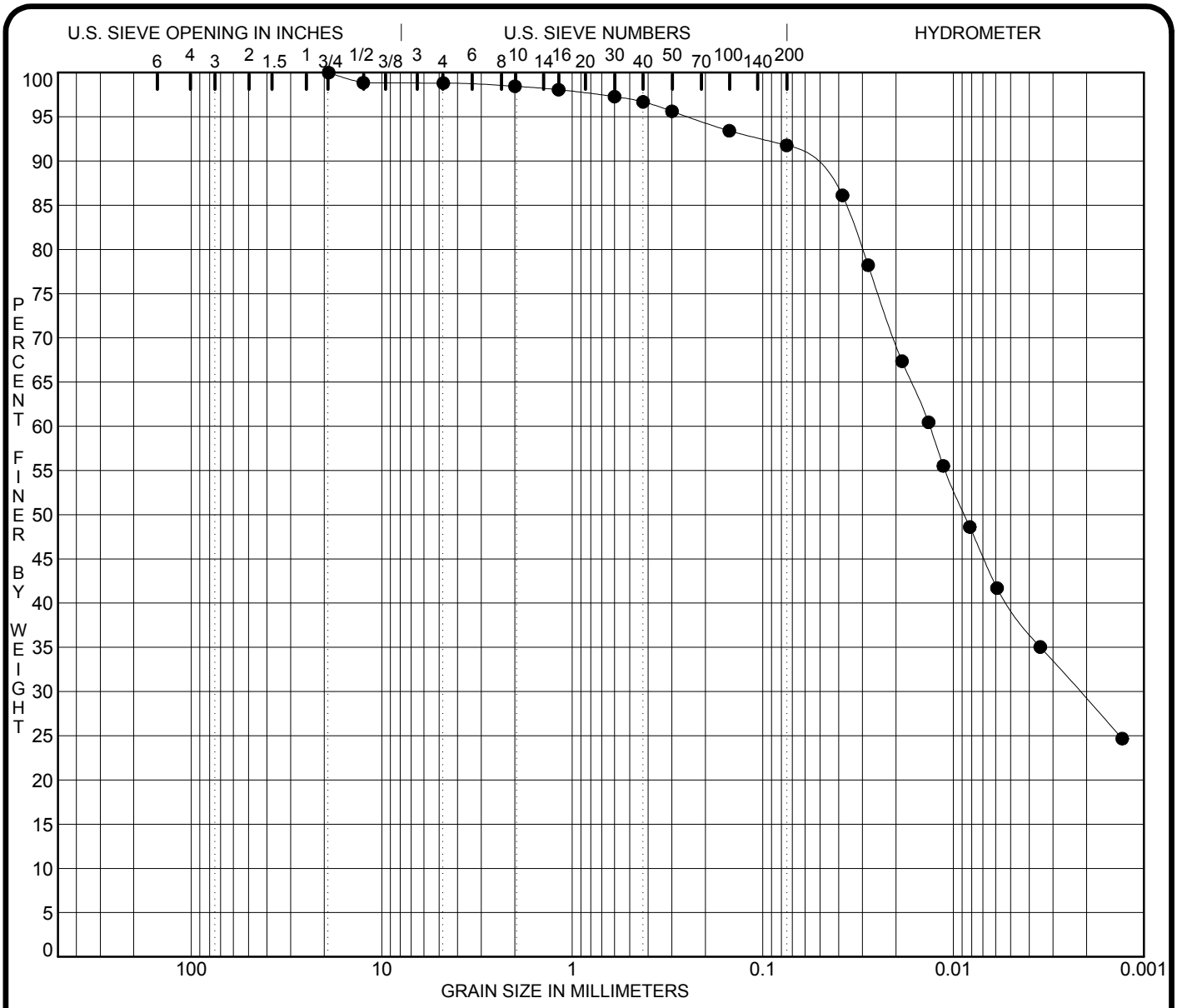
WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	⧩ After Drilling
To Water	---	---*	BF
To Cave-in		---	

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start **8/5/13** End **8/5/13** Rig **CME 750**
Drilling Method **3¼" I.D. HSA** **ATV**
Remarks **Backfilled with bentonite cement/grout. *Water introduced during drilling.**



BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Sample Identification		Station / Offset / Line	Depth, ft.	Elevation, USCGS
● HA-1	BS-1	---	0.0 - 1.0 ft.	- ---

Lab No.	Classification	pH	%Gravel	%Sand	%Silt	%Clay	MC%	LL	PL	PI
---	CL, LEAN CLAY		1.5	6.7	62.6	29.2	21.2	45	25	20

Remarks:

EARTH EXPLORATION, Inc.

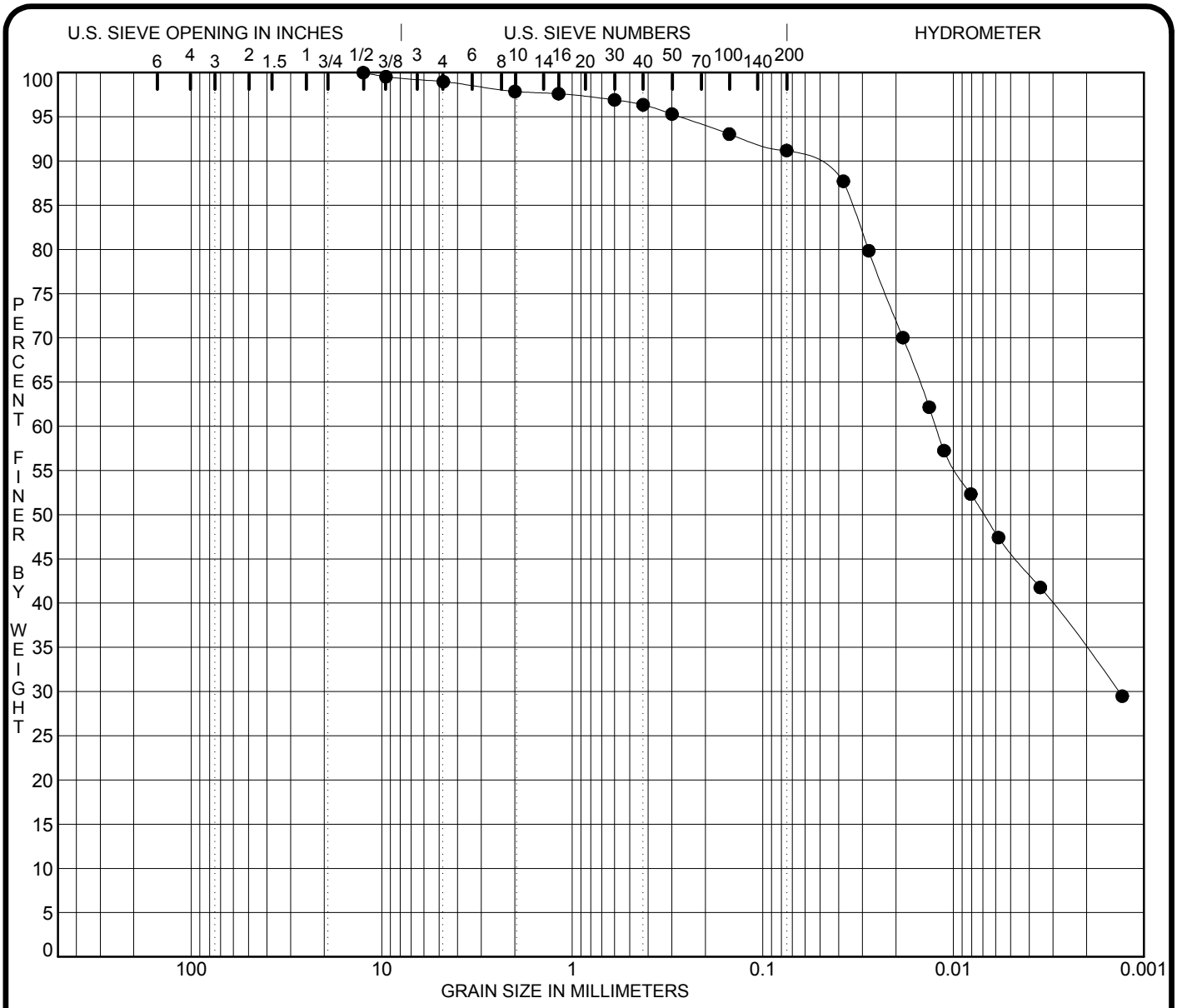
Project No. --- **Project** Schematic Design - Crosely Lake Dam

Structure No. --- **Location** Jennings County, Indiana

EEI Proj. No. 1-13-215 **Client** Commonwealth Engineers, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)



BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Sample Identification		Station / Offset / Line	Depth, ft.	Elevation, USCGS
● HA-2	BS-1	---	0.0 - 1.0 ft.	- ---

Lab No.	Classification	pH	%Gravel	%Sand	%Silt	%Clay	MC%	LL	PL	PI
---	CL, LEAN CLAY		2.1	6.7	56.4	34.8	25.4	49	24	25

Remarks:

EARTH EXPLORATION, Inc.

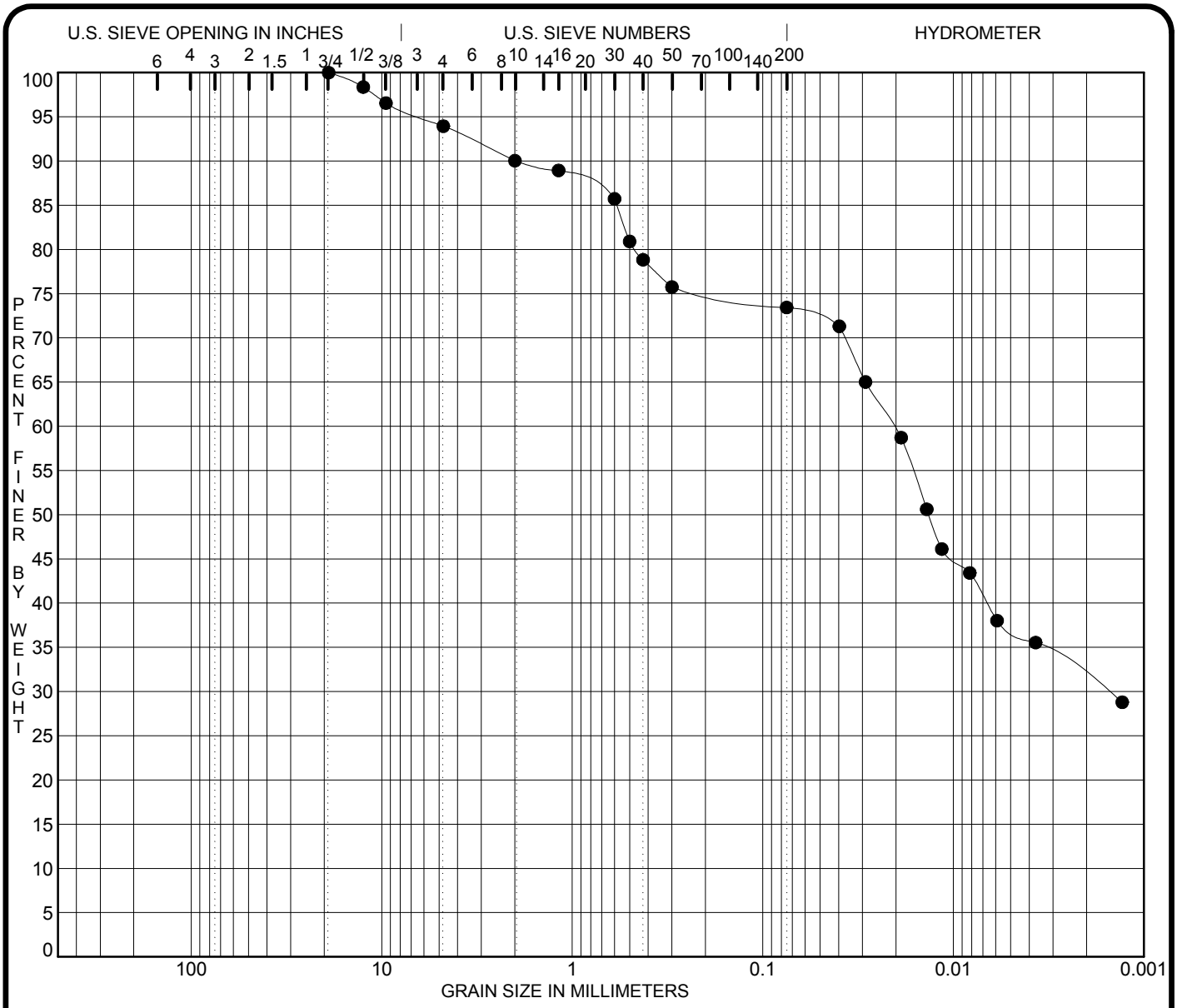
Project No. --- **Project** Schematic Design - Crosely Lake Dam

Structure No. --- **Location** Jennings County, Indiana

EEI Proj. No. 1-13-215 **Client** Commonwealth Engineers, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)



BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

	Sample Identification		Station / Offset / Line	Depth, ft.	Elevation, USCGS
●	HA-3	BS-1	---	0.0 - 1.0 ft.	- ---

Lab No.	Classification	pH	%Gravel	%Sand	%Silt	%Clay	MC%	LL	PL	PI
---	CL, LEAN CLAY		10.0	16.6	41.9	31.6	17.1	42	19	23

Remarks:

EARTH EXPLORATION, Inc.

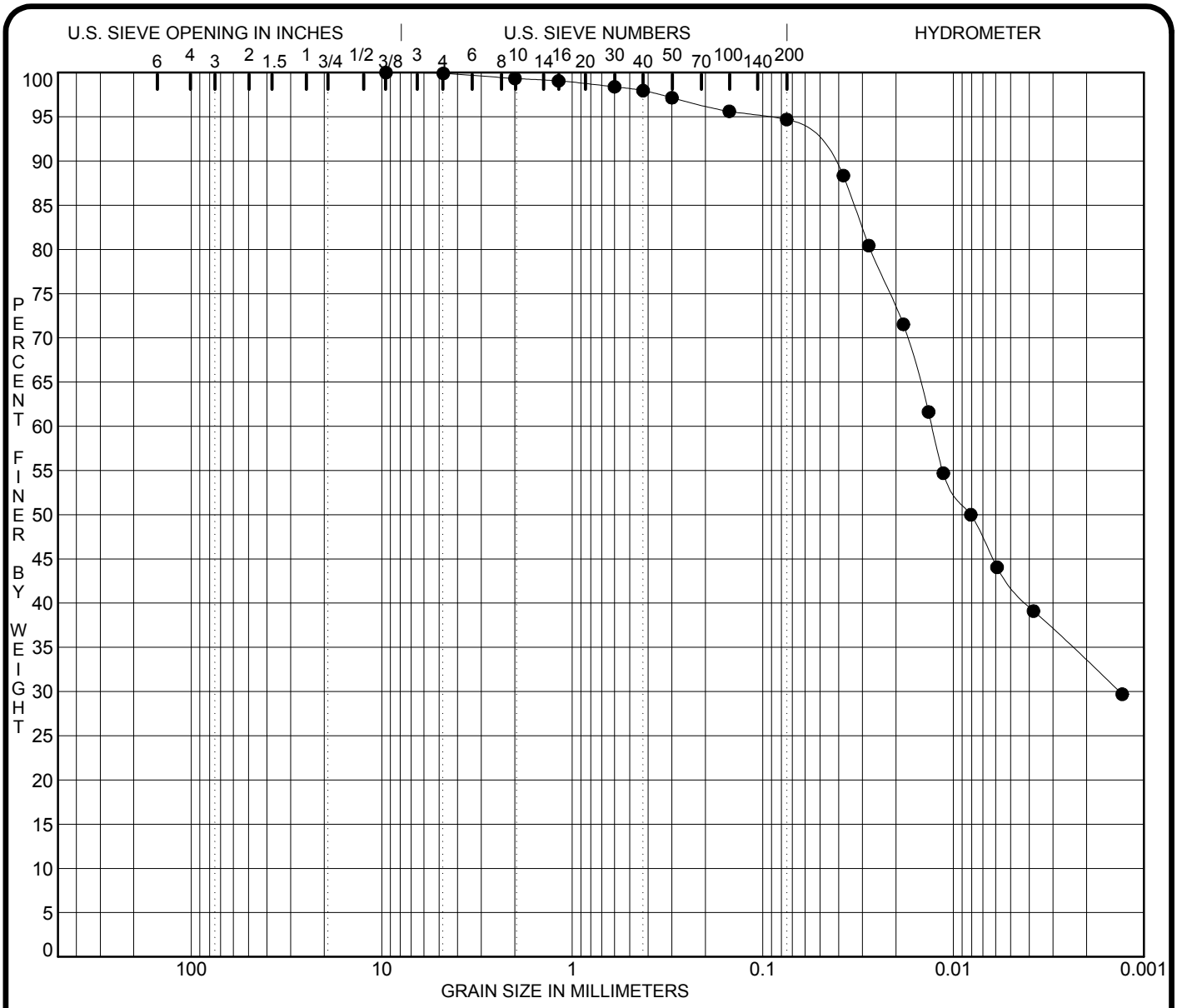
Project No. --- **Project** Schematic Design - Crosely Lake Dam

Structure No. --- **Location** Jennings County, Indiana

EEI Proj. No. 1-13-215 **Client** Commonwealth Engineers, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)



BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Sample Identification		Station / Offset / Line	Depth, ft.	Elevation, USCGS
● HA-4	BS-1	---	0.0 - 1.0 ft.	- ---

Lab No.	Classification	pH	%Gravel	%Sand	%Silt	%Clay	MC%	LL	PL	PI
---	CL, LEAN CLAY		0.7	4.6	61.2	33.5	20.1	46	22	24

Remarks:

EARTH EXPLORATION, Inc.

Project No. --- **Project** Schematic Design - Crosely Lake Dam

Structure No. --- **Location** Jennings County, Indiana

EEI Proj. No. 1-13-215 **Client** Commonwealth Engineers, Inc.

GRAIN SIZE DISTRIBUTION CURVE

Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

PART C
DETAILED SPECIFICATIONS

APPENDIX - A

ENGINEERING REPORT
CROSLEY LAKE DAM EVALUATION
CROSLEY FISH & WILDLIFE AREA
JENNINGS COUNTY, INDIANA
PUBLIC WORKS PROJECT NO. E019901B

Date: April 3, 2009

Note: Only relevant geotechnical information has been included from that report, irrelevant pages have been omitted from this document. Furthermore, the Technical Data contained in such report upon whose accuracy Contractor may rely are the boring logs.

ENGINEERING REPORT

CROSLEY LAKE DAM EVALUATION
CROSLEY FISH & WILDLIFE AREA
JENNINGS, COUNTY INDIANA

PUBLIC WORKS PROJECT NO. E019901B

Prepared for

DEPARTMENT OF NATURAL RESOURCES AND
DEPARTMENT OF ADMINISTRATION
STATE OF INDIANA

By

EARTH EXPLORATION, INC.
7770 WEST NEW YORK STREET
INDIANAPOLIS, INDIANA 46214-2988

April 3, 2009

EARTH EXPLORATION, INC.

EARTH EXPLORATION, INC.

7770 West New York Street
Indianapolis, IN 46214-2988
317-273-1690 (FAX) 317-273-2250

4310-C Technology Drive
South Bend, IN 46628
574-233-6820 (FAX) 574-233-8242

April 3, 2009

Mr. Larry Wayland, P.E.
Indiana Department of Natural Resources
Engineering Division
402 West Washington Street, Suite W299
Indianapolis, IN 46204

Re: Public Works Project No. E019901B
Crosley Lake Dam Evaluation
Crosley Fish & Wildlife Area
Jennings County, Indiana
EEI Project No. 1-02-020

Dear Mr. Wayland:

We have completed our hydrologic & hydraulic evaluation and geotechnical analysis for the referenced project. This report presents the results of our analyses and provides alternatives for addressing deficiencies associated with the dam. For your information, we are enclosing five copies of our report for your review, and additional copies can be provided, if necessary.

We appreciate the opportunity to provide our services to you and look forward to assisting you during the design of the selected improvements. Should you or others have any questions or require further assistance with the project, please contact our office.

Sincerely,
EARTH EXPLORATION, INC.

Scott J. Ludlow, Ph.D., P.E.
Principal Engineer

Darren R. Pleiman, P.E.
Senior Engineer

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1 INTRODUCTION

Earth Exploration, Inc. (EEI) has prepared this report to document the assessment of the hydraulic performance and existing geotechnical condition of the Crosley Lake dam and spillway, and to recommend improvements to the structure as appropriate. EEI's services were authorized by a contract between the State of Indiana Department of Administration and EEI dated March 22, 2002.

2 PROJECT CHARACTERISTICS

2.1 BACKGROUND INFORMATION

Crosley Lake is located within the Crosley Fish and Wildlife Area in Jennings County, Indiana (Drawing 1-02-020.A1). The dam was constructed in 1937 and purchased by the state in 1958. The statutes of the state of Indiana (IC 14-27-7.5-8) assign to the Indiana Department of Natural Resources (IDNR) the jurisdiction and supervision over the maintenance and repair of dams, defines a hazard classification scheme for dams and other structures, and requires the IDNR to develop criteria for assigning a hazard classification to flood control structures. By these criteria, the Crosley Lake dam has a hazard classification of "significant," indicating that the failure of the dam may damage isolated homes and highways, or cause the temporary interruption of public utility services.

2.2 PURPOSE OF SERVICES

The purpose of this work is to evaluate the ability of the Crosley Lake dam to safely pass the runoff from a design storm event. The IDNR developed guidelines[1] that specify design storm events according to the hazard classification assigned to the dam. A dam with a significant hazard classification should pass a 50% probable maximum precipitation (PMP) event.

2.3 PROJECT REQUIREMENTS

The scope of services was based on a October 5, 2000, site visit and meeting with representatives from the Indiana Department of Natural Resources (IDNR) Divisions of Engineering and Water. The proposed scope consisted of four primary tasks that are outlined below. This scope was discussed and approved during a January 30, 2003, meeting with representatives of EEI and the IDNR Divisions of Fish & Wildlife, Water, and Engineering. Once initial hydrologic and hydraulic calculations were performed, it was determined that the size of the spillway required to pass the design storms was too large, and that a reduction in the normal pool elevation, and thereby the spillway dimensions, was desired. Based on the discussions in a March 16, 2006 meeting with representatives of EEI and the IDNR Divisions of Fish & Wildlife, Water, and Engineering, EEI performed additional calculations to determine the loss in shoreline related to a pool decrease of 1.5 ft, and hydraulic modeling as needed to size a spillway to pass the 50% PMP storm.

2.3.1 Task 1: Information Review and Site Visit

The first task included a review of all existing information for the Crosley Lake dam, and a site visit to observe conditions and to become familiar with the characteristics of the structure.

2.3.2 Task 2: Survey of Existing Physical Conditions

Task 2 included aerial and topographic surveys of the dam, spillway, lake, and affected downstream area to a point approximately 500 ft downstream of the dam. A bathymetric survey of the upstream face and impoundment area of the dam was included to map the underwater topography for stage-storage relationships and stability assessments.

2.3.3 Task 3: Hydrologic and Hydraulic Analyses

To evaluate the spillway systems, Task 3 included a hydrologic and hydraulic characterization of the Crosley Lake dam catchment area. Components of the characterization included the computation of a runoff hydrograph, calculation of the time of concentration, determination of the appropriate design precipitations, routing the hydrograph through the reservoir, and development of stage-storage-discharge curves for the spillway system.

Using the derived stage-storage-discharge curves, EEI performed hydrologic modeling to route 100-year and 50% PMP design storms through the Crosley Lake catchment. The design bottom width of the principal spillway was iteratively lengthened until the modeled spillway would pass the 50% PMP; any additional precipitation was modeled as overtopping the spillway.

2.3.4 Task 4: Geotechnical Investigation and Analysis

Task 4 included the completion of subsurface exploratory and laboratory testing programs, and the analysis of the structural integrity (i.e., stability) of the embankment under various loading conditions. The analysis included an evaluation of critical sections of the embankment with loading from steady-state seepage under a normal pool, rapid drawdown, and seismic events.

Requirements of the subsurface exploratory and laboratory testing programs included performance of services in accordance with procedures outlined by the American Society for Testing and Materials (ASTM). Minimum guidelines included exploratory test borings (ASTM D 1452), Standard Penetration Test (SPT) sampling (ASTM D 1586), diamond core drilling (ASTM D 2113), and thin-walled tube sampling (ASTM D 1587). The task also includes the preparation of a final engineering analysis report to identify deficiencies, if present, and recommend alternative improvements with cost estimates.

3 EXISTING CONDITIONS

An evaluation of the existing conditions at Crosley Lake dam consisted of discussions during meetings and a site visit; direct observation of the embankment, spillway and downstream channel; a review of published literature and documents available in the IDNR files; and physical (topographic and bathymetric) mapping.

The Crosley Lake area is located in Jennings County approximately 1.3 mi southeast of Vernon, Indiana (refer to Drawing 1-02-020.A1 in Appendix A). Its drainage area is in Township 9 North, Range 8 and 9 East, within the Vernon topographic quadrangle[2]. Table 3.1 presents a synopsis of the history of the lake as gathered from available documents.

Table 3.1: Concise History of Crosley Lake

Date	Activity	Reference
1937	Crosley Lake appears in aerial photographs. Local residents related that the dam was constructed by horse-pulled slip scoops and a dozer pulling two hand-operated scraper pans. SCS[a] personnel advised the landowner to not construct the lake because it was thought that the underlying bedrock would not hold water.	3
1958	IDNR purchases the property.	3
1978 (?)	The dam starts to leak on the left abutment of the dam, along the shore.	3
1979	M. D. Wessler & Associates prepares drawings for seepage control. Plans include lowering the lake level by approximately 8.5 ft; excavating to bedrock; grouting 6 leak inlets; installing a 6-in. sand bed, overlying plastic liner, and soil cover.	4
1980	Repairs are completed to stop the leak.	3
1981	Spillway pipe is pumped completely full of concrete.	5
1982	A leak is noted on the right abutment of the dam, at a depth of 3 to 4 ft below the rock ledge that formed the base of the spillway.	3, 6
1988	A decision is made to plug the leak at the north end of the dam.	3, 6
1989	A new opening emerged next to the recently plugged hole. Water surfaces 700 ft downstream against a bank of a hillside, verified by dye tracing.	3, 6

a. Soil Conservation Service, now known as the Natural Resources Conservation Service.

3.1 HYDROGRAPHIC SETTING

Crosley Lake is located on an unnamed stream that drains to the Vernon Fork Muscatatuck River between gauging stations located at river miles 36.4 and 39.48. The Vernon Fork is part of the East Fork White River drainage basin, and like other rivers in the eastern portion of the basin, it exhibits a parallel drainage pattern.[7] It is within the Muscatatuck Regional Slope

physiographic unit, where Silurian and Devonian carbonate bedrock controls the regional slope and river valleys are deeply entrenched along joints and fracture zones.

3.2 GEOLOGIC SETTING

The 1° x 2° Louisville Quadrangle[8] geologic map indicates that the stream that is dammed to form Crosley Lake was incised through the Upper Devonian New Albany Shale and into the underlying Middle Devonian strata. The Middle Devonian Muscatatuck Group is bound above and below by unconformable erosional boundaries that can be correlated regionally across Indiana into Illinois, Michigan, and Ohio[9]. Greeman[10] reports that in Jennings County, the bedrock dips west-southwest at about 20 ft/mi and the bedrock erosional surface dips in the same direction at 12 ft/mi.

Within the study area, the Middle Devonian sequence consists of the North Vernon Limestone, the underlying Jeffersonville Limestone, and the basal Geneva Dolomite. In Jefferson County, Indiana[11], the North Vernon is reportedly 18.8 ft thick, and consists of gray to dark gray, very fine- to very coarse-grained, thin- to medium-bedded limestone. The unit contains whole and fragmented fossils, glauconite, and black phosphate grains and pebbles. The Jeffersonville Limestone is reportedly 28.3 ft thick and consists of gray, tan and yellow-brown, fine-grained, argillaceous, silty, massive limestone. The unit exhibits relict thin bedding and contains chert and fossils. The Geneva Dolomite is reportedly 18.6 ft thick, brown, fine-grained, finely vuggy, massive, and weathers "cavernous."

EEI reviewed field notes[12] from Alan Perry's geological reconnaissance of an area approximately 5,000 ft southeast of the Crosley Dam. The notes indicate that "not more than a couple of feet" of the New Albany Shale overlaid the North Vernon at the centerline of a proposed dam. Two prominent joint sets were observed in the North Vernon: one striking N70°E and the other N10°W. Mr. Perry noted "considerable solution channel development along the joints" was observed at outcrops of the North Vernon. However, it was indicated that there is much less development of solution channels in the North Vernon where it is overlain by the New Albany Shale. These observations corroborated those of Greeman[10], who noted that dissolution along joints is most pronounced at the top of his "upper sequence" (i.e., North Vernon, Jefferson and Geneva) where solution sinkholes are present.

Greeman mapped lineaments and fracture traces within Jennings County[10]. He defined lineaments as linear or broadly curvilinear features that are observable in aerial photographs and topographic maps, and extend for 1 mi or more. Although the geologic origin of the mapped lineaments is undocumented, the author noted that some lineaments have been documented as expressions of vertical bedrock fractures. The map that accompanies Greeman's report shows a lineament that begins at the southwestern end of Crosley Lake and extends northeastward, parallel to the lake axis, and beyond the lake for a total distance of 48,000 ft. The orientation of the lineament is approximately N64°E.

3.3 SEISMOLOGY

A map of the 1990 seismic impact zones indicate that the Crosley Lake area has a <10% probability that the maximum horizontal acceleration will exceed 0.10g (3.2 ft/s^2) in 250 yrs. The U.S. Geological Survey Earthquake Hazards Program[13] indicates that the area has a 10%

probability of exceedence in 50 years of peak horizontal ground acceleration of 0.0356g (1.15 ft/s^2). An Indiana Geological Survey report[14] indicates that paleoliquefaction sites have been mapped along the Muscatatuck River, and that their presence suggests that liquefaction could be widespread along the White River valley during major local earthquake events.

3.4 PHYSICAL MAPPING

The existing physical conditions at Crosley Lake were documented by four types of mapping. First, aerial photography was performed in order to generate smaller scale maps of the Crosley Lake area and larger scale maps of the embankment and spillway channel areas. Second, small- and large-scale topographic maps were generated from the photographic images of the respective areas. Third, a ground survey was conducted to produce detailed topographic mapping of the embankment and drainage channels. Fourth, a bathymetric survey was completed to generate a topographic map of the lake floor.

3.4.1.1 Aerial Photography

EEI contracted Accu-Air Surveys, Inc. (AASI) to provide aerial photography and mapping services for the Crosley Lake drainage area. Specifications of the survey were discussed and agreed upon in advance with IDNR Division of Water personnel. Grayscale aerial photographs were acquired at two scales. Crosley Lake and its immediately surrounding area, comprising approximately 152 ac., were photographed at a negative scale of 1:6,000 (1 in. = 500 ft); the dam embankment and spillway channel were also photographed at a larger negative scale of 1:3,000 (1 in. = 250 ft). AASI surveyed in ground control points for rectifying the aerial photos from publicly available benchmark data. The orthophotographs, provided to EEI in digital GeoTIFF format, were spatially referenced to the Indiana East State Plane Coordinate System (1301), North American Datum of 1983 (NAD83) and the 1988 North American Vertical Datum (NAVD88).

3.4.1.2 Topographic Mapping

AASI used the aerial photography to create topographic maps at two scales. A topographic map of Crosley Lake and its immediately surrounding area were mapped at a scale of 1:1,200 (1 in. = 100 ft) and a topographic contour interval of 2 ft. The dam embankment and spillway channel were mapped at a scale of 1:600 (1 in. = 50 ft) and a contour interval of 1 ft. The maps were referenced to the Indiana East State Plane Coordinate System using NAD83 and NAVD88. AASI issued the topographic contour maps in digital AutoCAD® *.dwg* format, which allows the inclusion of the orthophotographs as image layers. The resulting topographic map is presented in Appendix A as Drawing 1-02-020.B2.

3.4.1.3 Detailed Topography of Embankment and Downstream Channel

EEI performed a detailed topographic survey of the dam embankment, spillway channel, and downstream channel. The survey was conducted on April 10, 2003, using a Leica TPS1100 auto tracking total station instrument. Spatial control and coordinate system translation was achieved by ties to two IDNR benchmarks (data provided by the Division of Water) and a rectification point established on the crest of the dam embankment by AASI. Approximately 750 total station measurements were combined with the larger scale topographic map data to compile a 1:600 (1 in. = 50 ft) contour map.

3.4.2 Bathymetric Survey

EEI conducted a bathymetric survey of Crosley Lake on March 26, 2003. Lake depths were measured with an Innerspace Technology Model 455 survey depth sounder with an Airmar 208 kHz, 8° beam transducer mounted in a johnboat. Horizontal positioning was achieved by creating a serial link to a Trimble GeoXT™ global positioning satellite (GPS) system. A total of 1,417 measurements were recorded in both a zigzag pattern and along longitudinal traverses. Data processing included differential corrections of the GPS coordinates, corrections for the length of the transducer mount and the depth of the transducer below the water surface, and conversion of the measured depths to topographic elevations. The corrected GPS data provided typical horizontal precisions (68% probability) of less than 1 m. A bathymetric contour map was generated in Autodesk® Field Survey (Field Survey) and combined with the topographic maps described in the above sections, and is presented in Appendix A as Drawing 1-02-020.D3.

3.4.3 Dimensions of Lake and Drainage Areas

The topographic and bathymetric datasets were compiled using Field Survey in order to generate a 3-dimensional model from the topographic contours and bathymetric depth points. This provided a tool to calculate lake areas and volumes at a given stage, and thereby produce a stage-storage relationship (Section 5.1.2.1). A 5-ft by 5-ft grid was used, resulting in a 591 by 500 grid cell model.

The drainage area for the Crosley Lake dam was delineated using the U.S. Geological Survey (USGS) 7.5-minute Vernon Quadrangle Digital Raster Graphic (DRG)[15]. A DRG is an electronic image of a topographic quadrangle that is georeferenced to true ground coordinates using a GeoTIFF format. The horizontal positional accuracy of the DRG matches the accuracy of the published source map. Technical details of DRG documents are presented in APPENDIX B.

The DRG was imported into Field Survey where basin boundaries were visually identified from the topographic contours (10-ft contour interval) and digitized. Two basins were defined: the entire drainage area for the stream that is dammed at Crosley Lake, and the drainage area above Crosley Lake dam (Drawing No.: 1-02-020.A4). Field Survey was used to compute the areas within the digitized boundaries (Table 3.2). No subbasins were defined for the two areas because the areas of the drainage basins were less than 2,000 ac.

Table 3.2: Dimensions of Drainage Areas

Crosley Dam Basin	646 ac	1.0 mi^2
Crosley Stream Basin	1,390 ac	2.2 mi^2

3.5 RESERVOIR

Crosley Lake is 15.5 ac in size and receives runoff from a 646-acre catchment area. The lake was frozen at the time it was surveyed and had a surface elevation of 696 ft (NGVD). The deepest portion of the lake had a maximum measured depth of 23 ft, yielding an approximate elevation of 673 ft NGVD. The volume of the lake at a stage of 696 ft NGVD was calculated to be 140.5 ac-ft. An undated water sampling datasheet shows the pH ranging from 9.8 at the surface to 7.3 at the bottom, indicating slightly alkaline conditions at the time of measurement.

3.6 EMBANKMENT

The Crosley Dam embankment is grass covered and appears to be well maintained (APPENDIX C). It is approximately 300 ft long and 17 ft wide at its crest. It stands 28 ft above the lowest point of the downstream toe, and 21 ft above the lowest point of the upstream toe. There are no lateral drains or toe drains within the dam. There was no evidence of seepage through or beneath the embankment at the time of the site visit. The upstream slope near the center of the embankment was measured to be 3.6:1 (horizontal:vertical), and the downstream embankment was 3.1H:1V.

3.7 PRINCIPAL SPILLWAY

The principal spillway currently consists of an open channel on the north end of the embankment (i.e., right abutment). The channel is trapezoidal in section. It is 29 ft wide at its base (an elevation of 696 ft NGVD), 82 ft wide at an elevation of 700 ft NGVD, and 4 ft deep. Channel stages greater than 4 ft. begin to overtop the adjacent embankment. Photographs of the spillway are presented in APPENDIX C.

The floor of the spillway channel consists of outcropping in-situ limestone. The bedrock is significantly fractured, with open systematic joints extending across the channel floor. An measured but apparently significant quantity of discharge flow enters one or more of the open joints, resulting in the abstraction of flow to the subsurface. The prominent (open) fracture set strikes N07°W and a less well-developed set strikes N72°E; the orientations are consistent with fracture and lineament orientations reported in the geologic literature (Section 3.1).

3.8 DOWNSTREAM CHANNEL

A relatively narrow and incised channel extends approximately 350 ft downslope (southwestward) from the base of the outcropping spillway bedrock to the point that it meets the main downstream channel (that which predated the construction of the dam). Over this distance, it drops from approximately 691 ft to about 669 ft NGVD. Once the discharge drops over the spillway, which is oriented N71°W, it has to turn at an acute angle to follow the drainage channel (N08°E). While this is not an issue at base flow rates, during flood-stage events the sudden change in direction could result in significant head loss due to backwater conditions, and channel erosion due to turbulent conditions. The main channel is approximately 32 ft wide and 3 ft deep, whereas the floodplain terrace is approximately 225 ft wide. The floodplain terrace slopes downstream at an approximate rate of 100H:1V within the mapped area.

6 GEOTECHNICAL ANALYSIS

6.1 EXPLORATORY FIELD AND LABORATORY TESTING PROGRAMS

6.1.1 General

Subsurface conditions for the earthen dam were explored by performing four test borings at the locations shown on Drawing 1-02-020.B5 in Appendix H. These exploratory locations are along the crest of the existing embankment. Subsurface information from this evaluation is included in Appendices I and J, respectively.

6.1.2 Exploratory Methods and Sample Collection

The exploratory test borings for this evaluation were performed by EEI on March 6 and 7, 2003, using 3¼-in. I.D. hollow stem augers to advance the boreholes. Samples of the soil strata were typically obtained on a continuous basis with a split-spoon sampler using Standard Penetration Test (SPT) procedures (ASTM D 1586), and rock core samples were obtained using an NX-sized core barrel (ASTM D 2113) at all four of the boring locations. In addition, sampling of cohesive soils was performed using a thin-walled tube sampler (Shelby tube) (ASTM D 1587) in adjacent boreholes. Following the completion of the field activities, final water level readings were obtained, and each borehole was backfilled with a cement and bentonite grout mixture. Further details of the drilling and sampling procedures, are included in Appendix I.

6.1.3 Laboratory Testing

Following the field activities, soil samples were visually classified by an engineering technician and reviewed by a geotechnical engineer. Final boring logs were then prepared and are attached in Appendix J. Soil classifications on the logs are according to the Unified Soil Classification System (ASTM D 2488). Tests on representative soil samples included: natural moisture content ($W_{\%}$; ASTM D 2216); hand penetrometer readings (q_p; which is an indication of the soil's shear strength); Atterberg limits determinations ($LL_{\%}$, $PL_{\%}$, $PI_{\%}$; ASTM D 4318; which provide and indication of the soil's shear/deformational characteristics); unconfined compression tests (q_u; ASTM D 2166); unit density; and consolidated undrained compression with pore water pressure measurements (ASTM D 4767). These results are provided on the boring logs and/or on separate sheets in Appendix I and J.

6.2 SITE CONDITIONS

6.2.1 Subsurface Conditions

6.2.1.1 Soil Conditions

Within the explored depths, the soil profile was somewhat similar and consisted primarily of cohesive-type fill soils including lean clays of moderate to high plasticity. Based on the borings, the soil fill that make up the dam are comprised exclusively of lean clays. Beneath the embankment fill, natural lean clay was encountered with occasional trace amounts of roots and rock fragments. Underlying the overburden soils, moderately weathered limestone was encountered to the maximum explored depths.

From our observations, the consistency of the lean clay fill was generally stiff to very stiff with hand penetrometer readings ranging from 1 to 3½ ton/ft^2 (tsf). Moisture contents were typically on the order of about 16 to 29 percent, with the majority of values between 19 and 26 percent. Thin seams of medium lean clay fill, with penetrometer readings ranging from ½ to ¾ tsf, were encountered in Borings C-1 and C-3. The consistency of the natural lean clays was generally medium to very stiff with hand penetrometer readings ranging from ½ to 3 tsf. Moisture contents were typically on the order of about 21 to 30 percent, with the majority of values between 22 and 27 percent. For your information, the moisture content is directly related to the shear strength characteristics of cohesive soils, i.e., as the moisture content increases the strength decreases.

In addition, several unconfined compression tests were performed on split spoon and Shelby tube samples of cohesive soils. Results from these tests indicated peak undrained shear strengths (i.e. using the Ø=0 concept) ranging from 0.94 to 2.58 tsf at axial strains ranging from 8.3 to 15%. Based on a comparison of the moisture contents and Atterberg limits, the cohesive soils generally appeared to be of moderate to high plasticity. Several unit density tests were performed on split spoon and Shelby tube samples of cohesive soils. Results from these test indicated dry densities ranging from 96 to 113 lbs/ft^3 (pcf). Dry densities of 100 pcf or more would generally indicate that these soils were placed with some compactive effort, while dry densities less than 100 pcf would indicate little or no compactive effort used for fill placement. All of the laboratory test results are presented on the boring logs or on additional sheets in Appendix J and K.

Results from consolidated undrained compression tests with pore water pressure measurements of Shelby tube samples yielded the following Mohr-Columb shear strength parameters:

Table 6.1: CU Compression with Pore Pressure Measurements

Soil Description:	Lean Clay Fill (about 18 to 19 ft)	Lean Clay Fill (about 23 to 24 ft)
Total Stress Parameters		
Cohesion, lbs/ft^2 (psf)	516	404
Angle of Internal Friction, degrees	12.3	21.8
Effective Stress Parameters		
Cohesion, psf	934	726
Angle of Internal Friction, degrees	10.9	18.1

6.2.1.2 Rock Conditions

As mentioned, weathered/sound rock consisting of limestone was encountered below the overburden soils. Rock coring was performed at the four boring locations as soon as bedrock was encountered. The table below summarizes the rock coring information on the boring logs. Limestone rock outcroppings were also observed at the principal spillway and along portions of the drainage channel.

Table 6.2: Summary of Rock Coring Information

Boring No.	Rock Core Interval (ft)	Recovery (%)	RQD	Notes
C-1	RC-1: 33.5 to 38.5 RC-2: 38.5 to 43.5	90 100	100 97	Horizontal fractures near 34.5, 35.3, and 36.8 ft.
C-2	RC-1: 30.5 to 35.5 RC-2: 35.5 to 40.5	96 100	97 73	Vertical fractures near 36 to 37.4 ft and 40 to 40.5 ft.
C-3	RC-1: 31 to 36 RC-2: 36 to 41	86 98	83 84	Vertical fracture near 34.8 to 35.2 ft. Fractured and broken near 40.2 to 41 ft.
C-4	RC-1: 17.5 to 22.5 RC-2: 22.5 to 27.5	100 83	65 96	Vertical fractures near 18.7 to 19.4 ft and 19.5 to 19.9 ft.

6.2.1.3 Groundwater Conditions

Groundwater level observations made during and upon completion of the sampling process are noted at the bottom of the boring logs. From observations, groundwater was encountered during the exploratory activities, only at Boring C-3 at the soil/rock interface, at a depth of 31 ft below the existing ground surface (about Elevation 671 NGVD). At-completion groundwater levels and up to 96 hrs after removal of augers were observed at depths of 7 to 18½ ft below the existing ground surface (Elevation 694.2 to 683.1 NGVD). It should be noted that water was introduced to the borings during rock coring and that the at-completion and 96-hr water level readings are likely influenced by this addition of water. Considering that groundwater was not encountered in the borings (during drilling), except in Boring C-3 at the soil/rock interface, and that the 96-hr water level readings were lower than the readings taken at-completion indicates that the underlying bedrock is likely fractured enough to allow seepage water to escape. In our opinion, the observed groundwater levels or lack thereof are likely due to seepage into the underlying bedrock. We believe that the actual long-term groundwater level is likely at or below the soil/rock interface. It should be recognized that groundwater levels could fluctuate due to changes in precipitation, infiltration, surface run-off, the water level of Crosley Lake, and other hydrogeological factors.

6.3 SLOPE STABILITY ANALYSIS

6.3.1 Rationale

Based on the history of the embankment dam and its anticipated future use as a recreational facility, a geotechnical analysis was performed to confirm the geometry of the dam and the adequacy of its existing condition. A cross-section for analysis is shown on Drawing No. 1-02-020.B6. This section is shown in plan view on Drawing No. 1-02-020.B5 and is anticipated to provide the embankment geometry of the greatest depth and steepest slopes. Furthermore, considering the over-consolidated nature and relatively low permeability of the foundation soils and the age of the embankment, settlement of the embankment is anticipated to be of little concern. The focus of this evaluation has been toward the analysis of the existing dam to assess its stability concerns under different impoundment level configurations.

The U.S. Department of Agriculture Technical Release No. 60, Earth Dams and Reservoirs[33], recommends that the following conditions be considered for embankment dams:

Case No.	Condition
I.	Sudden drawdown (minimum factor of safety 1.2);
II.	Steady state seepage without seismic forces (minimum factor of safety 1.5); and
III.	Steady state seepage with seismic forces (minimum factor of safety 1.1).

A generalized subsurface profile was constructed from the subsurface information obtained at the boring locations and from laboratory testing. The soil strength parameters used in the slope stability analyses are presented in Table 6.3. For the sudden drawdown, an appropriate excess pore pressure parameter was used within the embankment fill to account for an assumed 10-ft drop in pool elevation. This pore pressure parameter is used to simulate the pore pressure rise within the embankment fill during a sudden drawdown.

Table 6.3: Generalized Subsurface Profile

Depth (ft)	Total Stress		Effective Stress		Unit Weight (pcf)	
	c (psf)	ϕ (degrees)	c (psf)	ϕ (degrees)	γ_d	γ_w
0 – 7	500	12	400	21	102	122
7 – 15	550	12	450	22	105	130
15 – 26	900	11	400	18	105	128
26 – 32	850	11	350	17	100	125

6.3.2 Results

Based on the soil strength parameters, the observed groundwater levels, and the anticipated impoundment level, we have evaluated the embankment slope stability. In our analysis, we have considered the factors of safety against rotational mechanism in the embankment and foundation. For our analysis, we have utilized a computer program titled "STABL" developed at Purdue University. STABL was developed to perform general slope stability problems by the simplified Janbu method and the modified Bishop method of slices. The factors of safety obtained by these limiting equilibrium procedures, although not satisfying complete equilibrium, are considered reasonable. The results of our slope stability analyses are provided in Appendix K and are summarized in Table 6.4.

Table 6.4: Summary of Stability Analyses

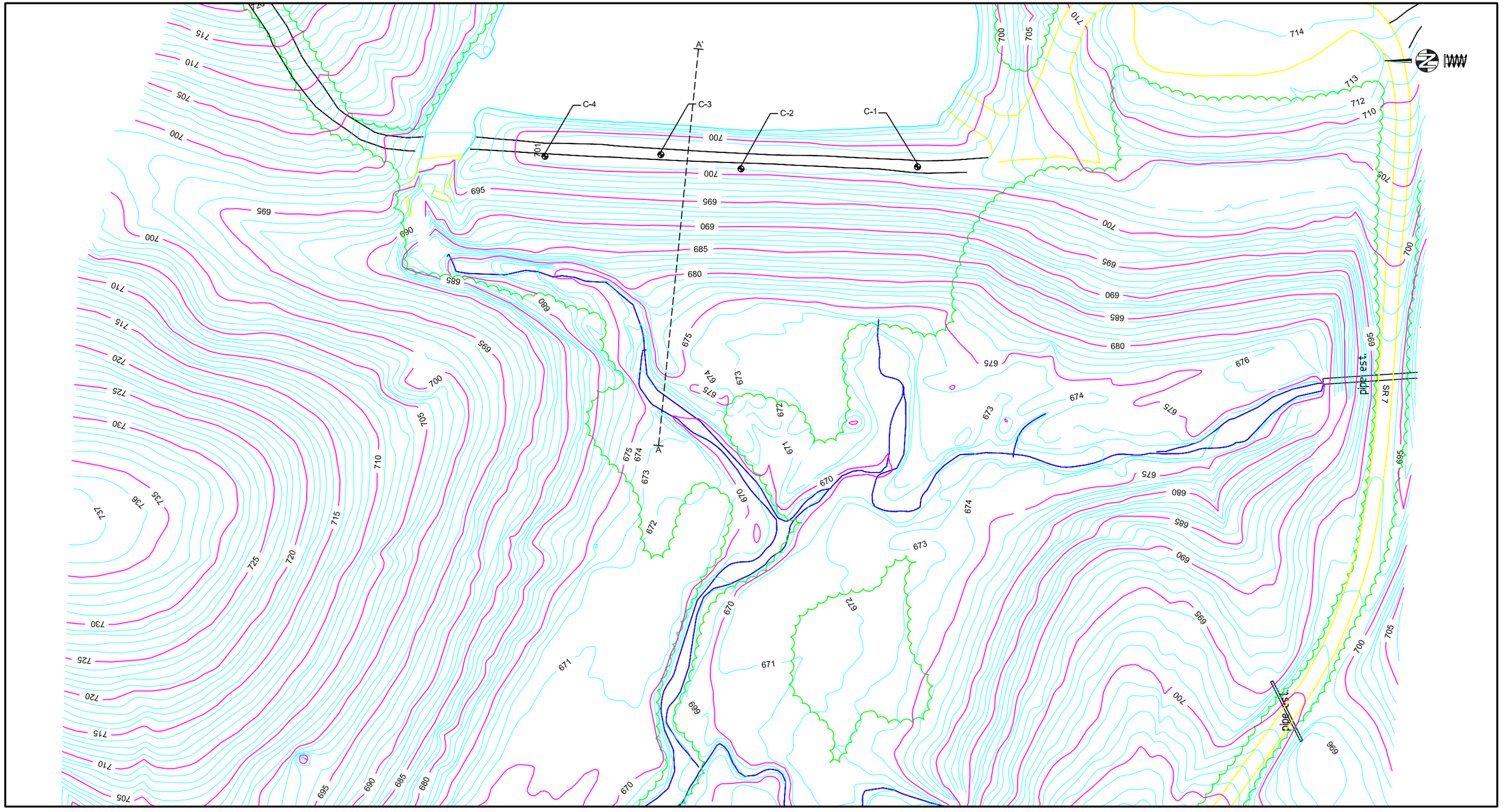
Existing Conditions			
Case	**Factor of Safety[1] (Total Stress)**	**Factor of Safety[1] (Effective Stress)**	**Required Factor of Safety[2]**
Case I - Sudden Drawdown from Normal Pool (Upstream Slope)	3.21	1.62 [3]	1.2
Case II - Steady-state Seepage at Normal Pool (Downstream Slope)	---	2.42	1.5
Case III - Steady-state Seepage at Normal Pool with Earthquake Loading (Downstream Slope)	2.66	1.69	1.1

Notes: [1] Minimum computed
[2] Based on normally acceptable levels
[3] Based on a 10 ft drop in the lake level.

Based on our analysis of the existing conditions, the minimum computed factors of safety exceed normally acceptable engineering levels for Cases I through III. In order to maintain an adequate factor of safety during drawdown, we recommend that a drawdown rate of about 1 ft per week (per General Guidelines for New Dams and Improvements to Existing Dams in Indiana[1]) be used prior to construction on the existing embankment. A comparison of the in-place dry densities and the expected dry density (about 105 to 110 pcf) indicates that the embankment soils were likely placed with some form of compactive effort. Based on the results or our analysis and review of the Earth Dam Inspection Reports going back to January of 1994, it appears that the embankment is performing adequately.

APPENDIX H

EXPLORATORY LOCATION PLAN (DRAWING 1-02-020.B5)
CROSS-SECTION A-A' THROUGH EMBANKMENT (DRAWING 1-02-020.B6)



NOTES

1. Map developed from an orthophotogrametric map developed by Accu-Air Surveys, Inc.
2. Contour Elevations in feet above mean sea level.
3. Borings were located in the field by Earth Exploration, Inc. on April 10, 2003.

LEGEND

C-4 ⊕ Test Boring Location and Designation

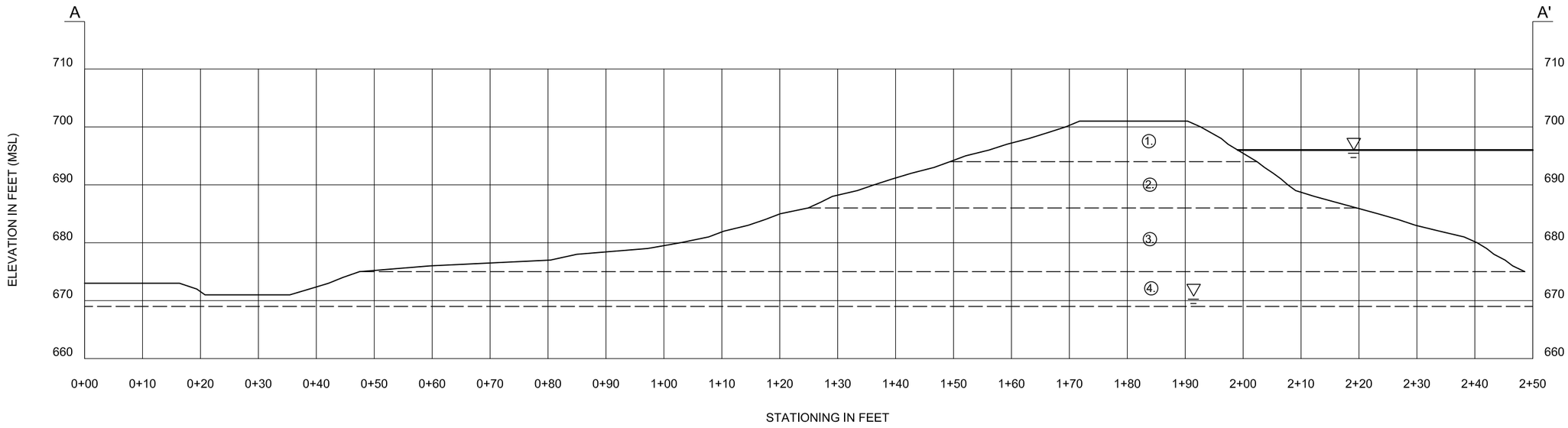
– – – – Cross-Section Location and Designation

EXPLORATORY LOCATION PLAN

PROJECT:	Crosley Lake Dam Evaluation
PROJECT NO.:	E019901B
LOCATION:	Jennings County, Indiana
CLIENT:	IDNR Division of Water
EEI PROJECT NO.:	1-02-020
SCALE:	1"=50'

PROJECT ENGINEER:	DRP
APPROVED BY:	MJH
DRAWN BY:	JDR
DATE AND TIME:	7-15-04
DRAWING NUMBER:	1-02-020.B5

Earth Exploration, Inc.
7770 West New York Street
Indianapolis, IN 46214-2988
317-273-1690
(FAX) 317-273-2250



LEGEND

Water Level at Boring C-3

Generalized Subsurface Profile Soil Boundaries

	Depth	Soil
1.	0'-7'	Lean Clay
2.	7'-15'	Lean Clay
3.	15'-26'	Lean Clay
4.	26'-32'	Lean Clay

NOTES

1. Refer to Drawing No. 1-02-020.B6 in Appendix H for location of cross section.
2. See Table 7.3, Generalized Subsurface Profile in report text.

CROSS SECTION A-A' THROUGH EMBANKMENT

PROJECT:	Crosley Lake Dam Evaluation
PROJECT NO.:	E019901B
LOCATION:	Jennings County, Indiana
CLIENT:	IDNR Division of Water
EEI PROJECT NO.:	1-02-020
SCALE:	1"=20' Horz. 1"=20' Vert.

PROJECT ENGINEER: DRP

APPROVED BY: MJH

DRAWN BY: JDR

DATE AND TIME: 7-19-04 12:00:00

EARTH EXPLORATION, Inc.
7770 West New York Street
Indianapolis, IN 46214-2988
317-273-1690
(FAX) 317-273-2250

DRAWING NUMBER:

1-02-020.B6

APPENDIX I

FIELD METHODS FOR EXPLORING AND SAMPLING SOILS AND ROCK
TEST BORING LOGS (C-1 THROUGH C-4)
UNIFIED SOIL CLASSIFICATION SYSTEM/GENERAL NOTES

FIELD METHODS FOR EXPLORING AND SAMPLING SOILS AND ROCK

A. Boring Procedures Between Samples

The boring is extended downward, between samples, by a hollow stem auger, continuous flight auger, driven and washed-out casing, or rotary boring with drilling mud or water.

B. Standard Penetration Test and Split-Barrel Sampling of Soils
(ASTM* Designation: D 1586)

This method consists of driving a 2-in. outside diameter split-barrel sampler using a 140-lb weight falling freely through a distance of 30 in. The sampler is first seated 6 in. into the material to be sampled and then driven 12 in. The number of blows required to drive the sampler the final 12 in. is recorded on the Log of Test Boring and known as the Standard Penetration Resistance or N-value. Recovered samples are first classified as to texture by the field personnel. Later in the laboratory, the field classification is reviewed by a geotechnical engineer who observes each sample.

C. Thin-walled Tube Sampling of Soils
(ASTM* Designation: D 1587)

This method consists of hydraulically pushing a 2-in. or 3-in. outside diameter thin wall tube into the soil, usually cohesive types. Relatively undisturbed samples are recovered.

D. Soil Investigation and Sampling by Auger Borings
(ASTM* Designation: D 1452)

This method consists of augering a hole and removing representative soil samples from the auger flight or bucket at 5-ft intervals or with each change in the substrata. Relatively disturbed samples are obtained and its use is therefore limited to situations where it is satisfactory to determine approximate subsurface profile.

E. Diamond Core Drilling for Site Investigation
(ASTM* Designation: D 2113)

This method consists of advancing a hole in rock or other hard strata by rotating downward a single tube or double tube core barrel equipped with a cutting bit. Diamond, tungsten carbide, or other cutting agents may be used for the bit. Wash water is used to remove the cuttings. Normally, a 3-in. outside diameter by 2-in. inside diameter coring bit is used unless otherwise noted. The rock or hard material recovered within the core barrel is examined in the field and laboratory. Cores are stored in partitioned boxes and the length of recovered material is expressed as a percentage of the actual distance penetrated.

* American Society for Testing and Materials, Philadelphia, PA

LOG OF TEST BORING

Project: Crosley Lake Dam
Location: Jennings County, Indiana
Client: Indiana Department of Natural Resources

7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. C-1
Elevation 700.9
Datum USC & GS
EEI Proj. No. 1-02-020
Sheet 1 of 2

Proj. No.	---	Station	---	Weather	Cloudy	Driller	J.M.
Struct. No.	---	Offset	---	Temp.	30° F	Inspector	K.E.

SAMPLE No.	Type	Rec %	N Value	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL							
SS-1		80	8		700		2.25		---	18.0			
									---	19.9			
SS-2		75	6			**CL, LEAN CLAY**, little to some sand and gravel, very stiff to stiff, brown and gray, (fill)	1.5		---	19.6			
									112.9	17.7			
SS-3		65	7	5	695		1.5	2.36	---	19.1	38	14	24
							3.0		113.1	18.2			
SS-4		100	8				1.0		---	24.9			
							3.0		105.2	21.6			
SS-5		80	7				1.5		---	22.1			
				10 ▼			2.25		99.7	25.0			
SS-6		90	6		690 ▽		2.0		104.3	22.5			
							2.5		---	22.4			
SS-7		80	6				1.5		108.2	21.5			
							1.0		---	22.3			
SS-8		95	8	15		**CL, LEAN CLAY**, trace sand and gravel, very stiff to stiff, brown to reddish brown and gray, (fill)	3.5		107.4	22.2			
					685		2.25		---	23.2			
SS-9		70	5				1.5	2.13	105.4	23.2			
							1.75		---	22.1	42	17	25
SS-10		85	5				0.5		99.4	25.6			
							1.0		---	25.1			
SS-11		0	7	20	680		---		---	---			
							---		---	---			
SS-12		75	7				2.25		---	20.9			
							1.5		104.1	22.5			
SS-13		65	6	25		**CL, LEAN CLAY**, little sand, trace gravel, stiff, brown and gray, trace roots (fill)	1.5		102.4	23.6			
					675								
SS-14		65	6				1.0		100.4	23.9			
							1.25		---	24.8	34	19	15
SS-15		65	4				1.5		---	26.5			
							1.25		97.5	25.6			
				30									

Continued Next Page

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	▽ 96 hrs After Drilling
To Water	NW	10*	11½*
To Cave-in		32	23

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 3/6/03 End 3/6/03 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks *Water introduced at 33½' during coring operations. Backfilled with a cement bentonite grout.

LOG OF TEST BORING

Project: Crosley Lake Dam
Location: Jennings County, Indiana
Client: Indiana Department of Natural Resources

EARTH EXPLORATION, Inc.
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. C-1
Elevation 700.9
Datum USC & GS
EEI Proj. No. 1-02-020
Sheet 2 of 2

Proj. No.	---	Station	---	Weather	Cloudy	Driller	J.M.
Struct. No.	---	Offset	---	Temp.	30° F	Inspector	K.E.

SAMPLE No.	Type	Rec %	N Value	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
SS-16		65	2		670	**CL, LEAN CLAY**, trace sand and gravel, stiff to medium, brown and gray, with rock fragments	0.5 0.75		95.9 ---	27.1 25.8			
SS-17		65	50/2				0.5		---	---			
						WEATHERED LIMESTONE, moderately hard, gray							
RC-1		90	RQD=100%	35	665	**LIMESTONE**, low bedding planes, fine to medium grained, hard, gray and brown, horizontal fracture near 34.5', 35.3', 36.8', small vugs below 35', moderately weathered from 42' to 42.2'							
RC-2		100	RQD=97%	40	660								
						End of Boring at 43.5 ft							

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

LOG OF TEST BORING

EARTH EXPLORATION, Inc.
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Project: Crosley Lake Dam
Location: Jennings County, Indiana
Client: Indiana Department of Natural Resources

Boring No. C-2
Elevation 701.2
Datum USC & GS
EEI Proj. No. 1-02-020
Sheet 1 of 2

Proj. No.	---	Station	---	Weather	Cloudy	Driller	J.M.
Struct. No.	---	Offset	---	Temp.	34° F	Inspector	K.E.

SAMPLE No.	Type	Rec %	N Value	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL							
SS-1		95	4		700		3.0		---	18.5			
							2.25		---	16.4			
SS-2		40	4				1.0		---	24.4			
							1.75		102.7	24.2			
SS-3		65	6	5		**CL, LEAN CLAY**, little to some sand and gravel, very stiff to stiff, reddish brown and brown, with rock fragments (fill)	1.5		---	18.7			
							3.0		112.2	16.9			
SS-4		100	8		695		3.0		109.7	19.5			
							2.0		---	19.9			
SS-5		75	7				2.0		---	24.0			
				10			2.25		100.2	24.6			
SS-6		90	11		690	**CL, LEAN CLAY**, trace sand and gravel, very stiff, brown and gray to reddish brown, with rock fragments (fill)	2.5		---	24.7	45	20	25
							1.25		105.6	20.5			
SS-7		100	8				2.5	2.10	101.4	25.4			
							2.5		---	25.0			
SS-8		65	5	15			2.75		---	22.5			
					685		1.75		102.2	24.7			
SS-9		95	6				2.25		105.6	21.3			
							1.25		---	21.8			
SS-10		90	6			**CL, LEAN CLAY**, little to some sand, trace gravel, very stiff to stiff, reddish brown and gray, (fill)	2.0		102.8	23.1			
				20			2.75		---	21.7			
SS-11		100	8		680		3.0		---	22.1	41	16	25
							2.0		115.2	15.8			
SS-12		100	8				2.0		---	28.8			
						CL, LEAN CLAY, trace sand and gravel, stiff, reddish brown and gray, (fill)	1.0		---	22.4			
SS-13		85	6	25			1.0		108.0	21.5			
							2.25		---	22.1			
SS-14		75	7		675	**CL, LEAN CLAY**, little sand and gravel, stiff to very stiff, reddish brown and gray, with trace roots (fill)	1.25	2.58	107.9	21.4			
							2.5		---	26.0			
SS-15		100	11				2.5		---	22.7			
				30		**CL, LEAN CLAY**, little sand, trace gravel, stiff,	1.0		99.1	26.7			

Continued Next Page

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	▽ 96 hrs After Drilling
To Water	NW	7*	15½*
To Cave-in		28½	19

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 3/6/03 End 3/6/03 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks *Water introduced at 30½' during coring operations. Backfilled with a cement bentonite grout.

LOG OF TEST BORING

EARTH EXPLORATION Inc

7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Project: Crosley Lake Dam
Location: Jennings County, Indiana
Client: Indiana Department of Natural Resources

Boring No. C-2
Elevation 701.2
Datum USC & GS
EEI Proj. No. 1-02-020
Sheet 2 of 2

Proj. No.	---	Station	---	Weather	Cloudy	Driller	J.M.
Struct. No.	---	Offset	---	Temp.	34° F	Inspector	K.E.

SAMPLE No.	Type	Rec %	N Value	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
SS-16	X	100	50/.1			brownish gray	1.5		---	17.9			
					670								
RC-1		96	RQD=97%			**LIMESTONE**, low bedding planes, fine to medium grained, hard, gray, with small vugs below 31.5', vertical fracture from 36' to 37.4' and 40' to 40.5'							
				35									
					665								
RC-2		100	RQD=73%										
				40									
						End of Boring at 40.5 ft							
						Hydraulically pushed 3-in. diameter Shelby tubes at offset boring (C-3A) located 5' north of Boring C-2. Samples obtained from: 18 ft to 20 ft (Sample ST-1); Rec. = 92%, 20 ft to 22 ft (Sample ST-2); Rec. = 44%, 22 ft to 24 ft (Sample ST-3); Rec. = 79% and 24 ft to 26 ft (Sample ST-4); Rec. = 46%							

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

LOG OF TEST BORING

EARTH EXPLORATION Inc

Project: Crosley Lake Dam
Location: Jennings County, Indiana
Client: Indiana Department of Natural Resources
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. C-3
Elevation 701.6
Datum USC & GS
EEI Proj. No. 1-02-020
Sheet 1 of 2

Proj. No.	---	Station	---	Weather	Cloudy	Driller	J.M.
Struct. No.	---	Offset	---	Temp.	28° F	Inspector	K.E.

SAMPLE No.	Type	Rec %	N Value	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL							
SS-1		55	4		700		1.5		---	16.4			
									99.1	20.5			
SS-2		45	3				1.0		102.0	22.5			
									---	24.7			
SS-3		55	2	5		**CL, LEAN CLAY**, little to some sand and gravel, stiff to very stiff, dark brown to reddish brown, with shale fragments near 0.5' (fill)	1.5		---	26.0			
							1.0		---	19.8			
SS-4		100	6		695		1.25		107.4	19.4			
							3.5		---	19.2	38	16	22
SS-5		65	7				3.0		100.2	26.1			
				10			1.5		---	25.5			
SS-6		75	5		690		0.75		106.3	24.1			
							1.5		---	25.8			
SS-7		75	6			**CL, LEAN CLAY**, trace sand and gravel, medium to stiff, reddish brown and gray, (fill)	1.25		112.6	18.5			
							1.75		---	24.6			
SS-8		65	5	15			1.5		---	19.2			
							1.5	0.94	99.2	26.8			
SS-9		80	3		685	**CL, LEAN CLAY**, trace sand and gravel, medium to stiff, brown, (fill)	0.75		---	25.8			
							1.25		104.3	23.0			
SS-10		75	4				0.75		---	20.5			
							2.5		111.2	18.9			
SS-11		85	8	20		**CL, LEAN CLAY**, trace sand and gravel, stiff to very stiff, reddish brown and gray, (fill; very moist at 21.2')	1.75		---	20.3			
					680		2.5		106.9	21.2			
SS-12		80	5				1.25		104.0	22.1			
							1.5		---	22.3			
						CL, LEAN CLAY, trace sand and gravel, stiff, brown and gray, (fill)							
SS-13		65	13	25		**CL, LEAN CLAY**, trace sand and gravel, very stiff, reddish brown, with limestone fragments (fill)	2.5		---	21.4			
									108.5	19.9			
SS-14		65	6		675		1.5		---	29.6			
						CL, LEAN CLAY, little sand, trace gravel, stiff, dark brown, with trace roots	1.0		---	26.1	35	19	16
SS-15		85	7				1.0		102.9	24.3			
				30			1.0		---	23.8			

Continued Next Page

WATER LEVEL OBSERVATIONS

Depth ft	While Drilling	Upon Completion	96 hrs After Drilling
To Water	31	11*	18½*
To Cave-in		29	21

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 3/7/03 End 3/7/03 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks *Water introduced at 31' during coring operations. Backfilled with a cement bentonite grout.

EARTH EXPLORATION Inc

LOG OF TEST BORING

Project: Crosley Lake Dam
Location: Jennings County, Indiana
Client: Indiana Department of Natural Resources

7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. C-3
Elevation 701.6
Datum USC & GS
EEI Proj. No. 1-02-020
Sheet 2 of 2

Proj. No.	---	Station	---	Weather	Cloudy	Driller	J.M.
Struct. No.	---	Offset	---	Temp.	28° F	Inspector	K.E.

SAMPLE No.	Type	Rec %	N Value	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
SS-16	X	100	50/.5			**CL, LEAN CLAY**, trace sand and gravel, very stiff, reddish brown	3.0		---	21.9			
					670								
RC-1		86	RQD=83%	35		**LIMESTONE**, low bedding planes, fine to medium grained, hard, gray and brown, with vugs below 31.5', vertical fracture near 34.8' to 35.2', fractured and broken near 40.2' to 41'							
					665								
RC-2		98	RQD=84%	40									
						End of Boring at 41 ft							
						Hydraulically pushed 3-in. diameter Shelby tube at offset boring (C-3A) located 5' north of Boring C-3. Samples obtained from: 16 ft to 18 ft (Sample ST-1); Rec. = 100%, 18 ft to 20 ft (Sample ST-2); Rec. = 71%, 20 ft to 22 ft (Sample ST-3); Rec. = 46% and 22 ft to 24 ft (Sample ST-4); Rec. = 83%							

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

LOG OF TEST BORING

Project: Crosley Lake Dam
Location: Jennings County, Indiana
Client: Indiana Department of Natural Resources

EARTH EXPLORATION Inc
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. C-4
Elevation 701.0
Datum USC & GS
EEI Proj. No. 1-02-020
Sheet 1 of 1

Proj. No.	---	Station	---	Weather	Sunny	Driller	J.M.
Struct. No.	---	Offset	---	Temp.	45° F	Inspector	K.E.

SAMPLE No.	Type	Rec %	N Value	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
SS-1		80	6		700	**CRUSHED STONE**, (fill)	3.25		---	18.8			
							3.0		107.7	20.5			
SS-2		60	7				2.0		101.1	23.4			
									---	23.7	50	17	33
SS-3		45	6	5		**CL, LEAN CLAY**, little to some sand and gravel, very stiff to stiff, reddish brown and gray, with shale and limestone fragments (fill)	1.25		---	20.3			
					695		1.75		---	16.4			
SS-4		10	6				2.0		---	20.4			
SS-5		75	6				1.75		---	27.5			
				10			1.75	1.86	103.6	22.8			
SS-6		65	7		690	**CL, LEAN CLAY**, little sand, trace gravel, stiff, brownish gray	1.0		---	24.8			
							1.25		105.8	20.9			
SS-7		50	7			**CL, LEAN CLAY**, trace sand and gravel, stiff, reddish brown and gray	1.5		104.8	22.3			
							1.25		---	24.5			
SS-8		40	9	15 ▼			2.25		---	22.5			
					685	**CL, LEAN CLAY**, trace sand and gravel, very stiff to stiff, brown and gray, (residual soil)			---	21.8			
SS-9		100	8				1.5		---	22.0			
							1.75		---	25.0			
RC-1		100	RQD=65%	20									
					680	**LIMESTONE**, low bedding planes, fine to medium grained, hard, gray, with vertical fractures near 18.7' to 19.4', and 19.5' to 19.9'.							
27.5		83	RQD=96%	25									
					675								
						End of Boring at 27.5 ft							

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	⊻ 96 hrs After Drilling
To Water	NW	15*	NW
To Cave-in		17½	17½

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 3/7/03 End 3/7/03 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks *Water introduced at 17½' during coring operations. Backfilled with a cement bentonite grout.

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EARTH EXPLORATION, Inc.

UNIFIED SOIL CLASSIFICATION SYSTEM / GENERAL NOTES

FINE-GRAINED SOILS

CONSISTENCY	UNCONFINED STRENGTH (tsf)
Very Soft	<0.25
Soft	0.25 - 0.5
Medium	0.5 - 1.0
Stiff	1.0 - 2.0
Very Stiff	2.0 - 4.0
Hard	>4.0

COARSE-GRAINED SOILS

RELATIVE DENSITY	N-VALUE* (Blows/ft)
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50+

RELATIVE PROPORTIONS

TERM	DEFINING RANGE BY % OF WEIGHT
Trace	0 - 5
Little	5 - 12
Some	12 - 35
And	35 - 50

ORGANIC CONTENT BY COMBUSTION METHOD

SOIL DESCRIPTION	LOI
Trace Organic Matter	0 - 5%
Little Organic Matter	5 - 12%
Organic Silt/Clay	12 - 35%
Sedimentary Peat	35 - 50%
Fibrous and Woody Peat	50%±

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

MAJOR DIVISIONS			SYMBOLS	DESCRIPTIONS
COARSE-GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	More than 50% of coarse fraction retained on No. 4 sieve	Little or no fines	GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
		Appreciable amount of fines	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
More than 50% of material coarser than No. 200 sieve	SAND AND SANDY SOILS	CLEAN SANDS	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		Little or no fines	SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	More than 50% of coarse fraction passing No. 4 sieve	SANDS WITH FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
		Appreciable amount of fines	SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE-GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SAND OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
More than 50% of material finer than No. 200 sieve	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT

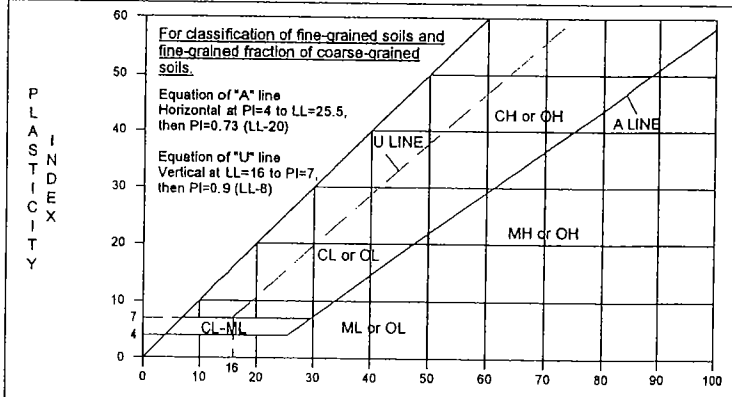
NOTE: DUAL SYMBOLS USED FOR BORDERLINE CLASSIFICATIONS

GRAIN SIZE TERMINOLOGY

SOIL FRACTION		PARTICLE SIZE	US STANDARD SIEVE SIZE
Boulders		Larger than 12-in.	Larger than 12-in.
Cobbles		3 to 12-in.	3 to 12-in.
Gravel	Coarse	3/4 to 3-in.	3/4 to 3-in.
	Fine	4.75 mm to 3/4-in.	#4 to 3/4-in.
Sand	Coarse	2.00 to 4.75 mm	#10 to #4
	Med	0.425 to 2.00 mm	#40 to #10
	Fine	0.075 to 0.425 mm	#200 to #40
Silt		0.005 to 0.075 mm	Smaller than #200
Clay		Smaller than 0.005 mm	Smaller than #200

Plasticity characteristics differentiate between silt and clay.

PLASTICITY CHART



EXPLORATORY SAMPLING ABBREVIATIONS

AS	- Auger Sample	PID	- Photo-Ionization Detector
BF	- Backfilled Upon Completion	PMT	- Borehole Pressuremeter Test
BS	- Bag Sample	PT	- 3-in. O.D. Piston Sample
C	- Casing: Size 2½-in., NW; 4-in., HW	PTS	- Peat Sample
COA	- Clean-Out Auger	RB	- Rock Bit
CS	- Continuous Sampler	RC	- Rock Core
CW	- Clear Water	REC	- Recovery
DC	- Driven Casing	RQD	- Rock Quality Designation
DM	- Drilling Mud	RS	- Rock Sounding
FA	- Flight Auger	S	- Soil Sounding
FT	- Fish Tail	SS	- 2-in. O.D. Split-Spoon Sample
HA	- Hand Auger	ST	- Thin-Walled Tube Sample
HSA	- Hollow Stem Auger	VS	- Vane Shear Test
NW	- No Water Encountered	WPT	- Water Pressure Test

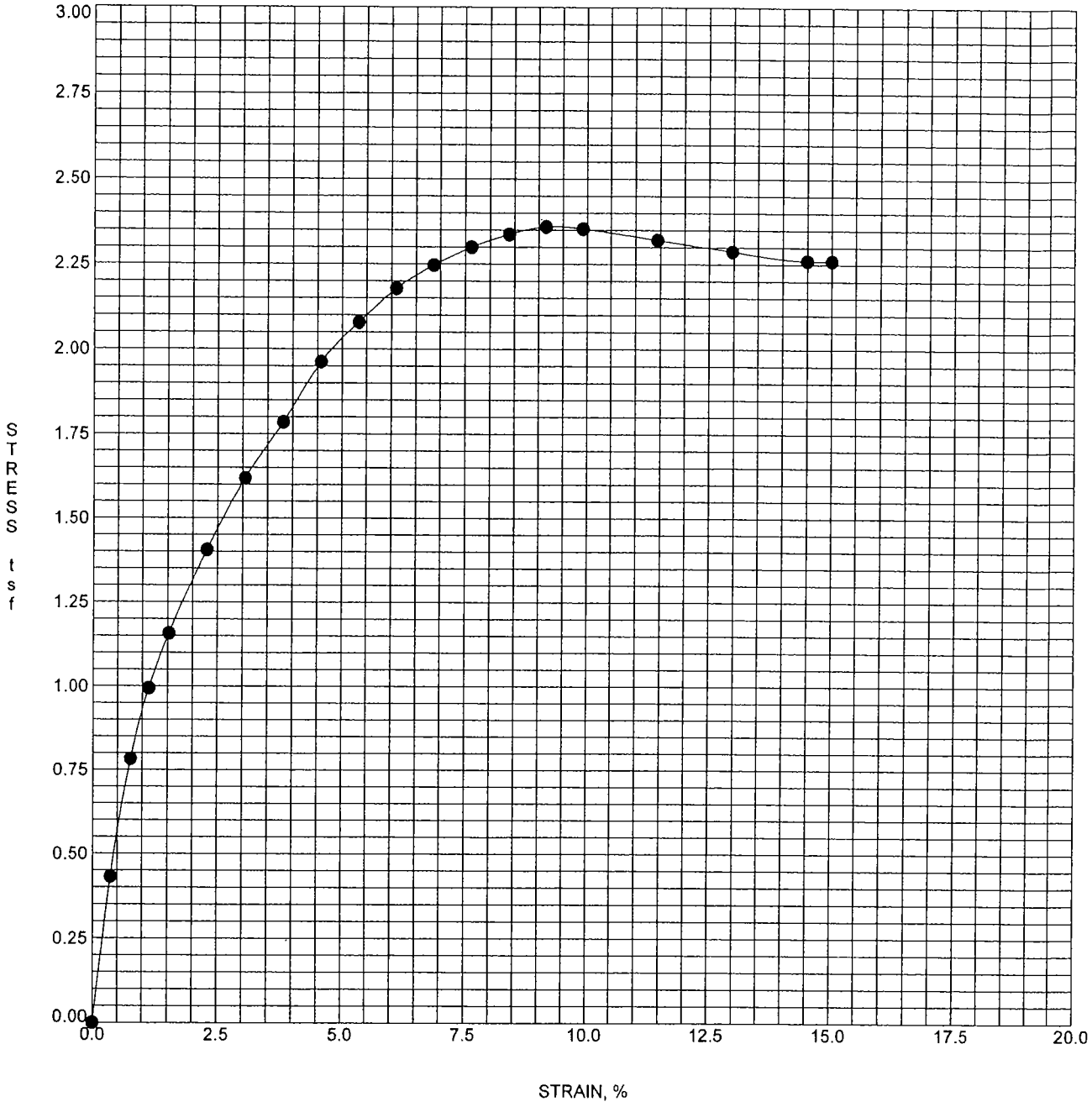
LABORATORY TEST ABBREVIATIONS

qp	- Hand Penetrometer Reading, tsf
qu	- Unconfined Compressive Strength, tsf
W	- Moisture Content, %
LL	- Liquid Limit, %
PL	- Plastic Limit, %
PI	- Plasticity Index, %
SL	- Shrinkage Limit, %
LOI	- Loss on Ignition, %
γ_d	- Dry Unit Weight, pcf
pH	- Hydrogen-Ion Concentration
P_{200}	- Percent Passing a No. 200 Sieve

*The penetration resistance, N, is the summation of the number of blows required to effect two successive 6" penetrations of the 2" O.D. split-spoon sampler. The sampler is driven with a 140 lb weight falling 30" and is seated to a depth of 6" before commencing the standard penetration test.

APPENDIX J

GEOTECHNICAL LABORATORY TEST RESULTS
UNCONFINED COMPRESSION TEST RESULTS
TRIAXIAL SHEAR TEST REPORT; CONSOLIDATED – ISOTROPICALLY UNDRAINED
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA



	Sample Identification	Station / Offset / Line	Depth, ft	Classification
●	C-1 SS-3	---	4.0 - 6.0	CL, LEAN CLAY

Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
5369SL	69.9	34.7	18.2	133.7	113.1	99.5	2.36	9.2	1.5

EARTH EXPLORATION Inc

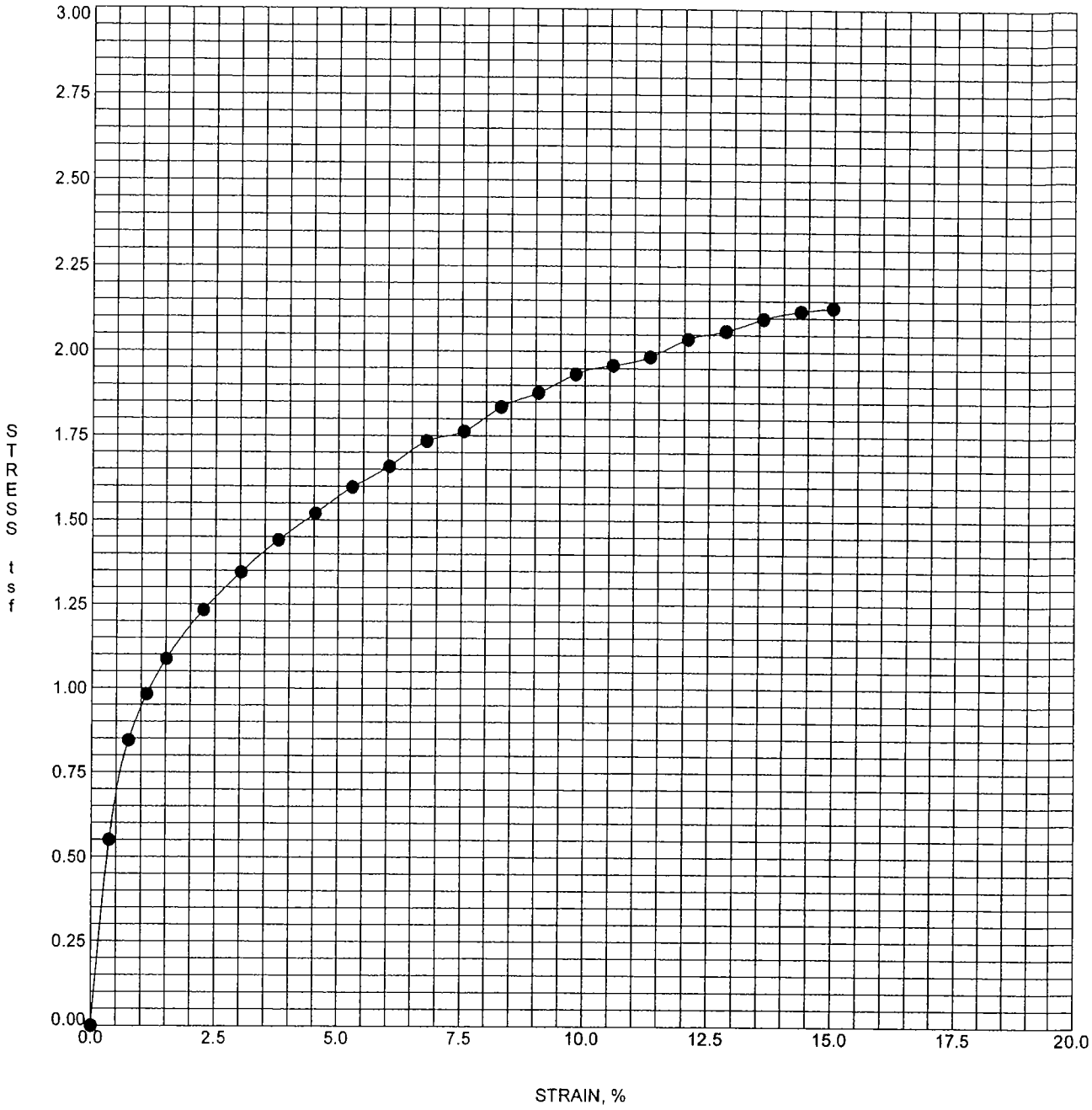
Project No. --- **Project** Crosley Lake Dam

Structure No. --- **Location** North Vernon, Jennings Co., Indiana

EEI Proj. No. 1-02-020 **Client** Indiana Department of Natural Resources

UNCONFINED COMPRESSION TEST

Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)



	Sample Identification		Station / Offset / Line	Depth, ft	Classification
●	C-1	SS-9	---	16.0 - 18.0	CL, LEAN CLAY

Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
5370SL	70.7	34.4	23.2	129.9	105.4	98.8	2.13	15.0	1.5

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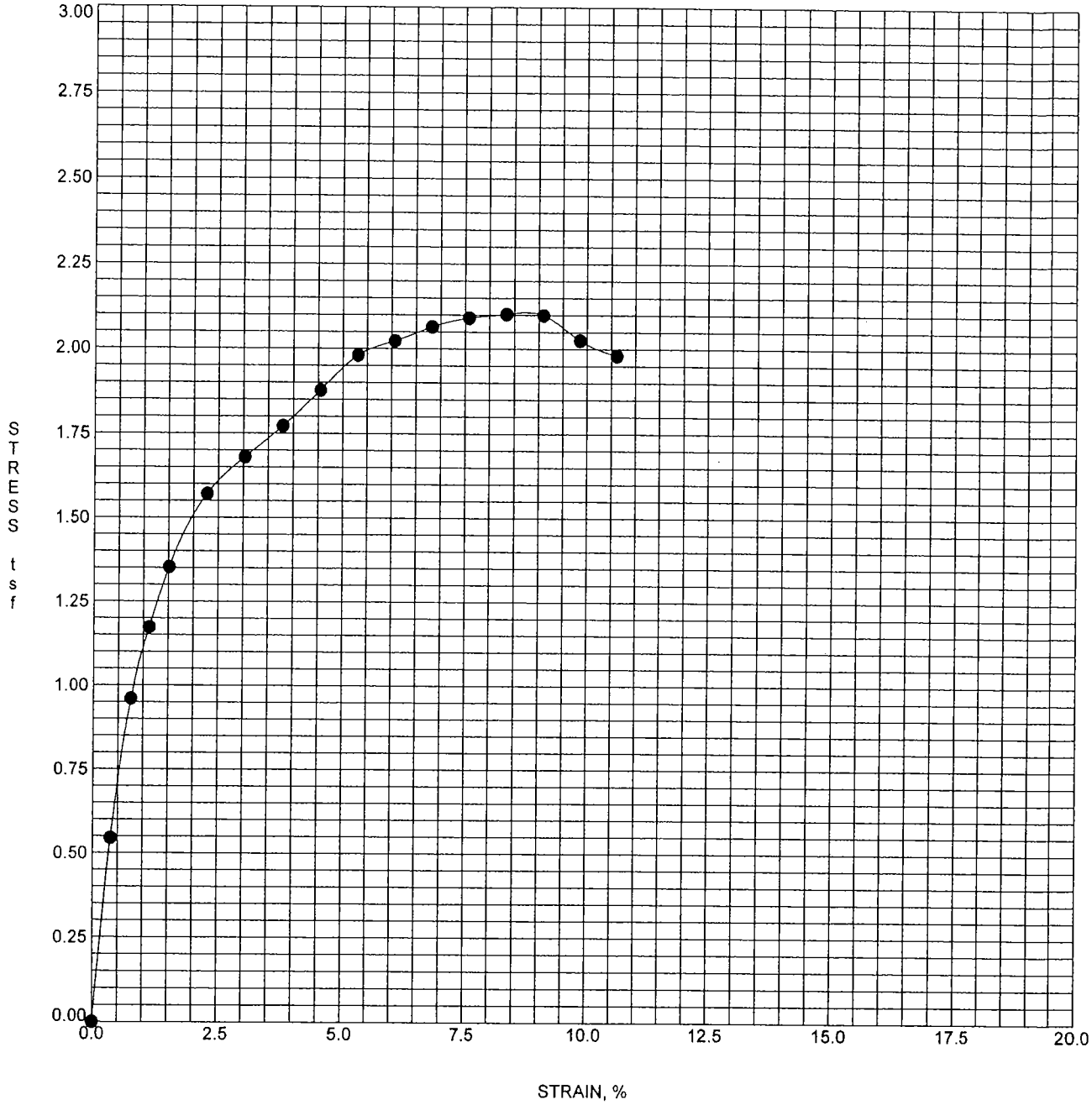

	Sample Identification		Station / Offset / Line	Depth, ft	Classification
●	C-2	SS-7	---	12.0 - 14.0	CL, LEAN CLAY

Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
5371SL	70.3	34.5	25.4	127.2	101.4	99.9	2.10	8.3	1.5

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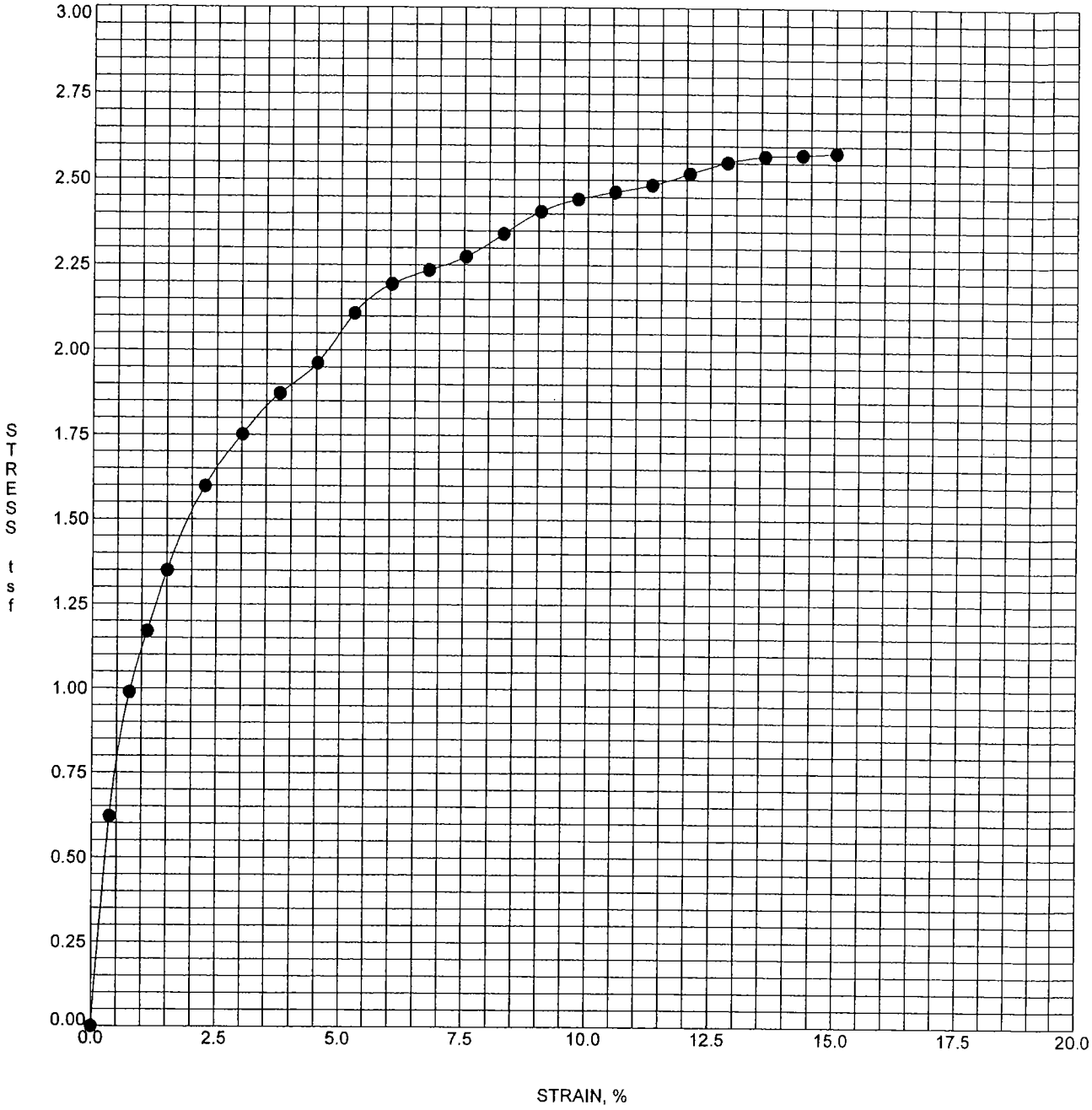

	Sample Identification	Station / Offset / Line	Depth, ft	Classification
●	C-2 SS-14	---	26.0 - 28.0	CL, LEAN CLAY

Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
5372SL	70.7	34.6	21.4	131.1	107.9	98.6	2.58	15.0	1.5

EARTH EXPLORATION, Inc.

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EEI Proj. No. 1-02-020 **Client** Indiana Department of Natural Resources

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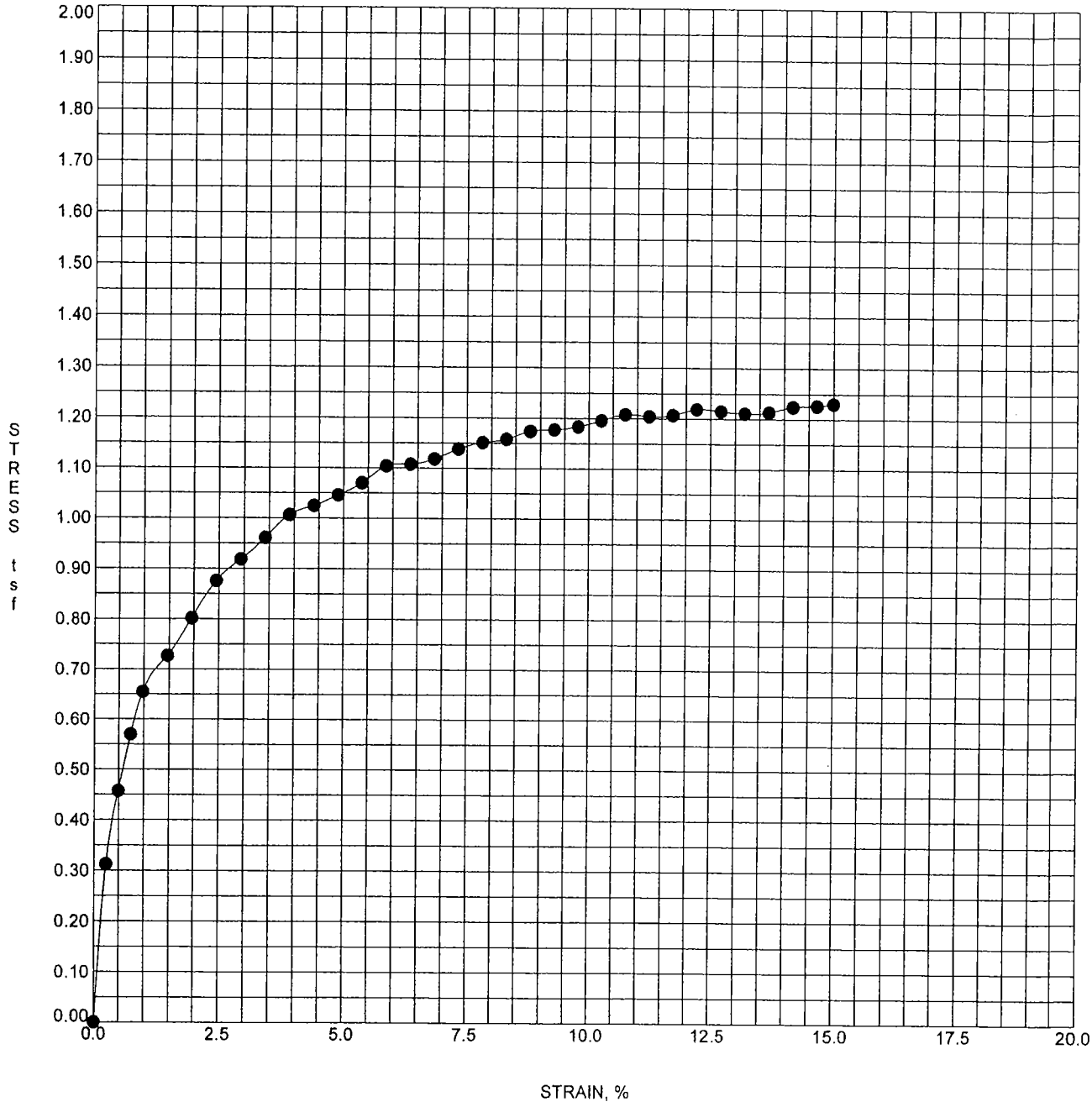

	Sample Identification		Station / Offset / Line	Depth, ft	Classification
●	C-2A	ST-3	---	22.8 - 23.3	CL, LEAN CLAY

Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
5469SL	145.5	73.1	21.5	127.9	105.3	95.3	1.23	15.0	1.0

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Location North Vernon, Jennings Co., Indiana
Client Indiana Department of Natural Resources

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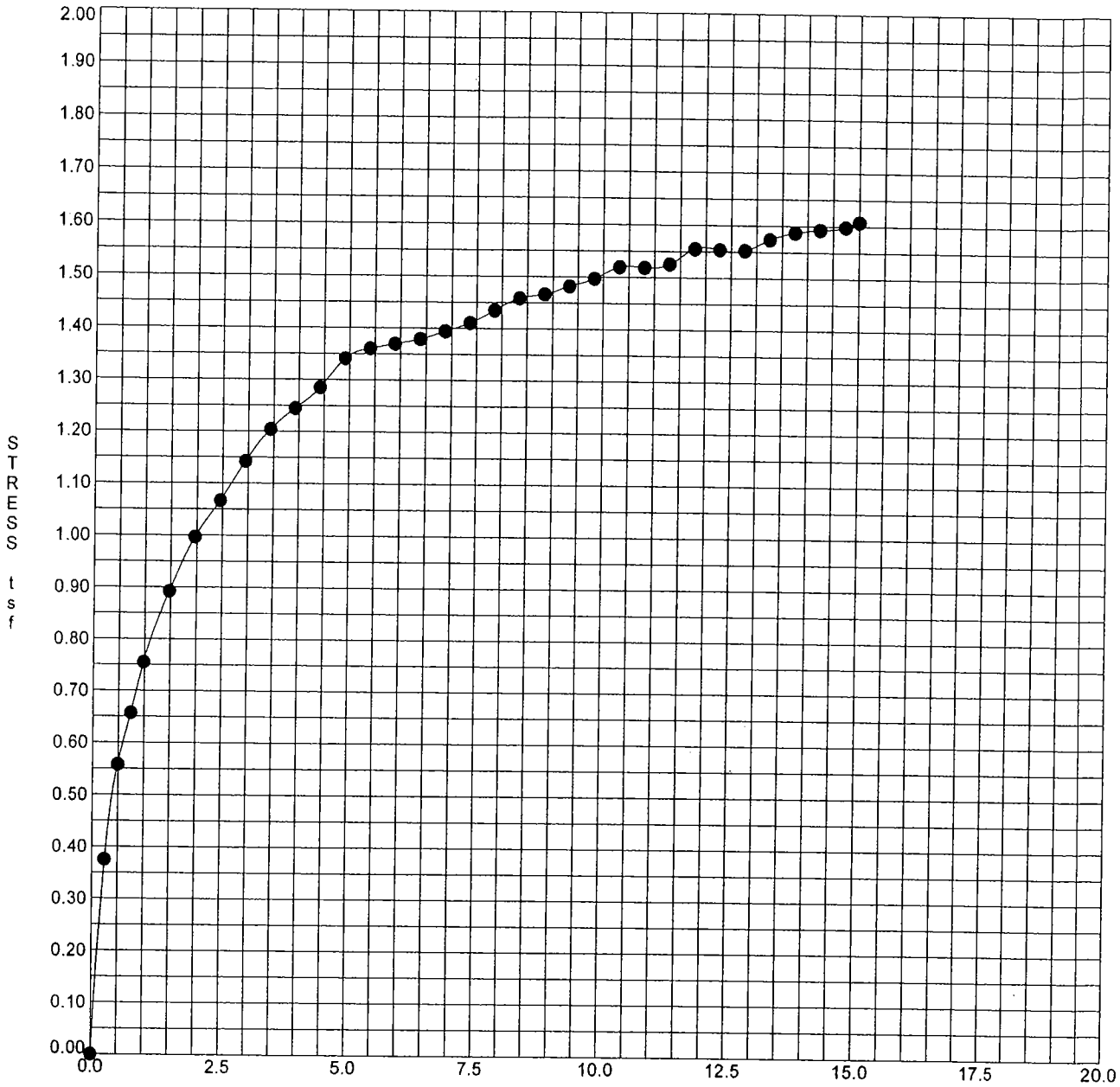

	Sample Identification	Station / Offset / Line	Depth, ft	Classification
●	C-2A ST-4	---	24.4 - 24.9	CL, LEAN CLAY

Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
5470SL	144.8	73.1	23.9	126.4	102.1	97.8	1.61	15.0	1.0

EARTH EXPLORATION Inc

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Structure No. ---
EEI Proj. No. 1-02-020

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UNCONFINED COMPRESSION TEST

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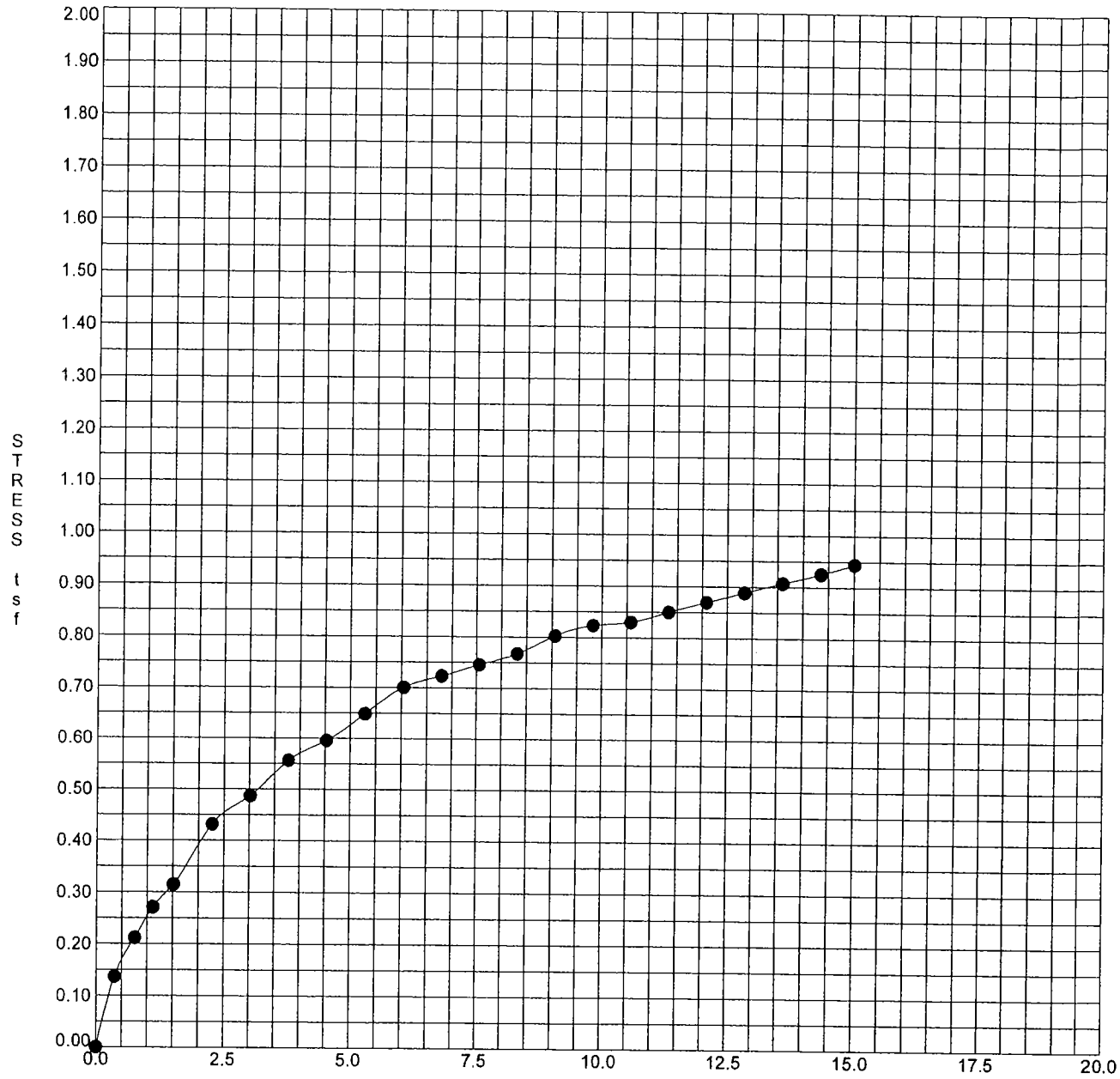

	Sample Identification	Station / Offset / Line	Depth, ft	Classification
●	C-3 SS-8	---	14.0 - 16.0	CL, LEAN CLAY

Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
5373SL	70.6	35.0	26.8	125.9	99.2	99.5	0.94	15.0	1.5

EARTH EXPLORATION Inc

Project No. ---
Structure No. ---
EEI Proj. No. 1-02-020

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Client Indiana Department of Natural Resources

UNCONFINED COMPRESSION TEST

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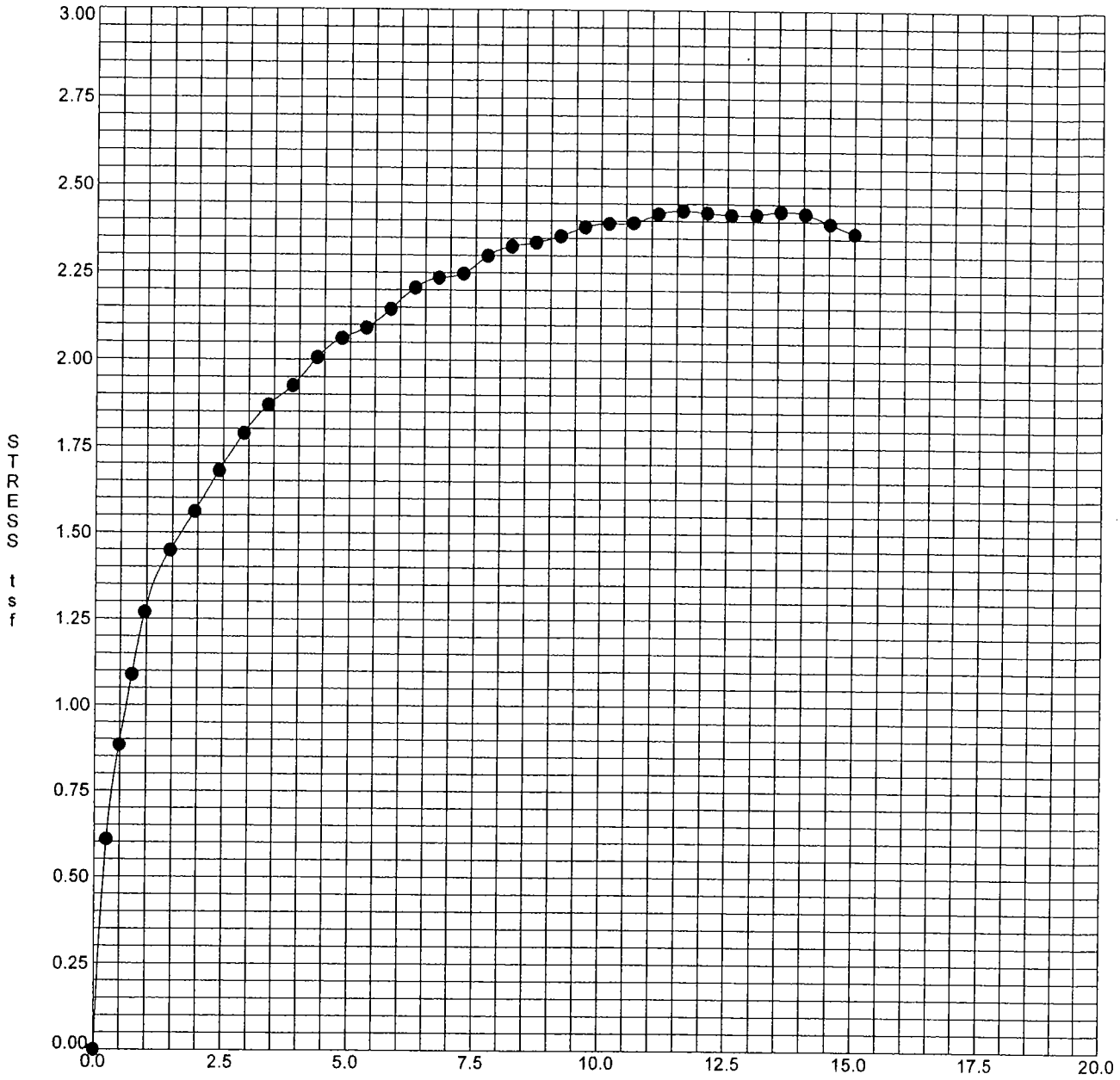

	Sample Identification		Station / Offset / Line	Depth, ft	Classification
●	C-3A	ST-3	---	20.4 - 20.9	CL, LEAN CLAY

Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
5471SL	147.0	73.1	21.6	128.6	105.8	97.0	2.43	11.6	1.0

EARTH EXPLORATION Inc

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Structure No. ---
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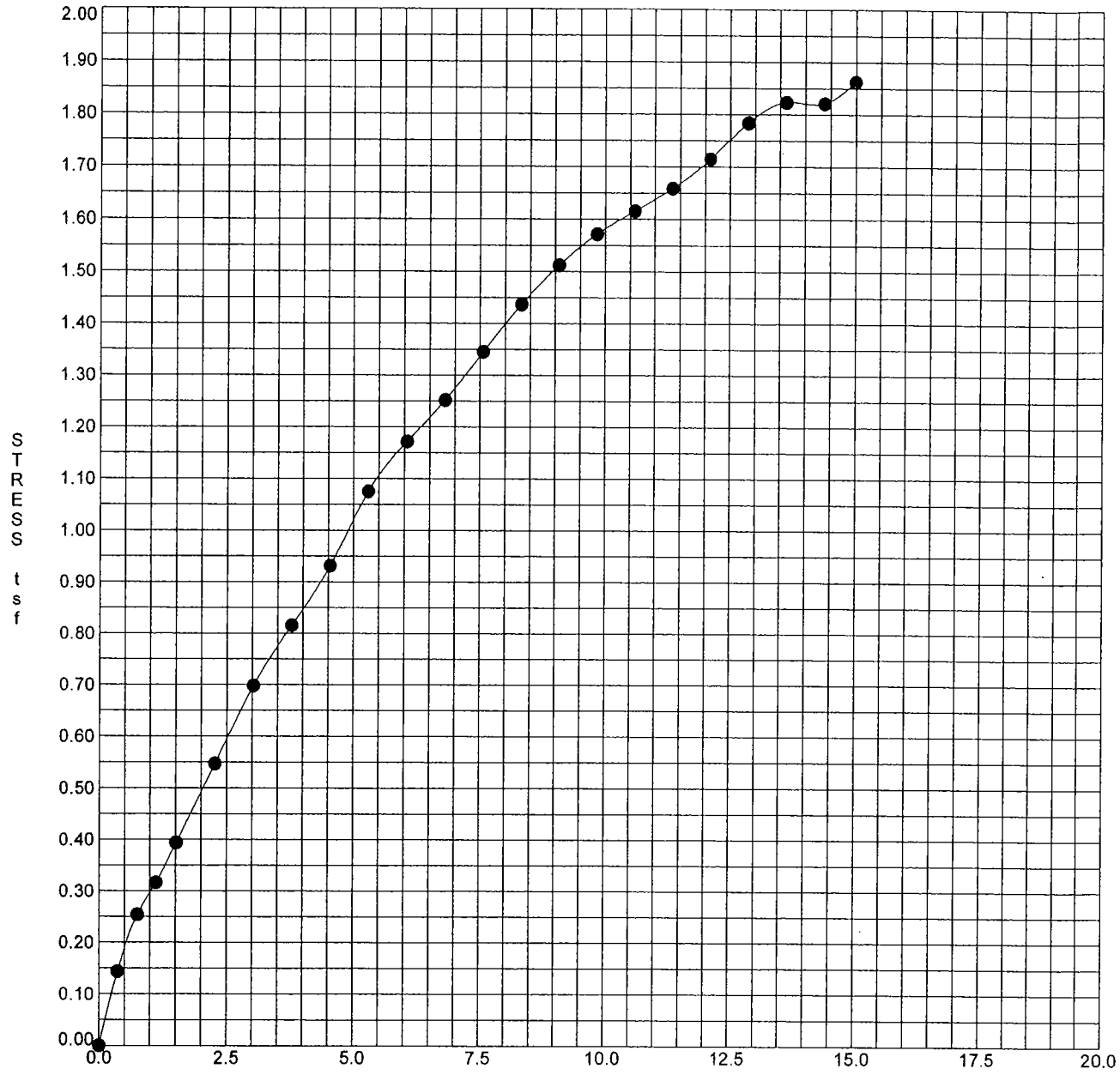
317-273-1690 / 317-273-2250 (Fax)



	Sample Identification	Station / Offset / Line	Depth, ft	Classification
●	C-4 SS-5	---	8.0 - 10.0	CL, LEAN CLAY

Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
5374SL	70.5	34.1	22.8	127.3	103.6	98.3	1.86	15.0	1.5

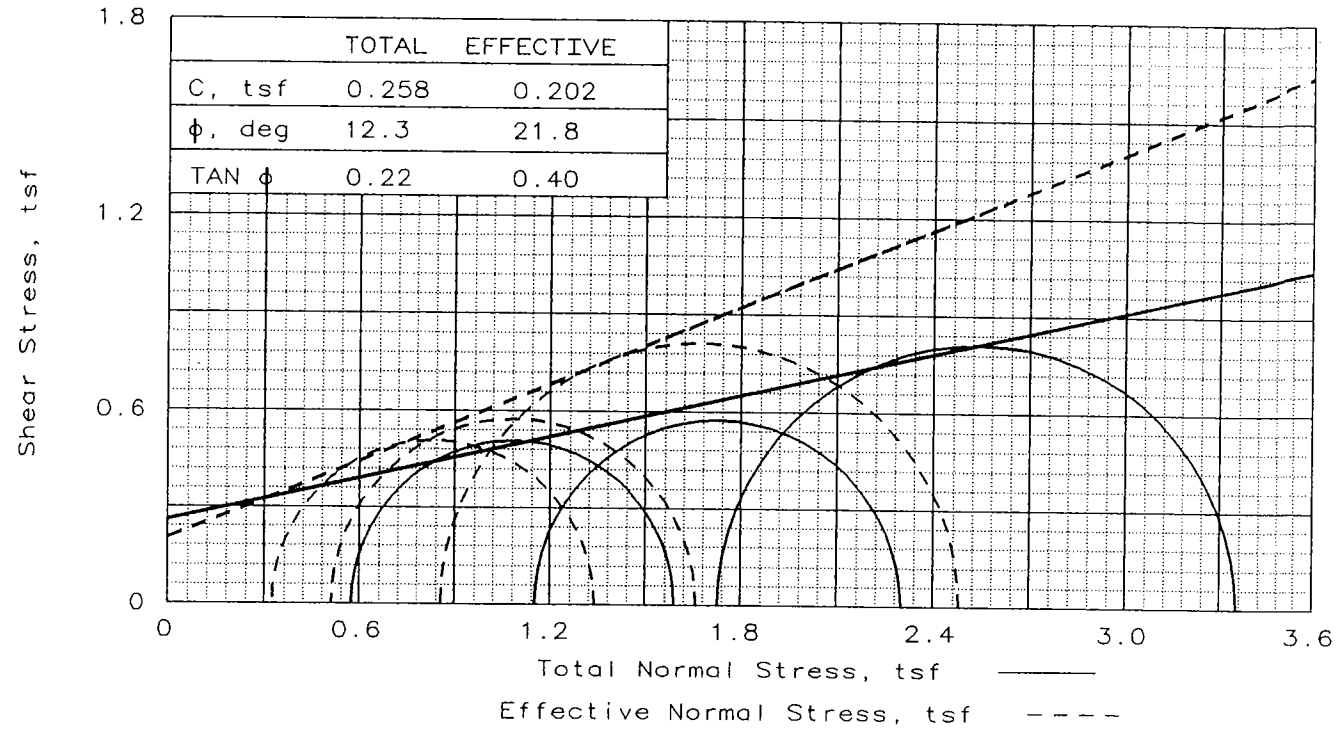
EARTH EXPLORATION Inc

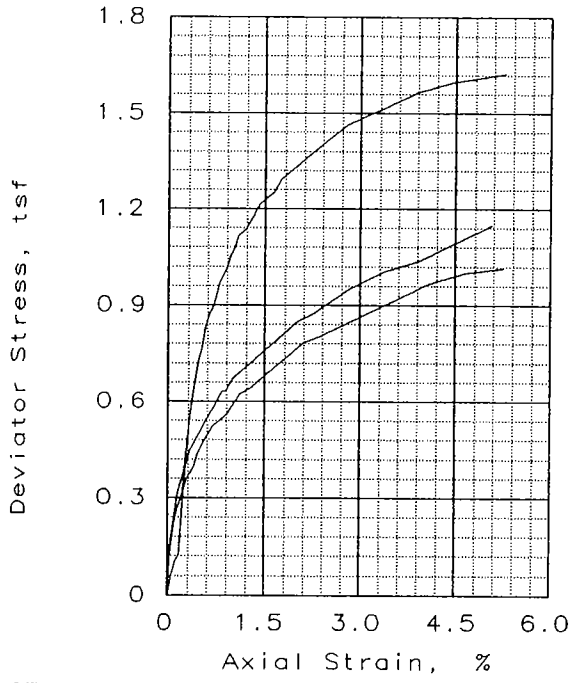
Project No. ---
Structure No. ---
EEI Proj. No. 1-02-020

Project Crosley Lake Dam
Location North Vernon, Jennings Co., Indiana
Client Indiana Department of Natural Resources

UNCONFINED COMPRESSION TEST

Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)





SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	22.9	22.5	23.9
	DRY DENSITY, pcf	103.5	104.5	102.5
	SATURATION, %	97.3	97.8	98.9
	VOID RATIO	0.640	0.625	0.656
	DIAMETER, in	2.876	2.872	2.880
	HEIGHT, in	5.801	5.803	5.801
AT TEST	WATER CONTENT, %	22.8	21.6	23.6
	DRY DENSITY, pcf	104.9	107.0	103.5
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.619	0.587	0.641
	DIAMETER, in	2.864	2.849	2.872
	HEIGHT, in	5.776	5.757	5.784
Strain rate, %/min		0.10	0.10	0.10
BACK PRESSURE, tsf		2.520	2.160	2.160
CELL PRESSURE, tsf		3.096	3.312	3.888
FAIL. STRESS, tsf		1.016	1.149	1.623
TOTAL PORE PR., tsf		2.772	2.801	3.031
ULT. STRESS, tsf				
TOTAL PORE PR., tsf				
$\bar{\sigma}_1$ FAILURE, tsf		1.340	1.660	2.480
$\bar{\sigma}_3$ FAILURE, tsf		0.324	0.511	0.857

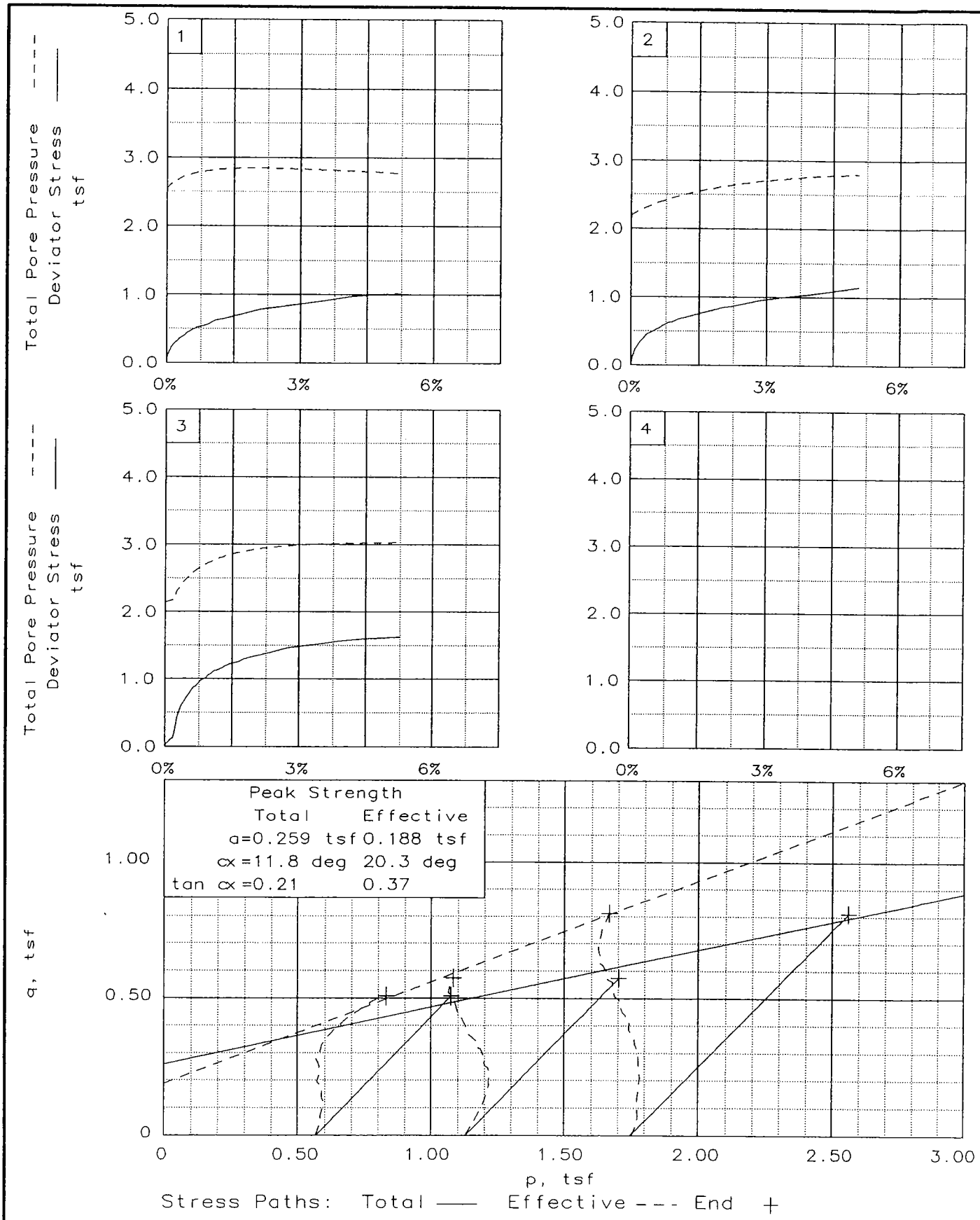
TYPE OF TEST:
CU with Pore Pressures
SAMPLE TYPE: UNDISTURBED
DESCRIPTION: CL, LEAN CLAY

ASSUMED SPECIFIC GRAVITY= 2.72
REMARKS:
Spec.#1,C-3A 17.4-17.9'
Spec.#2,C-2A 18.8-19.3'
Spec.#3,C-2A 19.3-19.8'
LAB NO.: 5451SL

CLIENT: Indiana Department of Natural Resources
PROJECT: Crosley Lake Dam
North Vernon, Jennings Co., Indiana
SAMPLE LOCATION: C-3A ST-1 16'-18' & C-2A ST-1 18'-20'
PROJ. NO.: 1-02-020 DATE: 4-23-03

TRIAXIAL SHEAR TEST REPORT

Earth Exploration, Inc.

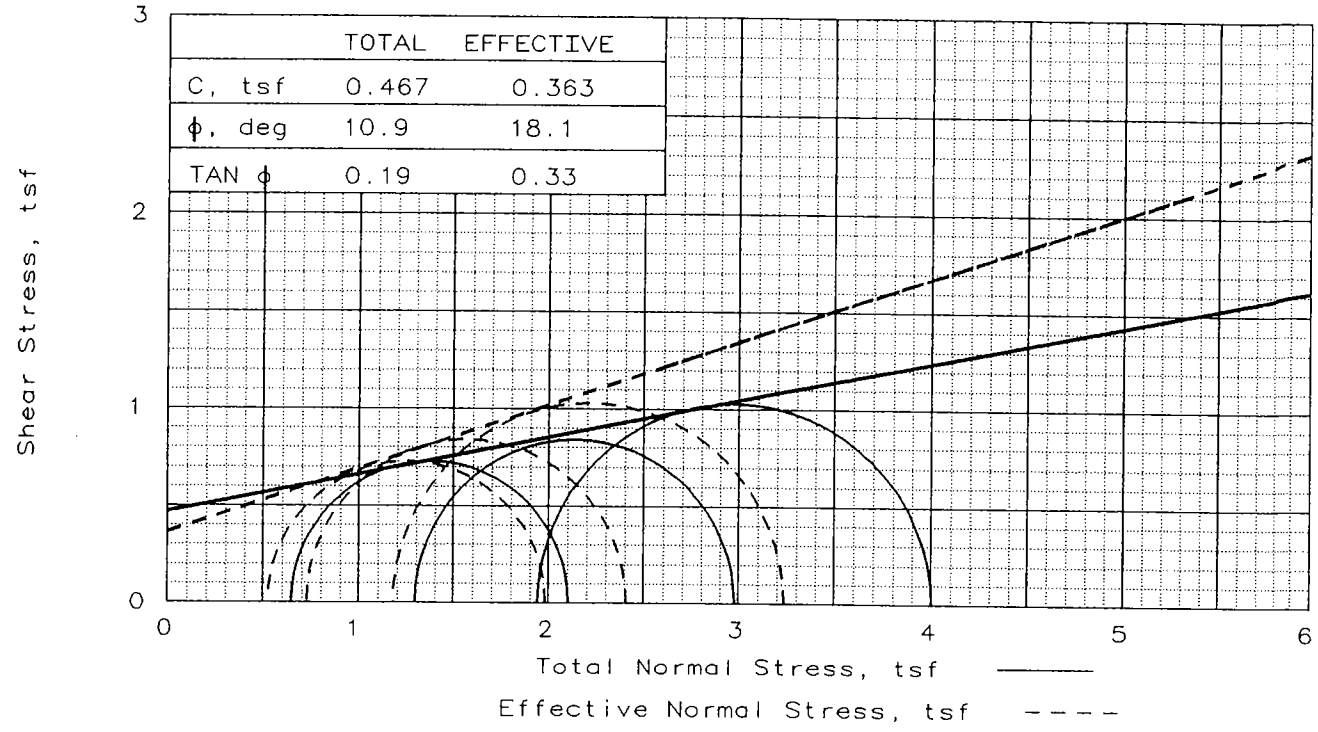


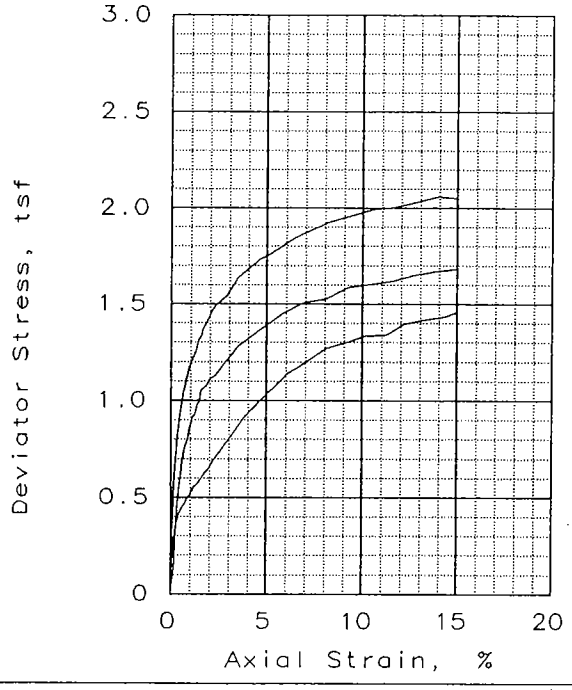
Client: Indiana Department of Natural Resources

Project: Crosley Lake Dam North Vernon, Jennings Co., Indiana

Location: C-3A ST-1 16'-18' & C-2A ST-1 18'-20'

File: 1020201 Project No.: 1-02-020 LAB NO.: 5451SL





SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	21.8	21.1	19.7
	DRY DENSITY, pcf	103.2	107.4	108.8
	SATURATION, %	91.8	98.7	95.6
	VOID RATIO	0.645	0.581	0.561
	DIAMETER, in	2.875	2.876	2.875
	HEIGHT, in	5.792	5.796	5.793
AT TEST	WATER CONTENT, %	23.4	20.5	19.3
	DRY DENSITY, pcf	103.8	109.0	111.3
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.636	0.559	0.525
	DIAMETER, in	2.870	2.862	2.853
	HEIGHT, in	5.782	5.768	5.749
Strain rate, %/min		0.10	0.10	0.10
BACK PRESSURE, tsf		2.520	2.880	2.880
CELL PRESSURE, tsf		3.168	4.176	4.824
FAIL. STRESS, tsf		1.458	1.682	2.059
TOTAL PORE PR., tsf		2.642	3.449	3.643
ULT. STRESS, tsf				
TOTAL PORE PR., tsf				
$\bar{\sigma}1$ $\bar{\sigma}_1$ FAILURE, tsf		1.984	2.409	3.239
$\bar{\sigma}_3$ FAILURE, tsf		0.526	0.727	1.181

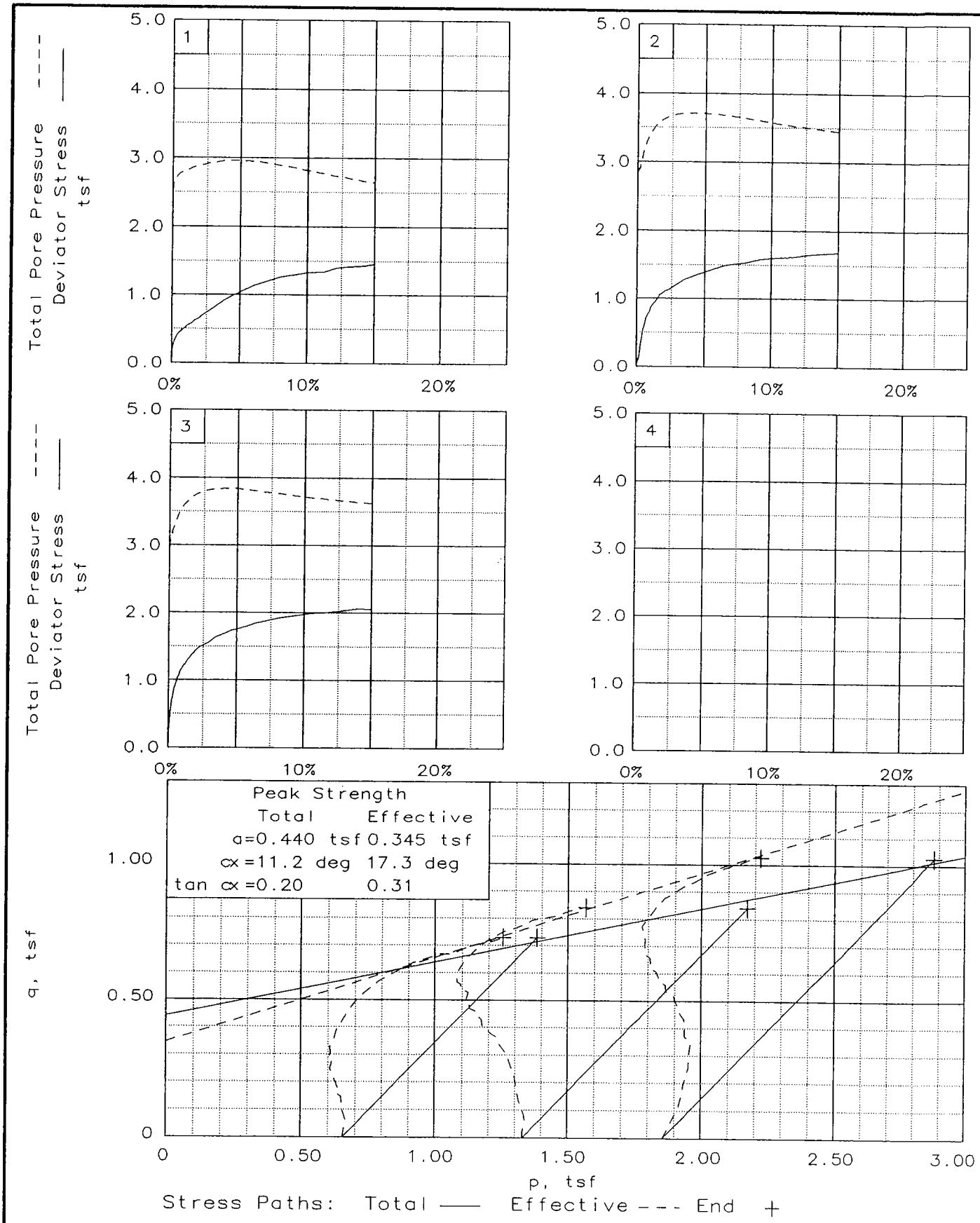
TYPE OF TEST:
CU with Pore Pressures
SAMPLE TYPE: UNDISTURBED
DESCRIPTION: CL, LEAN CLAY

ASSUMED SPECIFIC GRAVITY= 2.72
REMARKS:
Spec.#1,C-2A 22.3-22.8'
Spec.#2,C-3A 23.2-23.7'
Spec.#3,C-3A 22.7-23.2'
LAB NO.: 5452SL

CLIENT: Indiana Department of Natural Resources
PROJECT: Crosley Lake Dam
North Vernon, Jennings Co., Indiana
SAMPLE LOCATION: C-2A ST-3 22'-24' & C-3A ST-4 22'-24'
PROJ. NO.: 1-02-020 DATE: 4-30-03

TRIAXIAL SHEAR TEST REPORT

Earth Exploration, Inc.



Client: Indiana Department of Natural Resources

Project: Crosley Lake Dam North Vernon, Jennings Co., Indiana

Location: C-2A ST-3 22'-24' & C-3A ST-4 22'-24'

File: 1020202 Project No.: 1-02-020 LAB NO.: 5452SL

TABLE 1.
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA

EEI Project No. 1-02-020

TEST LOCATION	SAMPLE NO.	SAMPLE DEPTH INTERVAL (as noted)	SOIL DESCRIPTION	LABORATORY SOIL TEST RESULTS																
				WATER CONTENT (%)	LOSS-ON-IGNITION (%)	DRY UNIT WEIGHT (pcf)	PARTICLE-SIZE ANALYSIS				ATTERBERG LIMITS			SHEAR STRENGTH RESULTS (ksf)						
														S_u from q_u TESTS (ksf)		S_u from UU TESTS (ksf)	CU TESTS			
																	TOTAL STRESS PARAMETERS		EFFECTIVE STRESS PARAMETERS		
							% GRAVEL	% SAND	% FINES		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	3-in. DIAMETER SHELBY TUBE	SPLIT-SPOON		c (ksf)	φ (deg.)	c′ (ksf)	φ′ (deg.)	A_f
									% SILT	% CLAY											
C-1	SS-1	0.0 - 1.0	CL, Lean Clay	18.0		---															
	SS-1	1.0 - 2.0	CL, Lean Clay	19.9		---															
	SS-2	2.0 - 3.0	CL, Lean Clay	19.6		---															
	SS-2	3.0 - 4.0	CL, Lean Clay	17.7		112.9															
	SS-3	4.0 - 5.0	CL, Lean Clay	19.1		---					38	14	24								
	SS-3	5.0 - 6.0	CL, Lean Clay	18.2		113.1									2.36						
	SS-4	6.0 - 7.0	CL, Lean Clay	24.9		---															
	SS-4	7.0 - 8.0	CL, Lean Clay	21.6		105.2															
	SS-5	8.0 - 9.0	CL, Lean Clay	22.1		---															
	SS-5	9.0 10.0	CL, Lean Clay	25.0		99.7															
	SS-6	10.0 - 11.0	CL, Lean Clay	22.5		104.3															
	SS-6	11.0 - 12.0	CL, Lean Clay	22.4		---															
	SS-7	12.0 - 13.0	CL, Lean Clay	21.5		108.2															
	SS-7	13.0 - 14.0	CL, Lean Clay	22.3		---															
	SS-8	14.0 - 15.0	CL, Lean Clay	22.2		107.4															
	SS-8	15.0 - 16.0	CL, Lean Clay	23.2		---															
	SS-9	16.0 - 17.0	CL, Lean Clay	23.2		105.4									2.13						
	SS-9	17.0 - 18.0	CL, Lean Clay	22.1		---					42	17	25								
	SS-10	18.0 -19.0	CL, Lean Clay	25.6		99.4															
	SS-10	19.0 - 20.0	CL, Lean Clay	25.1		---															
	SS-11	20.0 - 21.0	CL, Lean Clay	---		---															
	SS-11	21.0 - 22.0	CL, Lean Clay	---		---															
	SS-12	22.0 -23.0	CL, Lean Clay	20.9		---															
	SS-12	23.0 - 24.0	CL, Lean Clay	22.5		104.1															
	SS-13	24.0 - 26.0	CL, Lean Clay	23.6		102.4															
	SS-14	26.0 - 27.0	CL, Lean Clay	23.9		100.4															

TABLE 1.
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA

EEI Project No. 1-02-020

TEST LOCATION	SAMPLE NO.	SAMPLE DEPTH INTERVAL (as noted)	SOIL DESCRIPTION	LABORATORY SOIL TEST RESULTS																	
				WATER CONTENT (%)	LOSS-ON-IGNITION (%)	DRY UNIT WEIGHT (pcf)	PARTICLE-SIZE ANALYSIS				ATTERBERG LIMITS			SHEAR STRENGTH RESULTS (ksf)							
														S_u from q_u TESTS (ksf)		S_u from UU TESTS (ksf)	CU TESTS				
							% GRAVEL	% SAND	% FINES		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	3-in. DIAMETER SHELBY TUBE	SPLIT-SPOON		TOTAL STRESS PARAMETERS		EFFECTIVE STRESS PARAMETERS		
									% SILT	% CLAY							c (ksf)	φ (deg.)	c′ (ksf)	φ′ (deg.)	$\bar{A}_f$
C-1	SS-14	27.0 - 28.0	CL, Lean Clay	24.8		---					34	19	15								
	SS-15	28.0 - 29.0	CL, Lean Clay	26.5		---															
	SS-15	29.0 - 30.0	CL, Lean Clay	25.6		97.5															
	SS-16	30.0 - 31.0	CL, Lean Clay	27.1		95.9															
	SS-16	31.0 - 32.0	CL, Lean Clay	25.8		---															
C-2	SS-1	0.0 - 1.0	CL, Lean Clay	18.5		---															
	SS-1	1.0 - 2.0	CL, Lean Clay	16.4		---															
	SS-2	2.0 - 3.0	CL, Lean Clay	24.4		---															
	SS-2	3.0 - 4.0	CL, Lean Clay	24.2		102.7															
	SS-3	4.0 - 5.0	CL, Lean Clay	18.7		---															
	SS-3	5.0 - 6.0	CL, Lean Clay	16.9		112.2															
	SS-4	6.0 - 7.0	CL, Lean Clay	19.5		109.7															
	SS-4	7.0 - 8.0	CL, Lean Clay	19.9		---															
	SS-5	8.0 - 9.0	CL, Lean Clay	24.0		---															
	SS-5	9.0 10.0	CL, Lean Clay	24.6		100.2															
	SS-6	10.0 - 11.0	CL, Lean Clay	24.7		---					45	20	25								
	SS-6	11.0 - 12.0	CL, Lean Clay	20.5		105.6															
	SS-7	12.0 - 13.0	CL, Lean Clay	25.4		101.4									2.10						
	SS-7	13.0 - 14.0	CL, Lean Clay	25.0		---															
	SS-8	14.0 - 15.0	CL, Lean Clay	22.5		---															
	SS-8	15.0 - 16.0	CL, Lean Clay	24.7		102.2															
	SS-9	16.0 - 17.0	CL, Lean Clay	21.3		105.6															
	SS-9	17.0 - 18.0	CL, Lean Clay	21.8		---															
	SS-10	18.0 -19.0	CL, Lean Clay	23.1		102.8															
	SS-10	19.0 - 20.0	CL, Lean Clay	21.7		---															

TABLE 1.
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA

EEI Project No. 1-02-020

TEST LOCATION	SAMPLE NO.	SAMPLE DEPTH INTERVAL (as noted)	SOIL DESCRIPTION	LABORATORY SOIL TEST RESULTS																
				WATER CONTENT (%)	LOSS-ON-IGNITION (%)	DRY UNIT WEIGHT (pcf)	PARTICLE-SIZE ANALYSIS				ATTERBERG LIMITS			SHEAR STRENGTH RESULTS (ksf)							
														S_u from q_u TESTS (ksf)		S_u from UU TESTS (ksf)	CU TESTS				
																	TOTAL STRESS PARAMETERS		EFFECTIVE STRESS PARAMETERS		
							% GRAVEL	% SAND	% FINES		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	3-in. DIAMETER SHELBY TUBE	SPLIT-SPOON		c (ksf)	φ (deg.)	c′ (ksf)	φ′ (deg.)	$\bar{A}_f$
									% SILT	% CLAY											
C-2	SS-11	20.0 - 21.0	CL, Lean Clay	22.1		—					41	16	25								
	SS-11	21.0 - 22.0	CL, Lean Clay	15.8		115.2															
	SS-12	22.0 -23.0	CL, Lean Clay	28.8		—															
	SS-12	23.0 - 24.0	CL, Lean Clay	22.4		—															
	SS-13	24.0 - 25.0	CL, Lean Clay	21.5		108.0															
	SS-13	25.0 - 26.0	CL, Lean Clay	22.1		—															
	SS-14	26.0 - 27.0	CL, Lean Clay	21.4		107.9									2.58						
	SS-14	27.0 - 28.0	CL, Lean Clay	26.0		—															
	SS-15	28.0 - 29.0	CL, Lean Clay	22.7		—															
	SS-15	29.0 - 30.0	CL, Lean Clay	26.7		99.1															
	SS-16	30.0 - 30.5	CL, Lean Clay	17.9		—															
C-2A	ST-1	18.3 - 18.8	CL, Lean Clay	23.2		101.7															
	ST-1	18.8 - 19.3	CL, Lean Clay	22.5		—					47	19	28								
	ST-1	19.3 - 19.8	CL, Lean Clay	23.9		—					46	20	26				0.516	12.3	0.404	21.8	-0.22 to 0
	ST-2	20.2 - 20.5	CL, Lean Clay	23.3		—					43	17	26								
	ST-2	20.5 - 20.7	CL, Lean Clay	21.1		106.0															
	ST-2	20.7 - 20.9	CL, Lean Clay	18.3		112.0															
	ST-3	22.3 - 22.8	CL, Lean Clay	21.8		—					51	19	32								
	ST-3	22.8 - 23.3	CL, Lean Clay	21.5		—					46	16	30	1.23							
	ST-4	24.1 - 24.4	CL, Lean Clay	23.8		101.5															
	ST-4	24.4 - 24.9	CL, Lean Clay	23.9		—					46	27	29	1.61							
C-3	SS-1	0.0 - 1.0	CL, Lean Clay	16.4		—															
	SS-1	1.0 - 2.0	CL, Lean Clay	20.5		99.1															
	SS-2	2.0 - 3.0	CL, Lean Clay	22.5		102.0															

TABLE 1.
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA

EEI Project No. 1-02-020

TEST LOCATION	SAMPLE NO.	SAMPLE DEPTH INTERVAL (as noted)	SOIL DESCRIPTION	LABORATORY SOIL TEST RESULTS																
				WATER CONTENT (%)	LOSS-ON-IGNITION (%)	DRY UNIT WEIGHT (pcf)	PARTICLE-SIZE ANALYSIS				ATTERBERG LIMITS			SHEAR STRENGTH RESULTS (ksf)							
														S_u from q_u TESTS (ksf)		S_u from UU TESTS (ksf)	CU TESTS				
							% GRAVEL	% SAND	% FINES		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	3-in. DIAMETER SHELBY TUBE	SPLIT-SPOON		TOTAL STRESS PARAMETERS		EFFECTIVE STRESS PARAMETERS		
									% SILT	% CLAY							c (ksf)	φ (deg.)	c′ (ksf)	φ′ (deg.)	$\bar{A}_f$
C-3	SS-2	3.0 - 4.0	CL, Lean Clay	24.7		---														
	SS-3	4.0 - 5.0	CL, Lean Clay	26.0		---														
	SS-3	5.0 - 6.0	CL, Lean Clay	19.8		---														
	SS-4	6.0 - 7.0	CL, Lean Clay	19.4		107.4														
	SS-4	7.0 - 8.0	CL, Lean Clay	19.2		---					38	16	22							
	SS-5	8.0 - 9.0	CL, Lean Clay	26.1		100.2														
	SS-5	9.0 10.0	CL, Lean Clay	25.5		---														
	SS-6	10.0 - 11.0	CL, Lean Clay	24.1		106.3														
	SS-6	11.0 - 12.0	CL, Lean Clay	25.8		---														
	SS-7	12.0 - 13.0	CL, Lean Clay	18.5		112.6														
	SS-7	13.0 - 14.0	CL, Lean Clay	24.6		---														
	SS-8	14.0 - 15.0	CL, Lean Clay	19.2		---														
	SS-8	15.0 - 16.0	CL, Lean Clay	26.8		99.2										0.94				
	SS-9	16.0 - 17.0	CL, Lean Clay	25.8		---														
	SS-9	17.0 - 18.0	CL, Lean Clay	23.0		104.3														
	SS-10	18.0 -19.0	CL, Lean Clay	20.5		---														
	SS-10	19.0 - 20.0	CL, Lean Clay	18.9		111.2														
	SS-11	20.0 - 21.0	CL, Lean Clay	20.3		---														
	SS-11	21.0 - 22.0	CL, Lean Clay	21.2		106.9														
	SS-12	22.0 -23.0	CL, Lean Clay	22.1		104.0														
	SS-12	23.0 - 24.0	CL, Lean Clay	22.3		---														
	SS-13	24.0 - 25.0	CL, Lean Clay	21.4		---														
	SS-13	25.0 - 26.0	CL, Lean Clay	19.9		108.5														
	SS-14	26.0 - 27.0	CL, Lean Clay	29.6		---														
	SS-14	27.0 - 28.0	CL, Lean Clay	26.1		---					35	19	16							
	SS-15	28.0 - 29.0	CL, Lean Clay	24.3		102.9														

TABLE 1.
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA

EEI Project No. 1-02-020

TEST LOCATION	SAMPLE NO.	SAMPLE DEPTH INTERVAL (as noted)	SOIL DESCRIPTION	LABORATORY SOIL TEST RESULTS																	
				WATER CONTENT (%)	LOSS-ON-IGNITION (%)	DRY UNIT WEIGHT (pcf)	PARTICLE-SIZE ANALYSIS				ATTERBERG LIMITS			SHEAR STRENGTH RESULTS (ksf)							
														S_u from q_u TESTS (ksf)		S_u from UU TESTS (ksf)	CU TESTS				
							% GRAVEL	% SAND	% FINES		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	3-in. DIAMETER SHELBY TUBE	SPLIT-SPOON		TOTAL STRESS PARAMETERS		EFFECTIVE STRESS PARAMETERS		
									% SILT	% CLAY							c (ksf)	φ (deg.)	c′ (ksf)	φ′ (deg.)	$\bar{A}_f$
C-3	SS-15	29.0 - 30.0	CL, Lean Clay	23.8		---															
	SS-16	30.0 - 31.0	CL, Lean Clay	21.9		---															
C-3A	ST-1	16.0 - 16.3	CL, Lean Clay	23.2		---															
	ST-1	16.3 - 16.6	CL, Lean Clay	24.3		---															
	ST-1	16.6 - 16.9	CL, Lean Clay	24.2		---															
	ST-1	16.9 - 17.2	CL, Lean Clay	23.8		---															
	ST-1	17.4 - 17.9	CL, Lean Clay	22.9		---					44	19	25								
	ST-2	18.0 - 18.2	CL, Lean Clay	24.7		98.8															
	ST-2	18.5 - 18.8	CL, Lean Clay	25.6		100.4					45	18	27								
	ST-3	20.4 - 20.9	CL, Lean Clay	21.6		---					42	18	24	2.43							
	ST-4	22.0 - 22.3	CL, Lean Clay	21.7		104.4															
	ST-4	22.3 - 22.6	CL, Lean Clay	20.7		106.8															
	ST-4	22.7 - 23.2	CL, Lean Clay	19.7		---					43	17	26								
	ST-4	23.2 - 23.7	CL, Lean Clay	21.1		---					47	16	31				0.934	10.9	0.726	18.1	-0.19 to -0.12
C-4	SS-1	0.0 - 1.0	CL, Lean Clay	18.8		107.7															
	SS-1	1.0 - 2.0	CL, Lean Clay	20.5		---															
	SS-2	2.0 - 3.0	CL, Lean Clay	23.4		101.1															
	SS-2	3.0 - 4.0	CL, Lean Clay	23.7		---					50	17	33								
	SS-3	4.0 - 5.0	CL, Lean Clay	20.3		---															
	SS-3	5.0 - 6.0	CL, Lean Clay	16.4		---															
	SS-4	6.0 - 8.0	CL, Lean Clay	20.4		---															
	SS-5	8.0 - 9.0	CL, Lean Clay	27.5		---															
	SS-5	9.0 10.0	CL, Lean Clay	22.8		103.6									1.86						
	SS-6	10.0 - 11.0	CL, Lean Clay	24.8		---															

TABLE 1.
SUMMARY OF GEOTECHNICAL LABORATORY TEST DATA

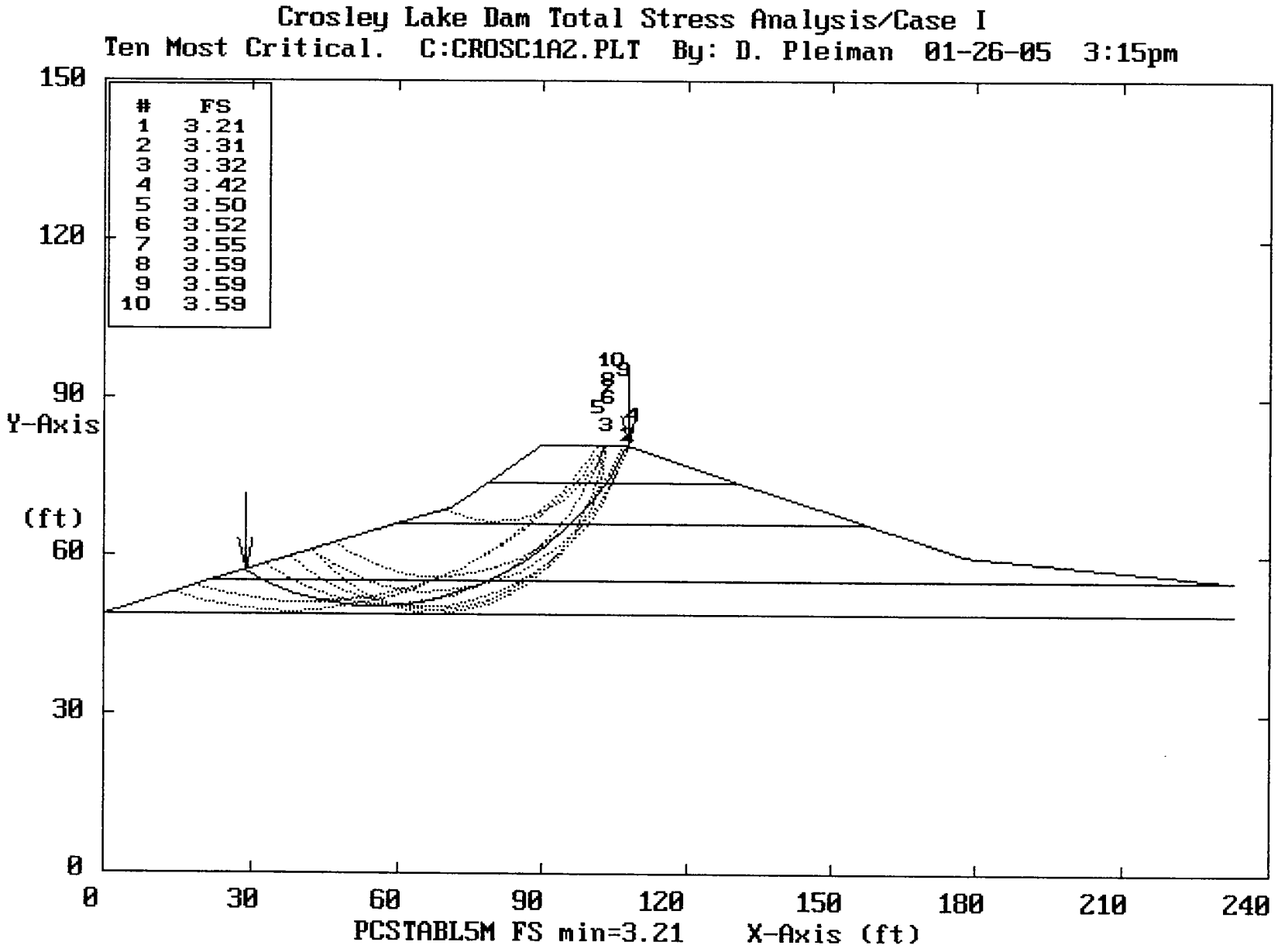
EEI Project No. 1-02-020

TEST LOCATION	SAMPLE NO.	SAMPLE DEPTH INTERVAL (as noted)	SOIL DESCRIPTION	LABORATORY SOIL TEST RESULTS																
				WATER CONTENT (%)	LOSS-ON-IGNITION (%)	DRY UNIT WEIGHT (pcf)	PARTICLE-SIZE ANALYSIS				ATTERBERG LIMITS			SHEAR STRENGTH RESULTS (ksf)							
														S_u from q_u TESTS (ksf)		S_u from UU TESTS (ksf)	CU TESTS				
							% GRAVEL	% SAND	% FINES		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	3-in. DIAMETER SHELBY TUBE	SPLIT-SPOON		TOTAL STRESS PARAMETERS		EFFECTIVE STRESS PARAMETERS		
									% SILT	% CLAY							c (ksf)	φ (deg.)	c′ (ksf)	φ′ (deg.)	$\bar{A}_f$
C-4	SS-6	11.0 - 12.0	CL, Lean Clay	20.9		105.8															
	SS-7	12.0 - 13.0	CL, Lean Clay	22.3		104.8															
	SS-7	13.0 - 14.0	CL, Lean Clay	24.5		—															
	SS-8	14.0 - 15.0	CL, Lean Clay	22.5		—															
	SS-8	15.0 - 16.0	CL, Lean Clay	21.8		—															
	SS-9	16.0 - 16.75	CL, Lean Clay	22.0		—															
	SS-9	16.75 - 17.5	CL, Lean Clay	25.0		—															

APPENDIX K

STABILITY ANALYSES (EXISTING CONDITIONS, TOTAL STRESS)
Case I - Sudden Drawdown from Normal Pool (Upstream)
Case III - Steady-state Seepage at Normal Pool with Earthquake Loading (Downstream)

STABILITY ANALYSES (EXISTING CONDITIONS, EFFECTIVE STRESS)
Case I - Sudden Drawdown from Normal Pool (Upstream)
Case II - Steady-state Seepage at Normal Pool (Downstream)
Case III - Steady-state Seepage at Normal Pool with Earthquake Loading (Downstream)


Crosley Lake Dam Total Stress Analysis/Case I
Ten Most Critical. C:CROSC1A2.PLT By: D. Pleiman 01-26-05 3:15pm
FS
1 3.21
2 3.31
3 3.32
4 3.42
5 3.50
6 3.52
7 3.55
8 3.59
9 3.59
10 3.59
150
120
90
Y-Axis
(ft)
60
30
0
0
30
60
90
120
150
180
210
240
PCSTABL5M FS min=3.21
X-Axis (ft)

*rB

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	01-26-05
Time of Run:	3:15pm
Run By:	D. Pleiman
Input Data Filename:	C:CROSC1A2
Output Filename:	C:CROSC1A2.OUT
Plotted Output Filename:	C:CROSC1A2.PLT

PROBLEM DESCRIPTION Crosley Lake Dam
Total Stress Analysis/Case I

BOUNDARY COORDINATES

10 Top Boundaries
14 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	49.00	21.80	55.00	4
2	21.80	55.00	60.10	66.00	3
3	60.10	66.00	71.00	69.00	2
4	71.00	69.00	78.90	74.00	2
5	78.90	74.00	90.00	81.00	1
6	90.00	81.00	108.00	81.00	1
7	108.00	81.00	131.30	74.00	1
8	131.30	74.00	158.00	66.00	2
9	158.00	66.00	178.00	60.00	3
10	178.00	60.00	233.00	55.00	3
11	78.90	74.00	131.30	74.00	2
12	60.10	66.00	158.00	66.00	3
13	21.80	55.00	233.00	55.00	4
14	.00	49.00	233.00	49.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	102.0	122.0	500.0	12.0	.00	.0	0
2	105.0	130.0	550.0	12.0	.00	.0	0
3	105.0	128.0	900.0	11.0	.00	.0	0
4	100.0	125.0	850.0	11.0	.00	.0	0

Searching Routine Will Be Limited To An Area Defined By 1 Boundaries
Of Which The First 1 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	49.00	233.00	49.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

225 Trial Surfaces Have Been Generated.

15 Surfaces Initiate From Each Of 15 Points Equally Spaced Along The Ground Surface Between X = 10.00 ft.
and X = 75.00 ft.

Each Surface Terminates Between X = 80.00 ft.
and X = 108.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	28.57	56.94
2	33.11	54.85
3	37.81	53.14
4	42.64	51.84
5	47.56	50.94
6	52.53	50.46
7	57.53	50.40
8	62.52	50.76
9	67.46	51.54
10	72.32	52.73
11	77.05	54.33
12	81.64	56.31
13	86.05	58.68
14	90.24	61.41
15	94.19	64.48
16	97.86	67.87
17	101.24	71.55
18	104.29	75.51
19	107.00	79.71
20	107.69	81.00

Circle Center At X = 55.7 ; Y = 109.8 and Radius, 59.4

*** 3.210 ***

Individual data on the 27 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	4.2	697.9	.0	.0	.0	.0	.0	.0	.0
2	.3	112.2	.0	.0	.0	.0	.0	.0	.0
3	4.7	2408.1	.0	.0	.0	.0	.0	.0	.0
4	4.8	3893.3	.0	.0	.0	.0	.0	.0	.0
5	4.9	5232.4	.0	.0	.0	.0	.0	.0	.0
6	5.0	6378.8	.0	.0	.0	.0	.0	.0	.0
7	5.0	7294.7	.0	.0	.0	.0	.0	.0	.0
8	2.6	4021.4	.0	.0	.0	.0	.0	.0	.0
9	2.4	3926.9	.0	.0	.0	.0	.0	.0	.0
10	4.9	8303.0	.0	.0	.0	.0	.0	.0	.0
11	3.5	6094.5	.0	.0	.0	.0	.0	.0	.0
12	1.3	2310.9	.0	.0	.0	.0	.0	.0	.0
13	4.7	8823.7	.0	.0	.0	.0	.0	.0	.0
14	1.6	3043.8	.0	.0	.0	.0	.0	.0	.0
15	.3	575.3	.0	.0	.0	.0	.0	.0	.0
16	2.7	5506.2	.0	.0	.0	.0	.0	.0	.0
17	4.4	9034.5	.0	.0	.0	.0	.0	.0	.0
18	4.0	8143.9	.0	.0	.0	.0	.0	.0	.0
19	.2	487.3	.0	.0	.0	.0	.0	.0	.0
20	3.9	7400.7	.0	.0	.0	.0	.0	.0	.0
21	1.7	2698.6	.0	.0	.0	.0	.0	.0	.0
22	2.0	2945.9	.0	.0	.0	.0	.0	.0	.0
23	3.4	3932.2	.0	.0	.0	.0	.0	.0	.0
24	1.9	1590.6	.0	.0	.0	.0	.0	.0	.0
25	1.2	743.3	.0	.0	.0	.0	.0	.0	.0
26	2.7	937.1	.0	.0	.0	.0	.0	.0	.0
27	.7	45.0	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	37.86	59.61
2	41.96	56.75
3	46.36	54.37
4	50.99	52.50
5	55.81	51.16
6	60.75	50.37
7	65.74	50.14
8	70.73	50.47
9	75.65	51.37
10	80.44	52.81
11	85.03	54.77
12	89.38	57.25
13	93.42	60.19
14	97.10	63.57
15	100.38	67.35
16	103.22	71.46

17	105.58	75.88
18	107.42	80.52
19	107.55	81.00

Circle Center At X = 65.3 ; Y = 94.6 and Radius, 44.4

*** 3.312 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	33.21	58.28
2	37.53	55.75
3	42.09	53.70
4	46.84	52.14
5	51.73	51.10
6	56.70	50.59
7	61.70	50.62
8	66.67	51.17
9	71.55	52.26
10	76.29	53.85
11	80.83	55.95
12	85.12	58.52
13	89.12	61.53
14	92.76	64.95
15	96.03	68.73
16	98.87	72.85
17	101.25	77.25
18	102.79	81.00

Circle Center At X = 59.0 ; Y = 97.3 and Radius, 46.7

*** 3.322 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	42.50	60.95
2	46.75	58.31
3	51.27	56.17
4	56.01	54.58
5	60.90	53.54
6	65.88	53.07
7	70.88	53.17
8	75.83	53.85
9	80.67	55.10
10	85.34	56.90
11	89.76	59.22
12	93.89	62.04
13	97.67	65.32
14	101.05	69.01
15	103.98	73.06
16	106.42	77.42

17	107.91	81.00

Circle Center At X = 67.5 ; Y = 96.4 and Radius, 43.3

*** 3.423 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	14.64	53.03
2	19.45	51.67
3	24.34	50.61
4	29.29	49.87
5	34.27	49.44
6	39.27	49.33
7	44.26	49.54
8	49.23	50.07
9	54.16	50.91
10	59.03	52.06
11	63.81	53.52
12	68.49	55.28
13	73.05	57.33
14	77.47	59.67
15	81.73	62.29
16	85.81	65.17
17	89.71	68.31
18	93.40	71.69
19	96.86	75.29
20	100.09	79.11
21	101.50	81.00

Circle Center At X = 38.5 ; Y = 127.9 and Radius, 78.6

*** 3.497 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	19.29	54.31
2	24.11	53.01
3	29.01	52.02
4	33.97	51.35
5	38.96	51.00
6	43.96	50.97
7	48.95	51.27
8	53.91	51.88
9	58.82	52.82
10	63.66	54.07
11	68.41	55.63
12	73.05	57.49
13	77.57	59.65
14	81.93	62.09
15	86.12	64.81

16	90.13	67.79
17	93.95	71.03
18	97.54	74.51
19	100.90	78.21
20	103.13	81.00

Circle Center At X = 41.9 ; Y = 128.4 and Radius, 77.4

*** 3.524 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	70.36	68.82
2	75.07	67.16
3	80.03	66.49
4	85.02	66.83
5	89.83	68.17
6	94.28	70.46
7	98.18	73.59
8	101.36	77.45
9	103.24	81.00

Circle Center At X = 80.9 ; Y = 91.1 and Radius, 24.7

*** 3.546 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	42.50	60.95
2	46.04	57.42
3	50.06	54.44
4	54.46	52.07
5	59.16	50.36
6	64.06	49.34
7	69.05	49.05
8	74.03	49.47
9	78.90	50.61
10	83.55	52.43
11	87.90	54.91
12	91.84	57.99
13	95.29	61.60
14	98.19	65.68
15	100.47	70.13
16	102.09	74.86
17	103.00	79.77
18	103.05	81.00

Circle Center At X = 68.6 ; Y = 83.6 and Radius, 34.5

*** 3.590 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	47.14	62.28
2	51.52	59.86
3	56.15	57.99
4	60.99	56.70
5	65.94	56.01
6	70.94	55.94
7	75.91	56.48
8	80.78	57.62
9	85.47	59.36
10	89.91	61.65
11	94.04	64.47
12	97.79	67.78
13	101.11	71.52
14	103.94	75.63
15	106.25	80.07
16	106.60	81.00

Circle Center At X = 69.0 ; Y = 96.6 and Radius, 40.7

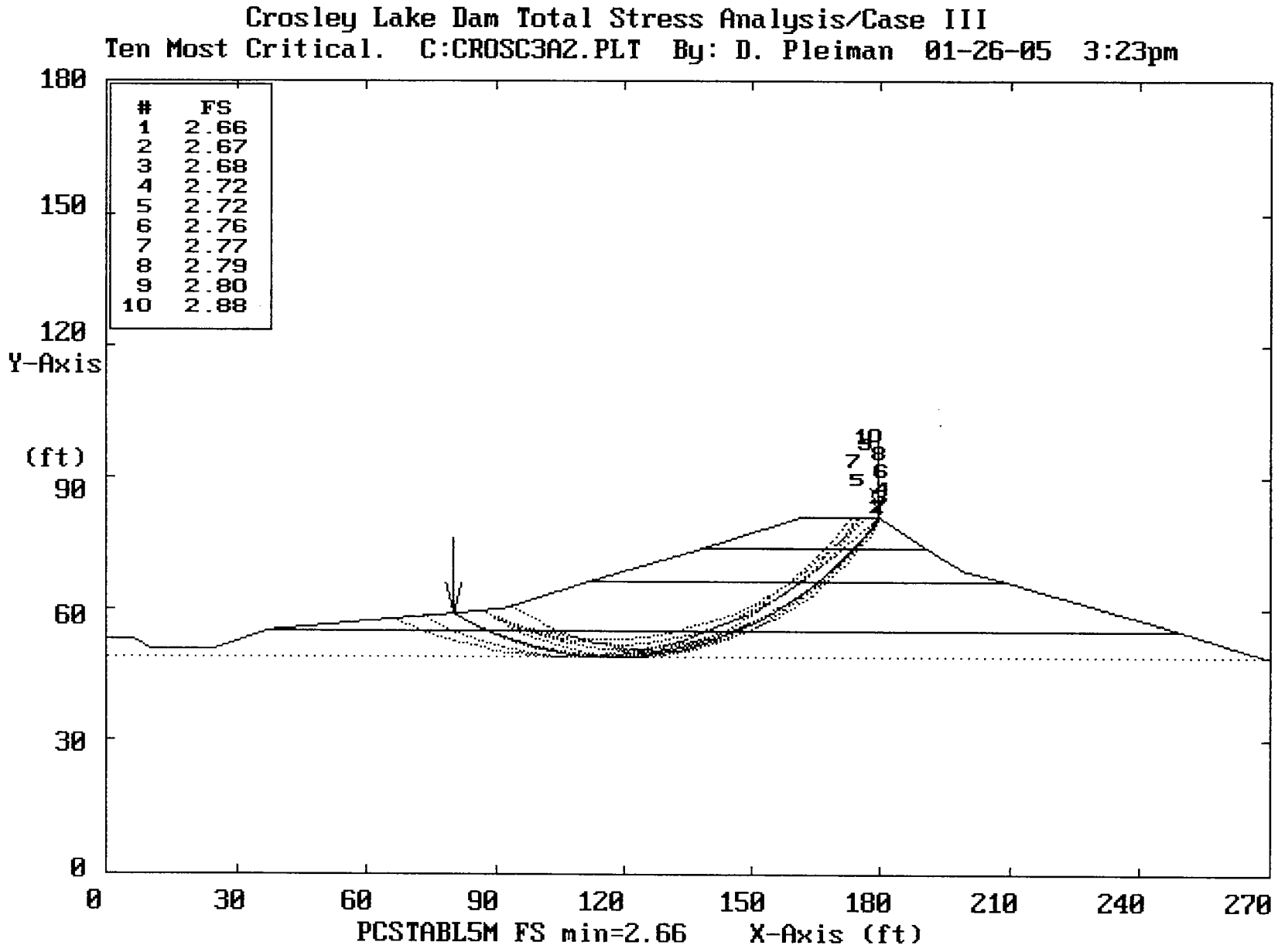
*** 3.592 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	42.50	60.95
2	46.10	57.48
3	50.17	54.56
4	54.61	52.27
5	59.34	50.65
6	64.25	49.72
7	69.25	49.52
8	74.22	50.05
9	79.06	51.29
10	83.68	53.21
11	87.96	55.79
12	91.83	58.96
13	95.20	62.65
14	98.00	66.80
15	100.16	71.30
16	101.66	76.08
17	102.44	81.00

Circle Center At X = 68.1 ; Y = 83.9 and Radius, 34.4

*** 3.593 ***


Crosley Lake Dam Total Stress Analysis/Case III
Ten Most Critical. C:CROSC3A2.PLT By: D. Pleiman 01-26-05 3:23pm
FS
1 2.66
2 2.67
3 2.68
4 2.72
5 2.72
6 2.76
7 2.77
8 2.79
9 2.80
10 2.88
180
150
120
90
60
30
0
Y-Axis
(ft)
0
30
60
90
120
150
180
210
240
270
PCSTABL5M FS min=2.66
X-Axis (ft)

*rB

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 01-26-05
Time of Run: 3:23pm
Run By: D. Pleiman
Input Data Filename: C:CROSC3A2
Output Filename: C:CROSC3A2.OUT
Plotted Output Filename: C:CROSC3A2.PLT

PROBLEM DESCRIPTION Crosley Lake Dam
Total Stress Analysis/Case III

BOUNDARY COORDINATES

14 Top Boundaries
17 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	53.00	6.00	53.00	4
2	6.00	53.00	10.00	51.00	4
3	10.00	51.00	25.00	51.00	4
4	25.00	51.00	37.00	55.00	4
5	37.00	55.00	92.00	60.00	3
6	92.00	60.00	112.10	66.00	3
7	112.10	66.00	138.70	74.00	2
8	138.70	74.00	162.00	81.00	1
9	162.00	81.00	180.00	81.00	1
10	180.00	81.00	191.10	74.00	1
11	191.10	74.00	199.00	69.00	2
12	199.00	69.00	209.90	66.00	2
13	209.90	66.00	250.00	55.00	3
14	250.00	55.00	270.00	49.00	4
15	138.70	74.00	191.10	74.00	2
16	112.10	66.00	209.90	66.00	3
17	37.00	55.00	250.00	55.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	102.0	122.0	500.0	12.0	.00	.0	0
2	105.0	130.0	550.0	12.0	.00	.0	0
3	105.0	128.0	900.0	11.0	.00	.0	0
4	100.0	125.0	850.0	11.0	.00	.0	0

A Horizontal Earthquake Loading Coefficient
Of .100 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

Searching Routine Will Be Limited To An Area Defined By 1 Boundaries
Of Which The First 1 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	49.00	270.00	49.00

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

289 Trial Surfaces Have Been Generated.

17 Surfaces Initiate From Each Of 17 Points Equally Spaced
Along The Ground Surface Between X = 25.00 ft.
and X = 135.00 ft.

Each Surface Terminates Between X = 140.00 ft.
and X = 180.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	58.91
2	84.44	56.60
3	89.02	54.59
4	93.72	52.89
5	98.52	51.50
6	103.40	50.42
7	108.34	49.66
8	113.32	49.23
9	118.32	49.13
10	123.32	49.36
11	128.29	49.91
12	133.21	50.79
13	138.07	51.98

14	142.83	53.50
15	147.49	55.32
16	152.02	57.44
17	156.39	59.85
18	160.61	62.55
19	164.63	65.51
20	168.45	68.74
21	172.06	72.20
22	175.43	75.90
23	178.55	79.80
24	179.38	81.00

Circle Center At X = 117.4 ; Y = 125.4 and Radius, 76.2

*** **2.664** ***

Individual data on the 31 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	4.4	630.9	.0	.0	.0	.0	63.1	.0	.0
2	3.7	1410.8	.0	.0	.0	.0	141.1	.0	.0
3	.9	473.4	.0	.0	.0	.0	47.3	.0	.0
4	3.0	1806.7	.0	.0	.0	.0	180.7	.0	.0
5	1.7	1255.9	.0	.0	.0	.0	125.6	.0	.0
6	4.8	4488.8	.0	.0	.0	.0	448.9	.0	.0
7	4.9	5908.7	.0	.0	.0	.0	590.9	.0	.0
8	4.9	7195.0	.0	.0	.0	.0	719.5	.0	.0
9	3.8	6183.3	.0	.0	.0	.0	618.3	.0	.0
10	1.2	2138.0	.0	.0	.0	.0	213.8	.0	.0
11	5.0	9269.2	.0	.0	.0	.0	926.9	.0	.0
12	5.0	10019.1	.0	.0	.0	.0	1001.9	.0	.0
13	5.0	10556.6	.0	.0	.0	.0	1055.7	.0	.0
14	4.9	10874.4	.0	.0	.0	.0	1087.4	.0	.0
15	4.9	10970.5	.0	.0	.0	.0	1097.1	.0	.0
16	.6	1444.9	.0	.0	.0	.0	144.5	.0	.0
17	4.1	9395.4	.0	.0	.0	.0	939.5	.0	.0
18	3.8	8677.7	.0	.0	.0	.0	867.8	.0	.0
19	.8	1809.8	.0	.0	.0	.0	181.0	.0	.0
20	4.5	9910.4	.0	.0	.0	.0	991.0	.0	.0
21	4.4	9139.7	.0	.0	.0	.0	914.0	.0	.0
22	4.2	8214.8	.0	.0	.0	.0	821.5	.0	.0
23	1.4	2568.3	.0	.0	.0	.0	256.8	.0	.0
24	2.6	4490.1	.0	.0	.0	.0	449.0	.0	.0
25	.6	911.4	.0	.0	.0	.0	91.1	.0	.0
26	3.2	4577.7	.0	.0	.0	.0	457.8	.0	.0
27	3.6	3908.8	.0	.0	.0	.0	390.9	.0	.0
28	1.6	1324.9	.0	.0	.0	.0	132.5	.0	.0
29	1.7	1067.7	.0	.0	.0	.0	106.8	.0	.0
30	3.1	1002.1	.0	.0	.0	.0	100.2	.0	.0
31	.8	50.7	.0	.0	.0	.0	5.1	.0	.0

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.88	59.53
2	91.20	57.02
3	95.70	54.84
4	100.35	53.01
5	105.13	51.53
6	110.00	50.42
7	114.95	49.67
8	119.93	49.31
9	124.93	49.31
10	129.92	49.70
11	134.86	50.46
12	139.73	51.59
13	144.50	53.09
14	149.14	54.94
15	153.64	57.14
16	157.95	59.67
17	162.06	62.51
18	165.94	65.66
19	169.58	69.09
20	172.95	72.79
21	176.02	76.73
22	178.80	80.89
23	178.86	81.00

Circle Center At X = 122.3 ; Y = 115.5 and Radius, 66.3

*** 2.674 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	58.91
2	84.48	56.70
3	89.10	54.77
4	93.83	53.14
5	98.65	51.82
6	103.54	50.80
7	108.49	50.10
8	113.48	49.71
9	118.48	49.64
10	123.47	49.89
11	128.44	50.46
12	133.36	51.33
13	138.22	52.52
14	142.99	54.02
15	147.66	55.81
16	152.20	57.90
17	156.60	60.27
18	160.85	62.91
19	164.91	65.82
20	168.79	68.98
21	172.45	72.38

22	175.90	76.01
23	179.10	79.85
24	179.95	81.00

Circle Center At X = 117.1 ; Y = 128.3 and Radius, 78.7

*** 2.681 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.88	59.53
2	91.36	57.32
3	95.98	55.42
4	100.73	53.85
5	105.57	52.60
6	110.49	51.70
7	115.46	51.13
8	120.45	50.91
9	125.45	51.03
10	130.43	51.50
11	135.36	52.31
12	140.23	53.46
13	145.00	54.94
14	149.67	56.75
15	154.19	58.87
16	158.56	61.31
17	162.75	64.03
18	166.74	67.04
19	170.52	70.32
20	174.06	73.85
21	177.35	77.62
22	179.91	81.00

Circle Center At X = 121.2 ; Y = 123.3 and Radius, 72.4

*** 2.715 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	58.91
2	84.41	56.55
3	88.97	54.51
4	93.67	52.79
5	98.48	51.41
6	103.37	50.38
7	108.32	49.70
8	113.31	49.37
9	118.31	49.39
10	123.30	49.77
11	128.24	50.50
12	133.12	51.58

13	137.92	53.00
14	142.60	54.76
15	147.14	56.85
16	151.53	59.25
17	155.73	61.96
18	159.73	64.96
19	163.51	68.23
20	167.04	71.77
21	170.32	75.54
22	173.32	79.54
23	174.26	81.00

Circle Center At X = 115.5 ; Y = 119.8 and Radius, 70.5

*** 2.720 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	93.75	60.52
2	98.05	57.98
3	102.55	55.79
4	107.21	53.98
5	112.01	52.56
6	116.90	51.53
7	121.86	50.91
8	126.86	50.69
9	131.85	50.89
10	136.82	51.49
11	141.71	52.49
12	146.51	53.89
13	151.18	55.68
14	155.69	57.85
15	160.01	60.37
16	164.10	63.24
17	167.95	66.43
18	171.52	69.93
19	174.79	73.71
20	177.75	77.74
21	179.75	81.00

Circle Center At X = 127.0 ; Y = 111.8 and Radius, 61.1

*** 2.764 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	73.13	58.28
2	77.61	56.07
3	82.22	54.15
4	86.95	52.52
5	91.77	51.20

6	96.67	50.19
7	101.62	49.50
8	106.61	49.12
9	111.61	49.06
10	116.60	49.32
11	121.57	49.91
12	126.49	50.80
13	131.34	52.01
14	136.10	53.53
15	140.76	55.34
16	145.29	57.45
17	149.68	59.85
18	153.91	62.52
19	157.96	65.46
20	161.81	68.65
21	165.45	72.08
22	168.86	75.73
23	172.03	79.59
24	173.05	81.00

Circle Center At X = 110.0 ; Y = 127.2 and Radius, 78.2

*** 2.771 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.25	57.66
2	70.88	55.77
3	75.60	54.11
4	80.39	52.70
5	85.25	51.52
6	90.17	50.59
7	95.12	49.91
8	100.10	49.48
9	105.10	49.29
10	110.10	49.36
11	115.09	49.68
12	120.05	50.25
13	124.99	51.07
14	129.87	52.13
15	134.70	53.44
16	139.45	54.99
17	144.12	56.78
18	148.70	58.79
19	153.17	61.04
20	157.52	63.50
21	161.74	66.18
22	165.82	69.07
23	169.75	72.16
24	173.52	75.44
25	177.12	78.91
26	179.08	81.00

Circle Center At X = 106.2 ; Y = 148.9 and Radius, 99.6

*** 2.793 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.88	59.53
2	91.43	57.48
3	96.12	55.74
4	100.92	54.34
5	105.81	53.27
6	110.75	52.55
7	115.74	52.17
8	120.74	52.14
9	125.73	52.45
10	130.68	53.12
11	135.58	54.12
12	140.40	55.47
13	145.11	57.15
14	149.69	59.15
15	154.12	61.46
16	158.38	64.08
17	162.45	66.99
18	166.30	70.17
19	169.93	73.62
20	173.30	77.30
21	176.24	81.00

Circle Center At X = 118.7 ; Y = 123.9 and Radius, 71.8

*** 2.798 ***

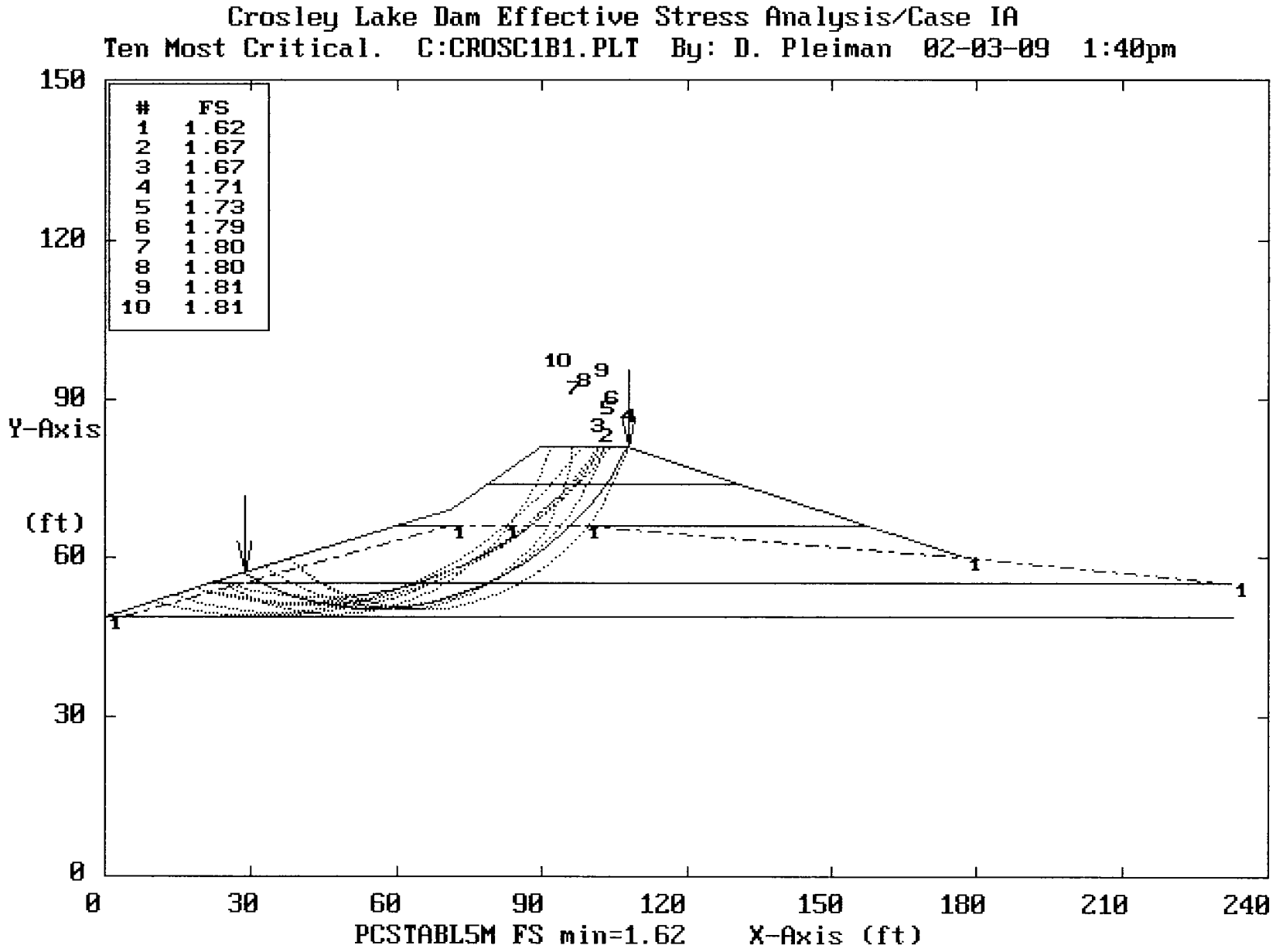
Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.88	59.53
2	91.52	57.68
3	96.28	56.15
4	101.13	54.93
5	106.05	54.04
6	111.02	53.48
7	116.01	53.25
8	121.01	53.36
9	125.99	53.79
10	130.93	54.56
11	135.81	55.66
12	140.60	57.08
13	145.29	58.81
14	149.86	60.85
15	154.27	63.20
16	158.53	65.83
17	162.59	68.74
18	166.46	71.91
19	170.10	75.34

20	173.51	79.00
21	175.14	81.00

Circle Center At X = 116.9 ; Y = 128.3 and Radius, 75.0

*** 2.884 ***


Crosley Lake Dam Effective Stress Analysis/Case IA
Ten Most Critical. C:CROSC1B1.PLT By: D. Pleiman 02-03-09 1:40pm
FS
1 1.62
2 1.67
3 1.67
4 1.71
5 1.73
6 1.79
7 1.80
8 1.80
9 1.81
10 1.81
150
120
90
60
30
0
Y-Axis
(ft)
0
30
60
90
120
150
180
210
240
PCSTABL5M FS min=1.62
X-Axis (ft)

*rB

** PCSTABL5M **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	02-02-09
Time of Run:	11:11am
Run By:	D. Pleiman
Input Data Filename:	C:CROSC1B1
Output Filename:	C:CROSC1B1.OUT
Plotted Output Filename:	C:CROSC1B1.PLT

PROBLEM DESCRIPTION Crosley Lake Dam
Effective Stress Analysis/Case IA

BOUNDARY COORDINATES

10 Top Boundaries
14 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	49.00	21.80	55.00	4
2	21.80	55.00	60.10	66.00	3
3	60.10	66.00	71.00	69.00	2
4	71.00	69.00	78.90	74.00	2
5	78.90	74.00	90.00	81.00	1
6	90.00	81.00	108.00	81.00	1
7	108.00	81.00	131.30	74.00	1
8	131.30	74.00	158.00	66.00	2
9	158.00	66.00	178.00	60.00	3
10	178.00	60.00	233.00	55.00	3
11	78.90	74.00	131.30	74.00	2
12	60.10	66.00	158.00	66.00	3
13	21.80	55.00	233.00	55.00	4
14	.00	49.00	233.00	49.00	4

1

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	102.0	122.0	400.0	21.0	.00	.0	1
2	105.0	130.0	450.0	22.0	.45	.0	1
3	105.0	128.0	400.0	18.0	.28	.0	1
4	100.0	125.0	350.0	17.0	.22	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	49.00
2	71.00	66.00
3	82.10	66.00
4	99.00	66.00
5	178.00	60.00
6	233.00	55.00

1

Searching Routine Will Be Limited To An Area Defined By 1 Boundaries
Of Which The First 1 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	49.00	233.00	49.00

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

225 Trial Surfaces Have Been Generated.

15 Surfaces Initiate From Each Of 15 Points Equally Spaced
Along The Ground Surface Between X = 10.00 ft.
and X = 75.00 ft.

Each Surface Terminates Between X = 80.00 ft.
and X = 108.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	28.57	56.94
2	33.11	54.85
3	37.81	53.14
4	42.64	51.84
5	47.56	50.94
6	52.53	50.46
7	57.53	50.40
8	62.52	50.76
9	67.46	51.54
10	72.32	52.73
11	77.05	54.33
12	81.64	56.31
13	86.05	58.68
14	90.24	61.41
15	94.19	64.48
16	97.86	67.87
17	101.24	71.55
18	104.29	75.51
19	107.00	79.71
20	107.69	81.00

Circle Center At X = 55.7 ; Y = 109.8 and Radius, 59.4

*** 1.620 ***

Individual data on the 29 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	1.6	97.5	.0	30.1	.0	.0	.0	.0	.0
2	2.6	655.0	.0	365.2	.0	.0	.0	.0	.0
3	.3	126.6	.0	73.6	.0	.0	.0	.0	.0
4	4.7	2785.0	.0	1712.7	.0	.0	.0	.0	.0
5	4.8	4580.9	.0	2908.3	.0	.0	.0	.0	.0
6	4.9	6193.6	.0	3937.6	.0	.0	.0	.0	.0
7	5.0	7566.6	.0	4793.2	.0	.0	.0	.0	.0
8	5.0	8654.4	.0	5469.3	.0	.0	.0	.0	.0
9	2.6	4767.5	.0	3018.1	.0	.0	.0	.0	.0
10	2.4	4652.2	.0	2942.0	.0	.0	.0	.0	.0
11	4.9	9822.9	.0	6257.9	.0	.0	.0	.0	.0
12	3.5	7193.4	.0	4639.4	.0	.0	.0	.0	.0
13	1.3	2723.6	.0	1752.0	.0	.0	.0	.0	.0
14	4.7	10196.8	.0	6257.7	.0	.0	.0	.0	.0
15	1.6	3450.3	.0	2025.8	.0	.0	.0	.0	.0
16	.3	648.5	.0	414.1	.0	.0	.0	.0	.0
17	2.7	6154.7	.0	3795.2	.0	.0	.0	.0	.0
18	.5	1031.5	.0	637.6	.0	.0	.0	.0	.0
19	3.9	8864.6	.0	5160.6	.0	.0	.0	.0	.0
20	4.0	8692.5	.0	4679.6	.0	.0	.0	.0	.0
21	.2	512.9	.0	254.2	.0	.0	.0	.0	.0
22	3.9	7678.4	.0	3678.0	.0	.0	.0	.0	.0
23	1.7	2727.6	.0	1145.9	.0	.0	.0	.0	.0
24	2.0	2945.9	.0	1803.7	.0	.0	.0	.0	.0
25	3.4	3932.2	.0	2619.9	.0	.0	.0	.0	.0
26	1.9	1590.6	.0	1171.4	.0	.0	.0	.0	.0
27	1.2	743.3	.0	.0	.0	.0	.0	.0	.0
28	2.7	937.1	.0	.0	.0	.0	.0	.0	.0
29	.7	45.0	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	33.21	58.28
2	37.53	55.75
3	42.09	53.70
4	46.84	52.14
5	51.73	51.10
6	56.70	50.59
7	61.70	50.62
8	66.67	51.17
9	71.55	52.26
10	76.29	53.85
11	80.83	55.95
12	85.12	58.52
13	89.12	61.53

14	92.76	64.95
15	96.03	68.73
16	98.87	72.85
17	101.25	77.25
18	102.79	81.00

Circle Center At X = 59.0 ; Y = 97.3 and Radius, 46.7

*** 1.666 ***

1

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	14.64	53.03
2	19.45	51.67
3	24.34	50.61
4	29.29	49.87
5	34.27	49.44
6	39.27	49.33
7	44.26	49.54
8	49.23	50.07
9	54.16	50.91
10	59.03	52.06
11	63.81	53.52
12	68.49	55.28
13	73.05	57.33
14	77.47	59.67
15	81.73	62.29
16	85.81	65.17
17	89.71	68.31
18	93.40	71.69
19	96.86	75.29
20	100.09	79.11
21	101.50	81.00

Circle Center At X = 38.5 ; Y = 127.9 and Radius, 78.6

*** 1.671 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	37.86	59.61
2	41.96	56.75
3	46.36	54.37
4	50.99	52.50
5	55.81	51.16
6	60.75	50.37
7	65.74	50.14
8	70.73	50.47
9	75.65	51.37
10	80.44	52.81
11	85.03	54.77
12	89.38	57.25
13	93.42	60.19
14	97.10	63.57
15	100.38	67.35
16	103.22	71.46
17	105.58	75.88
18	107.42	80.52
19	107.55	81.00

Circle Center At X = 65.3 ; Y = 94.6 and Radius, 44.4

*** 1.710 ***

1

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	19.29	54.31
2	24.11	53.01
3	29.01	52.02
4	33.97	51.35
5	38.96	51.00
6	43.96	50.97
7	48.95	51.27
8	53.91	51.88
9	58.82	52.82
10	63.66	54.07
11	68.41	55.63
12	73.05	57.49
13	77.57	59.65
14	81.93	62.09
15	86.12	64.81
16	90.13	67.79
17	93.95	71.03
18	97.54	74.51
19	100.90	78.21
20	103.13	81.00

Circle Center At X = 41.9 ; Y = 128.4 and Radius, 77.4

*** 1.728 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	19.29	54.31
2	24.16	53.19
3	29.09	52.36
4	34.06	51.82
5	39.06	51.59
6	44.05	51.66
7	49.04	52.02
8	54.00	52.68
9	58.90	53.64
10	63.75	54.89
11	68.50	56.43
12	73.16	58.25
13	77.70	60.34
14	82.11	62.70
15	86.36	65.33
16	90.46	68.20
17	94.37	71.31
18	98.09	74.65
19	101.60	78.21
20	104.04	81.00

Circle Center At X = 40.5 ; Y = 135.0 and Radius, 83.4

*** 1.791 ***

1

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	37.86	59.61
2	41.74	56.46
3	46.04	53.90
4	50.65	51.98
5	55.50	50.75
6	60.47	50.21
7	65.47	50.40
8	70.39	51.29

9	75.13	52.88
10	79.59	55.14
11	83.68	58.01
12	87.33	61.43
13	90.44	65.34
14	92.97	69.66
15	94.85	74.29
16	96.04	79.15
17	96.23	81.00

Circle Center At X = 61.7 ; Y = 85.0 and Radius, 34.9

*** 1.800 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.00	51.75
2	14.88	50.66
3	19.81	49.85
4	24.79	49.32
5	29.78	49.09
6	34.78	49.14
7	39.77	49.49
8	44.73	50.12
9	49.64	51.04
10	54.50	52.24
11	59.27	53.72
12	63.95	55.48
13	68.53	57.50
14	72.97	59.79
15	77.28	62.32
16	81.43	65.11
17	85.42	68.13
18	89.22	71.37
19	92.83	74.83
20	96.24	78.50
21	98.30	81.00

Circle Center At X = 31.3 ; Y = 135.4 and Radius, 86.3

*** 1.804 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	23.93	55.61
2	28.75	54.28
3	33.65	53.30
4	38.61	52.66
5	43.60	52.38
6	48.60	52.44
7	53.58	52.86
8	58.52	53.63
9	63.40	54.75
10	68.18	56.21
11	72.85	58.00
12	77.38	60.12
13	81.75	62.55
14	85.93	65.29
15	89.92	68.31
16	93.67	71.61
17	97.19	75.16
18	100.45	78.95
19	101.97	81.00

Circle Center At X = 45.1 ; Y = 123.2 and Radius, 70.8

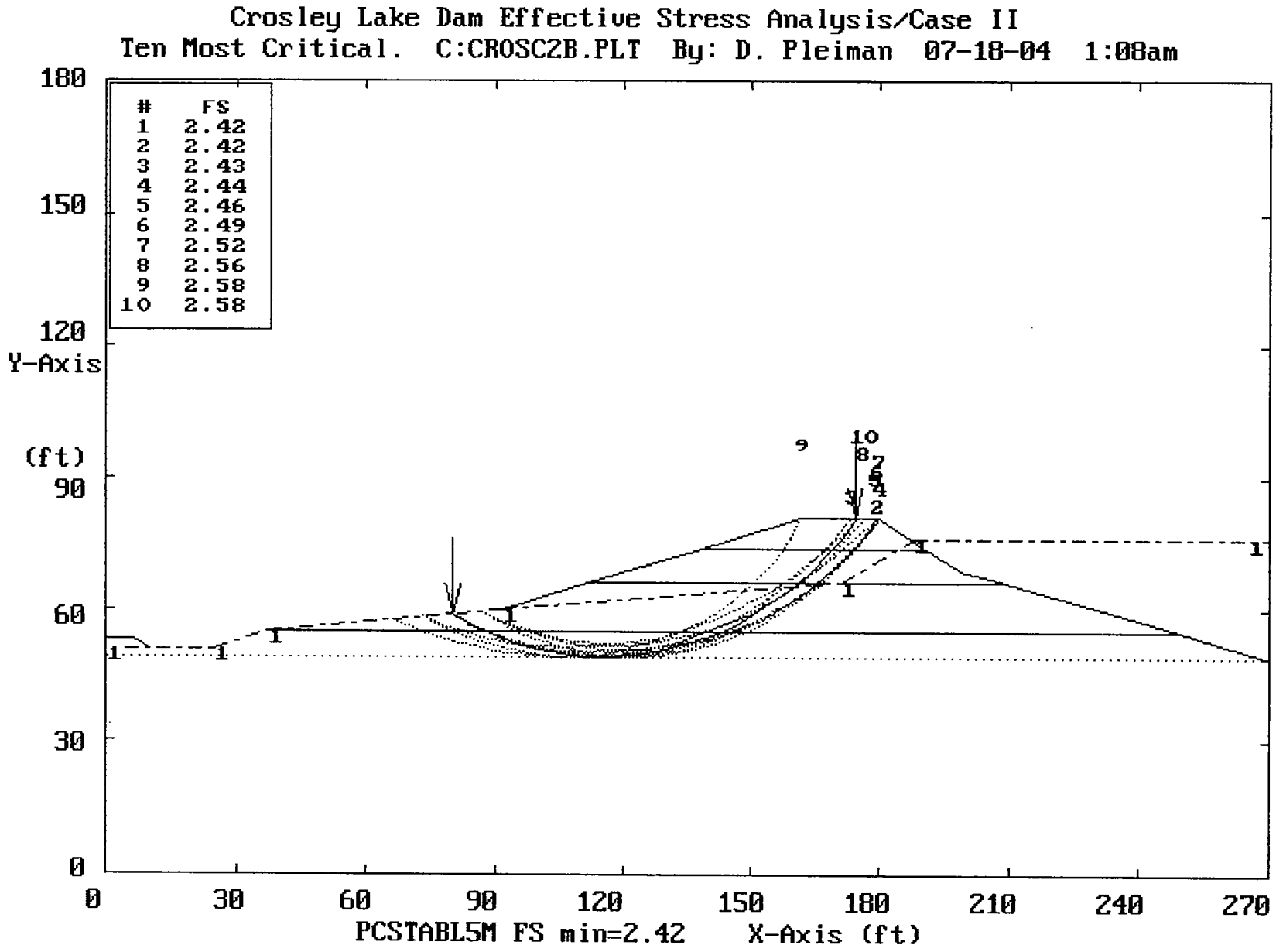
*** 1.809 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.93	55.61
2	28.37	53.32
3	33.03	51.51
4	37.86	50.22
5	42.80	49.45
6	47.80	49.23
7	52.79	49.54
8	57.72	50.38
9	62.53	51.75
10	67.16	53.64
11	71.56	56.00
12	75.68	58.83
13	79.48	62.09
14	82.90	65.74
15	85.91	69.73
16	88.47	74.03
17	90.55	78.57
18	91.36	81.00

Circle Center At X = 47.4 ; Y = 95.5 and Radius, 46.3

*** 1.810 ***


Crosley Lake Dam Effective Stress Analysis/Case II
Ten Most Critical. C:CROSC2B.PLT By: D. Pleiman 07-18-04 1:08am
FS
1 2.42
2 2.42
3 2.43
4 2.44
5 2.46
6 2.49
7 2.52
8 2.56
9 2.58
10 2.58
180
150
120
Y-Axis
(ft)
90
60
30
0
0
30
60
90
120
150
180
210
240
270
PCSTABL5M FS min=2.42
X-Axis (ft)

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 07-02-04
Time of Run: 2:15pm
Run By: D. Pleiman
Input Data Filename: P:CROSC2B
Output Filename: P:CROSC2B.OUT
Plotted Output Filename: P:CROSC2B.PLT

PROBLEM DESCRIPTION Crosley Lake Dam
Effective Stress Analysis/Case II

BOUNDARY COORDINATES

14 Top Boundaries
17 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	53.00	6.00	53.00	4
2	6.00	53.00	10.00	51.00	4
3	10.00	51.00	25.00	51.00	4
4	25.00	51.00	37.00	55.00	4
5	37.00	55.00	92.00	60.00	3
6	92.00	60.00	112.10	66.00	3
7	112.10	66.00	138.70	74.00	2
8	138.70	74.00	162.00	81.00	1
9	162.00	81.00	180.00	81.00	1
10	180.00	81.00	191.10	74.00	1
11	191.10	74.00	199.00	69.00	2
12	199.00	69.00	209.90	66.00	2
13	209.90	66.00	250.00	55.00	3
14	250.00	55.00	270.00	49.00	4
15	138.70	74.00	191.10	74.00	2
16	112.10	66.00	209.90	66.00	3
17	37.00	55.00	250.00	55.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	102.0	122.0	400.0	21.0	.00	.0	1
2	105.0	130.0	450.0	22.0	.00	.0	1
3	105.0	128.0	400.0	18.0	.00	.0	1
4	100.0	125.0	350.0	17.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 7 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	51.00
2	25.00	51.00
3	37.00	55.00
4	92.00	60.00
5	171.00	66.00
6	187.90	76.00
7	270.00	76.00

Searching Routine Will Be Limited To An Area Defined By 1 Boundaries
Of Which The First 1 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	49.00	270.00	49.00

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

289 Trial Surfaces Have Been Generated.

17 Surfaces Initiate From Each Of 17 Points Equally Spaced
Along The Ground Surface Between X = 25.00 ft.
and X = 135.00 ft.

Each Surface Terminates Between X = 140.00 ft.
and X = 180.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	58.91
2	84.41	56.55
3	88.97	54.51

4	93.67	52.79
5	98.48	51.41
6	103.37	50.38
7	108.32	49.70
8	113.31	49.37
9	118.31	49.39
10	123.30	49.77
11	128.24	50.50
12	133.12	51.58
13	137.92	53.00
14	142.60	54.76
15	147.14	56.85
16	151.53	59.25
17	155.73	61.96
18	159.73	64.96
19	163.51	68.23
20	167.04	71.77
21	170.32	75.54
22	173.32	79.54
23	174.26	81.00

Circle Center At X = 115.5 ; Y = 119.8 and Radius, 70.5

*** **2.419** ***

Individual data on the 31 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	4.4	778.4	.0	429.1	.0	.0	.0	.0	.0
2	3.5	1633.6	.0	869.6	.0	.0	.0	.0	.0
3	1.1	694.9	.0	370.4	.0	.0	.0	.0	.0
4	3.0	2279.6	.0	1183.9	.0	.0	.0	.0	.0
5	1.7	1510.4	.0	770.1	.0	.0	.0	.0	.0
6	4.8	5462.1	.0	2553.1	.0	.0	.0	.0	.0
7	4.9	7080.6	.0	3042.5	.0	.0	.0	.0	.0
8	5.0	8506.3	.0	3425.7	.0	.0	.0	.0	.0
9	3.8	7257.2	.0	2783.3	.0	.0	.0	.0	.0
10	1.2	2447.6	.0	917.6	.0	.0	.0	.0	.0
11	5.0	10652.1	.0	3866.6	.0	.0	.0	.0	.0
12	5.0	11325.9	.0	3922.0	.0	.0	.0	.0	.0
13	4.9	11712.3	.0	3866.8	.0	.0	.0	.0	.0
14	4.9	11807.5	.0	3701.4	.0	.0	.0	.0	.0
15	4.8	11616.2	.0	3426.4	.0	.0	.0	.0	.0
16	.8	1886.5	.0	539.6	.0	.0	.0	.0	.0
17	3.9	9257.4	.0	2503.8	.0	.0	.0	.0	.0
18	.5	1212.8	.0	318.6	.0	.0	.0	.0	.0
19	4.0	9182.6	.0	2235.6	.0	.0	.0	.0	.0
20	4.4	9405.8	.0	1961.3	.0	.0	.0	.0	.0
21	4.2	8227.0	.0	1267.7	.0	.0	.0	.0	.0
22	4.0	6901.6	.0	476.9	.0	.0	.0	.0	.0
23	.2	372.5	.0	1.8	.0	.0	.0	.0	.0
24	1.0	1499.1	.0	.0	.0	.0	.0	.0	.0
25	1.1	1591.7	.0	.0	.0	.0	.0	.0	.0
26	1.5	2092.9	.0	.0	.0	.0	.0	.0	.0

27	3.5	4009.9	.0	.0	.0	.0	.0	.0	.0
28	1.9	1609.5	.0	.0	.0	.0	.0	.0	.0
29	1.3	851.5	.0	.0	.0	.0	.0	.0	.0
30	3.0	1057.8	.0	.0	.0	.0	.0	.0	.0
31	.9	69.7	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	58.91
2	84.44	56.60
3	89.02	54.59
4	93.72	52.89
5	98.52	51.50
6	103.40	50.42
7	108.34	49.66
8	113.32	49.23
9	118.32	49.13
10	123.32	49.36
11	128.29	49.91
12	133.21	50.79
13	138.07	51.98
14	142.83	53.50
15	147.49	55.32
16	152.02	57.44
17	156.39	59.85
18	160.61	62.55
19	164.63	65.51
20	168.45	68.74
21	172.06	72.20
22	175.43	75.90
23	178.55	79.80
24	179.38	81.00

Circle Center At X = 117.4 ; Y = 125.4 and Radius, 76.2

*** 2.420 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	73.13	58.28
2	77.61	56.07
3	82.22	54.15
4	86.95	52.52
5	91.77	51.20
6	96.67	50.19
7	101.62	49.50
8	106.61	49.12
9	111.61	49.06
10	116.60	49.32
11	121.57	49.91
12	126.49	50.80

13	131.34	52.01
14	136.10	53.53
15	140.76	55.34
16	145.29	57.45
17	149.68	59.85
18	153.91	62.52
19	157.96	65.46
20	161.81	68.65
21	165.45	72.08
22	168.86	75.73
23	172.03	79.59
24	173.05	81.00

Circle Center At X = 110.0 ; Y = 127.2 and Radius, 78.2

*** 2.428 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	58.91
2	84.48	56.70
3	89.10	54.77
4	93.83	53.14
5	98.65	51.82
6	103.54	50.80
7	108.49	50.10
8	113.48	49.71
9	118.48	49.64
10	123.47	49.89
11	128.44	50.46
12	133.36	51.33
13	138.22	52.52
14	142.99	54.02
15	147.66	55.81
16	152.20	57.90
17	156.60	60.27
18	160.85	62.91
19	164.91	65.82
20	168.79	68.98
21	172.45	72.38
22	175.90	76.01
23	179.10	79.85
24	179.95	81.00

Circle Center At X = 117.1 ; Y = 128.3 and Radius, 78.7

*** 2.443 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.88	59.53

2	91.20	57.02
3	95.70	54.84
4	100.35	53.01
5	105.13	51.53
6	110.00	50.42
7	114.95	49.67
8	119.93	49.31
9	124.93	49.31
10	129.92	49.70
11	134.86	50.46
12	139.73	51.59
13	144.50	53.09
14	149.14	54.94
15	153.64	57.14
16	157.95	59.67
17	162.06	62.51
18	165.94	65.66
19	169.58	69.09
20	172.95	72.79
21	176.02	76.73
22	178.80	80.89
23	178.86	81.00

Circle Center At X = 122.3 ; Y = 115.5 and Radius, 66.3

*** 2.457 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.25	57.66
2	70.88	55.77
3	75.60	54.11
4	80.39	52.70
5	85.25	51.52
6	90.17	50.59
7	95.12	49.91
8	100.10	49.48
9	105.10	49.29
10	110.10	49.36
11	115.09	49.68
12	120.05	50.25
13	124.99	51.07
14	129.87	52.13
15	134.70	53.44
16	139.45	54.99
17	144.12	56.78
18	148.70	58.79
19	153.17	61.04
20	157.52	63.50
21	161.74	66.18
22	165.82	69.07
23	169.75	72.16
24	173.52	75.44
25	177.12	78.91

26	179.08	81.00

Circle Center At X = 106.2 ; Y = 148.9 and Radius, 99.6

*** 2.491 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.88	59.53
2	91.36	57.32
3	95.98	55.42
4	100.73	53.85
5	105.57	52.60
6	110.49	51.70
7	115.46	51.13
8	120.45	50.91
9	125.45	51.03
10	130.43	51.50
11	135.36	52.31
12	140.23	53.46
13	145.00	54.94
14	149.67	56.75
15	154.19	58.87
16	158.56	61.31
17	162.75	64.03
18	166.74	67.04
19	170.52	70.32
20	174.06	73.85
21	177.35	77.62
22	179.91	81.00

Circle Center At X = 121.2 ; Y = 123.3 and Radius, 72.4

*** 2.517 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.88	59.53
2	91.43	57.48
3	96.12	55.74
4	100.92	54.34
5	105.81	53.27
6	110.75	52.55
7	115.74	52.17
8	120.74	52.14
9	125.73	52.45
10	130.68	53.12
11	135.58	54.12
12	140.40	55.47
13	145.11	57.15
14	149.69	59.15

15	154.12	61.46
16	158.38	64.08
17	162.45	66.99
18	166.30	70.17
19	169.93	73.62
20	173.30	77.30
21	176.24	81.00

Circle Center At X = 118.7 ; Y = 123.9 and Radius, 71.8

*** 2.561 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	58.91
2	84.35	56.45
3	88.90	54.37
4	93.61	52.70
5	98.45	51.43
6	103.38	50.59
7	108.36	50.18
8	113.36	50.19
9	118.34	50.64
10	123.26	51.52
11	128.09	52.82
12	132.79	54.53
13	137.32	56.64
14	141.66	59.13
15	145.76	61.99
16	149.60	65.19
17	153.15	68.71
18	156.39	72.52
19	159.28	76.60
20	161.81	80.91
21	161.83	80.95

Circle Center At X = 110.7 ; Y = 108.0 and Radius, 57.9

*** 2.578 ***

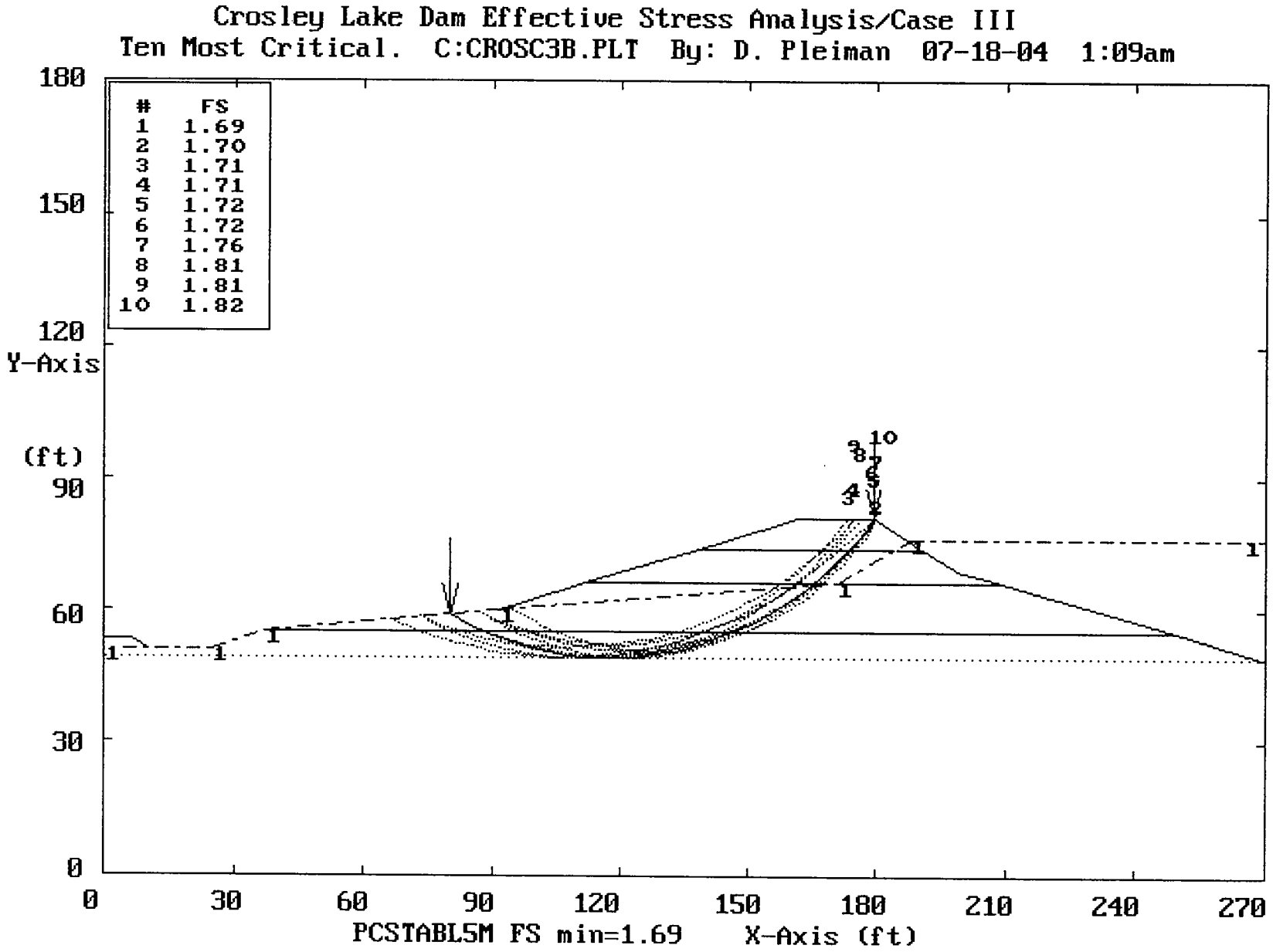
Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	73.13	58.28
2	77.80	56.50
3	82.56	54.98
4	87.40	53.73
5	92.30	52.74
6	97.25	52.02
7	102.23	51.58
8	107.23	51.41
9	112.23	51.51

10	117.21	51.89
11	122.17	52.54
12	127.08	53.46
13	131.94	54.66
14	136.72	56.11
15	141.42	57.83
16	146.01	59.80
17	150.49	62.02
18	154.84	64.49
19	159.05	67.19
20	163.10	70.12
21	166.99	73.26
22	170.70	76.62
23	174.22	80.17
24	174.95	81.00

Circle Center At X = 107.8 ; Y = 142.3 and Radius, 90.9

*** 2.584 ***


Crosley Lake Dam Effective Stress Analysis/Case III
Ten Most Critical. C:CROSC3B.PLT By: D. Pleiman 07-18-04 1:09am
FS
1 1.69
2 1.70
3 1.71
4 1.71
5 1.72
6 1.72
7 1.76
8 1.81
9 1.81
10 1.82
180
150
120
Y-Axis
(ft)
90
60
30
0
0
30
60
90
120
150
180
210
240
270
PCSTABL5M FS min=1.69
X-Axis (ft)

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	07-02-04
Time of Run:	2:25pm
Run By:	D. Pleiman
Input Data Filename:	P:CROSC3B
Output Filename:	P:CROSC3B.OUT
Plotted Output Filename:	P:CROSC3B.PLT

PROBLEM DESCRIPTION Crosley Lake Dam
Effective Stress Analysis/Case III

BOUNDARY COORDINATES

14 Top Boundaries
17 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	53.00	6.00	53.00	4
2	6.00	53.00	10.00	51.00	4
3	10.00	51.00	25.00	51.00	4
4	25.00	51.00	37.00	55.00	4
5	37.00	55.00	92.00	60.00	3
6	92.00	60.00	112.10	66.00	3
7	112.10	66.00	138.70	74.00	2
8	138.70	74.00	162.00	81.00	1
9	162.00	81.00	180.00	81.00	1
10	180.00	81.00	191.10	74.00	1
11	191.10	74.00	199.00	69.00	2
12	199.00	69.00	209.90	66.00	2
13	209.90	66.00	250.00	55.00	3
14	250.00	55.00	270.00	49.00	4
15	138.70	74.00	191.10	74.00	2
16	112.10	66.00	209.90	66.00	3
17	37.00	55.00	250.00	55.00	4

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	102.0	122.0	400.0	21.0	.00	.0	1
2	105.0	130.0	450.0	22.0	.00	.0	1
3	105.0	128.0	400.0	18.0	.00	.0	1
4	100.0	125.0	350.0	17.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 7 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	51.00
2	25.00	51.00
3	37.00	55.00
4	92.00	60.00
5	171.00	66.00
6	187.90	76.00
7	270.00	76.00

A Horizontal Earthquake Loading Coefficient
Of .100 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

Searching Routine Will Be Limited To An Area Defined By 1 Boundaries
Of Which The First 1 Boundaries Will Deflect Surfaces Upward

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)
1	.00	49.00	270.00	49.00

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

289 Trial Surfaces Have Been Generated.

17 Surfaces Initiate From Each Of 17 Points Equally Spaced
Along The Ground Surface Between X = 25.00 ft.
and X = 135.00 ft.

Each Surface Terminates Between X = 140.00 ft.
and X = 180.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	58.91
2	84.44	56.60
3	89.02	54.59
4	93.72	52.89
5	98.52	51.50
6	103.40	50.42
7	108.34	49.66
8	113.32	49.23
9	118.32	49.13
10	123.32	49.36
11	128.29	49.91
12	133.21	50.79
13	138.07	51.98
14	142.83	53.50
15	147.49	55.32
16	152.02	57.44
17	156.39	59.85
18	160.61	62.55
19	164.63	65.51
20	168.45	68.74
21	172.06	72.20
22	175.43	75.90
23	178.55	79.80
24	179.38	81.00

Circle Center At X = 117.4 ; Y = 125.4 and Radius, 76.2

*** **1.690** ***

Individual data on the 32 slices

Slice No.	Width Ft(m)	Weight Lbs(kg)	Water Force Top Lbs(kg)	Water Force Bot Lbs(kg)	Tie Force Norm Lbs(kg)	Tie Force Tan Lbs(kg)	Earthquake Force Hor Lbs(kg)	Earthquake Force Ver Lbs(kg)	Surcharge Load Lbs(kg)
1	4.4	768.5	.0	420.8	.0	.0	76.9	.0	.0
2	3.7	1718.6	.0	911.9	.0	.0	171.9	.0	.0
3	.9	577.2	.0	306.6	.0	.0	57.7	.0	.0
4	3.0	2209.6	.0	1146.4	.0	.0	221.0	.0	.0
5	1.7	1532.2	.0	779.7	.0	.0	153.2	.0	.0
6	4.8	5410.1	.0	2526.4	.0	.0	541.0	.0	.0
7	4.9	7037.1	.0	3025.1	.0	.0	703.7	.0	.0
8	4.9	8492.3	.0	3426.0	.0	.0	849.2	.0	.0
9	3.8	7248.3	.0	2787.7	.0	.0	724.8	.0	.0
10	1.2	2497.0	.0	939.7	.0	.0	249.7	.0	.0
11	5.0	10774.9	.0	3927.9	.0	.0	1077.5	.0	.0
12	5.0	11559.3	.0	4026.8	.0	.0	1155.9	.0	.0
13	5.0	12083.9	.0	4023.6	.0	.0	1208.4	.0	.0
14	4.9	12342.1	.0	3918.2	.0	.0	1234.2	.0	.0
15	4.9	12333.8	.0	3711.2	.0	.0	1233.4	.0	.0
16	.6	1615.1	.0	473.9	.0	.0	161.5	.0	.0
17	4.1	10442.5	.0	2929.6	.0	.0	1044.3	.0	.0

18	3.8	9544.5	.0	2508.1	.0	.0	954.4	.0	.0
19	.8	1977.4	.0	488.2	.0	.0	197.7	.0	.0
20	4.5	10741.9	.0	2491.5	.0	.0	1074.2	.0	.0
21	4.4	9750.2	.0	1891.1	.0	.0	975.0	.0	.0
22	4.2	8586.6	.0	1197.8	.0	.0	858.7	.0	.0
23	1.4	2638.8	.0	237.3	.0	.0	263.9	.0	.0
24	2.6	4542.7	.0	177.2	.0	.0	454.3	.0	.0
25	.0	5.6	.0	.0	.0	.0	.6	.0	.0
26	.6	905.8	.0	.0	.0	.0	90.6	.0	.0
27	3.2	4577.7	.0	.0	.0	.0	457.8	.0	.0
28	3.6	3908.8	.0	.0	.0	.0	390.9	.0	.0
29	1.6	1324.9	.0	.0	.0	.0	132.5	.0	.0
30	1.7	1067.7	.0	.0	.0	.0	106.8	.0	.0
31	3.1	1002.1	.0	.0	.0	.0	100.2	.0	.0
32	.8	50.7	.0	.0	.0	.0	5.1	.0	.0

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	58.91
2	84.48	56.70
3	89.10	54.77
4	93.83	53.14
5	98.65	51.82
6	103.54	50.80
7	108.49	50.10
8	113.48	49.71
9	118.48	49.64
10	123.47	49.89
11	128.44	50.46
12	133.36	51.33
13	138.22	52.52
14	142.99	54.02
15	147.66	55.81
16	152.20	57.90
17	156.60	60.27
18	160.85	62.91
19	164.91	65.82
20	168.79	68.98
21	172.45	72.38
22	175.90	76.01
23	179.10	79.85
24	179.95	81.00

Circle Center At X = 117.1 ; Y = 128.3 and Radius, 78.7

*** 1.704 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	73.13	58.28
2	77.61	56.07

3	82.22	54.15
4	86.95	52.52
5	91.77	51.20
6	96.67	50.19
7	101.62	49.50
8	106.61	49.12
9	111.61	49.06
10	116.60	49.32
11	121.57	49.91
12	126.49	50.80
13	131.34	52.01
14	136.10	53.53
15	140.76	55.34
16	145.29	57.45
17	149.68	59.85
18	153.91	62.52
19	157.96	65.46
20	161.81	68.65
21	165.45	72.08
22	168.86	75.73
23	172.03	79.59
24	173.05	81.00

Circle Center At X = 110.0 ; Y = 127.2 and Radius, 78.2

*** 1.705 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.00	58.91
2	84.41	56.55
3	88.97	54.51
4	93.67	52.79
5	98.48	51.41
6	103.37	50.38
7	108.32	49.70
8	113.31	49.37
9	118.31	49.39
10	123.30	49.77
11	128.24	50.50
12	133.12	51.58
13	137.92	53.00
14	142.60	54.76
15	147.14	56.85
16	151.53	59.25
17	155.73	61.96
18	159.73	64.96
19	163.51	68.23
20	167.04	71.77
21	170.32	75.54
22	173.32	79.54
23	174.26	81.00

Circle Center At X = 115.5 ; Y = 119.8 and Radius, 70.5

*** 1.707 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.25	57.66
2	70.88	55.77
3	75.60	54.11
4	80.39	52.70
5	85.25	51.52
6	90.17	50.59
7	95.12	49.91
8	100.10	49.48
9	105.10	49.29
10	110.10	49.36
11	115.09	49.68
12	120.05	50.25
13	124.99	51.07
14	129.87	52.13
15	134.70	53.44
16	139.45	54.99
17	144.12	56.78
18	148.70	58.79
19	153.17	61.04
20	157.52	63.50
21	161.74	66.18
22	165.82	69.07
23	169.75	72.16
24	173.52	75.44
25	177.12	78.91
26	179.08	81.00

Circle Center At X = 106.2 ; Y = 148.9 and Radius, 99.6

*** 1.720 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.88	59.53
2	91.20	57.02
3	95.70	54.84
4	100.35	53.01
5	105.13	51.53
6	110.00	50.42
7	114.95	49.67
8	119.93	49.31
9	124.93	49.31
10	129.92	49.70
11	134.86	50.46
12	139.73	51.59
13	144.50	53.09
14	149.14	54.94

15	153.64	57.14
16	157.95	59.67
17	162.06	62.51
18	165.94	65.66
19	169.58	69.09
20	172.95	72.79
21	176.02	76.73
22	178.80	80.89
23	178.86	81.00

Circle Center At X = 122.3 ; Y = 115.5 and Radius, 66.3

*** 1.722 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.88	59.53
2	91.36	57.32
3	95.98	55.42
4	100.73	53.85
5	105.57	52.60
6	110.49	51.70
7	115.46	51.13
8	120.45	50.91
9	125.45	51.03
10	130.43	51.50
11	135.36	52.31
12	140.23	53.46
13	145.00	54.94
14	149.67	56.75
15	154.19	58.87
16	158.56	61.31
17	162.75	64.03
18	166.74	67.04
19	170.52	70.32
20	174.06	73.85
21	177.35	77.62
22	179.91	81.00

Circle Center At X = 121.2 ; Y = 123.3 and Radius, 72.4

*** 1.762 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	86.88	59.53
2	91.43	57.48
3	96.12	55.74
4	100.92	54.34
5	105.81	53.27
6	110.75	52.55

7	115.74	52.17
8	120.74	52.14
9	125.73	52.45
10	130.68	53.12
11	135.58	54.12
12	140.40	55.47
13	145.11	57.15
14	149.69	59.15
15	154.12	61.46
16	158.38	64.08
17	162.45	66.99
18	166.30	70.17
19	169.93	73.62
20	173.30	77.30
21	176.24	81.00

Circle Center At X = 118.7 ; Y = 123.9 and Radius, 71.8

*** 1.812 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	73.13	58.28
2	77.80	56.50
3	82.56	54.98
4	87.40	53.73
5	92.30	52.74
6	97.25	52.02
7	102.23	51.58
8	107.23	51.41
9	112.23	51.51
10	117.21	51.89
11	122.17	52.54
12	127.08	53.46
13	131.94	54.66
14	136.72	56.11
15	141.42	57.83
16	146.01	59.80
17	150.49	62.02
18	154.84	64.49
19	159.05	67.19
20	163.10	70.12
21	166.99	73.26
22	170.70	76.62
23	174.22	80.17
24	174.95	81.00

Circle Center At X = 107.8 ; Y = 142.3 and Radius, 90.9

*** 1.814 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	93.75	60.52
2	98.05	57.98
3	102.55	55.79
4	107.21	53.98
5	112.01	52.56
6	116.90	51.53
7	121.86	50.91
8	126.86	50.69
9	131.85	50.89
10	136.82	51.49
11	141.71	52.49
12	146.51	53.89
13	151.18	55.68
14	155.69	57.85
15	160.01	60.37
16	164.10	63.24
17	167.95	66.43
18	171.52	69.93
19	174.79	73.71
20	177.75	77.74
21	179.75	81.00

Circle Center At X = 127.0 ; Y = 111.8 and Radius, 61.1

*** 1.823 ***

APPENDIX L

REFERENCES

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PART C
DETAILED SPECIFICATIONS

APPENDIX - B

IDNR CONSTRUCTION IN FLOODWAY PERMIT
APPROVAL No. FW28943

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

CERTIFICATE OF APPROVAL
CONSTRUCTION IN A FLOODWAY

APPLICATION # : FW-28943

MAILED: December 20, 2017

LAKE : Crosley Lake

APPLICANT : Indiana Department of Natural Resources
Dale Gick, PE
402 West Washington Street, Room W299
Indianapolis, IN 46204

AGENT : Commonwealth Engineers Inc
Drew Flamion
7256 Company Drive
Indianapolis, IN 46237-9212

AUTHORITY : IC 14-28-1 with 312 IAC 10

DESCRIPTION : The dam will be reconstructed to provide a uniform 12' wide crest at an elevation of 702.00' NAVD. The existing principal spillway will be upgraded and two new emergency spillways will be added. The principal spillway channel will have a reinforced concrete retaining wall and a precast block wall to direct discharges away from the dam embankment and protect the toe of the dam from eroding. Two new 40' wide trapezoidal articulated concrete block channels will engage simultaneously at an elevation of 697.70' NAVD. The emergency spillways have 3:1 side slopes and will be installed at 3:5-3.25:1 slopes. The north emergency spillway will discharge over the top of a notched area in the reinforced concrete retaining wall. The south emergency spillway discharges into 6 rows of A-jacks energy dissipators and 42" thick riprap outlet protection. Additionally, the dam will be provided with an 8" lake drawdown facility. The upstream embankment will be stabilized with riprap on filter fabric to a uniform 2:1 slope or flatter. Filter drains will be installed with a length of 150' and a diameter of 8". Additional work includes brush and tree removal and grout injection at the principal spillway crest. The normal pool will remain at an elevation of 695.65' NAVD. Details of the project are contained in information and plans received at the Division of Water on June 1, 2017, October 27, 2017, November 6, 2017, November 15, 2017, November 22, 2017 and November 30, 2017.

LOCATION : Crosley Lake Dam near Vernon, Vernon Township, Jennings County
Section 13, T 6N, R 8E, Vernon Quadrangle
UTM Coordinates: Downstream 4312816 North, 621994 East

APPROVED BY : 

James J. Hebenstreit, PE, Assistant Director
Division of Water

APPROVED ON : December 20, 2017

Included: Notice Of Right To Administrative Review - General Conditions - Special Conditions - Service List

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

CERTIFICATE OF APPROVAL
CONSTRUCTION IN A FLOODWAY

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

NOTICE OF RIGHT TO ADMINISTRATIVE REVIEW

APPLICATION #: FW- 28943

This signed document constitutes the issuance of a permit by the Department of Natural Resources, subject to the conditions and limitations stated on the pages entitled "General Conditions" and "Special Conditions".

The permit or any of the conditions or limitations which it contains may be appealed by applying for administrative review. Such review is governed by the Administrative Orders and Procedures Act, IC 4-21.5, and the Department's rules pertaining to adjudicative proceedings, 312 IAC 3-1.

In order to obtain a review, a written petition must be filed with the Division of Hearings within 18 days of the mailing date of this notice. The petition should be addressed to:

Natural Resources Commission
Division of Hearings
Indiana Government Center North, Room N103
100 North Senate Avenue
Indianapolis, Indiana 46204-2200

The petition must contain specific reasons for the appeal and indicate the portion or portions of the permit to which the appeal pertains.

If an appeal is filed, the final agency determination will be made by the Natural Resources Commission following a legal proceeding conducted before an Administrative Law Judge. The Department of Natural Resources will be represented by legal counsel.

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

GENERAL CONDITIONS

APPLICATION #: FW- 28943

(1) If any archaeological artifacts or human remains are uncovered during construction, federal law and regulations (16 USC 470, et seq.; 36 CFR 800.11, et al) and State Law (IC 14-21-1) require that work must stop and that the discovery must be reported to the Division of Historic Preservation and Archaeology within 2 business days.

Division of Historic Preservation and Archaeology
Room W274
402 West Washington Street
Indianapolis, IN 46204

Telephone: (317) 232-1646, FAX: (317) 232-8036

(2) This permit must be posted and maintained at the project site until the project is completed.

(3) This permit does not relieve the permittee of the responsibility for obtaining additional permits, approvals, easements, etc. as required by other federal, state, or local regulatory agencies. These agencies include, but are not limited to:

Agency	Telephone Number
Jennings County Drainage Board	(812) 346-2045
US Army Corps of Engineers	(502) 315-6686
Indiana Department of Environmental Management	(317) 233-8488 or (800) 451-6027
Local city or county planning or zoning commission	

(4) This permit must not be construed as a waiver of any local ordinance or other state or federal law.

(5) This permit does not relieve the permittee of any liability for the effects which the project may have upon the safety of the life or property of others.

(6) This permit may be revoked by the Department of Natural Resources for violation of any condition, limitation or applicable statute or rule.

(7) This permit shall not be assignable or transferable without the prior written approval of the Department of Natural Resources. To initiate a transfer contact:

Director
Division of Water
Room W264
402 West Washington Street
Indianapolis, IN 46204

Telephone: (317) 232-4160, Toll Free: (877) 928-3755
FAX: (317) 233-4579

(8) The Department of Natural Resources shall have the right to enter upon the site of the permitted activity for the purpose of inspecting the authorized work.

(9) The receipt and acceptance of this permit by the applicant or authorized agent shall be considered as acceptance of the conditions and limitations stated on the pages entitled "General Conditions" and "Special Conditions".

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

SPECIAL CONDITIONS

APPLICATION #: FW- 28943

PERMIT VALIDITY : This permit is valid for 24 months from the "Approved On" date shown on the first page. If construction work in the floodway has not been completed by December 20, 2019 the permit will become void. This permit may be renewed one (1) time if a written request is received by DNR, Division of Water prior to December 20, 2019. Thereafter the permit will become void and a new permit will be required in order to continue work on the project.

This permit becomes effective 18 days after the "MAILED" date shown on the first page. If both a petition for review and a petition for a stay of effectiveness are filed before this permit becomes effective, any part of the permit that is within the scope of the petition for stay is stayed for an additional 15 days.

CONFORMANCE : Other than those measures necessary to satisfy the "General Conditions" and "Special Conditions", the project must conform to the information received by the Department of Natural Resources on: June 1, 2017, October 27, 2017, November 6, 2017, November 15, 2017, November 22, 2017 and November 30, 2017. Any deviation from the information must receive the prior written approval of the Department.

Number	Special Condition
(1)	submit as-built plans, signed and stamped by a Professional Engineer, certifying that the dam was constructed in accordance with the approved design plans to the Division of Water within 6 months of project completion
(2)	revegetate all bare and disturbed areas in the floodway with a mixture of native grasses, sedges, wildflowers, and outside the woody vegetation free zone include native hardwood trees and shrubs as soon as possible upon completion; do not use any varieties of Tall Fescue or other non-native plants (e.g. crown-vetch)
(3)	minimize and contain within the project limits inchannel disturbance and the clearing of trees and brush
(4)	do not work in the waterway from April 1 through June 30 without the prior written approval of the Division of Fish and Wildlife
(5)	do not cut any trees suitable for Indiana bat or Northern Long-eared bat roosting (greater than 3 inches dbh, living or dead, with loose hanging bark, or with cracks, crevices, or cavities) from April 1 through September 30
(6)	use minimum average 6 inch graded riprap stone extended below the normal water level to provide habitat for aquatic organisms in the voids
(7)	appropriately designed measures for controlling erosion and sediment must be implemented to prevent sediment from entering the stream or leaving the construction site; maintain these measures until construction is complete and all disturbed areas are stabilized
(8)	seed and protect disturbed stream banks and slopes that are 3:1 or steeper with biodegradable heavy-duty erosion control blankets (follow manufacturer's recommendation for installation); seed and apply mulch on all other disturbed areas
(9)	keep all splilway waterway openings within the scope of this project free of debris and sediment at all times

STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES

SERVICE LIST

APPLICATION #: FW- 28943

Indiana Department of Natural Resources
Dale Gick, PE
402 West Washington Street, Room W299
Indianapolis, IN 46204

Commonwealth Engineers Inc
Drew Flamion
7256 Company Drive
Indianapolis, IN 46237-9212

Department of Natural Resources
Division of Law Enforcement
District 9 Headquarters
1387 East US Highway 50
Versailles, IN 47042

Jennings County Drainage Board
County Surveyor
PO Box 365
North Vernon, IN 47265

Jennings County SWCD
Robert Steiner
2600 North State Highway 7
North Vernon, IN 47265

Marie Shepherd
200 East Brown Street
PO Box 400
Vernon, IN 47282

US Army Corps of Engineers
Louisville District
PO Box 59
Louisville, KY 40201-0059

Staff Assignment:

Administrative	: Justin Eshelman
Technical	: Justin Eshelman
Environmental	: J. Matthew Buffington
Fish and Wildlife	: Daniel Gautier
Engineering	: Adam M Bales

PART C
DETAILED SPECIFICATIONS

APPENDIX - B

IDEM SECTION 401 WATER QUALITY
CERTIFICATION
IDEM No. 2017-487-40-ALF-A

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
We Protect Hoosiers and Our Environment.
100 N. Senate Avenue • Indianapolis, IN 46204
(800) 451-6027 • (317) 232-8603 • www.idem.IN.gov

Eric J. Holcomb
Governor

Bruno Pigott
Commissioner

September 5, 2017

VIA CERTIFIED MAIL HAND DELIVERY

Mr. Dale Gick
Indiana Department of Natural Resource
402 W Washington St. W264
Indianapolis, IN 46204

Dear Mr. Gick:

Re: Section 401 Water Quality Certification
Project: Crosley Lake Dam
Improvements
IDEM No.: 2017-487-40-ALF-A
County: Jennings

The Office of Water Quality has reviewed your application for Section 401 Water Quality Certification dated June 27, 2017, and received July 5, 2017. According to the application, you are proposing upgrades to the dam and spillway of Crosley Lake to meet current IDNR design requirements. The proposed upgrades to the principal spillway include a reinforced concrete training wall and large precast concrete block wall to protect the toe of the dam, grouted riprap to protect the spillway channel, lean concrete installation in large rock fissures, and removal of existing loose rock. The work will impact approximately 300 linear feet of the principal spillway. The improvements also include placement of riprap on filter fabric on the upstream dam embankment, and installation of a lake drawdown facility including an 8" suction line, concrete anchoring devices, and riprap. The proposed impacts to Crosley Lake will result in 0.10 acre of open water fill. Disturbed areas along the principal spillway and off the dam embankment will be re-vegetated with a native seed mixture including a flowering component. The project is located within the Crosley State Fish and Wildlife property approximately 0.6 miles from the IDNR entrance, on the south side of Crosley Lake in Section 24, Township 6 North, Range 8 East, Vernon USGS Quad, in Jennings County.

Based on available information, it is the judgment of this office that the proposed project will comply with the applicable provisions of 327 IAC 2 and Sections 301, 302, 303, 306, and 307 of the Clean Water Act if you comply with the conditions set forth below. Therefore, subject to the following conditions, the Indiana Department of

Environmental Management (IDEM) hereby grants Section 401 Water Quality Certification for the project described in your application received July 5, 2017, and modifications received July 24, and 26, 2017. Any changes in project design or scope not detailed in the application described above or modified by the conditions below are not authorized by this certification.

CONDITIONS OF THE SECTION 401 WATER QUALITY CERTIFICATION:

You shall:

1) Allow the commissioner or an authorized representative of the commissioner (including an authorized contractor), upon the presentation of credentials:

   a) to enter your property, including impact and mitigation site(s);
   b) to have access to and copy at reasonable times any records that must be kept under the conditions of this certification;
   c) to inspect, at reasonable times, any monitoring or operational equipment or method; collection, treatment, pollution management or discharge facility or device; practices required by this certification; and any mitigation site;
   d) to sample or monitor any discharge of pollutants or any mitigation site.

2) Complete all approved discharges no later than two (2) years of the date of issuance of this Section 401 Water Quality Certification. You may request a one (1) year extension to the Section 401 Water Quality Certification by submitting a written request ninety (90) days prior to the deadline stated above. The written request shall contain an account of which discharges and mitigation have been completed and list the reasons an extension is requested.

3) Deposit any dredged material in a contained upland disposal area to prevent sediment runoff to any waterbody.

4) Install erosion control methods prior to any soil disturbance to prevent soil from leaving the construction site. Appropriate erosion control methods include, but are not limited to, straw bale barriers, silt fencing, erosion control blankets, phased construction sequencing, and earthen berms. Monitor and maintain erosion control structures and devices regularly, especially after rain events, until all soils disturbed by construction activities have been permanently stabilized.

5) Stabilize and seed all disturbed areas immediately after work is completed. Use the native seed mixture with flowering component in the disturbed areas along the spillway and off of the dam embankment, as described in email correspondence received July 24, and 26, 2017, from Commonwealth Engineers, Inc.

6) Submit an as-built report that includes photo documentation of the native herbaceous buffer within 6 months of the completion of the dam improvement project.

7) To protect any habitat suitable for the federally endangered Indiana Bat (*Mytosis sodalis*) and Northern Long Eared Bat (*Myotis septentrionalis),* allow no tree clearing within the project boundaries during April 1 through September 30.

8) Allow no construction equipment, temporary run-arounds, coffer dams, temporary causeways, temporary crossings, or other such structures to enter or be constructed within any waterbody, unless specifically stated, depicted, or detailed in the application.

9) Remove any temporary causeway or other approved temporary structures used to facilitate construction or access upon completion of construction activities.

This certification does not relieve you of the responsibility of obtaining any other permits or authorizations that may be required for this project or related activities from IDEM or any other agency or person. You may wish to contact the Indiana Department of Natural Resources at 317-232-4160 (toll free at 877-928-3755) concerning the possible requirement of natural freshwater lake or floodway permits. In addition, you may wish to contact IDEM's Storm Water Permits Section at 317-233-1864 concerning the possible need for a 327 IAC 15-5 (Rule 5) permit if you plan to disturb greater than one (1) acre of soil during construction.

This certification does not:

(1) authorize impacts or activities outside the scope of this certification;
(2) authorize any injury to persons or private property or invasion of other private rights, or any infringement of federal, state or local laws or regulations;
(3) convey any property rights of any sort, or any exclusive privileges;
(4) preempt any duty to obtain federal, state or local permits or authorizations required by law for the execution of the project or related activities; or
(5) authorize changes in the plan design detailed in the application.

Failure to comply with the terms and conditions of this Section 401 Water Quality Certification may result in enforcement action against you. If an enforcement action is pursued, you could be assessed up to $25,000 per day in civil penalties. You may also be subject to criminal liability if it is determined that the Section 401 Water Quality Certification was violated willfully or negligently.

This certification is effective eighteen (18) days from the mailing of this notice unless a petition for review and a petition for stay of effectiveness are filed within this 18-day period. If a petition for review and a petition for stay of effectiveness are filed within this period, any part of the certification within the scope of the petition for stay is

stayed for fifteen (15) days, unless or until an Environmental Law Judge further stays the certification in whole or in part.

This decision may be appealed in accordance with IC 4-21.5, the Administrative Orders and Procedures Act. The steps that must be followed to qualify for review are:

1) You must petition for review in writing that states facts demonstrating that you are either the person to whom this decision is directed, a person who is aggrieved or adversely affected by the decision, or a person entitled to review under any law.

2) You must file the petition for review with the Office of Environmental Adjudication (OEA) at the following address:

   Office of Environmental Adjudication
   100 North Senate Avenue
   IGCN Room N501
   Indianapolis, IN 46204

3) You must file the petition within eighteen (18) days of the mailing date of this decision. If the eighteenth day falls on a Saturday, Sunday, legal holiday, or other day that the OEA offices are closed during regular business hours, you may file the petition the next day that the OEA offices are open during regular business hours. The petition is deemed filed on the earliest of the following dates: the date it is personally delivered to OEA; the date that the envelope containing the petition is postmarked if it is mailed by United States mail; or, the date it is shown to have been deposited with a private carrier on the private carrier's receipt, if sent by private carrier.

Identifying the certification, decision, or other order for which you seek review by number, name of the applicant, location, or date of this notice will expedite review of the petition.

Note that if a petition for review is granted pursuant to IC 4-21.5-3-7, the petitioner will, and any other person may, obtain notice of any prehearing conferences, preliminary hearings, hearings, stays, and any orders disposing of the proceedings by requesting copies of such notices from OEA.

If you have procedural questions regarding filing a petition for review you may contact the Office of Environmental Adjudication at 317-232-8591.

If you have any questions about this certification, please contact Amari Farren, Project Manager, by phone at 317-234-6351, or by e-mail at afarren@idem.in.gov or you may contact the Office of Water Quality through the IDEM Environmental Helpline (1-800-451-6027).

Sincerely,

Brian Wolff, Branch Chief
Surface Water, Operations, and Enforcement
Office of Water Quality

cc: Michael Davis, USACE- Louisville
Marissa Reed, USFWS
Danny Gautier, IDNR
Drew Flamion, Commonwealth Engineers, Inc.

PART C
DETAILED SPECIFICATIONS

APPENDIX - B

US ACOE
SECTION 404 OF THE CLEAN WATER ACT

ID No. LRL-2017-776-jlt

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
P.O. BOX 59
LOUISVILLE KY 40201-0059
FAX: (502) 315-6677

January 26, 2018

Regulatory Division
North Branch
ID No. LRL-2017-776-jlt

Dale Gick
Indiana Department of Natural Resources
402 West Washington Street, Room W264
Indianapolis, Indiana 46204

Dear Mr. Gick,

This is in response to your request for authorization received July 7, 2017, for a Department of the Army Permit to conduct maintenance activities and improvements to an existing lake dam. The impacts to Crosley Lake and an unnamed tributary to Vernon Fork Muscatatuck River would be 300 linear feet over an area of 0.1 acre. The project is identified as the Crosley Lake Dam Improvements Project. The project is located at the Crosley Lake Dam, Vernon, Jennings County, Indiana (Latitude: 38.955556°; Longitude: -85.591944°). The information supplied by you was reviewed to determine whether a Department of the Army (DA) permit will be required under the provisions of Section 10 of the Rivers and Harbors Act of 1899 or/and Section 404 of the Clean Water Act.

Your project is considered maintenance of a structure which has been previously authorized, either by DA Permit or by having been constructed prior to current Federal laws. Therefore, the project is authorized under the provisions of 33 CFR 330 Nationwide Permit (NWP) No. 3, Maintenance, as published in the Federal Register January 6, 2017. Under the provisions of this authorization you must comply with the enclosed Terms and General Conditions for Nationwide Permit No. 3. You must also comply with the enclosed Individual Water Quality Certification (WQC) dated September 5, 2017, issued by the Indiana Department of Environmental Management (IDEM).

This verification is valid until March 18, 2022. The enclosed Compliance Certification must be submitted to the District Engineer within 30 days of completion of the authorized activity or the implementation of any required compensatory mitigation, whichever occurs later. Note that we also perform periodic inspections to ensure compliance with our permit conditions and applicable Federal laws. A copy of this letter will be forwarded to your agent and to the IDEM.

If you have any questions, please contact this office by writing to the above address, ATTN: CELRL-RDN, or by calling me at (502) 315-6710. All correspondence pertaining to this matter should refer to our ID No. LRL-2017-776-jlt.

Sincerely,

Original Signed

Jim Thomas
Project Manager, North Branch
Regulatory Division

PART C
DETAILED SPECIFICATIONS

APPENDIX - B

IDEM NPDES 327 IAC 15-5

NOTICE OF SUFFICIENCY INR10P418

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
We Protect Hoosiers and Our Environment.
100 N. Senate Avenue • Indianapolis, IN 46204
(800) 451-6027 • (317) 232-8603 • www.idem.IN.gov

Eric J. Holcomb **Bruno Pigott**

September 8, 2017

65-42 WQS/RJB
Dale A. Gick
State of Indiana - via Department of Natural Resources
402 W Washington St W264
Indianapolis, IN 46204

Dear Mr Gick:

Re: **Notice of Sufficiency**
INR10P418
Crosley Lake Dam Improvements Project

Jennings County

The Notice of Intent (NOI) letter submitted for the project referenced above has been reviewed by the Indiana Department of Environmental Management (IDEM) to determine compliance with the requirements of the National Pollutant Discharge Elimination System (NPDES) General Permit for storm water discharge associated with construction activity (327 IAC 15-5). The items contained in the NOI are sufficient. This letter is being issued for 327 IAC 15-5 and does not constitute approval to conduct activities that are related to other local, state, or federal permits.

An NPDES general permit identification number has been assigned to this project. This number and the above referenced project name should be included on any correspondence or amended NOI information submitted to IDEM pertaining to this project. The general permit number assigned to this project is: **INR10P418**.

It is important that all activities associated with your site are in compliance with the requirements of 327 IAC 15-5 (Rule 5) and any local storm water permits. In accordance with 327 IAC 15-5-10, you are required to implement your construction plan, implement and maintain all storm water quality measures, and monitor the effectiveness of the storm water quality measures until the project is complete.

All Notices of Intent submitted for Rule 5 NPDES general permit coverage are automatically limited to a maximum term length of 5 years (327 IAC 15-5-12). The General Permit issued for the project referenced above will expire on **8/3/2022**. If this project requires coverage beyond this date the applicant must reapply for a new permit 90 days prior to the expiration date.

Upon completion of the project, you are required to terminate the permit. Information for termination can be found in 327 IAC 15-5-8. To expedite this process, it

is recommended that you first receive verification from the plan review entity prior to submittal of the Notice of Termination.

Any questions regarding this letter or the enclosed materials should be directed to the Storm Water Permits Coordinator at 317-233-1864 or 800-451-6027, ext. 3-1864.

Questions regarding the development or implementation of the Construction Plan/Storm Water Pollution Prevention Plan should be directed to the local plan review authority (Soil and Water Conservation District (SWCD) or the local Municipal Separate Storm Sewer entity). If you are unable to reach the SWCD or have other questions please direct those inquiries to the IDEM Storm Water Permits Coordinator at 317-233-1864 or 800-451-6027 ext.3-1864. For more information on the storm water program and forms please visit: www.idem.IN.gov/4896.htm.

Sincerely,

Randy J. Braun, CPESC, CMS4S
Section Chief
Storm Water and Wetlands Section
Office of Water Quality

PART C
WORKMANSHIP & MATERIALS

PART C

WORKMANSHIP AND MATERIALS SPECIFICATIONS

TABLE OF CONTENTS

WORKMANSHIP AND MATERIALS SPECIFICATIONS

(SECTION WM 1)

GENERAL

PART 1 GENERAL

1.01 The following specifications for Workmanship and Materials are of general application, and are to be used with the Detailed Specifications and drawings as far as applicable.

The Sections of the Workmanship and Materials Specifications shall accompany or be attached to each set of the Detailed Specifications. Additional Sections of Workmanship and Materials Specifications, other than those listed, may be included as a part of the contract documents attached to the listed Sections.

Materials for which no detailed specifications are given herein or under the Detailed Specifications shall in general conform to the physical characteristics and methods of treatment as set forth in the latest specifications of the American Society for Testing Materials insofar as they may apply, and shall be of the quality and character best adapted to the purpose for which they are to be used. No material shall be used for any purpose unless the material has previously been in use for a like purpose for a sufficient length of time to demonstrate the materials' satisfactory use.

All materials and equipment to be provided by the Contractor under this contract shall be new, unless otherwise specified. Any equipment offered shall be new and of a make and type which can be shown to have operated satisfactorily and continually in actual service for a sufficient length of time to demonstrate the equipment's success for the purpose for which the equipment is to be used.

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(SECTION WM 2)

EXCAVATION

PART 1 GENERAL

1.01 Description

A. The Contractor shall make all earth excavations required, to the widths and depths necessary for proper construction (and only to such widths and depths), for constructing according to the plans, all structures included in this contract. Earth shall mean all kinds of materials, wet and/or dry, excavated, or which are to be excavated, including rock, shale, hardpan, muck, quicksand, etc., unless provisions are made elsewhere in the contract documents for specified soil types.

B. Excavation shall include clearing the site for the work; the loosening, loading, removing, transporting, and disposing of all materials, wet or dry, necessary to be removed for purposes of construction; all sheeting and bracing; all draining, dewatering and pumping; backfilling of trenches, excavations and pits; earth borrow; the supporting of the excavations and structures (new and existing) above and below ground; the handling of water; and all incidental work.

C. Prior to commencing construction operations, the Contractor shall make all the provisions necessary to assure the protection of all existing improvements, both public and private. He shall protect trees, shrubs, plantings and grassed areas and shall make provisions for maintaining public travel in an acceptable manner.

PART 2 EXECUTION

2.01 Clearing

Preparatory to excavation, the site of all open cut excavations, embankments and fills shall be first cleared of obstructions and existing facilities (except those which must remain temporarily or permanently in service). On all public or private property where grants or easements have been obtained, and on the property of the Owner, the Contractor shall remove and keep separate the topsoil, and shall carefully replace it after the backfilling is completed.

2.02 Pavement Cutting

Prior to excavating paved areas all excavation edges falling within the pavement shall be saw cut in a neat straight manner. Cutting shall be performed with a saw designed specifically for this purpose. The cut shall penetrate the entire pavement thickness where possible. If the existing pavement is more than 6 inches thick then a cut of not less than 6 inch depth shall be made. Sawing equipment shall be submitted to the Engineer for approval before initial use. When the approved cutting equipment makes a cut more than 1" wide the cutting shall precede the excavation no more than one block or 400 feet which ever is less. If pavement cuts (those less than 1 inch wide) are made in streets which are reopened to traffic prior to excavation then the cuts shall be thoroughly filled with sand and maintained full until the excavation is performed.

2.03 Protection of Existing Improvements

A. Before any excavation is started, adequate protection shall be provided for all lawns, trees, shrubs, landscape work, fences, sidewalks, hydrants, utility poles, street, alley and driveway paving, curbs, storm sewers, ditches, headwalls, catch basins, surface inlets and all other improvements that are to remain in place. Such protection shall be provided as long as necessary to prevent damage from the Contractor's operations. Shrubs, bushes, small trees and flowers, which have to be removed to permit excavation for the project, shall be protected and replanted or replaced when the backfill is complete unless otherwise directed by the Engineer.

B. The Contractor shall exercise every precaution to prevent damage to property within and outside the immediate vicinity of the work. He shall remove all debris and rock from the site and restore the ground surfaces, replace or repair all driveways, buildings, fences, retaining walls, culverts, drains, paving, sidewalks, etc., which are removed or damaged during construction.

C. Repair, restoration or replacement of any improvements damaged or removed outside of the work to be performed shall be the obligation of the Contractor at no additional cost to the Owner.

2.04 Protection of Trees and Shrubs

A. No existing trees or shrubs in street Rights-of-Way and easements shall be damaged or destroyed. Where branches of trees or shrubs interfere with the Contractor's operations, they shall be protected by tying back wherever possible. No limbs or branches shall be cut. If his operations will not permit saving certain trees, the Contractor shall be wholly responsible for satisfying all claims for restoration or restitution resulting from their damage or removal.

B. If small trees and shrubs are moved or pruned to permit more working space, pruning shall be done in accordance with HGB083 (1984), U.S. Department of Agriculture, "Pruning Shade Trees and Repairing Their Injuries." However, the Contractor shall obtain, in writing, the property owner's permission to move or prune trees or shrubs on his property.

C. Trees and shrubs damaged by the Contractor's operation shall be repaired in accordance with said HGB083 (1984).

D. Payment for protecting trees and shrubs shall be the obligation of the Contractor at no additional cost to the Owner.

2.05 Maintenance of Public Travel

A. The CONTRACTOR shall carry out the WORK in a manner which will cause a minimum of interruption to traffic, and may close to through travel not more than two (2) consecutive blocks, including the cross street intersected. Where traffic must cross open trenches, the CONTRACTOR shall provide suitable bridges to street intersections and driveways. The CONTRACTOR shall post suitable signs indicating that a street is closed and necessary detour signs for the proper

maintenance of traffic. Prior to closing of any streets the CONTRACTOR shall notify responsible municipal authorities.

B. The CONTRACTOR shall plan construction activities to minimize impact to traffic. Local traffic access must be maintained at all times. To maintain traffic movement, appropriate traffic control devices shall be used. Such traffic control devices shall comply with the latest edition of the Indiana Manual on Uniform Traffic Control Devices. The CONTRACTOR shall follow the requirements of the INDOTSS Traffic Control Plans when no other plan is submitted for review.

C. The Local Highway Department shall be notified no less than five (5) calendar days prior to any construction activities occurring within the right-of-way.

2.06 Utility Interruption

A. The CONTRACTOR shall proceed with caution in the excavation and preparation of the trench or pit so that the exact location of underground structures may be determined. Prior to proceeding with trench excavation the CONTRACTOR shall contact all utility companies in the area to aid in locating their underground services.

B. The CONTRACTOR shall take all reasonable precautions against damage to existing utilities. However, in the event of a break in an existing water main, gas main, sewer or underground cable, he shall immediately notify the responsible official of the organization operating the utility interrupted. The CONTRACTOR shall lend all possible assistance in restoring services and shall assume all costs, charges, or claims connected with the interruption and repair of such services.

2.07 Construction in Easements

A. In easements across private property, the CONTRACTOR shall confine all operations in the easement area and shall be responsible and liable for all damage outside of the easement area. Trees, fences, shrubbery or other types of surface improvements located in easements will require protection during construction. Precautions shall be taken by adequate sheeting or other approved method to prevent any cave-in or subsidence beyond the easement limits or damage to improvements within the easement. In general, the easement area is intended to provide reasonable access and working area for efficient operation by the CONTRACTOR. Where easement space for efficient operation is not provided, the CONTRACTOR shall be responsible for organizing his operations to perform within the restrictions shown on the plans. When requested, the OWNER shall furnish the CONTRACTOR a copy of the construction easements. Anytime the CONTRACTOR has to work outside of the easement area, he must obtain written permission from the property owner and furnish the ENGINEER with a copy.

2.08 Drainage

A. The Contractor shall make provisions for handling all flows in existing creeks, ditches, sewers and trenches by pipes, flumes or other approved methods at all times when his operations would, in any way, interfere with the natural

functioning of said creeks, ditches, sewers and drains. The Contractor shall at all times during construction provide and maintain sufficient equipment for the disposal of all water which enters the excavation, both in open cut trenches and in tunnels, to render such excavation firm and dry, until the structures to be built thereon are completed.

B. Pipe underdrains, well point systems, deep well pumps or other suitable equipment and methods shall be used to keep all excavations firm and dry, at no additional cost to the Owner unless otherwise provided in the Proposal.

2.09 Disposal of Unsuitable Materials

A. Excavated materials which are either surplus and not required or are unsuitable for backfilling shall be removed from the site of operations as soon as excavated. All excavated materials so removed shall be disposed of, at no additional cost to the Owner, on privately owned property for which the Contractor has made prior arrangements. The Contractor is responsible for the restoration of areas within Public Rights-of-Way bordering properties for which the Contractor has a dump permit or release.

B. The Contractor is to provide the Engineer with a copy of the said permit, stating the condition in which the Property Owner will accept the spoil materials.

2.10 Storage of Suitable Materials

A. Excavated materials suitable and required for immediate backfill, shall be stored in neat piles adjacent to the excavation in a manner so as to interfere as little as possible with traffic, but shall not be placed at such heights above or closeness to the sidewalls of the excavation to endanger such operations due to slides or cave-ins. Fire hydrants under pressure, valve pit covers, valve boxes, curb stop boxes, or other utility controls within Right-of-Ways shall be left unobstructed and accessible until the WORK is completed.

B. Excavated materials suitable for use as backfill, fill and embankments but not needed immediately shall be transported to a location approved by the Engineer and stored at the contractors expense. Storage shall be on the owners property provided the site offers sufficient room without hindering the Work or the normal operation of the Owner's facilities. All weather access must be maintained to all operating facilities on the site at no additional expense to the Owner. Gutters and catch basins shall be kept clear or other satisfactory provisions made for drainage. Natural watercourses shall not be obstructed.

2.11 Open Cut Excavation

A. Open cut excavation, either in earth or rock, shall be safely supported and of sufficient width and depth (and only to such width and depth) to provide adequate room for the construction or installation of the work to the lines, grades and dimensions shown on the Plans.

2.12 Trench Dimensions

A. The bottom width of the trench at and below the top of the pipe and inside the sheeting and bracing, if used, shall not exceed the recommendations as contained in the applicable ASTM Standard for the pipe being used.

B. Trench sheeting and bracing or a trench shield or box shall be used as required by the rules and regulations of OSHA. The bottom of the trench shall still meet the above standards.

C. If the trench widths are exceeded without the written permission of the Engineer, the pipe shall be installed with a concrete cradle or with concrete encasement or other ASTM approved methods as approved by the Engineer and at no additional cost to the Owner.

2.13 Excavations With Sloping Sides, Limited

A. The Contractor may, at his option, where working conditions and right of way permit (as determined by the Engineer), excavate pipe line trenches and pits for structures with sloping sides, but with the following limitations:

1. In general, only braces and vertical trenches will be permitted in traveled streets, alleys, narrow easements and for pit excavations more than 10 feet deep.

2. Where pipe line trenches with sloping sides are permitted, the slopes shall not extend below the top of the pipe, and trench excavations below this point shall be made with near-vertical sides with widths not exceeding those specified herein before.

3. Slopes shall conform to all OSHA regulations.

4. When pit excavations with sloping sides are permitted, the Contractor shall assume full responsibility for all costs incurred to backfill the larger excavation in accordance with the Contract Documents including furnishing materials if adequate quantities of suitable materials are not available from those excavated on the site.

2.14 Sheeting and Bracing

A. The Contractor shall furnish, place and maintain adequate sheeting and bracing as may be required to support the sides of the excavation and prevent any movements of earth which could, in any way; diminish the width of the excavation to less than that necessary for proper construction; cause damage to the pipe or structure being constructed or to adjacent structures, utilities, pavements or walks; cause injury to workmen or others through movement of the adjacent earth banks; or to otherwise damage or delay the work.

1. Materials: Sheeting may be of wood or steel and shall be of adequate strength for the excavation, subject to the approval of the Engineer, who shall have the right to order the Contractor to furnish heavier sheeting

than that being used or proposed to be used by the Contractor, at no additional cost to the Owner.

2. Additional Supports: If the Engineer is of the opinion that sufficient or proper supports have not been provided at any location, he may order additional supports installed at the expense of the Contractor, and the compliance with such orders shall not relieve or release the Contractor from his responsibility for adequately supporting the sides of the excavation.

3. Methods: Wherever possible, the sheeting and bracing shall be driven ahead of the excavation to avoid loss of material from behind the sheeting. If it is necessary to excavate below the sheeting, care shall be taken to avoid trimming behind the face along which the sheeting will be driven. Care shall be taken to prevent voids outside the sheeting; but, if voids develop, they shall be immediately filled with selected sandy materials and compacted by flushing and jetting with water or as directed by the Engineer. Where drop inlets or stacks are constructed, the excavation shall be offset, as required, without additional compensation.

4. Left in Place: The engineer may order sheeting and bracing to be left in place at locations other than shown by the Plans. Sheeting left in place may be ordered to be cut off at any specified elevation, but in no case shall it be left in the ground above an elevation eighteen (18) inches below the existing or proposed surface of the ground. All voids created by the cutting off of the sheeting to be left in place shall be immediately filled with selected sandy materials and compacted by flushing and jetting with water or as directed by the Engineer. Sheeting and bracing left in place in open cut trenches as shown on the Plans or as ordered by the Engineer shall be paid for only in accordance with applicable provisions of the Contract Documents.

   If the Contractor elects not to remove certain sheeting and bracing, he will not be paid additionally for such sheeting and bracing left in place.

5. Not Left In Place: All sheeting and bracing not to be left in place shall be carefully removed (after the backfill is complete) so as not to endanger the pipes and other structures. All voids created by withdrawal of the sheeting shall be immediately filled with selected sandy materials and compacted by flushing and jetting with water or as approved by the Engineer.

6. All sheeting and shoring is to be done in accordance with the Occupational Safety and Health Standards 40 CFR Part 1926 Subpart P, Excavation.

2.15 Earth Excavation

A. Earth materials shall be excavated so that the open cuts conform with the lines, grades and dimensions shown on the drawings.

1. Unsuitable Foundation: When the bottom of the excavation is unsuitable as a foundation, it shall be excavated below grade and then refilled with concrete or crushed stone to the grade as the Engineer may direct. The crushed stone refill shall be mechanically compacted in six (6) inch layers or as directed by the Engineer. Such authorized work shall be paid for as set forth under the appropriate Item of the Proposal or the Change Order. This provision shall not relieve the Contractor of his obligation to dewater the excavation at no additional expense to the Owner.

2. Unauthorized Excavation: Unauthorized excavation below grade shall be filled with crushed stone or concrete and compacted as ordered and directed by the Engineer at no additional cost to the Owner.

3. Excavated Earth For Backfill: Excavated earth materials may be used for backfill subject to the approval of the Engineer, and the Contract Documents. Such material may be used only where its class is allowed. For example: Excavated material conforming to "Class II" description may be used where "Class II" material is required. When the Contract provides a unit price payment for classified backfill or fill material, excavated materials may qualify for such payment only if it is transported to another location for installation or temporary storage. The Contractor shall not transport the material solely to qualify it for such payments.

2.16 Rock Excavation

A. Rock shall be defined as follows: Boulders measuring one-half (½) cubic yard or more in volume; rock material in ledges, bedded deposits, unstratified masses and conglomerate deposits so firmly cemented that they possess the characteristics of solid rock that cannot be removed without systematic drilling and blasting; and concrete and masonry structures, except sidewalks and paving. Pockets or seams of earth or clay less than four (4) inches in thickness, occurring below or between solid ledges of rock, shall be considered rock.

B. When rock is encountered in open cut excavation, it shall be removed by drilling, blasting, digging or other approved methods so that open cut trenches conform with the lines, grades and dimensions shown on the Plans as specified herein or in the Detailed Specifications as follows:

1. Explosives: The Contractor shall comply with all Federal, State and Local laws, rules, regulations, insurance and ordinances governing the transportation, storage, use and permits for explosives.

2. Description: Solid rock excavation shall consist of the necessary excavation and satisfactory disposal of all rock in place which can not be removed from its original position without the use of explosives, or with a modern power shovel of not less than three-quarter (3/4) cubic yard capacity, properly used, having adequate power and in good running condition, or other equivalent powered equipment. The excavation shall also include all loose stone or boulders necessary to be removed which have a volume of one-half (½) cubic yard or more. Boulders of less than one-half (½) cubic yard in volume shall not be classed as rock excavation.

3. Safety Precautions: When blasting is required for the removal of rock, every precaution shall be used for the protection of persons and private and public property. Each blast shall be well covered with mats or other suitable means to confine the rock fragments within the excavation. At the discretion of the Engineer, he may order an evaluation survey of properties within the blasting zone. Only the minimum amounts of explosives shall be used; no excessive charges will be permitted. Except with written permission and approval of the Engineer, no blasting of rock will be permitted at nights or on Sundays.

4. Blasting Methods:

   a. The method of blasting will be as determined by the Contractor, subject to the approval of the Engineer prior to construction. Blasting shall be performed at a safe distance ahead of the installation of the pipe and structures to prevent damage to them as the work progresses. Blasting of rock for property service connections, T-branches, Y-branches, and stubs shall be performed at the same time as the pipe trench blasting. The rock at the ends of all pipes, branches, stubs and property service connections, shall be shattered by continuing the drilling and blasting operations six (6) feet beyond the end of the pipe, branch, stub or property service connection.

   b. Sufficient dynamite shall be used to shatter the rock for future excavation, as may be determined and ordered by the Engineer.

   c. The blasting of rock under existing paving prior to uncovering the rock will be permitted, provided, the Contractor assumes full responsibility for all damage to the existing paving; however, the Owner reserves the right to require the uncovering of rock prior to blasting if blasting without uncovering proves unsatisfactory.

   d. If the Contractor chooses to blast rock under paving without uncovering the rock, he shall immediately repair humps in the paving which create a traffic hazard, as determined by the Engineer; and, all distortions outside the limits of the trench caused by this method of blasting shall later be removed and replaced as part of the paving restoration, as directed by the Engineer. The Contractor is fully responsible for all damages that occur.

5. Repairs of Damage: In case injury occurs to any portion of the work, or to the material surrounding or supporting the same, through blasting the Contractor at his own expense shall remove such injured work and shall rebuild said work and shall replace the material surrounding or supporting the same, or shall furnish such material and perform such work of repairs or replacements as are necessary for satisfactory restoration. Any damage whatever to any existing structure due to blasting shall be

promptly, completely and satisfactorily repaired by the Contractor at his own expense.

2.17 Boring and Jacking

A. Construction of the pipeline by boring and jacking methods will be permitted unless otherwise specified on the plans.

1. **Backstop**: The backstop shall be of sufficient strength and positioned to support the thrust of the boring equipment without incurring any vertical or horizontal displacement during such boring operations.

2. **Guide Rails**: The guide rails for the boring equipment may be of either timber or steel. They shall be laid accurately to line and grade and maintained in this position until completion of the boring operations.

3. **Casing Pipe**: Steel casing pipe shall be new, conform to ASTM A 139 and shall be of the size (diameter) shown on the plans. The lengths of pipe shall be welded as they are installed. Where lengths of casing pipe are joined during the boring operations, care shall be taken to insure that the proper line and grade is maintained.

B. The minimum wall thickness for casing pipes under highways, railroads and streams shall be 0.375 inches. Steel shall be Grade B under railroads and Grade A at all other locations.

2.18 Removal of Water

A. The Contractor shall at all times during construction provide and maintain ample means and devices with which to promptly remove and properly dispose of all water and sewage entering the excavations or other parts of the work and shall keep said excavations dry until the structures to be built therein are completed or connections to existing structures are completed. No masonry shall be laid in water nor shall water be allowed to rise over masonry, until the concrete and mortar have attained a sufficient and satisfactory set. In no event shall concrete be placed in water, nor shall water be allowed in the excavation, which may set up unequal pressures in the concrete, until the concrete has set at least twenty-four (24) hours and any danger of flotation has been removed.

B. In order to provide a dry foundation, the Contractor, if required by the Engineers, shall pre-drain all wet material (except hardpan or rock) by lowering the ground water to a depth of at least one (1) foot below the deepest point of subgrade. The work of pre-draining shall be done by the use of a well point system, or by any other method approved by the Engineer that will permit the construction work to be carried on under dry foundation conditions. All discharge water shall be piped to the nearest point of disposal in order to prevent such water from again entering the excavation. Any method or system that may be used to lower the ground water shall be kept in operation continuously unless otherwise permitted. The Engineer's approval of the proposed system shall not relieve the Contractor from the responsibility of providing and maintaining dry excavations as required.

C. The Contractor shall dispose of water from the work in a suitable manner without damage to adjacent property or piping. No water shall be drained into work built or under construction unless the consent of the Engineers is first obtained.

D. All removal and handling of water required to maintain dry trenches or other excavations for the construction of sewers, water mains, or other structures in the dry, shall be at the expense of the Contractor. This includes providing material, tools, and labor to transport such water to an acceptable outlet. Prior to bidding, the Contractor shall visit the project area to determine what drainage system is available to accept water.

E. The Contractor shall be responsible to provide all equipment and labor to maintain bypass pumping during connections to existing structures. The Contractor shall maintain adequate pumping capacity at all times to prevent any spills, overflows, or discharges from the existing sanitary system.

(SECTION WM 3)

BACKFILL, FILLS AND EMBANKMENTS

PART 1 GENERAL

1.01 Description

A. All trenches or excavations shall be backfilled to the original surface of the ground or such other grades as shown or directed. In general the backfilling shall be carried along as speedily as possible and as soon as the concrete, mortar, and/or other masonry work and pipe joints have sufficient strength to resist the imposed load without damage.

1.02 Backfill Materials

A. The following materials shall be used for backfill in accordance with and in the manner indicated by the requirements specified herein.

Class I - Angular, 6 to 40 mm (1/4 to 1 ½ inch), graded stone such as crushed stone.

Class II - Coarse sands and gravel with maximum particle size of 40 mm (1 ½ inch), including various grades of sands and gravel containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil types GW, GP, SW and SP are included in this class.

Class III - Fine sand and clayey gravel including fine sands, sand-clay mixtures and gravel-clay mixtures. Soil types GM, GC, SM and SC are included in this class.

Class IV - Silt, silty clays and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil types MH, ML, CH and CL are included in this class. These materials are not recommended for bedding. This class shall also include any excavated material free from rock (3 inches and larger), concrete, roots, stumps, rubbish, frozen material and other similar articles whose presence in the backfill would cause excessive settlement.

Flowable Fill Controlled low strength material (CLSM).

PART 2 PRODUCTS

2.01 Backfill of Trench Excavations for Pipes and Conduits

A. Bedding and Backfill materials samples shall be submitted to the Engineer prior to start of construction. Approved samples shall be kept at the Engineer's field office. Materials differing significantly from these samples shall not be used without written authorization from the Engineer.

PART 3 EXECUTION

3.01 Backfill Above Pipe

A. Method A - Backfill in Areas Not Subject to Vehicular Traffic

1. For purposes of this specification, trenches shall be considered subject to vehicular traffic if all or any portion of the excavation is located within five (5) feet of a roadway or alley which is routinely traveled by powered vehicles. In the event of any question regarding the susceptibility of an area to traffic, the Engineer's decision shall govern.

2. The trench between the pipe bedding and the ground surface shall be backfilled with Class I, II or III materials, as described above, deposited with mechanical equipment in such a manner that it will "flow" onto the bedding and not free fall. The Contractor shall consolidate the backfill by the back and forth travel of a suitable roller, wheeled device or other similar heavy equipment until no further settlement is obtained. Heavy equipment shall not be used until there is a cover of not less than three (3) feet over the pipes. To assist in promoting maximum settlement, the surface of the trench shall be left in a slightly rounded condition. Periodical dressing of the backfill in the trench to promote the drainage and safety conditions shall be made during the course of the contract as required or ordered by the Engineer.

B. Method B - Backfill in Areas Subject to Vehicular Traffic (Mechanical Compaction)

1. The trench between the pipe bedding and the surface, which are located in areas subject to or possibly subject to vehicular traffic, shall be backfilled with Class I or II materials, deposited in uniform horizontal layers of two (2) feet +/- six (6) inches. Each layer shall be thoroughly compacted by mechanical tamping utilizing a crane mounted hydraulic vibratory compactors. Each layer shall be thoroughly compacted before the next succeeding layer is placed. This procedure shall be followed where trench walls remain stable during compaction. If in the opinion of the Engineer and/or his representative (inspector), the trench walls become unstable during compaction, then the Engineer and/or his representative (inspector) may authorize the Contractor to push from the back of the trench the Class I or II material into the trench the full depth, not to exceed twenty (20) lineal feet horizontally along the trench bottom and compact using the vibratory compactor in two (2) foot diagonal lifts.

2. The crane mounted vibratory compactors shall be capable of producing 1900 cycles per minute and have a compaction plate with the minimum dimensions of twenty-three by thirty-one (23 x 31) inches. The compactor shall be similar to those as manufactured by Allied, Ho-Pac, or equal.

3. When Class I or II materials do not contain sufficient moisture to obtain proper compaction, in the opinion of the Engineer and/or his representative, it shall be moistened or wetted to within +/- 2% optimum

moisture content and as directed by the Engineer and/or his representative.

4. Granular backfill materials shall terminate at a point below finished grade sufficient to allow placement of the permanent surface materials. For portions of the surface subject to vehicular traffic, the remaining trench shall be filled with compacted aggregate base material, shaped, graded and compacted with a ten (10) ton roller. Where the permanent surface is asphalt or concrete the aggregate base thickness shall be the specified thickness of the pavement material plus six (6) inches. Where temporary cold mixed asphalt pavement is specified the compacted aggregate materials shall be stopped at required grade to accommodate the temporary pavement. Where the permanent surface is compacted aggregate the layer shall be eight (8) inches thick. In either case, the Contractor shall maintain the surface daily until the permanent pavement is placed.

5. For portions of the trench surface not subject to traffic the backfill material shall end eight (8) inches below the finished grade. This eight (8) inch depth shall be filled with good top soil and seeded in accordance with these Specifications. Existing top soil and sod may be used if properly separated and preserved.

6. The compacted aggregate base materials shall conform with the Indiana State Highway Department Standard Specifications, latest edition, for compacted Aggregate Base. In the event that suitable aggregate material, which conforms to the above specification is obtainable from the trench excavations and can be satisfactorily segregated, the Contractor may elect to use the material in lieu of purchased materials.

7. Density testing of the above backfilled trenches shall be the responsibility of the Contractor and shall be performed at no additional cost to the Owner. Testing shall be performed by an approved commercial testing laboratory. All backfill placed under this Method B shall be tested in accordance with AASHTO T99. Density testing shall be performed immediately prior to permanent pavement replacement and after the upper level of the compacted aggregate base or temporary pavement is removed to allow paving. When backfill has been placed using vibratory compaction, testing shall be made at the exposed surface one (1) time per location and not less than one (1) test per four hundred (400) feet. All test locations shall be determined by the Engineer. Should the results of the density test show a compaction of less than ninety-five percent (95%) Standard Proctor Density, the area(s) represented by such test shall be immediately recompacted to achieve the specified density and at no additional cost to the Owner.

C. Method C - Backfill in Areas Subject to Vehicular Traffic (Jetting and Watersoaking)

1. In lieu of the Mechanical Compaction described in Method B above, the Contractor may compact the Class I or II materials by jetting and watersoaking in the manner described below. Except for compaction procedures of the Class I or II materials, all provisions of Method B described above shall apply to this Method C. The trench compaction shall be started at the point of lowest elevation of the trench and work up along the trench. Jetting and watersoaking shall not begin until the trench has been backfilled to within eight (8) inches of the finished surface. Jetting and water soaking is not allowed when the groundwater table is above the spring line of the pipe.

2. The holes through which water is injected into the backfill shall be centered over the trench backfill and at longitudinal intervals of not more than six (6) feet. Additional holes shall be provided if deemed necessary by the Engineer to secure adequate settlement. All holes shall be jetted and shall be carried to a point one (1) foot above the top of the pipe. Drilling the holes by means of augers or other mechanical means will not be permitted. Care shall be taken in jetting so as to prevent contact with, or any disturbance of the pipe.

3. The water shall be injected at a pressure and rate just sufficient to sink the holes at a moderate rate. After a hole has been jetted to the required depth, the water shall continue to be injected until it begins to overflow the surface. The Contractor shall, at his own expense, bore test holes at such locations as the Engineer may designate in order to determine the effectiveness of the water soaking. An approved soil auger shall be used for boring test holes. As soon as the jetting and watersoaking has been completed, all holes shall be filled with soil and compacted. Surface depressions resulting from backfill subsidence caused by jetting and watersoaking shall be filled and recompacted by tamping or rolling to the satisfaction of the Engineer.

4. The Contractor shall provide all piping, fittings, etc., necessary to deliver the water along the site of the work and shall arrange with the Water Company for making the necessary taps and metering. All expenses incurred for installing the pipe and hose together with the cost of the water used shall be borne by the Contractor.

D. Method D – Backfill in Areas Subject to Vehicular Traffic (Flowable Fill)

1. In lieu of the mechanical compaction and jetting described in Methods B and C above, the Contractor may use controlled, low strength flowable mortar.

2. The flowable fill mix shall contain for every cubic yard of batch material, no more than 50 lbs. of Portland Cement, no more than 500 lbs. of Type F fly ash, no more than 500 lbs. of water, no more than 2850 lbs. of sand, and no more than 10% total air.

3. The compressive strength of the flowable fill shall not exceed 100 psi @ 28 days.

4. Standards: ASTM D4832
ASTM D6023

3.02 Temporary Surfaces Subject to Traffic

A. The Contractor shall open streets to traffic immediately after completing the backfill operation. He shall accomplish this by installing the compacted aggregate base immediately after granular backfill. When temporary asphalt pavement is required this shall also be installed immediately. The use of class II backfill as a temporary surface is specifically prohibited. When using Method C backfilling, the Contractor may elect to delay the jetting operation until just prior to installing the permanent pavement. This shall not relieve the Contractor from the responsibility of maintaining the temporary surface in accordance with these specifications.

3.03 Maintaining Trench Surfaces

A. All surface settlement of the backfill along trenches located beneath streets, roads, alleys, driveways and parking lots which are subject to traffic shall be kept filled level with or slightly above the original paved surface at all times with compacted aggregate base material until the permanent pavement is satisfactorily restored. When temporary asphalt pavement is used, depressions and "pot holes" shall be promptly filled with the temporary asphalt material. Special attention shall be given by the Contractor to the timely and proper maintenance, leveling and grading of the surface of all backfilled trenches, especially those subject to traffic and especially following rains. The surface of streets, roads and alleys shall be maintained smooth and free of ruts and water trapping depressions by periodic power blading, scarifying; and/or filling settled areas, ruts, pockets, or holes with compacted aggregate base material or temporary asphalt where used.

B. As a dust preventive, the Contractor shall apply, at his expense, calcium chloride over the surface of the compacted aggregate base in such amounts and at such times as are necessary to avoid or eliminate dust complaints from nearby residents. In event of any question regarding the existence or nonexistence of a dust nuisance, the Engineer's decision on the matter will govern. The material used shall be Regular Flake Calcium Chloride having a minimum chemical content of Calcium Chloride of seventy-seven percent (77%). Unless otherwise specified or ordered by the Engineer, the rate of application shall be one and one half (1 ½) pounds per square yard of surface covered.

C. Wherever surface settlement is not important, unless otherwise specified or directed, the backfill shall be neatly rounded over the trench to a sufficient height to allow for settlement to grade after consolidation. Just prior to the completion of all work under the contract, any surface settlement below original ground surface shall be refilled in a satisfactory manner, and reseeded as specified if required.

3.04 Backfill Around Structures

A. For purposes of this specification, structures shall include but not be limited to footings, foundations, basements, grade beams, vaults, capsules, manholes, ducts, tanks, bridges, inlets, headwalls, anchors, and etc. Items specifically excluded from this definition of "structures" are pipe, conduits and their appurtenances except those listed herein.

B. The material for backfill around structures shall meet the requirements of Class I, II or III backfill materials, as defined on page WM 3 (1 of 8) under the paragraph entitled "Backfill Materials". Material removed from the project site may be used provided it meets this criteria. Materials classified as Class IV, clay balls, debris, topsoil, frozen or excessively wet or dry materials, weak soils or muck and other similar detrimental materials will not be put in place as backfill around structures.

C. All excavations shall be backfilled to the original surface of the ground or such other grade as shown on the plans or directed by the ENGINEER. The backfilling shall be carried along as speedily as possible and as soon as the concrete, mortar and/or other masonry work and pipe joints have sufficient strength to resist the imposed load without damage. All appurtenances and attachments to structure walls shall be made and any wall coatings shall be in place and cured prior to backfilling at that elevation.

D. Prior to backfilling, all formwork and construction debris will be removed. Any frozen or wet subsoil will be thawed or dried and compacted or removed prior to receiving backfill. During cold seasons, grades receiving backfill will be protected from frost during the work progress.

E. Begin backfill at the lowest elevation in the excavation. Place backfill in even, level layers. The thickness of the layer shall not exceed 75% of the compaction equipment manufacturer's rating for the equipment used when compacting the type of soil being placed for backfill, i.e. Class I, II and/or III.

F. Density tests will be made by the contractor, as directed by the Engineer, at no additional cost to the Owner. The tests are to be performed as described below and will be required as necessary to determine that uniform compaction throughout the depth of the lift has been achieved. Where backfill is required on both sides of structure or around the entire structure, backfill and compaction shall be done simultaneously on both sides or around the structure.

G. The compaction equipment used for compacting backfill around structures shall be submitted for approval of the Engineer. In general, the equipment will be approved for use upon demonstration that it is capable of compacting the soil to the required density without damaging adjacent structures and appurtenances. Tread mounted equipment shall not be considered effective compacting equipment.

H. The Contractor shall provide, when necessary, equipment and materials to moisten or aerate excessively wet or dry backfill to maintain optimum moisture content (+/- 2%) for the soil type being placed.

I. Rainfall and/or groundwater trapped in the excavation during backfill operations shall be pumped out by the Contractor. Excessively wet soil or soil which has eroded into the excavation shall be removed or excavated and recompacted prior to placing additional backfill material.

J. The in-place density obtained by the backfill operations will be measured by an Engineer approved independent testing laboratory obtained and paid for by the Contractor at no additional cost to the Owner. The percent compaction will be determined by dividing the density measurement by the maximum density for the soil type being tested. The maximum density will be determined by the standard proctor test, AASHTOT 99 for consistency. Test reports shall indicate the location and elevation of the test. Density testing shall be made at frequent intervals along the backfill layer, at the surface and at mid-depth as determined by the Engineer. All backfill shall be compacted to at least 95% of maximum density and the top two feet of backfill under areas subject to vehicular traffic shall be compacted to 98% of maximum density.

K. Openings in structures to receive pipe shall be temporarily plugged or bulkheaded during backfill operations. Backfill shall proceed to an elevation level with the invert of the pipe. The pipe shall then be bedded and backfilled in accordance with the applicable Detailed Specification and Workmanship and Materials Specifications. Backfill of pipe not in areas subject to vehicular traffic shall be with Class I, II or III materials and in areas subject to vehicular traffic with Class I or II materials only.

3.05 General Fill Areas

A. In areas where general site fill material is required and is not addressed in other parts of this section, Class IV material shall be acceptable. For general fill areas, fill materials shall be spread in layers not to exceed 8 inches when in a loose condition and be compacted to the satisfaction of the engineer by grading equipment.

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(SECTION WM 4)

RESTORATION OF SURFACES

PART 1 GENERAL

1.01 Description

A. Restoration of surfaces shall include the removal of the existing surface, the disposal of the surplus material and the construction of new surfaces and adjusting all new and existing structures for proper grade prior to paving as indicated on the plans and/or as specified in these Specifications.

1.02 Restoration of Paved Surfaces

A. Restoration

1. After all excavations within the limits of paved surfaces have been properly backfilled, compacted and repaired in accordance with Sections WM-2, WM-3 and WM-22 of these Specifications, the paved surfaces shall be restored to a condition as good as or better than existed prior to the beginning of the work, in accordance with the following specifications.

2. State Paved Surfaces: Highways, streets and roads constructed and/or maintained by the Indiana Department of Transportation (INDOT), which are wholly or partially removed, damaged or disturbed by the Contractor's operations shall be restored to a condition as good as or better than existed prior to the beginning of the work. Such restoration shall be performed in accordance with the pertinent specifications and standards of the Indiana Department of Transportation, as applicable.

3. Other Paved Surfaces: Streets, alleys, sidewalks, driveways, curbs and gutters, not constructed or maintained by the Indiana Department of Transportation, but paved with asphalt, concrete, cinders, crushed stone, waterbound macadam, oil-bound macadam, or heterogenous paving materials, which are wholly or partially removed, damaged, or disturbed by the Contractor's operations, shall be restored with like or better materials, acceptable to the Engineer, to a condition as good as or better than existed prior to the beginning of the work, so that movement of traffic, both vehicular and pedestrian, through the restored way shall be as free, safe and unimpeded as before.

B. Temporary Surface

Temporary trench surfaces shall be installed and maintained in accordance with section WM 3 Backfill, Fills and Embankments of this specification. This temporary surface shall be maintained by the Contractor until the permanent pavement is placed. Before placing permanent pavement, all or parts of the temporary surface shall be removed, as necessary, and hauled from the site of the work.

PART 2 EXECUTION

2.01 Temporary Pavement Replacement

A. Trench surfaces of highly traveled streets and roads may be designated to receive a temporary pavement replacement of cold mixed bituminous pavement. This temporary pavement shall be of the thickness specified or shown on the plans and shall be surface mixture Class A or B prepared and placed in accordance with Section 403 - Cold Mixed Asphalt, CMA, Pavement of the latest edition of the INDOT Standard Specifications. Prime and tack coats shall not be required. All temporary pavement shall be maintained by the Contractor to proper grade so as not to impede the safe flow of traffic until the permanent pavement replacement is made.

2.02 Permanent Paving

A. Permanent paved surfaces shall be restored in accordance with WM-22, “Roadways and Parking Areas” and the following requirements, unless otherwise set forth in the plans, the Special Provisions or Detailed Specifications; however, in all cases, the methods and materials of restoration shall meet the requirements of the INDOT, as applicable. All permanent cut / road repairs shall be installed level to existing pavement with no more than a 1/8” rise per foot of width of repair and a maximum rise over the cut width of no more than a 1/4".

2.03 Double Chip and Seal

A. This work shall consist of two applications of bituminous material, each followed by an application of cover aggregate in accordance with these specifications.

B. Grade and roll the sub-base prior to application.

C. The first application shall consist of applying a liquid sealing asphalt at the rate of 0.63 – 0.68 gallons per square yard followed by application of aggregate (Size No. 8 or 9) at the rate of forty (32) pounds per square yard and rolled to seat the stone in the asphalt.

D. The second application shall consist of applying liquid sealing asphalt at the rate of 0.41 – 0.46 gallons per square yard then chipped with aggregate (Size No. 11) at the rate of twenty (22) pounds per square yard.

E. All work shall be in accordance with Section 404 “Seal Coat” Type 6 or 7 of the INDOT Standard Specifications.

2.04 Restoration of Ground Surfaces

A. All ground surfaces in public Rights-of-Way, easements and on private property that have been damaged or destroyed by the Contractor's operations shall be restored in accordance with the following specifications. All surplus material, rock, trees, shrubs, concrete pipe, asphalt, crushed stone, etc., not to be used in the Contractor's restoration operations shall be removed from the site and disposed of in an acceptable manner.

All work, either sodding or seeding and mulching, shall be in accordance with WM-24, “Seeding and Sodding”.

2.05 Clean Up

A. Before final acceptance of the work, the Contractor shall satisfactorily clean all areas within the limits of his operations including the street surfaces, walks, gutters, fences, lawns, private property and structures, leaving them in as neat, clean and usable condition as originally found. He shall remove all machinery, tools, surplus materials, temporary buildings and other structures from the site of work. He shall also remove all organic matter and materials containing organic matter from all areas and places used by him during construction. All pipes, manholes, inlets, etc., shall be cleared of all scaffolding, sedimentation, debris, rubbish and dirt.

B. Where the Contractor's operations have resulted in filling existing ditches, clogging existing culverts, damaging existing bridges, ground surfaces, sidewalks, driveways, etc., the Contractor shall re-ditch, clean culverts, repair or replace bridges, ground surfaces, sidewalks, driveways, etc. so as to return them to a condition as good as or better than existed prior to the beginning of his operations.

C. The Contractor's cleanup operations, which include repair, restoration or replacement of ground surfaces and existing improvements and the removal of rock, shall be performed continuously during the construction operations.

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(SECTION WM 5.1)

CONCRETE FORMWORK

PART 1 GENERAL

1.01 Description

A. The work under this Section consists of furnishing all labor, equipment and services (including the design and detailing) required for Forms for all cast-in-place concrete indicated on the Drawings and subsequent removal of all such forms described in this Section.

B. Related work described elsewhere:

1.	Concrete Reinforcement	Section WM-6
2.	Cast-In-Place Concrete	Section WM-5.2
3.	Structural Steel	Section WM-18
4.	Miscellaneous Metals	Section WM-19

1.02 Quality Assurance

A. Qualifications of Workmen:

1. Provide at least one experienced person who shall be present at all times during execution of this portion of the Work and who shall be thoroughly familiar with the type of materials being installed, the referenced standards, and the requirements of this Work, and who shall direct all work performed under this Section.

B. Codes and Standards:

1. "Recommended Practice for Concrete Formwork", publication ACI 347, latest edition of the American Concrete Institute.

1.03 Submittals

A. Shop Drawings:

1. Prior to starting field work, submit shop drawings to Engineer for approval. All shop drawings shall be checked and the formwork Contractor's stamp of approval shall be placed on each drawing prior to submittal to Engineer. All shop drawings shall be prepared under the supervision of a registered professional engineer.

2. The shop drawings shall clearly show all concrete shapes, sizes, grade lines and dimensions indicated on the drawings. All door blockouts, recesses, sleeves, embedded items and any other items which affect exposed concrete visually shall also be shown.

3. Shop drawing review is for general conformance with the construction documents. The design of formwork for structural stability and efficiency is the responsibility of the formwork Contractor.

1.04 Design

A. All formwork, including reshoring, shall be designed and detailed by the formwork Contractor who shall be solely responsible for this work. Design of formwork shall be prepared under the supervision of a registered professional engineer.

B. Formwork for post-tensioned concrete shall be designed, taking into account the possibility of the member lifting off the formwork during the stressing operation.

PART 2 PRODUCTS

2.01 Form Materials & Accessories

A. Form Lumber:

1. All form lumber in contact with exposed concrete shall be new or of sufficient quality to insure an unblemished texture.

2. All form lumber shall be one of the following or a combination thereof.

a. Forms for concealed concrete:

1) Face Forms: B-B Plyform Class I or II, exterior, bearing APA grade stamp on each piece. Minimum thickness: 3/4".

b. Forms for exposed concrete:

1) Face Forms: High Density Overlaid Plyform Class I or II, exterior, bearing APA grade stamp on each piece. Minimum thickness: 3/4".

B. Steel Forms:

1. Steel is an acceptable material for formwork.

2. Steel forms shall be "like new" producing a clean, smooth, unblemished, texture for concrete exposed in the finished structure.

C. Forms for Exposed Finish Concrete:

1. Plywood, metal, metal framed plywood faced, or other acceptable panel-type materials, to provide continuous straight, smooth exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.

D. Forms for Unexposed Finish Concrete:

1. Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.

E. Forms for Textured Finish Concrete:

1. Units of face design, size, arrangement and configuration to match designer's control sample. Provide solid backing and form supports to ensure stability of textured form liners.

F. Forms for Cylindrical Columns and Supports:

1. Metal, fiberglass reinforced plastic, or paper or fiber tubes. Construct paper or fiber tubes of laminated plies using water-resistant adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation.

G. Form Ties:

1. Factory fabricated, adjustable length, snap-off metal form ties, designed to prevent form deflection and to prevent spalling of concrete upon removal. The metal after breaking should be at least 1" from the face of the wall. Ties used on walls subject to hydrostatic pressure shall have approved waterstops.

    a. Provide ties which, when removed, will leave holes not larger than 1" diameter in concrete surface.

H. Form Release Agent:

1. A non-staining, neutral, barrier type which will not cause softening or impede curing.

2. Standards - Release agent shall be similar to:

    a. Symons Manufacturing Company Magic Kote, or Grace Construction Products Formshield Chemical Release Agent, or equal.

I. Bracing/Shoring/Studs:

1. Such supports shall be selected for economy consistent with safety requirements and the quality required in the finished work. The formwork Contractor is responsible for the design, illustration, safety, and serviceability of all formwork.

2.02 Other Materials

A. All other materials, not specifically described but required for proper completion of concrete formwork, shall be as selected by the formwork Contractor subject to the advance approval of the Engineer of record.

PART 3 EXECUTION

3.01 Surface Conditions

A. Inspection:

1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is completed to the point where this installation may properly commence.

2. Verify that forms are constructed in accordance with all pertinent codes and regulations, the referenced standards, and the original design.

B. Discrepancies:

1. In the event of discrepancy, immediately notify the Engineer of record.

2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 Construction of Forms

A. Construction of forms to be substantial, sufficiently tight to prevent leakage of concrete, and able to prevent excessive deflection when filled with wet concrete.

B. Design, erect; support; brace, and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347, latest edition.

C. Design formwork to be readily removable without impact, shock, damage, or cutting to cast-in-place concrete surfaces and adjacent materials.

D. Construct forms to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.

1. Earth Forms: If recommended by Soils Engineer and approved by Engineer, forms for footings may be earth. Increase width of footing by 4" when using earth forms.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.

F. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.

G. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

H. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Carefully examine the drawings and specifications and consult with other trades as required relative to size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

I. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Re-tightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment.

J. Set all required pipe sleeves, steel frames, angles, grilles, bolts, inserts, and other such items required to be anchored in the concrete before the concrete is placed.

K. Bracing:

1. Properly brace and tie the forms together so as to maintain position and shape and to ensure safety to personnel.

L. Construct all forms straight, true, plumb and square within a tolerance as specified in ACI 301. Use a reference point on the ground to check plumbness and elevations.

M. Keep forms sufficiently wetted to prevent joints opening up before concrete is placed.

3.03 Footing Forms

A. Wood Forms:

1. All footing and pile cap forms shall be wood unless otherwise specifically approved by the Engineer of record.

3.04 Preparation of Form Surfaces

A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.

B. Coat contact surfaces of forms with a form-coating compound before reinforcement is places.

C. Thin form-coating compounds only with thinning agent of type, amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come in contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

D. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.05 Shores and Supports

A. Comply with ACI 347, latest edition, for shoring and reshoring in multilevel construction, and as herein specified.

B. Extend shoring from ground to roof for structures 4 levels or less, unless otherwise permitted.

C. Extend shoring at least 3 levels under floor or roof being placed for structures over 4 levels. Shore floor directly under floor or roof being placed, so that loads from construction above will transfer directly to these shores. Space shoring in stories below this level in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members where no reinforcing steel is provided. Extend shores beyond minimums to ensure proper distribution of loads throughout structure.

D. Remove shores and reshore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support work without excessive stress or deflection.

1. Keep reshores in place a minimum of 15 days after placing upper tier, and longer if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

3.06 Form Removal

A. Forms shall be removed in an approved manner under competent supervision so as to avoid damage to the concrete. Particular care shall be taken to avoid spalling.

B. Shores and other supports shall not be removed until concrete has attained sufficient strength to support without objectionable deflection under its own weight plus all anticipated construction loads.

C. The concrete shall have attained, as indicated by the field-cured cylinders, at least 70 per cent of its specified 28-day strength before shores are removed. The Contractor shall bear full responsibility for this operation. Concrete damaged by too early removal of supports shall be repaired to the satisfaction of the Engineer or replaced.

D. Forms for vertical elements (walls and columns) shall not be removed until 24 hours after the completion of concrete placement.

3.07 Maintenance

A. Formwork shall be cleaned and reconditioned before each use. Any damage to formwork during placing, removal, or storage shall be completely repaired. Formwork with repairs or patches which would result in adverse effects to the concrete finish shall not be used.

B. Storage of formwork and form materials shall be in a manner to prevent damage or distortion.

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(SECTION WM 5.2)

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 Scope

A. Materials, equipment and labor required for placing, finishing and curing all cast-in-place concrete.

B. Installation of all specified items to be embedded in cast-in-place concrete.

1.02 Products Installed But Not Furnished Under This Section

A. Section WM-18 - Structural Steel: Anchor bolts and other items to be embedded in cast-in-place concrete.

1.03 Related Sections

A. Section WM-5.1 - Concrete Formwork.

B. Section WM-6 - Concrete Reinforcement.

1.04 Codes And Standards (latest edition)

A. ACI 301 - Specifications for Structural Concrete for Buildings.

B. ACI 302 - Guide for Concrete Floor and Slab Construction

C. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete

D. ACI 305 - Hot Weather Concreting.

E. ACI 306 - Cold Weather Concreting.

F. ACI 309 - Guide for Consolidation of Concrete.

G. ACI 318 - Building Code Requirements for Reinforced Concrete.

H. ACI 350 - Concrete Sanitary Engineering Structures.

I. ASTM C31 - Making and Curing Concrete Test Specimens in the Field.

J. ASTM C33 - Concrete Aggregates.

K. ASTM C39 - Test for Compressive Strength of Cylindrical Concrete Specimens.

L. ASTM C42 - Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

M. ASTM C94 - Ready-Mixed Concrete.

N. ASTM C143 - Test for Slump of Portland Cement Concrete.

O. ASTM C150 - Portland Cement.

P. ASTM C171 - Sheet Materials for Curing Concrete.

Q. ASTM C172 - Sampling Fresh Concrete.

R. ASTM C173 - Test for Air Content of Freshly Mixed Concrete by the Volumetric Method.

S. ASTM C231 - Test for Air Content of Freshly Mixed Concrete by the Pressure Method.

T. ASTM C260 - Air-Entraining Admixtures for Concrete.

U. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.

V. ASTM C494 - Chemical Admixtures for Concrete.

W. ASTM C618 - Fly Ash and Raw or Calcined Natural Pozzolans for Use in Portland Cement Concrete.

X. ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

Y. Indiana Department of Highways - Standard Specifications.

1.05 Submittals

A. General: All submittals shall be in accordance with ACI 301 “Specifications for Structural Concrete for Buildings”.

B. Product Data: Submit data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others as requested.

C. Concrete Mix Designs:

1. Submit a mix design for each class of concrete required for the project per the General Conditions and including:

a. Standard deviation analysis, required average strength and documentation of average strength verifying compliance with Section 2.03 (Proportioning on the basis of field experience and/or trial mixtures) of ACI 318.
b. Mix proportions by weight, water-cement ratio, slump and air content.

c. Sieve analyses of fine and coarse aggregates.
d. Results of tests for water soluble chloride ion content described in Paragraph 2.03H for concrete used in water retaining structures.
e. Complete list of materials specified in Article 2.01 with product information demonstrating compliance with all specified requirements.

2. Submit with sufficient time allowed for review before concrete is required for the project.

D. Shop Drawings:

1. Submit complete shop drawings per the General Conditions and indicating:

a. Locations of all construction joints in walls and slabs.
b. Sizes and locations of all sleeves.
c. Locations of all waterstops.

E. Product Information: Submit product information for all materials specified in Article 2.02 per the General Conditions and demonstrating compliance with specified requirements.

F. Field Quality Control Test Reports: Submit to the Engineer of record per the General Conditions and within 3 days after completion of the 7-day and 28-day tests.

G. Concrete Placement Records: Turn over to the Engineer of record after completion of the project.

1.06 Quality Assurance

A. Perform work in accordance with ACI 301 and all codes and standards described in paragraph 1.04.

B. Conduct field sampling and testing of concrete, including the making of test specimens, with personnel holding current certificates issued by the Concrete Technician Certification Committee of Indiana. All sampling and test specimens shall be made in accordance with applicable ASTM procedures.

C. Materials and installed work may require testing and re-testing at any time during progress of work. Tests, including re-testing of rejected materials for installed work, shall be done at the Contractor's expense.

D. The Contractor shall attend a preconstruction meeting to discuss submittals, concrete placement, and concrete testing. A responsible representative of the concrete placing/finishing contractor, the concrete supplier, and the testing laboratory shall be present.

1.07 Delivery, Storage And Handling

A. Deliver concrete in accordance with ASTM C94. Do not use non-agitating transporting equipment.

B. Deliver materials and equipment in undamaged condition.

C. Store materials and equipment in designated areas and in accordance with manufacturer's instructions.

D. Store materials and equipment off the ground, totally protected from ground splash, mud, weather separation, intrusion of foreign materials, and other damage.

1.08 Environmental Requirements

A. Inclement Weather: Do not place concrete during rain, sleet or snow unless adequate protection is provided.

B. Hot Weather: Perform work under provisions of Article 3.10.

C. Cold Weather: Perform work under provisions of Article 3.11.

D. Protection of Footings Against Freezing: Cover completed work at footing level with sufficient temporary or permanent cover as required to protect footings and adjacent subgrade against possibility of freezing; maintain cover for time period as necessary.

E. Protect adjacent finish materials against spatter during concrete placement.

PART 2 PRODUCTS

2.01 Concrete Materials

A. Portland Cement: ASTM C150.

1. Structures not in contact with wastewater.

   a. Type I or Type III.

2. Structures in contact with wastewater.

   a. Type I with a tricalcium aluminate content less than eight percent (8%).
   b. Type II.

B. Flyash: ASTM C618, Type C.

1. Maximum loss on ignition: 1.50 percent.

2. Maximum amount retained when wet-sieved on No. 325 sieve: 30 percent.

C. Fine Aggregate: ASTM C33.

1. Natural sand of clean, hard, durable particles.

2. Indiana Department of Highways, Standard Specifications, Size #23.

D. Coarse Aggregate: ASTM C33.

1. Crushed stone or gravel of clean, sound, tough, durable particles.

2. Indiana Department of Highways, Standard Specifications, Class A, Size 8, 3/4 inch maximum size.

E. Water: Clean and free from injurious amounts of oil, acids, alkalis, salts, organic materials and other deleterious substances.

F. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.

1. Standards:

a. Micro-Air by Master Builders.
b. MB-VR by Master Builders.
c. Darex AEA by W. R. Grace & Co.
d. DarexII by W. R. Grace & Co.
e. Airalon by W.R. Grace & Co.
f. or Equal.

G. Water-Reducing Admixture: ASTM C494, Type A.

1. Standards:

a. Pozzolith 122-N or LL-960 by Master Builders.
b. Pozzolith 322-N or 220-N by Master Builders.
c. WRDA with Hycol by W. R. Grace & Co.
d. or Equal.

H. Retarding Admixture: ASTM C494, Type B.

1. Standards:

a. Pozzolith 122-R by Master Builders.
b. Daratard-17 by W. R. Grace & Co.
c. or Equal.

I. Accelerating Admixture: ASTM C494, Type C.

1. Standards:

a. Pozzolith 122-HE by Master Builders.
b. Pozzolith 555-Accelerator by Master Builders (Non-chloride).
c. Pozzutec 20 by Master Builders (Non-chloride).
d. Daraset by W. R. Grace & Co. (Non-chloride).
e. or Equal.

J. Water-Reducing & Retarding Admixture: ASTM C494, Type D.

1. Standards:

a. Pozzolith 122-R by Master Builders.
b. Daratard-17 by W. R. Grace & Co.
c. or Equal.

K. Water-Reducing & Accelerating Admixture: ASTM C494, Type E.

1. Standards:

a. Pozzolith 122-HE by Master Builders.
b. Daracel by W. R. Grace & Co.
c. or Equal.

L. High Range Water-Reducing Admixture: ASTM C494, Type F.

1. Standards:

a. Pozzolith 440-N by Master Builders.
b. Rheobuild 1000 Master Builders.
c. Daracem 100 by W. R. Grace & Co.
d. or Equal.

M. Synthetic Fibers:

1. Virgin (non-recycled), nylon fibers.

2. 3/4 inch length.

3. Denier less than 100.

4. Use in strict accordance with manufacturer's instructions.

5. Fibers shall be introduced into the concrete at the batch plant.

6. Standards:

a. Fibermesh by Fibermesh, Inc.
b. Nycon by Nycon Inc.
c. or Equal.

N. High Volume Grout:

Grout shall consist of a mixture of sulfate resistant cement, sand and water. Sand and cement shall be mixed in the proportion of one part cement to two parts sand by volume. The consistency of the grout shall be such as is suitable for the work to be done but W/C ration shall not exceed 0.49. Strength shall be a minimum of 5000 psi in twenty-eight (28) days.

2.02 Related Materials

A. Water Based Curing, Sealer and Dustproofer Compound: Liquid type membrane - forming curing, sealer and dustproofer compound complying with ASTM C309, Type 1, Class B and containing 30% solids in accordance with ASTM C4758.

1. Non-staining acrylic type curing compound.

2. Compatible with applied sealers and finishes specified for the concrete surfaces to be cured.

B. Penetrating Sealer: ASTM C642, C672.

1. A clear coating containing 30% solids by weight. One coat is required and shall be applied per manufacturer's directions.

2. Curing shall be as directed by the manufacturer.

3. Standards:

a. Hydrozo Clear 30M by Hydrozo Coatings Company, Waterban 90 (30%) by Lambert Corp, or approved equal.

C. Moisture Retention Cover: ASTM C171.

1. Waterproof paper, polyethylene film, or polyethylene-coated burlap.

D. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. Per sq. ft., complying with AASHTO M 182, Class 2.

E. Evaporation Retardant:

1. Apply in accordance with manufacturer's instructions.

2. Standards:

a. Confilm by Master Builders.
b. Euco-Bar by the Euclid Chemical Co.
c. or Equal.

F. Epoxy Bonding Adhesive:

1. Two-part structural epoxy adhesive, epoxy-polysulfide, 100 percent solids system.

2. Use to bond freshly mixed plastic concrete or patching mortar to hardened concrete.

3. Standards:

a. Polytops 40 by Chem-Masters Corporation.
b. 42-45 Hi-Bond by Celtite, Inc.
c. Sikadur 32, Hi-Mod by Sika Corporation.
d. or Equal.

G. Two-Component Epoxy Glue:

1. Dual-purpose, two-component, moisture insensitive epoxy adhesive.

2. Use to anchor reinforcing steel or anchor bolts into hardened concrete.

3. Standards:

a. Hilti HIT Doweling Anchor System with HY-150 cartridge by Hilti Fastening Systems.
b. Sikadur 32, Hi-Mod by Sika Corporation; (vertical holes with bottoms).
c. Sikadur Injection Gel by Sika Corporation; (horizontal holes).
d. Sikadur 31, Hi-Mod Gel by Sika Corporation; (overhead application).
e. Approved equal; submit literature including depth of embedment to develop reinforcing bars/anchor bolts and spacing requirements.

4. Drilled hole size and installation procedure shall conform to manufacturer's instructions.

5. Use carbide bit drill to prevent damage to reinforcement.

H. Patching Material:

1. Use to repair honeycombed and other defective concrete.

2. Standards:

a. Five Star Structural Concrete by U.S. Grout Corporation, Weber Corp, or equal.

I. Joint Filler: ASTM D1752, Type III.

1. Granulated cork particles, specially treated, dehydrated, and compressed to enable expansion in presence of moisture.

2. Standards:

a. Self Expanding Cork by W. R. Meadows, Inc., A.P.S. Cork, or equal.

J. EVA Joint Filler:

1. The joint material shall be a preformed, resilient and nonextrudable material, produced as an impermeable closed-cell, cross-linked, ethylene vinyl acetate, low density polyethylene copolymer, nitrogen blown material which is weather and wear resistant. The joint material shall be installed in strict accordance to the manufacturer's recommendations, including joint preparation, dimensions, bonding agents and joint installation.

2. Standards:

a. EVAZOTE 50 as manufactured by E-POXY Industries, Inc., Ravena, New York.
b. THERMAL-CHEM E.V.A. expansion joint as manufactured by Thermal-Chem, Inc., Elk Grove Village, Illinois, or equal.

K. Waterstops: (see plans for application of different types)

1. Waterstop Coil - 1" X 3/4" flexible strip of bentonite waterproofing compound.

a. Standards:

1. WATERSTOP-RX as manufactured by CETCO, Hydro-Flex Waterstop as manufactured by Henry Company, or equal.

b. Install in strict accordance with manufacturer's recommendations, including hydrating all in place material with potable water prior to exposure with wastewater.

c. Installation

1. Vertical Surfaces - Adhesive Primer.
2. Horizontal Surfaces - Adhesive Primer or nailing.

2. Extruded Polyvinyl Chloride (PVC).

a. Construction Joints

1. At least 6" wide X 3/8" thick with longitudinal ribs and hollow centerbulb. Split-fin waterstops may be used for vertical wall joints. Smaller widths, as shown on the Plans, may be required for special conditions.

b. Expansion Joints

1. At least 9" wide X 3/8" thick, unless otherwise shown, with a 3/4" ID hollow centerbulb.

c. Provide all waterstop corner joints and tee joints in prefabricated assemblies. Only field joints shall be splice butt welds using a controlled indirect heating element per manufacturer's instructions.

d. Standards:

1. Greenstreak Plastic Products Company.
2. Vinylex Corporation.
3. Wirestop, Paul Murphy Plastics Company.
4. or Equal.

L. Precompressed Expanding Sealant:

1. Will-Seal, precompressed expanding sealant, 250; by Will Seal Construction Foams, Dayton Superior, or Equal.

2.03 Proportioning Concrete Mixes

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method is used, use an independent testing facility for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.

B. Establish concrete proportions to produce homogeneous, durable mixes with the required average strength based on the appropriate amount of overdesign as required by Section 5.3 of ACI 318.

C. Proportion concrete mixes to provide workability and consistency to permit concrete to be worked readily into the corners and angles of the forms and around reinforcement by the methods of placement and consolidation to be employed, without segregation or excessive bleeding.

D. Include a water-reducing or high range water-reducing admixture, used in strict accordance with manufacturer's instructions, in all mix designs. Specified minimum cement contents are based on the use of such admixtures.

E. Include an air-entraining admixture in mix designs for all concrete exposed to wastewater, or freezing and thawing during service and for all concrete exposed to cold weather, as defined in Article 3.11, during construction, before attaining its specified compressive strength.

F. Base mix design on saturated surface dry aggregates. Adjust the amount of mixing water added at the batch plant for the moisture condition of the aggregates.

G. Flyash may be used as a cement substitute with a maximum 20 percent substitution rate on a pound for pound basis.

H. Water Soluble Chloride Ion Content:

1. Maximum percent in concrete by weight of cement:

   a. Prestressed or post-tensioned concrete - 0.06
   b. Reinforced concrete retaining water - 0.10.
   c. Reinforced concrete exposed to earth or weather - 0.15
   d. Other reinforced concrete construction - 0.30

2. Conduct tests for each class of concrete to verify compliance with the above requirements. Test samples of the hardened concrete for water soluble chloride ion content at an age of 28 to 42 days using the test procedure contained in AASHTO, method T-260.

I. Slump:

1. Mixes containing high range water-reducing admixture: 5 to 8 inches.
2. Mixes containing water-reducing admixture: 5 inches maximum.

J. Concrete Mix Classes:

1. Class A Concrete (building footings):

   a. Compressive strength at 28 days: 3000 psi.
   b. Minimum cement content: 423 lb/cu yd.
   c. Maximum water-cement ratio: 0.58.
   d. Air content: Optional

2. Class B & C Concrete (building foundation walls, interior: building columns, beams, supported slabs, walls, slabs-on-grade):

   a. Compressive strength at 28 days: 4000 psi.
   b. Minimum cement content: 517 lb/cu yd.
   c. Maximum water-cement ratio: 0.48.
   d. Air content: Optional
   e. High range water-reducing admixture as required to properly place the concrete.

3. Class D & E concrete (exterior: retaining walls, tank structural slabs, columns, beams, walls, slabs-on-grade, stoops, curbs and sidewalks exposed to de-icers):

   a. Compressive strength at 28 days: 4500 psi.
   b. Minimum cement content: 611 lb/cu yd.
   c. Maximum water-cement ratio: 0.40.
   d. Air content: 6± 1 percent.
   e. High range water-reducing admixture as required to properly place the concrete.

K. Submit written reports to Engineer of record of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed.

L. Adjustment to Concrete Mixes: Mix design adjustment may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as accepted by Engineer of record. Laboratory test data for revised mix design and strength results must be submitted to and accepted before using in work.

2.04 Batching And Mixing

A. Batch and mix concrete in accordance with ASTM C94.

B. Mix concrete until there is a uniform distribution of materials.

PART 3 EXECUTION

3.01 Preparation

A. Install all items to be embedded in concrete. Position accurately and secure against displacement.

   1. Do not embed aluminum items in concrete.

B. Remove all wood scraps, ice, snow, frost, standing water and debris from areas in which concrete will be placed.

C. Before fresh concrete is placed against hardened concrete, retighten forms and suitably clean and moisten the surface of the hardened concrete for bond to the fresh concrete.

D. Thoroughly moisten subgrade on which concrete is to be placed. Do not place concrete on frozen subgrade.

E. Thoroughly clean all conveying and handling equipment.

3.02 Surface Conditions

A. Before concrete is placed, inspect the installed work of this and other Sections and verify that all such work is complete.

B. Verify that concrete can be placed to the required lines and elevations with required cover for reinforcement.

C. Prevent groupings of conduits, pipes and sleeves in concrete that would significantly impair the strength of the concrete. See General Structural Notes for additional requirements.

D. Notify the Engineer of record when concrete placement is planned. Allow sufficient time for review of formwork, reinforcement and embedded items, and for any required corrective work.

3.03 Placing

A. Addition of water to the concrete during transport or at the site is strictly prohibited.

B. Convey concrete by methods and equipment capable of supplying concrete from mixer to place of final deposit without segregation and such that detectable setting of concrete does not occur before adjacent concrete is placed.

C. Use pumping equipment with sufficient design and pumping capacity to ensure a practically continuous flow of concrete at the point of discharge without segregation.

1. Do not add water or alter the mix design in any way to facilitate pumping.
2. Pumping concrete through aluminum pipe is prohibited.

D. Limit vertical drop of concrete to 3 feet unless appropriate equipment is used to prevent segregation.

E. Do not bear concrete conveying equipment on fresh concrete or reinforcement.

F. After concrete placing has started, provide continuous operation until placement of the section is complete. Do not place a greater section at one time than can be properly finished.

G. Deposit concrete as nearly as practicable to its final position to avoid segregation due to rehandling or flowing.

H. Place concrete at a rate such that the concrete is at all times plastic and flows readily between reinforcement and into corners of forms without segregation.

I. Place concrete in all slabs, mats, and beams for the full depth of the member at one time in such a way as to prevent a horizontal cold joint from occurring.

J. All concrete shall be discharged into the structure within 90 minutes after batching per ASTM C94.

K. Do not place concrete that has partially hardened, been retempered or contaminated by foreign materials.

3.04 Consolidation

A. Thoroughly consolidate all concrete with high frequency vibrators, working the concrete thoroughly around reinforcement and embedded items and into corners of forms.

B. Use a sufficient number of vibrators, of appropriate size and type, to provide complete vibration throughout the concrete at the same rate it is placed.

1. Provide at least one spare vibrator at the site for use in case of breakdown.

C. Provide properly spaced vibration of duration sufficient to produce complete consolidation, but not long enough to cause segregation. Continue vibration until mortar just begins to puddle at the surface. Remove any excess free water that collects on the surface.

D. Do not use vibrators to transport concrete within forms.

E. Supplement internal vibration with manual consolidation methods and external form vibration as required to produce concrete free of voids, honeycomb and rough surfaces.

1. Vibrate forms in such a way as to avoid form displacement.

3.05 Finishing Slabs

A. Tolerances: Finish level slabs on grade to a true plane with a tolerance of 1/4 inch in 10 feet as determined by a 10 foot straightedge placed anywhere on the slab in any direction. Finish supported and sloped slabs with comparable precision unless otherwise specified.

B. Screeding:

1. Immediately after placing, strike off excess concrete with a straightedge to bring the top surface to proper grade, aligning it to the contours of screeds.

2. Screed off edge forms, intermediate screed strips or pipe set accurately and firmly to the required elevations and contours for the finished surface.

3. Move straightedge across the concrete surface with a sawing motion, advancing forward a short distance with each movement. There should be a surplus of concrete against the front face of the straightedge to fill in low areas as the straightedge passes over the surface.

4. Complete screeding before any excess moisture or bleeding water is present on the surface.

C. Bull Floating:

1. Immediately after screeding, bull float the concrete surface, eliminating high and low spots, smoothing the surface and embedding the coarse aggregate.

2. Avoid overworking the concrete. Do not close up or seal the surface of the concrete.

3. Complete bull floating before any excess moisture or bleeding water is present on the surface.

D. Floating:

1. Begin floating operations when bleeding water has disappeared or been removed from the surface and when the surface has stiffened sufficiently to support the operation.

   a. Do not use dry cement and sand to take up bleeding water.

2. Hand or power float the concrete surface, removing slight imperfections and producing a relatively even and true surface with a uniform, sandy texture prepared for final finishing.

3. Avoid overworking the concrete. Do not close up or seal the surface of the concrete.

E. Final Finishing:

1. Hard Trowel Finish: All slabs unless otherwise specified.

   a. Immediately after floating, use power trowel for first trowelling to produce a smooth surface relatively free of defects.
   b. Use tilted hand trowel and heavy pressure for final trowelling after concrete has become hard enough to produce a ringing sound as the trowel is moved over the surface. Produce a smooth, hard, dense surface, uniform in texture and appearance and free of defects.
   c. Use hand trowelling in areas inaccessible to power trowelling and for final trowelling of concrete slabs with exposed finishes.

2. Broom Finish: Slip-resistant surfaces.

   a. Immediately after floating, draw a broom across the concrete surface transversely to the main direction of traffic, producing a coarse, scored, slip-resistant texture.

3. Rough Swirl Finish: Parking surfaces.

a. Modify the floating operation described in Paragraph 3.05D: Hand or power float the concrete surface, removing slight imperfections and producing a roughened surface with approximately 1/16 inch roughness amplitude.
b. Avoid overworking the concrete.
c. Finishing must not begin until any bleed water has disappeared.
d. Do not add water to concrete surface during the finishing operation.

3.06 Finishing Formed Surfaces

A. Rough Form Finish: All formed concrete surfaces not exposed to public view.

1. After being cleaned and thoroughly dampened, fill tie holes solid with patching mortar matching the color of the surrounding concrete.

2. Patch defective areas in accordance with Article 3.07.

3. Chip or rub off fins and projections exceeding 1/4 inch in height.

B. Smooth Form Finish: All formed concrete surfaces exposed to public view.

1. After being cleaned and thoroughly dampened, fill tie holes solid with patching mortar matching the color of the surrounding concrete.

2. Patch defective areas in accordance with Article 3.07.

3. Completely remove all fins and projections.

4. Apply grout cleandown treatment to surface areas with light honey-combing and air holes, completely filling all voids. Match grout color with that of the surrounding concrete.

C. Smooth Rubbed Finish: Formed concrete surfaces exposed to public view as specified.

1. Following smooth form finish described in Paragraph 3.06B (1, 2 and 3), wet the concrete surface and rub with carborundum brick or other abrasive until uniform color and texture are produced.

2. Do not use cement grout other than the cement paste drawn from the concrete by the rubbing process.

D. Finish concrete in accordance with the following schedule, unless specifically excepted.

SURFACE	FINISH
All exposed vertical surfaces from 8 inches below grade or minimum operating level	Smooth rubbed finish
Floor slabs of tanks and channel floors	Smooth floated finish
Floor slabs of tanks or channel floors which will receive leveling grout	Broomed finish
Interior building floors	Steel trowel finish w/Sealer
Leveling grout for tank slabs and channel floors	Screeded with steel trowel finish
Exterior horizontal traveled surfaces	Broomed finish
Exposed exterior horizontal surfaces except as listed above	Smooth rubbed finish

E. Cement based or acrylic polymer compounds will be considered as an alternative to rubbing. Preparation and application shall meet the requirements of cement based and acrylic polymer compound manufacturers.

3.07 Repair Of Defective Areas

A. Remove honeycombed and other defective concrete, exposing sound concrete. Cut and chip edges straight and perpendicular to the surface or slightly undercut. Featheredges are not permitted.

B. Dampen areas to be patched and surrounding areas. Patch with patching mortar or patching material.

1. Patching with patching mortar:

a. After surface water has evaporated from the area to be patched, brush an epoxy bonding adhesive onto the surface.
b. When the bonding coat begins to lose surface water, apply a patching mortar (1 part cement to 2½ parts sand with minimum mixing water required for handling and placing), matching the color of the surrounding concrete, to the surface.

2. Patching with patching material:

a. After surface water has evaporated from the area to be patched, apply patching material to the surface.
b. Apply patching material in accordance with manufacturer's instructions.

C. Thoroughly consolidate patching mortar or patching material into place and strike off so as to leave the patched area slightly higher than the surrounding surface.

D. To allow initial shrinkage, leave the patched area undisturbed for at least one hour. After initial shrinkage has occurred, strike off with a straightedge spanning the patched area and finish to match the surrounding surface.

E. Apply curing to the patched surface as soon as possible and maintain for a minimum of 2 days.

3.08 Curing

A. Maintain all concrete in a moist condition for at least 5 days at temperatures above 70 F and at least 7 days at temperatures above 50 F.

B. Curing Slabs: Curing Compounds or moisture retention covers (wet cure). Wet cure all slabs receiving tile floor covering.

1. Apply curing compounds to the concrete surface, immediately after final finishing of the concrete, in accordance with manufacturer's instructions.

2. Place moisture retention covers on the concrete surface immediately after final finishing of the concrete. Lap edges 6 inches and seal, creating a moisture barrier that must remain intact for the duration of the curing period.

C. Curing Formed Surfaces:

1. Formed surfaces may be cured by leaving forms in place. During hot, dry weather, keep forms moist by sprinkling.

2. When forms are removed before the end of the curing period, apply curing compound to walls and columns.

3.09 Joints

A. Construction Joints:

1. Locate construction joints so as not to impair the strength of the structure.

2. Continue all reinforcement across construction joints.

3. Provide keys in all vertical construction joint surfaces.

4. Thoroughly clean the concrete surface at construction joints and remove all laitance before placing adjoining concrete.

5. In slabs on grade with control joints, locate construction joints at control joint locations.

B. Slab on Grade Contraction Joints:

1. Sawcut Contraction Joints: Sawcut joints as soon as possible after the concrete hardens. The concrete is hard enough when the blade does not dislodge aggregate and when the edges of the cut do not ravel. Complete saw-cutting before shrinkage stresses become sufficient to produce cracking. Sawcut joints in straight lines to avoid unsightly joints.

2. Hand-Tooled Contraction Joints: Tool joints with hand groovers in straight lines to avoid unsightly joints.

3.10 Hot Weather Concreting

A. Follow the provisions of this Article and ACI 305 when the rate of evaporation of surface moisture from the concrete exceeds 0.18 lb/sq ft/hr (Figure 2.15, ACI 305).

B. Control concrete setting time with the use of retarding admixtures or water-reducing & retarding admixtures as required to facilitate placing and finishing operations.

C. Before placing concrete, spray the subgrade, forms and reinforcement with water to keep them cool and to prevent absorption of water from the concrete.

D. Transport, place and finish concrete as quickly as practicable. Plan concrete delivery, placing techniques and consolidation methods to avoid cold joints.

E. Maximum temperature of concrete during placing: 90 F.

F. Apply evaporation retardant to the surface of the fresh concrete after screeding and as needed during finishing.

G. Take additional precautions as necessary to prevent plastic shrinkage cracking.

H. Start curing the concrete immediately after finishing operations have been completed.

3.11 Cold Weather Concreting

A. Follow the provisions of this Article and ACI 306 when the average daily temperature (average of the highest and lowest temperature during the period from midnight to midnight) is less than 40 F.

B. Control concrete setting time with the use of accelerating admixtures and water-reducing accelerating admixtures as required to facilitate placing and finishing operations.

1. Do not use calcium chloride as an accelerating admixture.

C. Temperature of concrete during placing: 55 F to 75 F.

D. Provide heated enclosures or insulation to maintain the temperature at the concrete surface between 55 F and 75 F for a minimum of 7 days or until the concrete reaches its specified compressive strength.

1. Construct weathertight enclosures, allowing the heated air to circulate around the outer edges of the concrete.

2. Provide a sufficient number of heaters vented to the exterior to assure an even temperature within the enclosure and prevent dusting due to carbonation.

3. Add moisture to the heated air as required to maintain a minimum relative humidity of 40 percent within the enclosure. Do not allow any concrete surface to become dry during the protection period.

4. Maintain enclosures for 24 hours after heating has been discontinued to allow the concrete to cool gradually.

5. Lap insulating materials and cover the edges and corners of the concrete to provide complete and adequate protection.

6. Wrap columns and walls with insulated blankets.

7. Monitor the temperature of the concrete surface regularly with suitable thermometers throughout the protection period.

E. Provide insulation or temporary backfill to protect all earth supported concrete from damage due to frost heaving.

3.12 Protection

A. Protect all finished concrete surfaces from damage by construction equipment, materials or methods and by rain or running water.

B. Do not load self-supporting members in such a way as to overstress the concrete.

3.13 Field Quality Control

A. Testing Laboratory: Conduct testing and write reports as outlined in this Article per the requirements in the General Conditions.

B. Strength Tests:

1. During the progress of the work, take samples of concrete for strength tests in accordance with ASTM C172.

2. Make and cure a minimum of 4 cylinders in accordance with ASTM C31 for each of the following:

   a. Individual pours utilizing separate batches of concrete.
   b. Each 50 cubic yards of concrete.
   c. Each 3000 square feet of surface area for slabs and walls.
   d. Each class of concrete placed in a day's work.

3. Test each group of 4 cylinders in accordance with ASTM C39 as follows:

   a. Two field cured cylinders to be tested at 7 days or just before anticipated time of form removal.
   b. Two laboratory cured cylinders to be tested at 28 days.

4. A strength test is the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days.

5. The strength level of an individual class of concrete will be considered satisfactory if both of the following requirements are met:

   a. Average of all sets of three consecutive strength tests equal or exceed the specified compressive strength.
   b. No individual strength test (average of two cylinders) falls below the specified compressive strength by more than 500 psi.

6. If the strength level of an individual class of concrete is found to be unsatisfactory, conduct core testing in accordance with ASTM C42, impactometer testing or load testing on the area of concrete in question as required by the Engineer of record. If such additional testing does not produce acceptable results, corrective measures will be required to ensure structural adequacy.

   a. Make appropriate adjustments to the concrete mix designs as required.

C. Slump Tests:

1. Make one slump test in accordance with ASTM C143 with each group of 4 cylinders.

2. <u>When concrete is pumped, make the slump test at the point of discharge</u>.

3. Keep a slump cone available at the site for additional testing as required.

D. Air Content Tests: Make one air content test in accordance with ASTM C173 or ASTM C231 with each group of 4 cylinders for air-entrained concrete mixes at point of discharge.

E. Air-dry Density Tests:

1. Make one air-dry density test in accordance with ASTM C567 for each group of 4 cylinders.

F. Rejection of Concrete:

1. Any concrete that does not meet the specified requirements for air-entrainment, concrete temperature, or slump shall not be placed until corrective measures have been taken, and the concrete has been re-tested to indicate compliance.

2. The testing laboratory shall be responsible to furnish all testing data immediately to the Engineer of record. If tests fail to meet the specifications, the material shall be retested.

G. Field Quality Control Test Reports:

1. Include the following information in test reports:

a. Project identification and portion of structure represented.
b. Concrete mix class and specified compressive strength requirements.
c. Weather conditions and air temperature.
d. Concrete temperature, slump and air content test results.
e. Dates of placing and testing.
f. Method of curing (field or laboratory).
g. Strength test results.
h. Technician: name, certification number with expiration date.

3.14 Watertight Concrete

A. When the concrete has attained sufficient strength and before the basins, tank, etc., which hold water, are placed in service, they shall be filled with water and tested for watertightness. Any imperfections, leaks or combination of leaks which cause the surface of the water to drop more than one-quarter (1/4) inch in twenty-four (24) hours shall be satisfactorily repaired. Any visible leaks shall be made watertight.

The Contractor shall make concrete in all structures watertight. Any cracks or imperfections developing at any point in the work shall be thoroughly repaired in a manner satisfactory to the Engineer of record. The Contractor shall take extraordinary precautions to prevent the possibility of water leakage along construction joints. All special treatment of the concrete and joints necessary to fulfill the specifications for water tightness shall be at the Contractor's expense.

3.15 Pipe Piers, Pump And Equipment Bases

A. All concrete pipe piers, pump bases and equipment bases shall be constructed as a part of the concrete work. All pump and equipment bases or pads shall be securely anchored to the floor by means of the reinforcing steel dowels if the pads are poured separate from the floor. Special care shall be taken to accomplish a presentable finish on the pump and equipment bases, the surface of which shall be rubbed as specified under the heading of "Smooth Rubbed Finish". An approved nonshrinking grout shall be used for filling solid the void spaces between the bottoms of pump or equipment bases and the tops of the concrete pads.

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(SECTION WM 6)

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 Description

A. The work under this Section consists of furnishing all labor, equipment, materials and services required for the installation of all concrete reinforcement and associated items required and/or indicated on the Drawings or specified herein.

B. Related work specified elsewhere:

1.	Concrete Formwork	Section WM-5.1
2.	Cast-in-Place Concrete	Section WM-5.2

1.02 Quality Assurance

A. Provide at least one experienced person who shall be present at all times during execution of this portion of the Work and who shall be thoroughly familiar with the type of materials being installed and the best methods for their installation and who shall direct all work performed under this Section.

B. Codes and Standards (latest editions):

1. "Manual of Standard Practice for Detailing Reinforced Concrete Structures" ACI 315.
2. "Building Code Requirements for Reinforced Concrete" ACI 318.
3. “Specifications for Structural Concrete for Buildings”, ACI 301.
4. CRSI Manual of Standard Practice.
5. ACI 311, “Standard Specifications for Tolerances for Concrete Construction and Materials”.
6. Portland Cement Association, “Positioning Welded Wire Fabric”.
7. ASTM C1116, Type III, “Standard Specifications for Fiber-Reinforced Concrete and Shotcrete”.

C. The Contractor shall attend a pre-construction meeting to discuss the review of reinforcement steel installation. The ironworker foreman shall be present.

1.03 Submittals

A. Shop Drawings; Reinforcement: Submit original shop drawings prepared by registered Professional Engineer for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315 “Manual of Standard Practice for Detailing Reinforced Concrete Structures” showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

B. Shop Drawings:

1. Submit the proposed Shop Drawing Submittal Schedule prior to submitting any of the shop drawings for review.
2. Shop drawings giving details of fabrication and placing shall be prepared by the supplier and submitted to the Engineer of record for his review.
3. Shop drawing action codes:
    a. Shop drawings marked “no exception taken” require no corrections to be made. No re-submittal is required. Fabrication may commence leading to reinforcement installation.
    b. Shop drawings marked "make corrections noted” require the marked corrections to be made. No resubmittal is required. Fabrication may commence leading to reinforcement installation.
    c. Shop drawings marked “make corrections noted - revise and re-submit” require the marked corrections to be made. The drawings must be resubmitted for review. Fabrication may commence. Installation may not begin until the subsequent submission has been reviewed and returned for use in reinforcement installation.
    d. Shop drawings marked “rejected - revise and re-submit” require shop drawings be re-evaluated to be in compliance with the construction documents. The drawings must be re-submitted for review. Fabrication may not commence.
4. Shop drawings will be checked by the Engineer for correct interpretation of the drawings but this check shall not relieve the Contractor of his primary responsibility to provide the correct number of properly detailed bars in all members.
5. Resubmitted shop drawings:
    a. All information which is correct on the original submittal should not be changed in any way on the resubmitted shop drawings.
    b. If information on a shop drawing must be changed, then cloud all the changes on the resubmitted shop drawings.
6. See the "General Notes" and the "Typical Details" of the structural drawings for extra reinforcing around openings, over beams and other general information for the detailer.
7. Shop drawing shall be prepared in accordance with the following:
    a. Beams and Walls: 1/4-inch scale elevations of all walls and beams shall be provided with all the reinforcing shown on the elevations, not scheduled.
    b. Slabs and Mats: Reinforcing for all concrete slabs shall be shown on a floor plan drawn exclusively for this use. Reinforcing shall not be scheduled.
    c. Slabs and Mats: A support system plan for all slabs shall be provided. Supports for slab top and bottom bars shall be shown in number and location. The maximum spacing of support bars shall be 4'-0. The maximum overhang beyond a support bar or a slab bolster shall be 1'-0.
    d. Bar bending diagrams shall be provided for all bent bars (within a submittal) in that same submittal.
    e. Sections of walls, beams, joists and slabs shall be provided showing clearly bar positions and clearances to forms.

f. On wall sections, indicate spacers used to maintain clearances for vertical wall steel.
g. Beam bolsters and joist chairs shall be indicated as to size and spacing on the sections and the elevations.
h. Shop drawings shall include all details, sections, and installation instructions indicated on the structural drawings that are required by the Contractor to place the reinforcement without using the structural drawings.
i. Grades of reinforcement shall be indicated on each shop drawing.

8. Submit the following regarding the mechanical tension butt splices, the end-bearing splices and the dowel bar replacement system to be used:
   a. Shop drawings indicating fabrication and placement details per this section.
   b. Manufacturer's literature, product samples, and certified test reports substantiating compliance with the specification.

1.04 Product Handling

A. Protection:

1. Use all means necessary to protect concrete reinforcement before, during and after installation and to protect the installed work and materials of all other trades.
2. Store in a manner to prevent excessive rusting and fouling with dirt, grease, and other bondbreaking coatings.
3. Use all necessary precautions to maintain identification after the bundles are broken.

B. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer of record and at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 Concrete Reinforcement

A. All concrete reinforcement materials shall be new, free from rust, and complying with the following reference standards:

1.	Main reinforcing Bars:	ASTM A-615 Grade 60, deformed
2.	Stirrups and Column tie Bars:	ASTM A-615 Grade 60
3.	Wire Reinforcement	ASTM A- 82, plain, cold-drawn steel
4.	Welded Wire Fabric:	ASTM A-185
5.	Weldable Reinforcing Bars:	ASTM A706, Grade 60, weldable deformed
6.	Epoxy Coated Reinforcing Bars:	ASTM A775

2.02 Accessories

A. Provide bar supports, bolsters, chairs, spacers, ties, blocking, other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place and in accordance with CRSI "Manual of Standard Practice".

B. Bar supports shall be stainless steel or protected with plastic in contact area. When underneath side of floor is to be exposed and painted, bar supports shall be stainless steel.

C. Provide plastic spacers to properly maintain clearances for vertical wall reinforcement.

D. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

2.03 Mechanical Butt Splices

A. Mechanical butt splices shall conform to ACI318-89.

1. Lenton Rebar Splicing - Erico.
2. Grip Twist System - Dayton Barsplices, Inc.
3. Cadweld, C-Series - Erico.
4. or Equal.

2.04 Dowel Bar Replacement System

A. Shall conform to ACI 318-89.

1. Dowel Bar Substitution and Splice System-Richmond Screw Anchor Co.
2. Dowel Bar Replacement System-Dayton Superior
3. Stabox-Couplerbox Inc.
4. or Equal.

PART 3 EXECUTION

3.01 Fabrication

A. Fabrication, including bar bending shall comply with the requirements of ACI 318, ACI 315 and CRSI "Manual of Standard Practice".

3.02 Surface Conditions

A. Inspection:

1. Prior to installation of the Work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that concrete reinforcement may be installed in strict accordance with all pertinent codes and regulations, the approved Shop Drawings, and the original design.

B. Discrepancies:

1. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved and approved by the Engineer of record.

3.03 Installation

A. All reinforcement shall be held securely in design position by wiring to supports in accordance with CRSI standards and, in addition, any other supports needed to secure every bar against displacement shall be provided. Overhanging tails shall be supported positively. Walking on top slab bars shall be avoided. All bars bent and/or displaced during concrete placement shall be straightened and repositioned before they are encased in concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice and other materials which reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric in as long lengths as practicable in accordance with the Portland Cement Association. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction. Hooking welded wire fabric and lifting into position is not acceptable.

F. Tolerances on reinforcing placement:

Member	Top Steel	Bottom Steel	Side Steel
Slabs	3/8"±	1/4"±	
Joists			
Beams	½"±	1/4"±	½"±

G. Splicing of main reinforcement will not be permitted unless set out on the construction documents or approved by the Engineer of record.

H. Concrete protection shall comply with the requirements of ACI 318 except as modified on the Structural Drawings.

I. Avoid cutting or puncturing vapor retarder during reinforcement placement and concreting operation.

J. Obstructions:

1. In the event conduits, piping, inserts, sleeves or any other items interfere with placing reinforcement as indicated on the Drawings or as otherwise required, immediately consult the Engineer of record and obtain approval of new procedure before placing concrete.

3.04 Notification

A. Contractor shall notify the Engineer of record when reinforcement for a pour is nearing completion so that reinforcing steel in place may be reviewed.

1. Allow sufficient time for setters to make adjustments or corrections so that reinforcing steel correct in size, shape and position will be in place when concreting is started.

(SECTION WM 9)

STANDARD MANHOLES

PART 1 GENERAL

1.01 Description

A. Standard manholes shall be constructed complete, ready for use, including excavation, backfill, concrete work, cast iron frames and covers, manhole steps, walls of alternate construction, and pertinent work as shown on the plans, and as specified. All manholes shall be made watertight, and the Contractor shall furnish all materials and perform all work necessary for watertight construction.

B. All proposed castings set in paved areas shall match (be flush with) the final pavement elevations unless the casting is to be depressed in order to create a sump. All proposed castings to be set in non-paved areas shall match (be flush with) the final ground elevations unless they are shown to be set higher. This requirement may supersede casting elevations shown on the plans. Confirm with the Engineer prior to ordering and installing final structures and castings.

1.02 Product Handling

A. Store and protect miscellaneous items at the Project site. All precast structures must be delivered to job site by means which will adequately support them, and not subject it to undue stresses and are not damaged by crushing. The structures shall be unloaded carefully and strung or stored as close to the final point of placement as is practical.

1.03 Submittals

A. Submit shop drawings for all structures and other appurtenances.

B. Include all performance data such as strengths for concrete and steel and other material items. Reinforcing shall be detailed on the shop drawings.

C. Shop drawings with supportive documentation for all prefabricated manholes other fittings or integral components shall be submitted to the engineer prior to fabrication.

1.04 Related Specifications

A. Comply with applicable portions of the following WM Specifications:

WM-2	Excavation
WM-3	Backfill, Fills and Embankments
WM-5.2	Cast-in-Place Concrete
WM-6	Concrete Reinforcement

PART 2 PRODUCTS

2.01 Reinforced Concrete Manholes and Accessories

A. Manholes shall be constructed in accordance with the ASTM Specifications for "Precast Reinforced Concrete Manhole Risers and Tops", Designation C 478. The minimum wall thickness shall be five (5) inches for manholes four (4) feet in diameter.

B. The precast tops shall be of the eccentric cone type. Precast flat covers shall be not less than eight (8) inches thick and reinforced with two layers of steel with a minimum area of 0.39 square inches per linear foot in both directions in each layer. Precast flat bottoms of manholes shall also be reinforced the same as specified herein for precast flattop. Hoisting lugs or hooks shall be cast in place for handling and setting of the rings. Openings of proper sizes and suitable design shall be cast in place for receiving the sewer and/or drop pipes and connections. Adjusting riser rings shall be provided as approved by the Owner.

C. All manhole joints shall be tongue and groove and they shall be sealed with an O-ring and joint sealer conforming to Federal Specifications SS-S-00210 and similar to "Kent-Seal No. 2" as manufactured by the Hamilton Kent Manufacturing Co., of Kent, Ohio; "RAM-NEK" as manufactured by the K.T. Snyder Co. of Houston, Texas, or equal. Cracked or damaged barrel joints shall be rejected. All joints shall also have an exterior joint collar.

D. Manhole Steps. Steps shall be provided and manufactured of reinforced plastic and shall be twelve (12) inches wide and one (1) inch square.

E. Manhole Bases. Manhole bases shall be of cast-in-place monolithic concrete or precast concrete. Where sewer lines pass through or enter manholes, the invert channels shall be smooth and semi-circular in cross section and shall be formed directly in the concrete of the manhole base. Changes of direction of flow within the manholes shall be made with a smooth curve with as long as a radius as possible. The floor of the manhole outside the channels shall be smooth and slope toward the channel not less than one (1) inch per foot.

F. No mortar or concrete shall be placed in water, and no water shall be allowed to flow over or against the concrete before it has set for a period of time deemed sufficient by the Owner to prevent damage to the structure. The invert channel through manholes shall be provided and constructed to conform in shape and slope to that of the sewer. All invert channels are to have a properly mortared apron on either side, sloped to prevent solids deposition. Changes of direction of flow within the manhole shall be made with a smooth curve with as long as a radius as possible.

G. Adjusting Rings. Where one (1) solid riser or barrel section cannot be used, final adjustments in elevation of the frame and cover shall only be accomplished by the use of precast concrete adjusting rings conforming to ASTM C 478. Rings shall be of a nominal thickness of not less than four (4) inches. Not more than twelve (12) inches total of adjusting rings shall be allowed for adjustment of the manhole frame and cover to required elevation.

H. All exterior manhole joints shall have a joint collar equal to MacWrap Exterior Joint Sealer, RUBR–NEK External Joint Wrap, or equal. Collar shall be a minimum of 9” wide.

2.02 Sewer Pipe to Manhole Connections

A. To connect a sanitary sewer to a manhole, either a flexible boot KOR-N-SEAL 1 or 2, flexible connector, cast-in-place Dura-Seal gasket, "A"-lock gasket or an approved equal shall be used. Connections to an existing manhole shall be a flexible boot seal.

B. If the flexible boot connection is used, it shall be placed in the reinforced concrete manhole base and secured to the pipe by a stainless steel clamp. Flexible connectors shall conform to ASTM C 923.

C. The cast-in-place inflatable gasket shall conform to ASTM C 923.

D. All connections shall provide for a watertight seal between the pipe and manhole. The connector shall be the sole element relied upon to assure a flexible watertight seal of the pipe to the manhole.

E. The rubber for the connector shall comply with ASTM C 923 and shall be resistant to ozone, weather elements, chemicals, including acids and alkalis, animal and vegetable fats, oils and petroleum products.

F. The stainless steel elements of the connector shall be totally non-magnetic Series 305 stainless steel. The stainless steel clamp shall be capable of sustaining applied torque in excess of eighty (80) inch-pounds. It shall be the responsibility of the Contractor to submit details of the proposed connection to the Owner for approval. Connections not approved by the Owner shall be subject to removal and replacement with an approved adapter.

G. New connections made to any existing structure shall be drilled in the direction of flow and shall be accomplished by coring entirely through the wall and base of the structure. The connector boot shall be appropriately sized to fit the opening and shall be KOR-N-SEAL® by NPC, Inc., A-Lok Products, Inc., or approved equal.

2.03 Castings

A. Standard manholes shall have a R-1772-B frame and lid by Neenah Foundry, 1022-Z1 by East Jordan Iron Works, or approved equal. Material shall be in compliance with ASTM A 48, CL 35B. Each lid shall have 2 inch high letters indicating "Sanitary Sewer".

B. Where watertight castings are required, the manholes shall have a R-1916F frame and lid by Neenah Foundry, 1045 HD by East Jordan Iron Works, or approved equal. The frame shall be anchored to through the riser rings (if provided) to the cone section with four (4) galvanized rods.

2.04 Frame Chimney Seal

A. An internal or external rubber seal shall be installed on all sanitary manholes. A rubber seal extension, to cover any additional heights of chimney not covered by the seal itself, shall be used when required. The internal and external rubber seal and seal extensions shall be as manufactured by Cretex Specialty Products, NPC Specialty Products Mega-A-Lug (Oni-Flange), or equal.

B. The sleeves shall be extruded from a high grade rubber compound conforming to the applicable requirements of ASTM C 923. The bands used for compressing the sleeve and extension against the manhole shall be fabricated from 16 gauge stainless steel conforming to ASTM A 240 type 304, any screws, bolts or nuts used on this band shall be stainless steel conforming to ASTM F 593 and 594, type 304.

C. The joint between the manhole frame and chimney or cone shall be 3/4" thick and made using cement mortar. Any sealant used between the adjustment or grade rings of the chimney shall not be used in this joint. Installation of these rubber seals shall be in accordance with the manufacturer's recommendation.

PART 3 EXECUTION

3.01 Installation

A. All manholes, inlets and similar drainage structures shall be installed so that the top of the inlet casting and frame (at the lowest point where surface water can enter) is flush with the final ground elevation.

B. All structures shall be bedded on a minimum of 6 inches of compacted aggregate consisting of granular or crushed aggregate materials. No structure shall be set on soft our yielding soils.

PART 4 SANITARY MANHOLE TESTING

4.01 Testing

A. All manhole vacuum tests shall be conducted in the presence of a representative of the Engineer and in accordance with ASTM C1244, Standard Test Method for concrete Sewer Manholes by Negative Air Pressure (vacuum) Test.

B. The vacuum test equipment shall consist of: inflatable plugs for all incoming and outgoing sewer lines; an inflatable test collar to seal the manhole at the manhole frame; and a vacuum pump. A vacuum gauge shall be located in-line between the test collar and the pump to accurately indicate the vacuum in inches of mercury within the manhole. The vacuum gauge shall have a range to no more than thirty (30) inches of mercury, with scale markings of no greater than one-half (1/2) inch of mercury vacuum and an accuracy to within ± two percent (2%) of true vacuum.

C. Initial test manhole shall not be backfilled.

D. The vacuum test shall be conducted by plugging all incoming and outgoing sewer lines in the manhole at a location beyond the connection of the sewer pipe with the manhole. All plugs shall be blocked in place so as not to move during the test. The vacuum testing collar shall be inflated in the frame in accordance with the equipment manufacturer's recommendations. A vacuum of ten (10) inches of mercury shall be drawn and the vacuum pump turned off and the valve between the vacuum pump and the vacuum gauge shall be turned off.

E. The time period which is taken for the vacuum to fall from ten inches (10") of mercury to nine inches (9") of mercury shall be determined. If the time taken for the vacuum to reduce the ten inches (10") of mercury to nine inches (9") of mercury is less than the time indicated in the following Table, then the manhole work shall be considered not acceptable and shall be rejected. If the time is equal to or exceeds the time indicated below, the manhole work shall be accepted.

		Time (sec)		
Manhole Depth (ft.)	**Diameter =**	**48”**	**60”**	**72”**
8		20	26	33
10		25	33	41
12		30	39	49
14		35	46	57
16		40	52	65
18		45	59	73
20		50	65	81
22		55	72	89
24		59	78	97
26		64	85	105
28		69	91	113
30		74	98	121
For each add'l 2' add:		5	7	8

F. Contractor shall submit to the Engineer the results of each manhole vacuum test. Such reports shall include a description of the location of the manhole, the time, date and weather of the test, a list of all persons present, the diameter and depth of the manhole and the allowable test results, and the actual test results.

G. All manholes shall be repaired by Contractor and retested as described above until a successful test is made. After each test, the temporary plugs shall be removed.

4.02 Final Acceptance

A. Once all manholes have been tested, the manholes will be given a field visual inspection. The inspection shall be performed at the discretion of the Owner and Engineer during the warranty period. All leakage problems determined by this inspection shall be corrected by the Contractor within an agreed upon time to the satisfaction of the Owner. Where necessary to complete the work, the Contractor shall be responsible for the bypassing and/or blocking of the flow in

the manholes and must have prior approval by the Owner. It will be the Contractor's responsibility to supply his own traffic control as required by the particular location and/or jurisdiction.

(SECTION WM 11)

EXPOSED DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.01 Description

A. Ductile iron (D.I.) pipe shall be of the Class and Type of joint as specified under the Contract Items and as shown on the Plans.

B. Unless specified otherwise, all D.I. pipe shall as a minimum conform to these specifications. No deviation will be allowed unless approval from the Engineer is documented.

PART 2 PRODUCTS

2.01 Centrifugal Ductile Pipe

A. Unless otherwise specified, all ductile iron pipe shall be centrifugally cast and shall be made in accordance with latest American National Standards Institute Specifications, "Ductile Iron Pipe Centrifugally Cast in Metal Molds or Sand Lined Molds for Water or Other Liquids", ANSI A21.51 (AWWA Standard C-151).

B. Unless otherwise specified, all D.I. pipe four (4) inches through fifty-four (54) inches shall be thickness Class 53 per ANSI A21.51/AWWA C51. Joints shall be flanged per ANSI A21.10/AWWA C110 or ANSI A21.15/AWWA C115.

C. Coatings and Linings: Unless otherwise specified, all ductile iron pipe and fittings shall be given a "standard outside coating" and a "cement inside coating" in accordance with the applicable ANSI A21.4 and AWWA C104, "Cement - Mortar Lining for Ductile Iron and Gray Iron Pipe", and "Fittings for Water".

1. Ductile iron piping used for air mains shall not be provided on interior coating nor lining.

D. All pipe located under concrete structures shall be of minimum pressure class 350.

E. Fittings: All fittings shall be furnished as follows unless specified otherwise in the Detailed Specifications.

2.02 Mechanical Grooved Pipe Couplings and Fittings

A. Mechanical grooved pipe fittings and couplings as manufactured by Victaulic, Anvil International, or equal shall be acceptable for all ductile iron piping systems. Housings may be manufactured from malleable (ASTM A47 Grade 32018) or Ductile Iron (ASTM A536 Grade 65-45-12).

B. Ductile iron pipe barrels shall conform to the requirements of ANSI Specification A 21.51, or the latest revision and AWWA Specification C 151, or the latest revision.

C. Grooved end ductile iron pipe shall conform to AWWA Standard C 606-87, or the latest revision, for rigid grooving dimensions. Flexible grooved joints may be used for certain design considerations as shown on plans or detailed elsewhere in these specifications.

D. Fittings shall conform to the requirements of ANSI Specification A 2l.20 or AWWA C 110, or the latest revision, with the exception of the end preparation. End preparation shall be a radius grooved configuration conforming to Victaulic Company of America's, or equals, recommendation for rigid joints.

E. Couplings shall conform to AWWA Standard C 606-87. Coupling gaskets shall be suitable for use with ductile iron pipe with a short center gasket leg to bridge the pipe ends.

F. Transition flanges, Victaulic Style 341/342, Anvil Gruvlok 7012, or equal, shall be used to facilitate connection from grooved pipe or fittings to 125# cast iron flanged valves, pump, pipe, fittings, or other equipment.

G. The transition flanges shall be malleable iron conforming to ASTM Specification A 47 (Grade 32510, 35018) or ductile iron conforming to ASTM A 536 (Grade 65-45-12). Gaskets shall have properties as designed by ASTM D 2000(Grade 3BA 515 A14 B44Z) and shall be suitable for the required service.

H. Grooving dimensions shall conform to AWWA Standard C 606-87, or the latest revision.

2.03 Flanged Joints

A. Flanged joints shall be made up with ring or full faced rubber gaskets with cloth insertion of thickness to be approved by the Engineer. Flanges shall be firmly bolted with machine, stud or tap bolts of the proper size. No "Dutchman" or sleeves shall be used in the pipe lines except as shown on the plans or as approved by the Engineer. Field installed flange adaptors shall be cast from 60-42-10 as cast ductile iron per ASTM 536-77 and shall have bolt circles and bolt holes to meet ANSI B16.1 - 125 lbs. These flanges shall contain set screws made from ductile iron. The screws shall have a Rockwell hardness of C40-45 converted from Brinell. The use of these flange adaptors is permitted only when dimensional adjustments are required to accommodate equipment connections in header assemblies and only with written approval of the Engineer. When such flanges are permitted the Contractor shall assume full responsibility for additional blocking and bracing required to prevent movement from dynamic forces including water hammer.

B. Gaskets shall meet the requirements of ANSI/AWWA C111, latest edition, minimum 1/8 inch thick, full face and be made of synthetic rubber.

C. Gasket material shall be appropriate for application.

1. For air piping subject to temperatures up to 300º Fahrenheit, gaskets shall be make of Fluoroelastomer, or other equal material for this service.

2. For air piping subject to temperatures up to 250º Fahrenheit, gaskets shall be made of Fluoroelastomer, Ethylene propylene diene monomer or other equal material for this service.

3. For piping subject to significant hydrogen sulfide concentrations, gaskets shall be made of Butyl rubber (EPDM) or other equal or better material for this service.

2.04 Accessories

A. Couplings shall be galvanized steel with grade 30 rubber gaskets and high strength low alloy steel with heavy, semi-finished hexagon nuts and bolts.

B. Bolts and Nuts for flanged joints shall be of the hex-head type per ANSI B18.2.1 and B18.2.2 (ASTM 307) or AWWA C110 Appendix A. Bolts and nuts for mechanical joint pipe shall be Tee head and shall meet the requirements for ANSI A21.11 and be corrosion resistant high strength alloy steel.

C. Flexible connectors shall be 150 psi, flanged reinforced rubber where required by Drawings.

2.05 Electric Bond Conductor

A. When specified in the Detailed Specifications, an electric bond conductor made of copper shall be provided between the adjoining ends of cast and ductile iron pipe, fittings, valves and hydrants which are separated by a rubber gasket without metal to metal contact. The bonding conductor shall be capable of carrying six hundred (600) amps during an extended period for electrical pipe thawing operations. The conductor shall be of a type which can be easily and rapidly installed. Once installed, the connections, shall withstand ground load and movement, expansion and contractions, and other relative pipe movement. The type and design of the bond conductor shall meet with the approval of the Engineer. Also acceptable are silicon bronze wedges (2 per joint).

PART 3 EXECUTION

3.01 Piping List and Drawings

A. For any plant piping work, the Contractor shall submit for review by the Engineer, six (6) copies of a suitable marking system and piping list showing location, dimension, and description of all piping before shipping any pipe and fittings to the job. The Engineer's review of the drawings shall be for the purpose of determining general conformity with the contract plans, and not for purpose of detailed checking and fitting of parts which shall be the responsibility of the Contractor.

3.02 Handling

A. During loading, transporting and unloading, more than ordinary care shall be taken to prevent injury to the pipes and coating. Loading and unloading shall be done slowly with each pipe under perfect control at all times. Under no circumstances shall a pipe be dropped. Suitable skids or blocks shall be placed under each pipe in the shop before shipping, and the pipe shall be securely wedged during transportation to prevent injury.

3.03 Pipe Supports

A. All piping systems shall have anchorage, sway braces, guides and supports satisfactory to the Engineer, shall be fabricated in accordance with section 6 of the ASA code for pressure piping B 31.1-1955 or latest issue, and must be installed with due regard for general requirements.

B. All supporting equipment, with the exception of springs, shall be designed with a minimum factor of safety of 5 based on the ultimate tensile strength of the material.

C. Hangers or supports shall be based on the weight of the pipe, the weight of medium transported or the medium used for testing, whichever is heavier, and the weight of the insulation covering used.

D. Anchors and guides shall be capable of withstanding the forces imposed by expansion and contraction.

E. Hanger or sway brace springs shall be designed so as not to exceed a unit fiber stress of 75,000 pounds per square inch (psi) when compressed solid.

F. Supports shall be sufficiently close together so that the sag of the pipe is within limits that will permit drainage, also to avoid excessive bending stresses from concentrated loads between supports.

G. Maximum spacing of hangers or supports is shown below:

TABLE 1

Nominal Pipe Size (inches)	Max. Span (ft.)
½	5
3/4	6
1	7
1-1/2	9
2	10
2-1/2	11
3	12
3-1/2	13
4	14
5	16
6	17

TABLE 1	
Nominal Pipe Size (inches)	Max. Span (ft.)
8	19
10	22
12	23
14	25
16	27
18	28
20	30
24	32

H. The pipe suspension shall be such as to prevent excessive stress, excessive variation in supporting force, and possible resonance with imposed vibrations while the system is in operation. The fabrication and installation of supports for all pipe lines shall not constrain the piping to such an extent as to cause excessive transfer of load from supports to piping or from support to support when expansion or contraction occurs. In any case, supports, whether of the rigid or spring types, shall be capable of taking the entire piping load imposed by expansion or contraction, by failure of springs in spring supports, or during erection.

I. Accurate weight balance calculations shall be made to determine the required supporting force for each hanger. These calculations must be available to the Engineer.

J. If severe vibration of piping is encountered, hangers shall be supplemented by spring cushions or an energy absorbing means in the supports themselves, or through the addition of auxiliary equipment.

K. When piping is of a critical nature and subject to vertical movement in excess of one half (l/2) inch due to thermal expansion, and also at locations where it is necessary to avoid any transfer of load from support to support or on to critical terminals or connecting equipment, pipe hangers shall be of an approved constant support design. The following conditions are desirable:

1. The sum of the pipe line weights must equal the sum of the supporting forces.

2. The sum of the moments of piping weight acting at their center of gravity and the supporting forces shall be equal to zero (0).

3. Constant Support hangers must be calibrated to support the exact load of the piping system.

4. Pipe hangers located at points that are subject to vertical thermal movement and not covered by above paragraph shall be of an approved variable spring design.

5. The variation of hanger forces during operation shall not exceed twenty-five percent (25%) of the actual load.

6. All flexibly supported lines shall be suitably sway braced to prevent undue or unwanted movement or vibration, but such sway brace shall not interfere with the proper thermal movement of the piping. An approved sway brace that provides an instant counteracting force should be applied where required to control the piping.

7. Piping systems, where flexibility is not desirable, shall be supported by rigid hangers.

8. All parts of the supporting equipment shall be fabricated and assembled so that they will not be disengaged by movement of the supported pipe.

9. Hanger rods shall be provided with welded or forged eyes or suitable sockets to permit lateral movement of the piping without setting up severe bending action in the rod.

10. Pipe rings to be made of malleable iron shall be fitted with an adequate adjusting nut of the locking type threaded to a rod that will allow adjustment after erection while still supporting the load.

11. Screw adjustments shall be fabricated so that all threaded members will have a true and complete depth of thread. The turnbuckle or adjusting nut shall have its full length of thread in service while in use and the amount of adjustment shall be plainly visible at all times. All screw or equivalent adjustment shall be provided with suitable locking features.

12. Hangers shall be painted prior to installation to insure that the pipe surface in contact with the hanger does not rust or corrode. Noncorrosive spacers shall be used between the pipe and hanger where indicated by the Engineer.

13. Hanger rod size shall be as shown in Table 2 below:

TABLE 2

Nominal Rod Diameter (inches)	Root Area Thread (inches)	Maximum Safe Load Pounds Rod Temperature °F	
		650°	750°
3/8	.068	610	540
½	.126	1130	1010
5/8	.202	1810	1610
3/4	.302	2710	2420
7/8	.419	3770	3360
1	.552	4960	4420
1-1/8	.693	6230	5560
1-1/4	.889	8000	7140

TABLE 2			
Nominal Rod Diameter (inches)	Root Area Thread (inches)	Maximum Safe Load Pounds	
		Rod Temperature °F	
		650°	750°
1-1/2	1.293	11630	10370
1-3/4	1.744	15700	14000
2	2.300	20700	18460
2-1/4	3.023	27200	24260
2-1/2	3.719	33500	29880

All welding shall be in accordance with American Society of Mechanical Engineers, Welding Qualifications.

3.04 Painting

All exposed ductile iron piping and supports shall receive field coats of paint as specified under Workmanship and Materials Section 25.1 or 25.2 as needed.

3.05 Pipe Labels

All exposed ductile iron piping shall be provided with indication of flow direction and type of liquid. Labels shall be either:

A. Painting: Contractor shall use pre-cut stencils and epoxy paint per WM 25.
B. Self Sticking Vinyl made from B-946 vinyl (dry areas only).
C. Strap-on/Snap-on vinyl.

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(SECTION WM 12)

STORM SEWER STRUCTURES

PART 1 GENERAL

1.01 Description

A. Storm sewer structures include:

1. Manholes

2. Inlets

3. Special drainage structures including, but not limited to:

   a. Special manholes
   b. Drop pipe connections
   c. Cleanouts
   d. Catch basins
   e. End sections
   f. Grated box end sections
   g. Pipe anchors
   h. Headwalls
   i. Slotted drains
   j. Other similar drainage structures

B. Storm sewer structures shall be constructed complete, ready for use, including excavation, backfill, concrete work, ductile/cast iron frames and covers, manhole steps, walls of alternate construction, and other incidental work as shown on the plans, and as specified.

C. Structures shall be constructed of precast concrete, or Class A poured-in-place concrete. All manholes shall be made watertight, and the Contractor shall furnish all materials and perform all work necessary for watertight construction. Optional materials will be considered on a case-by-case basis but will not be acceptable without the expressed written permission of the Engineer.

D. If monolithic manholes are to be used, the Contractor shall submit drawings showing all reinforcement, dimensions, and connections for Owner approval. A registered Professional Engineer shall certify all drawings submitted for approval.

E. No less than five (5) feet of 6-inch perforated corrugated HDPE pipe shall extend out of all enclosed structures such as manholes, inlets, catch basins etc. in order to help drain groundwater, excavation areas and provide for future connections. The ends of the pipe shall be capped off with a watertight cap from the pipe manufacturer or as approved by the Engineer. The cost for this pipe, cap and coring shall be included in the cost of the structure, so no separate payment will be made, even when there may be a separate pay item for such pipe in the bid schedule.

F. All proposed castings set in paved areas shall match (be flush with) the final pavement elevations unless the casting is to be depressed in order to create a sump. All proposed castings to be set in non-paved areas shall match (be flush with) the final ground elevations unless they are shown to be set lower than existing in order to improve drainage for side ditches or off-street parking. This requirement may supersede casting elevations shown on the plans. Confirm with the Engineer prior to ordering and installing final structures and castings.

G. All manhole and inlet installations in non-paved areas receiving storm water flow into the castings shall include no less than 10 feet of linear grading in each direction in order to create a positive flow to the inlet, unless otherwise shown on the plans.

1.02 Product Handling

A. Store and protect miscellaneous items at the Project site. All precast structures must be delivered to job site by means which will adequately support them, and not subject it to undue stresses and are not damaged by crushing. The structures shall be unloaded carefully and strung or stored as close to the final point of placement as is practical.

1.03 Submittals

A. Submit shop drawings for all structures and other appurtenances.

B. Include all performance data such as strengths for concrete and steel and other material items. Reinforcing shall be detailed on the shop drawings.

C. Shop drawings with supportive documentation for all prefabricated manholes other fittings or integral components shall be submitted to the engineer prior to fabrication.

1.04 Related Specifications

A. Comply with applicable portions of the following WM Specifications:

WM-2	Excavation
WM-3	Backfill, Fills and Embankments
WM-5.2	Cast-in-Place Concrete
WM-6	Concrete Reinforcement
WM-13	Storm Sewer Pipe

PART 2 PRODUCTS

2.01 Reinforced Concrete Manholes

A. Manholes shall be constructed in accordance with the ASTM Specifications for "Precast Reinforced Concrete Manhole Risers and Tops", Designation C 478. The minimum wall thickness shall be five (5) inches for manholes four (4) feet in diameter.

B. The precast tops shall be of the eccentric cone type. Precast flat covers shall be not less than eight (8) inches thick and reinforced with two layers of steel with a minimum area of 0.39 square inches per linear foot in both directions in each layer. Precast flat bottoms of manholes shall also be reinforced the same as specified herein for precast flattop. Hoisting lugs or hooks shall be cast in place for handling and setting of the rings. Openings of proper sizes and suitable design shall be cast in place for receiving the sewer and/or drop pipes and connections. Adjusting riser rings shall be provided as approved by the Owner.

C. The castings shall be as indicated on the plans. Both the frame and cover shall be heavy duty as manufactured by Neenah, East Jordan, or approved equal. The inlet and castings shall be capable of supporting H-20 traffic loadings.

D. A minimum 6-inch adjusting ring shall be used in all turfed areas in order to provide a minimum 6 inches of topsoil at inlet areas.

E. All manhole joints shall be tongue and groove and they shall be sealed with an O-ring and joint sealer conforming to Federal Specifications SS-S-00210 and similar to "Kent-Seal No. 2" as manufactured by the Hamilton Kent Manufacturing Co., of Kent, Ohio; "RAM-NEK" as manufactured by the K.T. Snyder Co. of Houston, Texas, or equal. Cracked or damaged barrel joints not meeting ASTM C478 shall be rejected.

F. Manhole Steps. Steps shall be provided and manufactured of reinforced plastic and shall be twelve (12) inches wide and one (1) inch square.

G. Manhole Bases. Manhole bases shall be of cast-in-place monolithic concrete or precast concrete. Where sewer lines pass through or enter manholes, the invert channels shall be smooth and semi-circular in cross section and shall be formed directly in the concrete of the manhole base. Changes of direction of flow within the manholes shall be made with a smooth curve with as long as a radius as possible. The floor of the manhole outside the channels shall be smooth and slope toward the channel not less than one (1) inch per foot.

H. No mortar or concrete shall be placed in water, and no water shall be allowed to flow over or against the concrete before it has set for a period of time deemed sufficient by the Owner to prevent damage to the structure. The invert channel through manholes shall be provided and constructed to conform in shape and slope to that of the sewer. All invert channels are to have a properly mortared apron on either side, sloped to prevent solids deposition. Changes of direction of flow within the manhole shall be made with a smooth curve with as long as a radius as possible.

I. Adjusting Rings. Where one (1) solid riser or barrel section cannot be used, final adjustments in elevation of the frame and cover shall only be accomplished by the use of precast concrete adjusting rings conforming to ASTM C 478. Rings shall be of a nominal thickness of not less than four (4) inches. Not more than twelve (12) inches total of adjusting rings shall be allowed for adjustment of the manhole frame and cover to required elevation.

2.02 Reinforced Concrete Inlets

A. All inlets shall be constructed of reinforced pre-cast concrete sections with plain joints and 2" extrudable gasket to produce soil tightness (minimum). Inlets shall have tops as shown on the plans. Joints between sewer pipe and inlet walls shall be sealed with grout.

B. Precast concrete inlets shall be constructed in accordance with ASTM Standard C-478. Adjustment to final grade of inlet casting shall be accomplished by utilizing pre-cast concrete adjusting rings. Adjusting rings when required should be sized to adjust to Final Grade by using a maximum of three (3) adjusting rings. Adjusting rings shall be limited to less than one (1) foot of inlet depth. All inlet joints, along with the adjusting rings and top casting are to be sealed with 2-inch extrudable gasket (Kent Seal, Rub'R Nek LTM by Henry Co., or approved equal) to produce soil-tight joint (minimum).

C. Where sewer lines pass through or enter inlets, the invert channels shall be smooth and semi-circular in cross section and shall be formed directly in the concrete of the inlet base. Changes of direction of flow within the inlets shall be made with a smooth curve with as long as a radius as possible. The floor of the inlet outside the channels shall be smooth and slope toward the channel not less than one (1) inch per foot.

D. The castings shall be as indicated on the plans. Both the frame and cover shall be heavy duty as manufactured by Neenah, East Jordan, or approved equal. The inlet and castings shall be capable of supporting H-20 traffic loadings.

2.03 Poly (Vinyl Chloride) PVC Surface Drainage Inlets (Must be Approved by Owner for Use)

A. PVC surface drainage inlets, if approved by the Owner for use in writing, shall include inline drains or drain basins as indicated on the contract drawings and referenced within the contract specifications. The ductile iron grates for each of these fittings are to be considered an integral part of the surface drainage inlet. The surface drainage inlets shall be as manufactured by Nyloplast, Harco Fittings, Inc., or approved equal.

B. The inline drains and drain basins shall be manufactured from PVC pipe stock, utilizing a thermomolding process to reform the pipe stock to the furnished configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the piping system specified. This joint tightness shall conform to ASTM D3212.

C. Surface drainage products shall meet the mechanical property requirements for fabricated fittings as described in ASTM F794, F949 and F1336.

D. The grates furnished for all surface drainage inlets shall be ductile iron and shall be made specifically for each fitting. Grates for 12" and larger drain basins and inline drains shall be capable of supporting H-20 wheel loading for standard grates and solid covers. Grates for drain basins and inline drain inlets smaller than 12" shall be capable of supporting light wheel load traffic. Metal used in the

manufacture of the castings shall conform to ASTM A-48-83 Class 30B for cast iron or A536 grade 70-50-05. The castings shall be furnished with a black paint.

2.04 Other Structures

A. Other structures provided for a project shall generally conform to the requirements of the above manhole and inlet specifications. Structures such as cleanouts, end sections, grated box end sections, pipe anchors, headwalls, slotted drains and other similar drainage structures are generally covered in the latest edition of the Indiana Department of Transportation (INDOT) Standard Details and Specifications. These are readily available through INDOT by purchasing a hard copy or CD from INDOT or by accessing their web page. Therefore, INDOT information is not repeated herein and is the responsibility of the Contractor/Bidder.

B. If a structure is not completely detailed in the specifications or the plans, the INDOT standard details for that item shall be used. If no such details are available, the Contractor shall be required to detail out a structure and submit it to the Engineer for approval as part of the shop drawing process. In such latter cases, the Contractor shall submit shop drawings certified by an Indiana Registered Professional Engineer.

2.05 Pipe Connections

A. Joints between a manhole or inlet and a sewer pipe may be sealed with high strength, non-shrink grout or a flexible boot KOR-N-SEAL 1 or 2, flexible connector, cast-in-place Dura-Seal gasket, "A"-lock gasket or an approved equal. All connections shall provide for a watertight seal between the pipe and manhole or inlet.

PART 3 EXECUTION

3.01 Installation

A. All manholes, inlets and similar drainage structures shall be installed so that the top of the inlet casting and frame (at the lowest point where surface water can enter) is flush with the final ground elevation.

B. All structures shall be bedded on a minimum of 6 inches of compacted aggregate consisting of granular or crushed aggregate materials. No structure shall be set on soft or yielding soils.

C. PVC surface drainage inlets shall be installed using conventional flexible pipe backfill materials and procedures. For traffic rated installations H-20 the inline drain or drain basin shall be installed conforming to the manufacturer's installation guidelines for traffic rated (H-20) installations. The backfill material shall be crushed stone or other granular material meeting the requirements of Class 1 or 2 material as defined in ASTM D2321. The surface drainage inlets shall be bedded and backfilled uniformly in accordance with ASTM D2321.

For all PVC castings installed in traffic areas a minimum 6-inch thick by 4-foot diameter concrete collar shall be poured around the inlet to support the casting. Installation procedures shall be in accordance with the manufacturer's requirements.

PART 4 PROJECT CLOSE-OUT

4.01 Inspection

A. All structures shall be given a field visual inspection. The inspection will be performed at the discretion of the Owner and Engineer during the warranty period. The Contractor shall correct all leakage problems determined by this inspection within an agreed-upon time to the satisfaction of the Owner. Where necessary to complete the work, the Contractor shall be responsible for the bypassing and/or blocking of the flow in the structures, provide necessary traffic control, and must have prior approval by the Owner.

(SECTION WM 13)

STORM SEWER PIPE

PART 1 GENERAL

1.01 Description

A. The Contractor shall furnish all materials, equipment and labor to install storm sewer and culvert pipe, end sections and related fittings. Other items of work include:

Concrete encasement and caps; Earth and rock excavation; Removal and disposal of water; Sheeting and shoring; Protection of trees, shrubs, bushes, and other landscaping; Protection of existing structures; Protection of existing utilities; Temporary and permanent bulkheads or stoppers as noted or as required; Disposal of excess excavated material; Backfilling, including all aggregate/granular material necessary to meet the bedding requirements; Maintaining trench surfaces; Dust control; Deflection testing (mandrel testing) of flexible storm sewer pipe; Replacement and repair of sidewalks, curbs, gutters, catch basins, drainage pipes, field tiles; and other items of work needed to complete the work as shown on the plans.

B. Utility Conflicts

1. It shall be recognized by all parties that the exact location or type of utilities may not be known at the time a project is bid, whether it is due to the utility owner not having adequate records or not providing such information to the Engineer at all or in a timely manner. As such, it may be impossible for the Plans to accurately indicate all existing utility types and locations. Therefore, the Contractor has a responsibility to allow sufficient float time in his schedule and locate all existing utilities, both horizontally and vertically in the proximity of the work area well in advance of starting any construction. The Contractor shall notify the Engineer of any utility conflicts prior to beginning work.

2. Where storm sewers may be constructed parallel to and close to any buried or exposed utility (ie. existing water or sewer or gas line, cable or telecommunication cables etc.), the exact location of which is not shown:

   a. Before construction begins, the Contractor shall locate the utility(s) to determine the extent of the actual conflict.
   b. The Engineer may shift the location of the new storm sewer where possible to avoid interference with the existing conflict if encountered during construction.
   c. No equitable adjustment will be allowed for the shifting of the storm sewer line to avoid such interferences.
   d. The Contractor shall be required, at his own expense, to do everything necessary to protect, support and sustain all utilities including sewers, tiles, cables, water and gas pipes, conduits,

poles and other fixtures laid across or along the limits of the project in accordance with the Utility Owner's direction.

e. The Company or Corporation owning said pipes, poles or conduits must be notified prior to the work by the Contractor.

f. If any such utilities are damaged, they shall be repaired by the Contractor to original condition as directed by the Utility Owner and said repairs shall be at no additional costs to the Owner.

3. In the event the storm sewer cannot be relocated to avoid interferences as mentioned above and it becomes necessary to relocate or move:

   a. Either permanently or temporarily, any pipes, poles or conduits, not already specified to be moved on the plans or specifications a change order may be prepared and issued to the Contractor.

   b. Work done by the Contractor on such relocations until the Owner and the Engineer have approved the change order shall be at the Contractor's risk.

C. Drain Tile Conflicts

1. The Contractor will be required to connect to the new storm sewer system any existing storm drainage pipe or tile encountered during construction whether or not it is shown on the plans.

2. Payment under Change Orders for connecting unknown storm drainage lines to a new storm sewer system will not be allowed unless the number of connections exceeds that specified in the Plans or the Specifications. If the estimated number of unknown connections is not specified in the Plans or Specifications, a quantity of no less than one (1) per 500 feet of storm sewer installed shall be included in the cost for installing storm sewers.

3. Generally speaking, all such connections may be made directly to the new storm sewer without an additional structure using a tee fitting or insert-type-tee connection designed to work with the type of sewer pipe used.

4. If a structure is located at the point of connection, the line should be connected to the structure.

5. The Owner or Owner's Representative must be immediately notified when any existing storm drainage pipe or tile is located and must be present during all connections of same to the new storm sewer system.

6. All construction methods and materials to complete connections shall be per the Plans and Specifications. Where connections cannot be completed in accordance with details, the Engineer shall approve the materials and methods of such connections prior to the work.

D. Combination Sewers

1. If the Contractor encounters any existing line carrying both sanitary waste and stormwater, whether or not it is shown on the plans or located through previous inspection, the Contractor shall:

a. be required to install a separate stormwater and sanitary line into the new storm or sanitary sewer for future connection of separated storm water or sanitary flow by the property owner.
b. reroute lines to the right-of-way or permanent easement edge at a location chosen by the Owner and Engineer.
c. comply with construction methods and materials specified in applicable sections of these Plans and Specifications.
d. notify the Owner and Engineer immediately if this situation arises and shall be present during all work.

1.02 Product Handling

A. Store and protect all products and materials at the Project site. Pipe must be delivered to job site and stored by means, which will adequately support it and not subject it to undue stresses. In particular, the load shall be supported such that crushing does not damage the bottom rows of pipe. The pipe shall be unloaded carefully and strung or stored as close to the final point of placement as is practical.

1.03 Soil Borings

A. It will be the Contractor's responsibility to conduct a prebid inspection of the site to determine all additional characteristics of soils that may be present at a project site. This includes reviewing record soils information from previous contracts. Soils borings may be included in other portions of the Plans and Specifications.

1.04 Metric Units

A. INDOT details may be shown in metric units (e.g. millimeters, mm). The conversion is 304.80 mm per foot (25.40 mm per inch); however INDOT uses 300 mm per foot in order to simplify the difference. Therefore, 12-inch pipe is generally shown as 300 mm and 15- inch pipe as 375 mm. Should there be any questions regarding this format, the Contractor shall obtain a clarification from the Engineer.

1.05 Submittals

A. Submit shop drawings for all pipe, connections, and end sections and other appurtenances. This includes connections to end sections.

B. Include all performance data such as strengths for concrete and other pipe material items.

C. Shop drawings with supportive documentation for all wyes, tees, elbows, adapters, reducers, bulkheads, or other fittings or integral components shall be submitted to the Engineer prior to fabrication.

D. Prior to ordering pipe material, submit shop drawings to the Engineer and obtain Engineer's approval. All submittals shall include certification of conformance with the applicable ASTM Pipe Standard and allowable ASTM bedding certification. No fieldwork shall be started prior to shop drawing approval.

1.06 Related Specifications

Comply with applicable portions of the following WM Specifications:

WM-2	Excavation
WM-3	Backfill, Fills and Embankments
WM-4	Restoration of Surfaces
WM-7	Sanitary Sewer Pipe
WM-8	Pressure Pipe - Sanitary
WM-14	Pressure Pipe - Water
WM-12	Storm Sewer Structures

1.07 Quality Assurance

A. Codes and Standards

1. Each length of pipe shall be marked per the requirements of the respective ASTM Standard.

2. All codes and standards shall be set forth in the latest ASTM Standard.

3. Upon request by the Engineer, the Contractor as standard procedure shall furnish copies of all tests required by the applicable ASTM Standard.

PART 2 PRODUCTS

2.01 General

A. A number of different pipe materials may be accepted for the various sizes shown in the following Table No. 13-1. However, the Contractor shall use only the pipe materials specified in the Detailed Specifications. If no pipe material is specified in the Detailed Specifications or indicated on the drawings, then only the pipe shown in Table No. 13-1 may be used unless approved by the Engineer. The Contractor may choose different materials for each size, but may not mix materials used between structures. All pipe shall be constructed using water tight (minimum) joints and methods.

B. A deflection test shall be performed on each flexible pipe following the elapse of thirty (30) days after the placement of the final backfill. No pipe shall exceed a deflection of five percent (5%) or greater.

C. The diameter of the rigid ball or mandrel used for a deflection test shall be no less than ninety-five percent (95%) of the base inside diameter of the pipe to be tested dependent on what is specified in the corresponding ASTM standard. The Contractor shall be responsible for proving an ASTM approved proving ring to verify the correct diameter of the rigid ball or mandrel. The test shall not be performed with the aid of a mechanical pulling devise.

Table No. 13-1

Acceptable Pipe Material for Each Pipe Size (Shaded Box w/"X")*

			PVC					HDPE		
			SOLID WALL			PROFILE WALL				
PIPE SIZE	ALUM. STEEL TYPE 2 ASHTO M274 & ASTM A929	REING. CONC. (RCP) CLASS III ASTM C76	SDR 35 ASTM D3034	SDR 35 ASTM F679	CONTEC-H/ DIAMOND Plastics CORP CORR 21 "A-2000" ASTM F949	UPONER "ULTRA-COR" ASTM F949	UPONER "ULTRA-RIB" ASTM F794	HANCOR "Sur-Lok" ASTM D3350	ADS "N-12" ASTM D3350	HANCOR/ADS "HEAVY DUTY" TUBING ASTM F405
18"-54"	X	X		X	X	X	X	X	X	
15"	X	X	X		X	X	X	X	X	
12"	X	X	X		X	X	X	X	X	
6"	X		X							X

*Note: The pipe materials specified in the Detailed Specifications and indicated on the Drawings shall supersede this table.

2.02 Reinforced Concrete Pipe (RCP)

A. The drainpipe may be Reinforced Concrete Pipe (RCP), of various diameters. The pipe shall be Class III and Wall Type B, except where otherwise indicated. All RCP shall be considered "rigid" and shall be installed as such. The joint shall be tongue and groove or bell and spigot. The manufacturer's recommendation to provide a water-tight joint shall be followed.

B. Fittings shall be of the same class as the pipe they are installed along and shall be manufactured by the pipe manufacturer, or approved equal. Fittings shall meet the same ASTM requirements as the pipe. Plain end joints will not be allowed.

2.03 Poly (Vinyl Chloride) Pipe (PVC)

A. General

All PVC pipe shall be considered "flexible" and shall be installed as such. PVC pipe shall not be installed where exposed to sunlight unless current material certifications guarantee that it will not be subject to ultraviolet degradation.

1. Solid Wall

a. The drain pipe may be PVC SDR 35, solid wall pipe.

b. Fittings shall be of the same class and size as the pipe they are installed along and shall be manufactured by the pipe manufacturer. Fittings shall meet the same ASTM requirements as the pipe.

2. Profile Wall

a. The drainpipe may be PVC profile wall pipe of various diameters.
b. Acceptable profile wall pipe includes:
   1) A-2000 as manufactured by Contech Construction Products, Inc. of Middletown, Ohio or "Ultra-Cor" by Uponer ETI Company (Extrusion Technologies) of Denver, Colorado. The pipe shall have a minimum constant, non-variable pipe stiffness of 46 psi and shall meet the requirements of ASTM F949, D-2412, and AASHTO M304. Minimum cell classification shall be 12454B or 12454C per ASTM D-1784. Bedding shall be Class I or II only per ASTM D-2321. Elastomeric seals shall meet the requirements of ASTM F477.
   2) Ultra Rib, as manufactured by Uponer ETI Company (Extrusion Technologies, Inc.) of Denver, Colorado. It shall have a minimum constant, non-variable pipe stiffness of 46 psi and shall meet the requirements of ASTM F794, D2152, D2444, D3212 and D2412. Cell classification shall be 12454B as defined by ASTM D1784. Bedding shall be Class I or II only as described in ASTM D-2321.
   3) Vylon, as manufactured by Lamson Vylon Pipe of Cleveland, Ohio. It shall have a minimum, non-variable pipe stiffness of 46 psi per ASTM D-2412 and shall also meet the requirements of ASTM F-794, closed profile, ASTM D-1784, D-3212, F-477, D-2444, D-2152 and Uni-Bell Pipe Association Uni-B-9. Minimum cell classification shall be 12364-A as in ASTM D-1784. Bedding shall be Class I or II only as described in ASTM D-2321.
   4) Or approved equal.
d. Fittings shall be of the same class as the pipe they are installed along and shall be manufactured by the pipe manufacturer. Fittings shall meet the same ASTM requirements as the pipe.

2.04 High Density Polyethylene Pipe (HDPE)

A. General

All HDPE pipe shall be considered "flexible" and shall be installed as such. HDPE pipe shall not be installed where exposed to sunlight unless current material certifications guarantee that it will not be subject to ultraviolet degradation.

B. The drain pipe for the various pipe diameters may be "Sure-Lok" High Density Polyethylene (HDPE) pipe as manufactured by Hancor of Findlay, Ohio, N-12 High Density Polyethylene Pipe (HDPE) as manufactured by ADS, Inc. of

Columbus, Ohio, or approved equal. Bedding shall be Class I or II only as described in ASTM D-2321.

C. Production and Material Standards for HDPE

1. Corrugated High Density Polyethylene (HDPE) pipe shall be manufactured in accordance with AASHTO M 294 Type S. Pipe manufactured under this specification shall have a minimum cell class of 335420C in accordance with ASTM D-3350.
2. Ribbed Polyethylene pipe shall be in accordance with ASTM F-894 for the specified sizes, meeting the requirements for RSC 160. Pipe manufactured under this specification shall have a minimum cell class of 335420C in accordance with ASTM D-3350.

3. Smooth wall Polyethylene pipe shall be in accordance with ASTM F-714 for the specified sizes. Pipe manufactured under this specification shall have a minimum cell class of 335420C in accordance with ASTM D-3350.

4. All polyethylene pipe and fittings shall be made from high molecular weight high density polyethylene material meeting the application cell class requirements. All polyethylene material used in drain pipe manufacture shall be virgin resin.

D. HDPE Joints

1. High-density polyethylene pipe shall possess male and female pipe ends or molded HDPE or PVC couplers that allow the construction of overlapping, gasketed pipe joints in accordance with the requirements of ASTM D-3212 for a gasketed joint. The gasket material shall conform to all requirements of ASTM F-477.

E. Rejection of Damaged HDPE Pipe and Fittings

1. High density polyethylene pipe and fittings possessing the following defects may be rejected for installation: variations from straight centerline; elliptical shape in pipe intended to be round; illegible or improper markings as required herein; deep or excessive gouges or scratches on the pipe wall; fractures, punctures, or cracks; damaged or cracked ends where such damage would prevent making a satisfactory joint.

F. HDPE Pipe Markings

1. For high density polyethylene pipe products, each length of pipe shall be clearly marked with the following information as a minimum: manufacturer's name or identification symbol; nominal pipe size; and production/extrusion code.

2.05 High Density Polyethylene Tubing

A. 6" HDPE tubing shall be manufactured by Hancor of Findlay, Ohio, ADS, Inc., of Columbus, Ohio, or approved equal, and shall meet all applicable standards of ASTM F405.

B. The perforated pipe for subsurface drains shall be installed within the bedding of the pipe trench as indicated on the plans. All manufacturer's recommended installation procedures shall be followed. Due to the nature of the soils, a geotextile fabric sock shall be provided with the pipe when recommended by the manufacturer for the given soil.

2.06 End Sections

A. End sections shall be precast concrete or galvanized steel as indicated by the Detail Specifications or Drawings unless otherwise approved by the Engineer. Where differing materials are used, an appropriate water-tight connection shall be made to join the pipe to the end section.

2.07 Ductile Iron Pipe

A. Material

1. Ductile Iron Pipe shall be centrifugally cast and shall conform to ANSI Specifications A21.51 and AWWA C-151, latest revision. Ductile Iron Pipe shall be Pressure Class 350, 300, 250, 200 or 150.

B. Coatings and Linings

1. Pipe shall be standard cement lined and seal coated with an approved bituminous seal coat in accordance with AWWA Specification C-104 (ANSI A21.4).

C. Fittings

1. Fittings shall be standardized for the type of pipe and joint specified and shall comply with AWWA C-110 (ANSI A-21.10) or AWWA C-153 (ANSI A-21.53).

D. Joints

1. Mechanical joints or slip joints shall be provided.

2. Mechanical joints and accessories shall conform to AWWA Standard C-111, ANSI A-21.11. The bolts and nuts shall be corrosion resistant high strength alloy steel.

3. The O-ring gaskets sealing the slip joint shall be made of rubber of special composition having a texture to assure a watertight and permanent seal and shall be the product of a manufacturer having at least five (5) years experience in the manufacturer of rubber gaskets for pipe

joints. The gasket shall be a continuous ring of flexible joint rubber of a composition and texture which is resistant to common ingredients of sewage, industrial wastes and groundwater, and which will endure permanently under the conditions likely to be imposed by this service. The gasket shall conform to the requirements of AWWA C-111 (ANSI A-21.11).

E. Markings

1. The class designations for the various classes of pipe and fittings, manufacturer's name and year of manufacture shall be cast onto fittings in raised numerals, and cast or stamped on the outside of each joint of pipe.

F. Certification

1. The Contractor shall furnish, upon request by the Engineer, certified reports stating that inspection and specified tests have been made and that the results thereof comply with the applicable Standards.

2.08 Poly (Vinyl Chloride) Pipe

A. Material

1. Poly (Vinyl Chloride) (PVC) gravity storm sewer pipe shall be the integral wall bell and spigot type with elastomeric seal joints and smooth inner walls meeting or exceeding all of the requirements set forth in ASTM D-3034 for pipe diameters 15-inches or less and meeting or exceeding all of the requirements set forth in ASTM F-679 for pipe diameters greater than 15-inches.

2. For diameters 15-inches or less, the pipe shall have a minimum cell classification of 12454-B and for diameters greater than 15-inches the pipe shall have a minimum cell classification of 12454-C; with all pipe having a minimum tensile strength of 34.50 psi as defined in ASTM D-1784.

3. PVC storm sewer pipe shall have a minimum pipe stiffness of 46 psi for each diameter when measured at 5% vertical ring deflection and tested in accordance with ASTM D-2412.

4. NOTE: Poly (Vinyl Chloride) (PVC) Ribbed Sewer Pipe meeting or exceeding all of the requirements set forth in ASTM F 949-86a or ASTM F 794 is acceptable. The minimum cell classification acceptable shall be 12454-B as defined in ASTM D-1784. PVC Ribbed Sewer Pipe shall have a minimum pipe stiffness of 50 psi when measured in accordance with ASTM D-2412 for 8-inch through 18-inch pipe and 46 psi for 21-inch and greater.

B. Joints

1. Flexible gasket joints shall be compression type so that when assembled, the gasket inside the bell will be compressed radially on the pipe spigot to form a watertight seal. The assembly of joints shall be in accordance with the pipe manufacturer's recommendations and ASTM D-3212. The gaskets sealing the joint shall be made of rubber of special composition having a texture to assure a watertight and permanent seal and shall be the product of a manufacturer having at least five (5) years experience in the manufacture of rubber gaskets for pipe joints. The gasket shall be a continuous ring of flexible joint rubber of a composition and texture which is resistant to common ingredients of sewage, industrial wastes and groundwater and which will endure permanently under the conditions imposed by this service. The gasket shall conform to the requirements of ASTM F-477.

2. NO SOLVENT CEMENT JOINTS SHALL BE ALLOWED. Connections at manholes shall be water-tight.

3. All field-cutting of pipe shall be done in a neat manner as per manufacturer's recommendations and the cut end shall be beveled using a file or wheel to produce a smooth bevel of approximately 15° and be a minimum depth of one-third the pipe wall thickness. Field cut pipe is only allowed at manholes, at prefabricated fittings, and at the connection of new storm sewer and other structures to existing storm sewer pipe.

C. Fittings

1. Only manufactured fittings made of PVC plastic having a cell classification of 12454-B as defined in ASTM D-1784 shall be used.

2. Tee/Wye service connections for storm sewers where existing or proposed grade (to sewer invert), exceeds 15 feet shall be heavy wall.

3. **SADDLE CONNECTIONS SHALL NOT BE ALLOWED FOR NEW CONSTRUCTION.**

D. Design

1. The minimum wall thickness for PVC sewer pipe and lateral sewer pipe 15-inches or less in diameter shall conform to SDR-35 Type PSM as specified in ASTM D-3034. The minimum wall thickness for PVC sewer pipe greater than 15-inches in diameter shall conform to T-1 as specified in ASTM F-679.

E. Markings

1. The date of manufacture, class of pipe, specification designation, size of pipe, name or trademark of manufacturer, and identification of plant/location shall be legibly marked on the outside of each pipe section in accordance with the ASTM D-3034.

F. Certification

1. The Contractor shall furnish, upon request, certified reports stating that inspection and specified tests have been made and that the results thereof comply with the applicable Standards.

2.09 Aluminized Type 2 Steel Pipe

A. Storm sewers for pipe diameters 15" or larger may be Aluminized Steel Type 2 ULTRA FLO spiral rib pipe. Gravity storm sewers for pipe arches shall be Aluminized Steel Type 2, HEL-COR. Pipe shall be manufactured by Contech Construction Products, Inc. of Middletown, Ohio, Lane Enterprises, or an equal manufacturer approved by the engineer in writing.

B. The Aluminized Steel Type 2 material used in the pipe shall be manufactured to conform to the current AASHTO M36 (and ASTM A760) specification. The pipe shall be formed from an Aluminized Steel Type 2 coil and conform to the current AASHTO M274 (and ASTM A929) material specification. Round pipe shall conform to the type IR pipe classification: culvert pipe, circular section, single thickness of sheet, helical ribs projecting outwardly. The pipe shall be of the diameter as specified on the plans. The minimum metal thickness shall be sixteen (16) gage material. This is based on an H 20 live load design using 3/4" x 3/4" x 7 ½ " corrugations.

C. The manufacturer of the pipe shall provide certification of compliance with AASHTO M36 and M274 specifications.

D. Pipes may be joined by either of two (2) methods, 1) with re-rolled annular ends joined with H.S. bands with flat gaskets and lug and band connection assemblies; or 2) with metal sleeve stab joint if size is available. Joints shall be manufactured by Contech Construction Products, Inc. of Middletown, Ohio, Lane Enterprises, or an approved equal manufacturer. The bands shall be manufactured in accordance with the current AASHTO M36 (and ASTM A760) specification.

E. Fittings are to be manufactured by the pipe manufacturer and shall meet the same specification as the pipe. Integral bends with integral manholes may be permitted with sufficient documentation and certification by an Indiana Registered Professional Engineer.

F. Pipe found to be defective, damaged or excessively out of round or which does not match other similar pipe joints from joint to joint, or which cannot provide a reasonably tight joint may be cause for rejection.

G. All steel pipe coming in contact with concrete shall first be coated with a coal tar epoxy coating or other generally accepted bitumastic materials, or polyethylene sheet wrap materials.

H. Manufactured wyes, tees, elbows, or adapters may be accepted for use in place of precast storm sewer manholes and box inlets; however, precast manholes and

box inlets shall be required within the public right-of-way. In all cases the Contractor shall provide supportive documentation from the manufacturer. Adequate stiffeners shall be installed as required by the manufacturer.

I. Shop drawings with supportive documentation for all wyes, tees, elbows, adapters, reducers, bulkheads, prefabricated manholes or other fittings or integral components shall be submitted to the engineer prior to fabrication.

J. Handling and assembly shall be in accordance with the National Corrugated Steel Pipe Association (NCSPA) Standards.

K. Installation shall be in accordance with AASHTO Standard Specifications for Highway Bridges, Section 26, Division II or ASTM A 798 and in conformance with the drawings and specifications. Note that construction loads may be higher than final loads and should be incorporated into the design and submittals. The Contractor shall also follow the manufacturer's or NCSPA's guidelines with respect to this.

PART 3 EXECUTION

3.01 General Pipe Installation

A. Storm sewers shall be laid and tested in accordance with the Workmanship and Materials Specifications, Section WM 3, "Backfill, Fills and Embankments". All sewer pipe shall be laid to the lines and grades shown on the plans, unless otherwise directed by the Engineer. The jetting alternative, Method C of said Section WM 3 shall not be permitted in traffic areas but may be permitted in non-traffic areas when the existing groundwater elevation is lower than the sewer bedding elevation and the natural soils are free draining.

B. All storm sewers shall be jointed in the trench in accordance with the instructions and recommendations of the manufacturer of the joint system and/or pipe. The joints shall be of a design that will permit flexibility, promote water tightness, and prevent soil from entering the storm sewer system.

C. The Contractor shall be required, at his own expense, to protect, support and sustain all existing drains, tiles, cables, water and gas pipes, conduits, poles and other fixtures encountered across or along the site of the work. The Company or Corporation owning said pipes, poles or conduits must be notified by the Contractor before any such fixtures are disturbed in any way. They shall be supported as needed during construction. If any sewer, gas or water pipes, poles, conduits or other fixtures are damaged, they shall be repaired by the Contractor to their original condition or better and said repairs shall be at no additional cost to the Owner.

D. The Contractor shall remove the existing street pavements to the minimum width necessary to accommodate the pipe construction work. The pavement shall be saw cut and removed to straight lines parallel to the trench. The existing stone, or slag, or gravel aggregate base material which is satisfactorily removed and segregated may be salvaged and used at the Contractor's option for constructing

the compacted aggregate base under a compacted aggregate surface located over the sewer trench.

E. Any existing soft or yielding base material will not be considered satisfactory for reuse in any new pavement base. Unless otherwise permitted, the quality requirements of the reused base material shall meet the Indiana Department of Transportation Standard Specifications (INDOTSS) requirements for Class B or better coarse aggregate.

F. The satisfactorily removed base material may be directly incorporated into the work or it may be stockpiled and subsequently reused as conditions permit. Said salvaged base material will be considered to take the place of the specified new base material; however, where necessary or desirable in the opinion of the Engineer, the thickness of the reused salvaged based material shall be spread thinner than the specified thickness and then topped off with a layer of new aggregate material to make up the required total thickness.

G. Bedding material for all types of pipe shall be hand or mechanically tamped aggregate placed in 6-inch layers and as shown on the drawings.

H. Installation of storm sewer pipe by the directional drilling method will be considered on a case-by-case basis only. Directional drilling of storm sewers will require both real-time horizontal and vertical monitoring equipment.

I. Installation of culvert pipe shall be consistent with the INDOT Specifications, Section 716 “Jacked Pipe” and all such related INDOT sections.

3.02 <u>Rigid Conduit Installation</u> (Concrete Pipe)

A. All rigid pipe shall be laid in accordance with the Manufacturer’s instructions except that it shall have no less than three (3) inches of compacted granular bedding material (Class I or Class II) placed on a flat trench bottom and compacted granular haunching material up to no less than the halfway point on the pipe (Spring line). Pipe Laying may be achieved by “Class B” bedding method as shown in the ASCE Manual of Practice No. 37, latest edition and the American Concrete Pipe Association, Concrete Pipe Handbook, latest edition for granular foundations. All granular bedding material shall be placed in the trench in approximately six (6) inch layers. Compaction shall be accomplished by hand or mechanical tamping. The granular material may also be "walked in" to the pipe spring line by forcing the material below the haunch of the pipe up to the spring line by either mechanical or hand means. Subsequent compaction shall be provided by the Contractor.

B. The laying of pipe in finished trenches shall be commenced at the lowest point, proceeding upstream, with the spigot ends pointing the direction of flow.

C. Except as otherwise specified, the excavation work for the sewers shall be performed in accordance with the Workmanship and Materials Specifications for "Excavation and Backfill."

D. The practice of blocking pipe up to grade with bedding material, then backfilling under is prohibited. The entire length of the bed section is to be at proper grade before installing pipe.

E. All pipes and specials shall be carefully inspected before being laid, and no cracked, broken or defective pipe or special shall be used in the work. All pipe shall be carefully inserted in the bell in such a manner that there will be no unevenness of any kind along the bottom half of the pipes and so that there is a uniform joint space all around.

F. The Contractor is prohibited from adding patching compounds to the ends of damaged or cracked pipe without written instructions from the manufacturer and only while the inspector is present.

G. All pipe that is field cut shall have the homing-marks reestablished, insuring for proper seating depths. Pipes that are field cut shall have the cut ends retapered, by grinding or filing, as close to the original taper provided by the manufacturer as possible. When homing pipe with a spud-bar or other mechanical equipment, other than by hand, place a piece of wood between pipe and tool to prevent damage to bell end-section.

H. Pipe laid in open cut shall have all trench spaces and voids solidly and completely filled with suitable earth materials from the excavations, which shall be thoroughly and solidly rammed into place, unless otherwise specified.

I. The joints shall be constructed as specified. The interior of the sewer shall, as the work progresses, be cleared of all dirt and superfluous materials of every description. Whenever pipe laying is discontinued, the unfinished end of the sewer shall be protected from displacement and cave-in or other injuries. During the process of the laying, care shall be taken to protect both pipes and joints from disturbance, and the trench shall be kept free from water until the joints shall have set. All surplus mortar or debris shall be promptly and completely removed from the interior of the pipes. On storm sewers twenty-four (24) inches in diameter and less, a disc mold or swab attached to a rod sufficiently long to pass two (2) joints from the end of the pipe last laid, shall be continuously worked through as the laying of the pipe proceeds.

J. The ends of the pipes shall be protected to prevent the entrance of dirt or other foreign substances. Such protection shall be placed at night or whenever pipe laying is stopped for any reason. Suitable plugs designed for use with the pipe material shall be provided and properly secured and used to cap all slants and branches. Pipe end protection and devices shall be included in the prices bid per linear foot of sewer.

3.03 Flexible Conduit Installation

A. Plastic sewer pipe (PVC) and other flexible pipe shall be carefully installed in accordance with the above specification for Rigid Conduit Installation, except where the following paragraphs modify those specifications.

B. Flexible conduit for sewer pipe shall be installed in accordance with "Underground installation of Flexible Thermoplastic Sewer Pipe" ASTM Designation C 2321.

C. Pipe Laying for Flexible pipe may be achieved by the Class B Bedding Method as shown in the ASCE Manual of Practice No. 37, latest edition for granular bedding. Under this class B Bedding Method, the pipe shall be bedded in compacted granular material (Class I or II) to a point no less than twelve (12) inches above the crown of the pipe. All granular bedding material shall be placed in the trench in approximately six (6) inch layers and compacted.

D. Compaction shall be accomplished by hand or Mechanical Tamping or by "Walking" the granular material in for Class I materials only. When Class II materials are used compaction shall be accomplished by hand or mechanical tamping only to a minimum eighty-five percent (85%) Standard Proctor Density.

3.04 Semi-Rigid Pipe Installation

A. All semi-rigid pipe shall be laid in the same way as flexible pipe as described above.

3.05 Testing Gravity Storm Sewers

A. A deflection test shall be performed on each flexible pipe following the elapse of thirty (30) days after the placement of the final backfill. No pipe shall exceed a deflection of five percent (5%) or greater.

B. The diameter of the rigid ball or mandrel used for a deflection test shall be no less than ninety-five percent (95%) of the base inside diameter of the pipe to be tested dependent on what is specified in the corresponding ASTM standard. The Contractor shall be responsible for proving an ASTM approved proving ring to verify the correct diameter of the rigid ball or mandrel. The test shall not be performed with the aid of a mechanical pulling devise.

3.06 Restoration Work

A. The sections of trenches located outside the limits of the road driving surfaces shall be restored to original shape and grade, except as otherwise noted, by backfilling with excavated material and finishing with no less than 4-inches of topsoil (not subsoil) except where there are existing pavements or pavements specified to be replaced or reconstructed.

B. All excavations beneath pavements (including hard surfaced and compacted aggregate pavements) including those areas below curbs and sidewalks shall be backfilled with compacted granular backfill. The backfill shall be placed in a manner to minimize lumps and voids, and shall be compacted with mechanical tampers unless otherwise justified in writing by a geotechnical engineer or professional geologist. Equipment for compaction may be run over backfill after there is a minimum of two (2) feet of backfill over a pipe barrel unless justified otherwise by the manufacturer in writing. Completion of backfill to finished grade for temporary restoration prior to final pavement restoration shall be with

compacted aggregate. Compacted aggregate shall conform to the INDOT Standard Specifications for Compacted Aggregate Base. The aggregate shall be thoroughly compacted. Any settlement that occurs shall be immediately refilled with compacted aggregate. The Contractor shall apply an approved dust preventative as necessary to avoid or eliminate dust complaints from nearby residents.

C. Any curbs, sidewalks, sewers, drains, catch basins, mailboxes, street signs and miscellaneous structures damaged or removed shall be immediately restored to original or better condition and in accordance with the American Disabilities Act (ADA) requirements. The Contractor shall be responsible to comply with applicable INDOT Standards and Specifications.

D. Restoration work related to pavement repair shall comply with this and other related Workmanship and Materials and Detailed Specifications.

E. Final seeding, grading, and sodding shall comply with the applicable Workmanship and Materials sections. The Contractor must keep disturbed areas to a minimum.

3.07 Drain Tile Repair

A. When excavating in, across, or through an existing tile, the Contractor shall follow the following procedures:

B. Tile drains shall be repaired using perforated polyethylene corrugated drainage tubing. Existing intact drain line shall be supported during excavation. A "Fernco" type coupling shall be used for connection of new tile to existing tile. The Contractor shall backfill and compact the area around drain tile by hand until the new tile is completely covered.

C. The Contractor will be required to connect any existing drainage pipe or tile encountered during construction if in direct conflict unless directed otherwise by the Engineer. The Owner or Owner’s Representative must be immediately notified when any existing drain pipe or tile is located and must be present during all connections of same to the new storm sewer system. All construction methods and materials to accomplish this shall be in accordance with applicable sections of the Workmanship and Materials and as indicated on the drawings.

(SECTION WM 14)

PRESSURE PIPE - WATER

PART 1 GENERAL

1.01 Description

A. The Contractor shall furnish and lay, as required, water pressure pipe, together with all fittings, thrust blocking, service taps, service lines or other specials as shown on the plans or specified and, necessary to complete the work, including necessary pipe for purpose of tests. Water pressure pipe shall be constructed of the pipe materials as specified herein.

B. All water pressure pipe to be furnished under this Contract shall conform to specifications of this section. Actual materials furnished for water pressure pipe shall be permitted only as indicated in the Detailed Specifications.

C. Related work described elsewhere:

1. Excavation WM-2
2. Backfill WM-3

1.02 Quality Assurance

A. Codes and Standards

1. Each length of pipe shall be marked per the requirements of the respective ASTM Standard and/or AWWA.

2. All codes and standards shall be set forth in the latest ASTM and AWWA Standards.

3. Upon request by the Engineer, the Contractor at his own expense, shall furnish copies of all material tests required by the applicable Standards.

1.03 Submittals

A. Shop Drawings

1. Prior to ordering pipe material, submit shop drawings to the Engineer for approval. All submittals shall include certification of conformance with the applicable ASTM and AWWA Pipe Standards. No field work shall be started prior to shop drawing approval.

PART 2 PRODUCTS

2.01 Ductile Iron Pipe

A. Material

Ductile Iron Pipe shall be centrifugally cast and shall conform to ANSI Specifications A-21.51 and AWWA C-151, latest revision, and shall include the National Sanitation Foundation (NSF) seal of approval. Ductile Iron Pipe shall be Pressure Class 350, 300, 250, 200 or 150.

B. Coatings and Linings

Pipe shall be standard cement lines and seal coated with an approved bituminous seal coat in accordance with AWWA Specification C-104 (ANSI A21.4).

Pipe shall be installed with 4 mil high density cross linked polyethylene encasement material, inclusive of fittings. The material shall be furnished and installed in accordance with AWWA Specification C-105 (ANSI A21.5) to provide the pipe with a protective enclosure.

C. Fittings

Fittings shall be standardized for the type of pipe and joint specified and shall comply with AWWA C-110 (ANSI A21.10) or AWWA C-153 (ANSI A-21.53).

D. Joints

Mechanical joints or slip joints shall be provided.

Mechanical joints and accessories shall conform to AWWA Standard C-111, ANSI A21.11. The bolts and nuts shall be corrosion resistant high strength alloy steel. The O-ring gaskets sealing the slip joint shall be made of rubber of special composition having a texture to assure a watertight and permanent seal and shall be the product of a manufacturer having at least five (5) years experience in the manufacture of rubber gaskets for pipe joints. The gaskets shall be a continuous ring of flexible joint rubber of a composition and texture which is resistant to common ingredients of sewage, industrial wastes and groundwater; and which will endure permanently under the conditions likely to be imposed by this service. The gasket shall conform to the requirements of AWWA C-111 (ANSI A-2111).

Where indicated on plans for submerged crossings of rivers, lakes or streams, pipe shall be furnished with boltless ball and socket type joints, pipe pressure class shall be 350 psi.

Where indicated on plans, restrained joint pipe shall be provided. Restrained joints shall be designed in accordance with AWWA C-111 and shall permit horizontal and/or vertical deflection after assembly, yet adequately restrain the joint at the full design pressure.

E. Markings

The class designations for the various classes of pipe and fittings shall be cast onto fittings in raised numerals, and cast or stamped on the outside of each joint of pipe.

F. Certification

The Contractor shall furnish certified reports stating that inspection and specified tests have been made and that the results thereof comply with the applicable AWWA and ANSI Specifications.

G. Locate Wire

Locate wire shall be #12 standard copper wire with thermoplastic insulation and capable of carrying 600 Volts. The wire shall be temporarily held in place during initial backfilling of the pipe using duct tape. The wire shall be brought to the ground surface at 1000 foot intervals through a cast iron valve box. A minimum of 2 feet extra wire shall be left in the valve box for future connection to utility locate equipment. Each box shall be marked with a pipe line locate marker manufactured by Carsonite, Buckeye Partners, L.P., or equal. Labels selected by the Owner shall be affixed to the marker. Marker will be required at all riser locations unless instructed differently by the Engineer. Cast iron valve boxes shall be in accordance with WM-16, Paragraph 2.02, Valve Boxes.

2.02 High Density Polyethylene Pipe (4" and larger)

A. Pipe

Materials used for the manufacture of polyethylene pipe shall be extra high molecular weight, high density ethylene/hexane copolymer PE 3408 or PE 4710 polyethylene resin meeting the requirements of ASTM D-3350 with a cell classification of PE 345434C or 4454746 or higher. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All material shall be listed by the Plastic Pipe Industry in the name of the pipe manufacturer and shall be based on ASTM D2837 and PPI TR-3 testing and validation for samples of the pipe manufacturer's production pipe.

All High Density Polyethylene Pipe shall include the National Sanitation Foundation (NSF) seal of approval.

Pipe shall be designed and manufactured in accordance with AWWA C-906. The pipe shall be pressure rated in accordance with AWWA C-906, Pressure Class and Dimension Ratios (DR) shall be as follows:

Class 128	DR 13.5
Class 160	DR 11
Class 193	DR 9.3
Class 200	DR 9
Class 254	DR 7.3

B. Joining

HDPE pipe shall be joined into continuous lengths on the job-site above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements, alignment, and interracial fusion pressure. Socket fusion shall not be used.

C. Pipe Packaging, Handling, Storage

The manufacturer shall package the pipe in a manner designed to deliver the pipe to the project site neatly, intact and without physical damage. The transportation carrier shall use appropriate method to insure the pipe is properly supported, stacked and restrained during transport. On-site the pipe shall be stored on clean, level ground to prevent undue scratching or gouging. When lining fused sections of pipe, chains or cable type chokers must be avoided, nylon slings are preferred. Care must be exercised to avoid cutting or gouging the pipe.

D. Installation

Water main installation shall be in conformance with Specifications for Installation of Flexible Pipe as per all applicable ASTM requirements, including F-412, D-2321, D-2412, D-3212 and D-3350.

Where indicated on plans for submerged crossing of rivers, lakes or streams, pipe shall be furnished with an adequate number of concrete collars properly spaced to overcome pipe buoyancy.

E. Locator Tape and Wire

All HPDE pipe shall be installed with a metallic locator tape. Tape shall be color-coded and installed above the pipe in accordance with the tape manufacturer's instructions.

Locate wire shall be #12 standard copper wire with thermoplastic insulation and capable of carrying 600 Volts. The wire shall be temporarily held in place during initial backfilling of the pipe using duct tape. The wire shall be brought to the ground surface at 1000 foot intervals through a cast iron valve box. A minimum of 2 feet extra wire shall be left in the valve box for future connection to utility locate equipment. Each box shall be marked with a pipe line locate marker manufactured by Carsonite, Buckeye Partners, L.P., or equal. Labels selected by the Owner shall be affixed to the marker. Marker will be required at all riser locations unless instructed differently by the Engineer. Cast iron valve boxes shall be in accordance with WM-16, Paragraph 2.02, Valve Boxes.

F. Markings

During the extrusion production, the HDPE pipe shall be continuously marked with durable printing noting the nominal pipe size, dimension ratio, pressure rating, trade name, material classification, certification bases and date in accordance with AWWA C-906.

G. Certifications

The Contractor shall furnish upon request a certificate of conformance to the required AWWA and ASTM Standards.

2.03 Polyvinyl Chloride Pipe SDR Rated Pipe (SDR) (3" - 12")

A. Pipe

PVC water main pipe rated by SDR shall conform to ASTM Specification D-2241, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe (SDR PR). The material used shall conform to ASTM Specification D-1784, Standard Specification of Rigid Polyvinyl Chloride and Chlorinated Polyvinyl Chloride compounds, Class 12454-B (PVC 1120). Pipe larger than 12" diameter shall conform to AWWA C905.

The pipe shall be pressure rated in accordance with recommendations of the Plastic Pipe Institute. Pressure class and Standard Dimension Ratios (SDR) shall be as follows:

Class 160	SDR 26
Class 200	SDR 21
Class 250	SDR 17
Class 315	SDR 13.5

All plastic pipe shall bear identification markings in accordance with Sections 2.5.2 and 2.5.3 of AWWA C-900, which shall include the National Sanitation Foundation (NSF) seal of approval. In addition, the plain end of each pipe length shall have two (2) rings, 1" apart, painted around the pipe at the proper location to allow field checking of the correct setting depth of the pipe in the bell or coupling.

B. Joints

Joints shall be bell end or coupling push-on type.

The push-on joint and joint compounds shall meet the requirements for ASTM Specification D-3139, Joint for the Plastic Pressure Pipe, using Flexible Elastomeric Seals. The joint shall be designed so as to provide for the thermal expansion and contraction experienced with a total temperature change of seventy-five (75) degrees F in each joint of pipe. Details of the joint design and assembly shall be in accordance with joint manufacturer's standard practice.

The lubricant shall have no deteriorating effects on the gasket or the pipe. The lubricant containers shall be labeled with manufacturer's name.

Gaskets shall meet all applicable requirements of ANSI Standard A-21-11.

C. Fittings

Fittings shall be furnished in accordance with AWWA C-110 (ANSI A-21.10) and AWWA C-153 (ANSI A-21.53).

D. Locator Tape and Wire

All PVC pipe shall be installed with a metallic locator tape. Tape shall be color coded and installed above the pipe in accordance with the tape manufacturer's instructions.

Locate wire shall be #12 standard copper wire with thermoplastic insulation and capable of carrying 600 Volts. The wire shall be temporarily held in place during initial backfilling of the pipe using duct tape. The wire shall be brought to the ground surface at 1000 foot intervals through a cast iron valve box. A minimum of 2 feet extra wire shall be left in the valve box for future connection to utility locate equipment. Each box shall be marked with a pipe line locate marker manufactured by Carsonite, Buckey Partners, L.P., or equal. Labels selected by the Owner shall be affixed to the marker. Marker will be required at all riser locations unless instructed differently by the Engineer. Cast iron valve boxes shall be in accordance with WM-16, Paragraph 2.02, Valve Boxes.

E. Markings

The date of manufacture, class of pipe, specification designation, size of pipe, name or trademark of manufacturer, and identification of plant/location shall be legibly marked on the outside of each pipe section in accordance with the ASTM D-3034.

F. Certification

The Contractor shall, upon request, furnish manufacturer's certification stating that the pipe supplied meets or exceeds all requirements of the applicable ASTM and AWWA (where applicable) Standards.

2.04 Polyvinyl Chloride Pipe C-900 Rated (4" - 12")

A. Pipe

PVC water main rated C-900 shall conform to standards for polyvinyl chloride plastic pipe AWWA C-900. The material used shall conform to ASTM Specification D-1784 Standard Specification of rigid polyvinyl chloride and chlorinated polyvinyl chloride compounds. Class 12454-B (DOC 1170) and the National Sanitation Foundation Standard No. 61.

The pipe shall be pressure rated in accordance with AWWA C-900.

Class 235	DR-18
Class 305	DR-14

All plastic pipe shall bear identification markings in accordance with AWWA C-900, which shall include the National Sanitation Foundation (NSF) seal of approval. In addition, the plain end of each pipe length shall have two (2) rings 1" apart painted around the pipe at the proper location to allow field checking of the correct setting depth of the pipe in the bell or fitting.

B. Joints

Joints shall be bell end or coupling push-on type.

The push-on joint and joint components shall meet the requirements for ASTM Specification D-3139, Joint for the Plastic Pressure Pipe, using Flexible Elastomeric Seals (ASTM F-477). The joint shall be designed so as to provide for the thermal expansion and contraction experienced with a total temperature change of seventy-five (75) degrees F in each joint of pipe. Details of the joint design and assembly shall be in accordance with joint manufacturer's standard practice.

The lubricant shall have no deteriorating effects on the gasket or the pipe. The lubricant containers shall be labeled with manufacturer's name.

Gaskets shall meet all applicable requirements of ANSI Standard A-21-11.

C. Fittings

Fittings shall be furnished in accordance with AWWA C-110 (ANSI A-21.10) and AWWA C-153 (ANSI A-21.53).

D. Locator Tape and Wire

All PVC pipe shall be installed with a metallic locator tape. Tape shall be color coded and installed above the pipe in accordance with the tape manufacturer's instructions.

Locate wire shall be #12 standard copper wire with thermoplastic insulation and capable of carrying 600 Volts. The wire shall be temporarily held in place during initial backfilling of the pipe using duct tape. The wire shall be brought to the ground surface at 1000 foot intervals through a cast iron valve box. A minimum of 2 feet extra wire shall be left in the valve box for future connection to utility locate equipment. Each box shall be marked with a pipe line locate marker manufactured by Carsonite, Buckeye Partners, L.P., or equal. Labels selected by the Owner shall be affixed to the marker. Marker will be required at all riser locations unless instructed differently by the Engineer. Cast iron valve boxes shall be in accordance with WM-16, Paragraph 2.02, Valve Boxes.

E. Markings

Each section of pipe shall be marked with size and O.D. Base, PVC, DR ratio, AWWA pressure class, manufacturing name, production code and NSF seal in accordance with AWWA C-900, ASTM D-224 and ASTM F-1483.

F. Certification

The Contractor shall upon request furnish manufacturer's certification stating that the pipe supplied meets or exceeds all applicable requirements of AWWA C-900 and ASTM.

2.05 Polyvinyl Chloride Pipe C-905 Rated (14" and larger)

A. Pipe

PVC water main rated C-905 shall conform to standards for polyvinyl chloride plastic pipe AWWA C-905. The material used shall conform to ASTM Specification D-1784 Standard Specification of rigid polyvinyl chloride and chlorinated polyvinyl chloride compounds. Class 12454-B (DOC 1170) and the National Sanitation Foundation Standard No. 61.

The pipe shall be pressure rated in accordance with AWWA C-905.

Class 165	DR-25
Class 235	DR-18

All plastic pipe shall bear identification markings in accordance with AWWA C-905, which shall include the National Sanitation Foundation (NSF) seal of approval. In addition, the plain end of each pipe length shall have two (2) rings 1" apart painted around the pipe at the proper location to allow field checking of the correct setting depth of the pipe in the bell or fitting.

B. Joints

Joints shall be bell end or coupling push-on type.

The push-on joint and joint components shall meet the requirements for ASTM Specification D-3139, Joint for the Plastic Pressure Pipe, using Flexible Elastomeric Seals (ASTM F-477). The joint shall be designed so as to provide for the thermal expansion and contraction experienced with a total temperature change of seventy-five (75) degrees F in each joint of pipe. Details of the joint design and assembly shall be in accordance with joint manufacturer's standard practice.
The lubricant shall have no deteriorating effects on the gasket or the pipe. The lubricant containers shall be labeled with manufacturer's name.

Gaskets shall meet all applicable requirements of ANSI Standard A-21-11.

C. Fittings

Fittings shall be furnished in accordance with AWWA C-110 (ANSI A-21.10) and AWWA C-153 (ANSI A-21.53).

D. Locator Tape and Wire

All PVC pipe shall be installed with a metallic locator tape. Tape shall be color coded and installed above the pipe in accordance with the tape manufacturer's instructions.

Locate wire shall be #12 standard copper wire with thermoplastic insulation and capable of carrying 600 Volts. The wire shall be temporarily held in place during initial backfilling of the pipe using duct tape. The wire shall be brought to the ground surface at 1000 foot intervals through a cast iron valve box. A minimum of 2 feet extra wire shall be left in the valve box for future connection to utility locate equipment. Each box shall be marked with a pipe line locate marker manufactured by Carsonite, Buckeye Partners, L.P., or equal. Labels selected by the Owner shall be affixed to the marker. Marker will be required at all riser locations unless instructed differently by the Engineer. Cast iron valve boxes shall be in accordance with WM-16, Paragraph 2.02, Valve Boxes.

E. Markings

Each section of pipe shall be marked with size and O.D. Base, PVC, DR ratio, AWWA pressure class, manufacturing name, production code and NSF seal in accordance with AWWA C-905, ASTM D-224 and ASTM F-1483.

F. Certification

The Contractor shall upon request furnish manufacturer's certification stating that the pipe supplied meets or exceeds all applicable requirements of AWWA C-905 and ASTM.

2.06 Moleculary Oriented Polyvinyl Chloride Pipe (PVCO) (4" - 12")

A. Pipe

PVCO water main shall conform to standards for Moleculary Oriented Polyvinyl Chloride Plastic Pipe, AWWA C-909. The material used shall conform to ASTM D-1784 Standard Specification of rigid polyvinyl chloride - chlorinated polyvinyl chloride compounds, Class 12494-B.

The pipe shall be pressure rated in accordance with AWWA C-909.

Class 100	350 psi test
Class 150	500 psi test
Class 200	650 psi test

All plastic pipe shall bear identification markings in accordance with AWWA C-909, which shall include the National Sanitation Foundation (NSF) seal of

approval. In addition, the plain end of each pipe length shall have two (2) 1" apart painted, around the pipe at the proper location to allow field checking of the correct setting depth of the pipe in the bell or fitting.

B. Joints

Joints shall be bell end or coupling push-on type.

The push-on joint and joint components shall meet the requirements for ASTM Specification D-3139, Joint for the Plastic Pressure Pipe, using Flexible Elastomeric Seals. The joint shall be designed so as to provide for the thermal expansion and contraction experienced with a total temperature change of seventy-five (75) degrees F in each joint of pipe. Details of the joint design and assembly shall be in accordance with joint manufacturer's standard practice.

The lubricant shall have no deteriorating effects on the gasket or the pipe. The lubricant containers shall be labeled with manufacturer's name.

Gaskets shall meet all applicable requirements of ANSI Standard A-21-11.

C. Fittings

Fittings shall be furnished in accordance with AWWA C-110 (ANSI A-21.10) and AWWA C-153 (ANSI A-21.53). PVCO shall only be tapped through a service saddle. Direct tapping the wall of the pipe is not permitted.

D. Locator Tape and Wire

All PVCO pipe shall be installed with a metallic locator tape. Tape shall be color coded and installed above the pipe in accordance with the tape manufacturer's instructions.

Locate wire shall be #12 standard copper wire with thermoplastic insulation and capable of carrying 600 Volts. The wire shall be temporarily held in place during initial backfilling of the pipe using duct tape. The wire shall be brought to the ground surface at 1000 foot intervals through a cast iron valve box. A minimum of 2 feet extra wire shall be left in the valve box for future connection to utility locate equipment. Each box shall be marked with a pipe line locate marker manufactured by Carsonite, Buckey Partners, L.P., or equal. Labels selected by the Owner shall be affixed to the marker. Marker will be required at all riser locations unless instructed differently by the Engineer. Cast iron valve boxes shall be in accordance with WM-16, Paragraph 2.02, Valve Boxes.

E. Markings

Each section of pipe shall be marked with size and O.D. Base, PVC, AWWA pressure class, manufacturing name, production code and NSF seal in accordance with AWWA C-909.

2.07 Service Saddles

A. Shall be double strap type of stainless or brass construction with confined "O" ring seal and AWWA thread outlet. Service saddles shall be of a design which will accurately fit pipe (O.D.) to provide a positive seal between main and saddle at the rated working pressure of the main.

B. The service saddle shall be marked to indicate size of main (O.D.) and outlet size on body and strap. Service saddle shall be a double strap Ford Style 202B, Mueller BR 2S Series for service lines, or approved equal.

2.08 Corporation Stops

A. Shall be brass, designed and manufactured in accordance with AWWA Standard Specification C-800 and shall be individually inspected and tested for the leaks at the factory prior to shipment. Corporation stops shall be of a design which will permit use with drilling machines of current design.

B. Corporation stops shall be ball type furnished with AWWA inlet thread and compression joint outlet as manufactured by Ford Meter Box Co., Mueller Co., or approved equal.

2.09 Curb Stops and Curb Boxes

A. The curb stops shall be a brass ball valve with pack joints suitable for use with the plastic service line specified and manufactured by the Ford Meter Box Company, Inc., Muller Co., or equal. The curb boxes shall be an extension type curb box with an arch pattern base suitable for use with the specified curb stop. All boxes shall be heavily coated with an asphaltic-base coating. The lid shall have "Water" imprinted on it and brass pentagon head plug. The lid and base shall be cast iron.

2.10 Insert Stiffeners

A. Insert stiffeners are required for all PE pipe connections to corporation stop and meter setter pack joint inlet/outlet compression couplings or fittings. Stiffeners shall be solid, stainless steel, sized to match the I.D. of the service pipe, as manufactured by Ford, Mueller, or approved equal.

2.11 Polyethylene (PE) Service Pipe (CTS)

A. Polyethylene pipe (SDR-PR) service line for water distribution, hereinafter referred to as PE pipe, shall conform to all applicable requirements in the latest revision of ASTM D-1248, ASTM D-2737, ASTM D-3350, and AWWA C-901 standards for Copper Tube Size (SDR-9).

B. Polyethylene extrusion compound from which the polyethylene pipe is extruded shall comply with applicable requirements for PE-3408 ultra-high molecular weight polyethylene plastic material. Material shall be as described in ASTM D-1248 latest revision.

C. The PE pipe shall be rated for use with water at 73.4°F at a hydrostatic design stress of six hundred thirty (630) psi and a working pressure of one hundred sixty (160) psi in accordance with ASTM D-1599.

D. The minimum burst pressure at 73.4°F determined in accordance with ASTM D-1599, latest revision, shall be six hundred thirty (630) psi. The time of testing of such specimen shall be between sixty (60) and seventy (70) seconds.

E. PE service pipe shall have the following nominal dimensions and weights:

Nominal Size (Inches)	Nominal O.D. (Inches)	Approx. I.D. (Inches)	Minimum Wall (Inches)	Approx. Pounds/ 100-Feet
3/4	0.875	0.681	0.097	9.8
1	1.125	0.875	0.125	16.3
2	2.125	1.653	0.236	60.9

F. PE pipe shall be permanently marked indicating nominal size, PE 3408, standard dimension ratio, pressure rating at 73°F, manufacturer's name (or trademark), date, code, appropriate ASTM designation, and the NSF-pw seal indicating approval for potable water.

G. PE pipe shall be homogenous throughout and free of visible cracks, holes, foreign inclusions or other defects. It shall be uniform in color, capacity, density and other physical properties.

H. PE pipe shall be as manufactured by Phillips Drisco Pipe, Inc., Richardson, TX, Crestline Plastic Pipe Co., Inc., or approved equal.

I. The Contractor shall furnish a certification from the manufacturer of the pipe that the manufacturer is fully competent and capable of extruding PE pipe of uniform texture and strength to fully comply with the properties and ASTM specifications listed and further that the pipe for this project will be manufactured.

J. The service line shall include a #12 locating wire installed with it for future location.

2.12 Polyethylene (PE) Service Pipe (IPS)

A. Polyethylene pipe (SDR-PR) service line for water distribution hereinafter referred to as P.E. pipe shall conform to all applicable requirements in the latest revision of ASTM D-1248, ASTM D-2737, ASTM D-3350 and AWWA C-901 standards for Iron Pipe Size (SDR-7).

B. Polyethylene extrusion compound from which the polyethylene pipe is extruded shall comply with applicable requirements for PE-3408 ultra-high molecular weight polyethylene plastic material. Material shall be as described in ASTM D-1248 latest revision.

C. The PE pipe shall be rated for use with water at 73.4°F at a hydrostatic design stress of six hundred thirty (630) psi and a working pressure of one hundred sixty (160) psi in accordance with ASTM-D1599.

D. The minimum burst pressure at 73.4°F determined in accordance with ASTM D-1599 latest revision, shall be six hundred thirty (630) psi. The time of testing of such specimen shall be between sixty (60) and seventy (70) seconds.

E. PE service pipe shall have the following nominal dimensions and weights:

Nominal Size (inches)	Approx. O.D. (Inches)	Nominal I.D. (Inches)	Minimum Wall (inches)	Approx. Pounds/100 Ft.
3/4	1.060	0.824	0.118	15
1	1.349	1.049	0.15	25
2	2.657	20.67	0.295	96

F. PE pipe shall be permanently marked indicating nominal size, PE 3408, standard Dimension Ratio, pressure rating at 73°F, manufacturer's name (or trademark), date, code, appropriate ASTM designation, and the NSF-pw seal indicating approval for potable water.

G. PE pipe shall be homogenous throughout and free of visible cracks, holes, foreign inclusions or other defects. It shall be uniform in color, capacity, density and other physical properties.

H. PE pipe shall be as manufactured by Phillips Drisco Pipe, Inc., Richardson, TX; Crestline Plastic Pipe Co., Inc., or approved equal.

I. The Contractor shall furnish a certification from the manufacturer of the pipe that the manufacturer is fully competent and capable of extruding PE pipe of uniform texture and strength to fully comply with the properties and ASTM specifications listed and further that the pipe for this project will be manufactured.

J. The service line shall include a #12 locating wire installed with it for future location.

2.13 Copper Service Pipe

A. All copper pipe (“K”) service line for water distribution hereinafter referred to as pipe, shall conform to all applicable requirements in the latest revision of ASTM and AWWA Standards for Copper Tube Size (SDR-9).

PART 3 INSTALLATION OF POTABLE WATER MAIN

Potable water mains shall be installed in accordance with AWWA/ASTM D-2774 Standards and manufacturer’s recommendations, and Uni-Bell PVC Pipe Association, Standard Uni-B-3. If any conflict between these standards, manufacturer’s recommendations, the manufacturer’s recommendations shall take precedence.

3.01 Alignment and Grade

The water mains shall be laid and maintained to lines and grades established by the plans and specifications, with fittings, valves, tapped or bossed outlets, and hydrants at the required locations unless otherwise approved by the Engineer. Valve-operating stems shall be oriented in a manner to allow proper operation. Hydrants shall be installed plumb.

A. Clearance

When crossing existing pipelines or other structures, alignment and grade shall be adjusted as necessary, with the approval of the Engineer, to provide clearance as required by federal, state, and local regulations or as deemed necessary by the Owner to prevent future damage or contamination of either structure. Horizontal separation from sewers shall be 10' measured horizontally from outside edge of water main to the outside edge of any existing and proposed sanitary sewers or storm sewers. When installation closer than 10' is required or when crossing sewers, the water main shall be installed at least 18" above the top of the sewer.

Installation not meeting the above requirements shall be as shown on plans and in accordance to state regulations.

3.02 Trenching

A. Width

Refer to WM-2, Paragraph 2.12, for trench width requirements.

B. Bell Holes

Holes for the bells shall be provided at each joint, but shall be no longer than necessary to allow joint assembly and to ensure that the pipe barrel will lie flat on the trench bottom. Push-on type joints require only minimum depressions for bell holes.

Other than noted previously, the trench bottom shall be true and even to provide support for the full length of the pipe barrel, except that a slight depression may be provided to allow withdrawal of pipe slings or other lifting tackle without damaging coating or polyethylene encasement.

C. Rock Conditions

When excavation of rock is encountered, all rock shall be removed to provide a clearance below and on each side of all pipe, valves, and fittings of at least 6" for pipe sizes 24" or smaller and 9" for pipe sizes 30" and larger. When excavation is completed, a layer of appropriate backfill material shall be placed on the bottom of the trench to the previously mentioned depths, leveled, and tamped.

This installation procedure shall be followed when gravel formations containing loose boulders greater than approximately 8" (200 mm) in diameter are encountered.

In all cases, the specified clearances shall be maintained between the bottom of all pipe and appurtenances and any part, projection, or point or rock, boulder, or stone of sufficient size and placement that, in the opinion of the Engineer, could cause a fulcrum point or pointload.

3.03 Pipe Laying

Proper implements, tools and facilities shall be provided and used for the safe and convenient performance of the work. All pipe, fittings, valves, and hydrants shall be lowered carefully into the trench by means of a derrick, ropes, or other suitable tools or equipment, in such a manner as to prevent damage to water main materials and protective coatings and linings. Under no circumstances shall water main materials be dropped or dumped into the trench. Where practical, the trench should be dewatered prior to installation of the pipe.

A. Examination of Material

All pipe, fittings, hydrants, and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective materials shall be marked and held for inspection by the Engineer, who may prescribe corrective repairs or reject the materials.

B. Pipe Ends

All lumps, blisters, and excess coating shall be removed from the socket and plain ends of each pipe, and the outside of the plain end and the inside of the bell shall be wiped clean and dry and be free from dirt, sand, grit, or any foreign materials before the pipe is laid.

C. Pipe Cleanliness

Foreign material shall be prevented from entering the pipe while it is being placed in the trench. No debris, tools, clothing, or other materials shall be placed in the pipe at any time.

D. Pipe Placement

As each length of pipe is placed in the trench, the joint shall be assembled and the pipe brought to correct line and grade. The pipe shall be secured in place with approved backfill material.

E. Pipe Plugs

At times when pipe-Laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Engineer. The plug shall be fitted with a means for venting. When practical, the plug shall remain in

place until the trench is pumped completely dry. Care must be taken to prevent pipe flotation, should the trench fill with water.

Prior to removal of the plug for extending the line or for any other reason, air and/or water pressure in the line shall be released.

F. Ductile Iron Encasement

Polyethylene encasement for ductile iron pipe shall be installed in accordance with ANSI/AWWA C105/A21.5.

3.04 Joint Assembly

Joints shall be assembled in accordance with the manufacturer's instructions.

A. Assembly

After placing a length of pipe in the trench, the manufacturer's lubricant shall be properly applied. Spigot end shall then be centered in the bell and the pipe pushed home and brought to correct line and grade. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipe of proper dimensions to insure such uniform space. Precautions shall be taken to prevent dirt from entering the joint space.

B. Joint Deflection

When it is necessary to deflect pipe from a straight line in either the horizontal or vertical plane, the amount of joint deflection shall not exceed 80% of the allowance recommended by the manufacturer.

C. Pipe Cutting

Cutting pipe for insertion of valves, fittings, or closure pieces shall be done in conformance with all safety recommendations of the manufacturer of the cutting equipment. Cutting shall be done in a safe, workmanlike manner without creating damage to the pipe lining. An oxyacetylene torch shall not be used.

Cut ends and rough edges shall be ground smooth, and for push-on joint connections the cut end shall be beveled by methods recommended by the manufacturer and approved by the Engineer.

3.05 Bedding for Water Main

Bedding material shall be native soil, Class I, II or Class III as required for the various laying conditions.

Where rock excavation is required, a minimum of 6" of Class I, II or Class III bedding is required for mains up to 24" diameter and 9" for 30" and larger.

Where non-granular backfill is to be consolidated to the top of pipe earth, or loam free of rocks or other debris, shall be placed by hand or carefully by equipment to prevent

horizontal movement of the pipe. This material shall be hand tamped or spaded to firmly support the pipe haunches.

Backfilling shall be in accordance with Section WM 3.

Where granular backfill is required, granular fill shall be placed by hand or carefully by equipment. This material shall be hand tamped or spaded to firmly support the pipe haunches.

3.06 Thrust Restraint

A. Hydrants

The bowl of each hydrant shall be well braced against a sufficient area of unexcavated earth at the end of the trench with stone slabs or concrete thrust blocks, or it shall be tied to the pipe with suitable stainless steel tie rods, clamps, or restrained joints as shown on the plans.

B. Fittings

All plugs, caps, tees, reducers, and bens, unless otherwise specified, shall be provided with thrust blocks or suitably restrained joints as shown on the plans.

C. Design

The design pressure is the maximum pressure to which the pipeline will be subjected, with consideration given to the vulnerability of the pipe soil system when the pressure is expected to be applied. In most cases, this will be the test pressure of the pipe, applied shortly after installation, when the pipe soil system is normally most vulnerable.

For buried pipelines, thrust restraint is achieved by transferring the thrust force to the soil structure outside the pipe. The objective of the design is to distribute the thrust forces to the soil structure in such a manner that joint separation will not occur in unrestrained joints.

D. Concrete Thrust Blocks

Vertical and horizontal thrust blocks shall be made of concrete having a compressive strength of not less than 3000 psi after 28 days. The blocks shall be placed between solid ground, and the fitting to be anchored. The mass of the block and/or the area of bearing on the pipe and on the ground in each instance shall be that shown on the plans. The blocking shall, unless otherwise shown or directed, be so located as to contain the resultant thrust force in such a way that the pipe and fitting joints will be accessible for repair. Concrete for thrust blocks shall be properly mixed by truck or portable mixer. At no time shall pipe be restrained with bags of premixed concrete unless properly mixed with a portable mixer.

E. Restrained Joints

Restraining mechanisms for push-on or mechanical joints may be used instead of or in concert with concrete blocking, if so indicated in the plans and specifications. Tie rods, clamps, or other components of dissimilar metal shall be protected against corrosion by hand application of a suitable coating or by encasement of the entire assembly with 8 mil loose polyethylene film in accordance with ANSI/AWWA C105/A21.5.

Glands shall be manufactured of ductile iron conforming to ASTM A536-80, Grade 60-42-10. Set screws shall be hardened ductile iron. These devices shall have pressure rating with a safety factor of 221. Glands shall be listed with UL and factory manual.

3.07 Disinfection of System

After completion of each extension system, all hydrants and blow-offs shall be flushed to remove dirt and foreign material. The extension shall then be treated to provide water of safe bacteriologized quality and shall meet the approval of the Engineer and the Indiana Department of Environmental Management (IDEM). The Contractor shall furnish the Engineer with two (2) copies of the water analysis report approved by the Indiana Department of Environmental Management (IDEM) prior to installing service meters. The system shall be treated in accordance with AWWA C651 latest revision, however, either of the following modified methods shall be used.

A. Chlorinating the Main

1. Water from the existing distribution system or other approved source of supply shall be made to flow at a constant, measured rate into the newly laid water main. In the absence of a meter, the rate may be approximated by methods such as placing a Pitot gauge in the discharge, measuring the time to fill a container of known volume.

2. At a point not more than 10 ft. downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 50 mg/l free chlorine. To assure that this concentration is provided, measure the chlorine concentration at regular intervals in accordance with the procedures described in the current edition of *Standard Methods for the Examination of Water or Wastewater* or AWWA manual M12, or using appropriate chlorine test kits.

3. The following gives the amount of chlorine required for each 100 feet of various diameters. Solutions of one percent (1%) chlorine may be prepared with sodium hypochlorite or calcium hypochlorite. The latter solution requires 1 lb. of calcium hypochlorite in 8 gallons of water.

CHLORINE REQUIRED TO PRODUCE 50mg/l CONCENTRATION
in 100 Ft. of PIPE By DIAMETER

Pipe Diameter in.	100-Percent Chlorine lb.	One Percent (1%) Chlorine Solution gal.
4	0.026	0.32
6	0.06	0.72
8	0.108	1.30
10	0.17	2.04
12	0.24	2.88
16	0.434	5.2

4. During the application of chlorine, valves shall be positioned so that the strong chlorine solution in the main being treated will not flow into water mains in active service. Chlorine application shall not cease until the entire main is filled with heavily chlorinated water. The chlorinated water shall be retained in the main for at least 24 hours, during which time all valves and hydrants in the treated section shall be operated to ensure disinfection of the appurtenances. At the end of this period, the treated water in all portions of the main shall have a residual of not less than 10 mg/l free chlorine.

B. Clearing the Main of Heavy Chlorinated Water

After the applicable retention period, heavily chlorinated water should not remain in prolonged contact with pipe. In order to prevent damage to the pipe lining or corrosion damage to the pipe itself, the heavily chlorinated water shall be flushed from the main until chlorine measurements show that the concentration in the water leaving the main is greater than 0.5 mg/l but less than 2.0 mg/l.

C. Disposing of Heavily Chlorinated Water

Chlorinated water shall be properly discharged to a sanitary sewer. If there is no sanitary sewer available, then a reducing agent shall be applied to the water to be wasted to neutralize thoroughly the chlorine residual remaining in the water. The following table shows the amount of neutralizing chemicals required. Where necessary, federal, state and local regulatory agencies should be contacted to determine special provisions for the disposal of heavily chlorinated water.

POUNDS OF CHEMICALS REQUIRED TO NEUTRALIZE VARIOUS RESIDUAL
CHLORINE CONCENTRATIONS IN 100,000 GALS. OF WATER *

Residual Chlorine Concentration mg/l	Sulfur Dioxide (SO_2)	Sodium Bisulfate ($NaHSO_3$)	Sodium Sulfite (Na_2SO_3)	Sodium Thiosulfate ($Na_2S_2O_3 5H_2O$)
1	0.8	1.2	1.4	1.2
2	1.7	2.5	2.9	2.4
10	8.3	12.5	14.6	12.0
50	41.7	62.6	73.0	60.0

* Except for residual chlorine concentration, all amounts are in pounds

D. Bacteriological Tests

After final flushing and again after 24 hours, a sample shall be collected from the end of the line, shall be tested for bacteriological quality in accordance with *Standard Methods for the Examination of Water and Wastewater*, and shall show the absence of coliform organisms. At least one set of samples shall be collected from the new main and one fro each branch. In case of extremely long mains, it is desirable that samples be collected along the length of the line as well as its end. Samples shall be delivered to a State approved lab for testing.

Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate as required by *Standard Methods for the Examination of Water and Wastewater*.

E. Redisinfection

If the initial disinfection fails to produce satisfactory bacteriological samples, the main may be reflushed and shall be resampled. If check samples show the presence of coliform organisms, then the main shall be rechlorinated until satisfactory results are obtained.

High velocities in the existing system, resulting from flushing the new main, may disturb sediment that has accumulated in the existing mains. When check samples are taken, it is recommended to sample water entering the new main.

F. Disinfection Procedures When Cutting Into or Repairing Existing Mains

The following procedures apply primarily when mains are wholly or partially dewatered. After the appropriate procedures have been completed, the main may be returned to service prior to completion of bacteriological testing in order to minimize the time customers are out of water. Leaks or breaks that are repaired with clamping devices while mains remain full of pressurized water present little danger of contamination and require no disinfection.

1. Trench Treatment

When an old main is opened, either by accident or by design, the excavation will likely be wet and may be badly contaminated from nearby sewers. Liberal quantities of hypochlorite applied to open trench areas will lessen the danger from such pollution. Tablets have the advantage in such a situation because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation.

2. Swabbing With Hypochlorite Solution

The interiors of all pipe and fittings (particularly couplings and sleeves) used in making the repair shall be swabbed or sprayed with a one percent (1%) hypochlorite solution before they are installed.

3. Flushing

Thorough flushing is the most practical means of removing contamination introduced during repairs. If valve and hydrant locations permit, flushing toward the work location from both directions is recommended. Flushing shall be started as soon as the repairs are completed and shall be continued until discolored water is eliminated.

4. Slug Chlorination

Where practical, in addition to the procedures above, a section of main in which the break is located shall be isolated, all service connections shut off, and the section flushed and chlorinated, except that the dose may be increased to as much as 300 mg/l and the contact time to as little as 15 minutes. After chlorination, flushing shall be resumed and continued until discolored water is eliminated and the water is free of noticeable chlorine odor.

5. Sampling

Bacteriological samples shall be taken after repairs are completed to provide a record for determining the procedure's effectiveness. If the direction of flow is unknown, samples shall be taken on each side of the main break. If positive bacteriological samples are recorded, the situation shall be evaluated by a qualified Engineer who can determine corrective action, and daily sampling shall be continued until two (2) consecutive negative samples are recorded.

G. Special Procedure for Tapping Sleeves

Before a tapping sleeve is installed, the exterior of the main to be tapped shall be thoroughly cleaned and the interior surface of the sleeve shall be lightly dusted with calcium hypochlorite powder.

Tapping sleeves are used to avoid shutting down the main to be tapped. After the tap is made, it is impossible to disinfect the annulus without shutting down the main and removing the sleeve. The space between the tapping sleeve and the tapped pipe is normally ½ inch, more or less, so that as little as 100 mg of calcium hypochlorite powder per square foot will provide a chlorine concentration of over 50 mg/l.

3.08 Service Installation

Service lines shall be installed where shown on plans and/or as directed by Engineer. No tap shall be installed until the main passes the pressure leakage test and has been successfully disinfected.

The main shall be tapped and a corporation stop installed between 10 and 12 o'clock on the pipe circumference. Polyethylene encasement shall be properly cut and repaired. Service lines of dissimilar metals shall be polyethylene wrapped for a minimum clear distance of 3 ft.

Service lines shall be installed with the same depth of cover as specified for mains, and shall be laid with no unnecessary bends. Meter settings shall be as shown on the drawings.

3.09 Testing

All pipe shall be pressure tested in accordance with Section WM 15, Hydrostatic Testing of these WM Specifications.

(SECTION WM 15)

HYDROSTATIC TESTING

PART 1 GENERAL

1.01 Scope

A. After the pipe has been laid and partially backfilled as specified under "Backfill, Fills and Embankments", all newly laid pipe or any valved sections of it shall, unless otherwise expressly specified, be subjected to a hydrostatic pressure tests. The duration of each pressure test shall be for a period of not less than two hours and not more than six hours. The basic provisions of AWWA C-600 (DI pipe), C-605-94 (PVC pipe), ASTM F2164-02 (PE pipe) or ASTM F2163-02 (PE pipe) shall be followed for all pressure testing. The hydrostatic testing shall be completed after receipt of successful bacteriological test results.

B. The test pressure shall not exceed pipe and/or thrust resistant design pressures. The test pressure shall not vary by more than plus or minus 5 psi for the duration of the test.

C. All newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure of at least 1.5 times the working pressure at the point of testing or 50 psig whichever is greater.

PART 2 EXECUTION

2.01 Pressurization

A. Each valved section of pipe shall be slowly filled with water and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. The pump pipe connection and all necessary apparatus, including gauges and meters shall be furnished by the Contractor. Before applying the specified test pressure, air shall be expelled completely from the test section. If permanent air vents are not located at all high points, the Contractor shall install corporation cocks at all points so that the air can be expelled as the section is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test the corporation cocks shall be removed and plugged or left in place at the direction of the Engineer.

B. Any exposed pipe, fittings, valves, hydrants and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings, valves, hydrants or joints that are discovered following the pressure test shall be repaired or replaced with sound material approved by the Engineer and the test shall be repeated until it is satisfactory to the Engineer.

C. Pressure test shall be maintained for a minimum of 2 hours.

D. HDPE testing shall be conducted in phases as required by ASTM F2164. When the test section is completely filled and purged of air, the pressure shall be gradually increased to the required test pressure. Make-up water shall be added as necessary to maintain maximum test pressure for four (4) hours.

2.02 Leakage Test

A. After the completion of the pressure test a leakage test shall be conducted to determine the quantity of water lost by leakage under the specified test pressure. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled.

B. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

C. No ductile iron pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \frac{SD\sqrt{P}}{133{,}200}$$

Where:

L	=	allowable leakage, in gallons per hour
S	=	length of pipe tested, in feet
D	=	nominal diameter of the pipe, in inches
P	=	average test pressure during the leakage test, in pounds per square inch (gauge)

D. No PVC pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \frac{ND\sqrt{P}}{7{,}400}$$

Where:

L	=	allowable leakage, in gallons per hour
N	=	number of joints in length tested
D	=	nominal diameter of the pipe, in inches
P	=	average test pressure during the leakage test, in pounds per square inch (gauge)

E. No leakage will be accepted for HDPE pipe system during the one (1) hour test phase following the four (4) hour pressurization. The one (1) hour test shall be conducted after reducing initial pressure by 10 psi.

2.03 Acceptance

A. Acceptance shall be determined on the basis of allowable leakage. If any test of laid pipe discloses leakage greater than that specified, the Contractor shall at his own expense, locate and make approved repairs as necessary until the leakage is within the specified allowance.

B. All visible leaks are to be repaired regardless of the amount of leakage. All flanged pipe shall be "bottle-tight".

C. If the section under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

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(SECTION WM 16)

VALVES, GATES AND HYDRANTS

PART 1 GENERAL

1.01 Description

A. The Contractor shall furnish and install all valves, gates and hydrants as specified and as shown on the plans. This shall include all valve boxes, stems, valve operating stand, motor actuators, etc. as necessary for a fully functional installation.

1.02 Quality Assurance

A. Codes and Standards

All codes and standards shall be as set forth in the latest ASTM and AWWA Standards.

1.03 Submittals

A. Shop Drawings

Prior to ordering valves, gates or hydrants submit shop drawings to the Engineer for approval. All submittals shall include certification of conformance with the applicable ASTM or AWWA Standards. No valve, gate or hydrant shall be installed prior to shop drawing approval.

PART 2 PRODUCTS

2.01 Gate Valves

A. Double Disc

1. Gate valves shall conform to the latest specifications for valves of the American Water Works Association, AWWA Designation C500, so far as they apply, except as otherwise specified. Gate valves shall be of a design and construction for a working pressure of not less than 200 pounds per square inch (psi) for 2" through 12" and 150 psi for 14" and greater, and shall be tested for a water pressure of not less than one hundred fifty percent (150%) of the working pressure.

2. Gate valves four (4) inches in diameter or larger shall be of the double disc type with bronze seats, ductile iron body and removable cast iron bonnets. All such valves shall be entirely bronze-mounted and bronze-faced. Unless otherwise specified all valves four (4) inches and larger shall be of the non-rising stem type.

3. Valves in open chambers or buildings shall be equipped with handwheels unless otherwise shown, specified or required. Where shown or

specified, valves shall be provided with extension stems, operating nuts and tee handle wrenches.

4. Buried valves shall have mechanical joint ends.

B. Resilient Seated

1. Valves shall be designed for a water working pressure of not less than 200 pounds per square inch. Valves shall conform to the latest revision of American Water Works Association Standard C-509 covering resilient seat gate valves (Standard Wall/Cast Iron or Cast Iron). All valves must have a full round, smooth unobstructed oversized flow way which shall be at least as large as the connecting pipe inside diameter.

2. Valves shall have mechanical joint ends as required for buried piping. Gate valves shall have a clear waterway free of pockets, cavities and depressions, and shall accept full size tapping cutters.

3. The wedge shall be of cast iron (solid) completely encapsulated with EPDM. The EPDM shall be permanently bonded to the cast iron wedge to meet ASTM tests for rubber metal bond ASTM D429.

4. Valves shall be non-rising stem. Stems shall be cast bronze with integral collars in full compliance with AWWA. The stem stuffing box shall be O-ring seal type with one (1) ring located above the thrust collar. The ring shall be replaceable with valve fully open and subject to full rated working pressure.

5. All valves furnished shall open counter clockwise with 2-inch AWWA nuts. Keynuts are to be painted black.

6. The body and bonnet shall be coated with fusion bonded epoxy both interior and exterior. Each valve shall have maker's name, pressure rating and year in which manufactured cast on the body. Prior to shipment from factory, each valve shall be tested by hydrostatic pressure equal to requirement of both AWWA and 500 PSI ULFM requirements.

2.02 Valves Boxes

A. Valve boxes shall be of cast iron, complete with pavement rings, as applicable, and covers. Cast iron boxes shall be of extension type with screw or slide-type adjustment and with flared base. The minimum thickness of metal shall be 3/16". The word "WATER" or "SEWER" shall be cast in cover, as applicable. Boxes shall be installed over each buried valve unless otherwise shown on the drawings. The boxes shall be of such length as will be adapted, without full extension, to the depth of cover required over the pipe at the valve location. A keynut extension shall be installed if the valve nut is greater than 4 feet in depth.

B. Valve boxes shall be carefully installed and supported in a manner that will not allow surface loads to be transmitted to the valve or pipe. Care shall be taken to

see that the bottom of the box is clear and free of debris, rocks, etc., which will interfere with the operation of the valve stem.

C. In paved areas, all valve boxes shall be provided with an internal debris cap as manufactured by SW Services, Pollardwater, or equal.

2.03 Plug Valves

A. Ballcentric and/or Eccentric Valves

1. Ballcentric and/or Eccentric Valves shall be the non-lubricated resilient seating type. The valve manufacturer shall have completed proof of design test for two (2) way valves as specified under AWWA C517 and shall furnish or have on file with the engineers, certified copies of these tests. The design of two (2) way valves shall be such that they shall be capable of providing drip tight shut-off with pressure applied from either direction with proper torque applied to maintain the rotating element (plug) in the seated position. The laying length of flanged two (2) way valves twelve (12") inches and smaller shall be as listed in MSS Specification SP-70, for valves fourteen inches (14") and larger shall be manufactured standard. The laying length of three (3) way and four (4) way valves shall be as listed in ANSI Specifications B16.1, Class 125, Table 6, for tees, crosses, and rotating element (plug) shall be single or double style as required for the service.

2. The valve body, bonnet and rotating element (plug) shall be fabricated of cast iron ASTM A126 Class B unless noted otherwise. Valve body and bonnet thickness and flanged end connection shall conform to ANSI B16.1 Class 125 or 250 or be Victaulic grooved as required for the service. The body port area of all valves shall be not less than eighty one percent (81%) of the area of the nominal pipe size, and valves twenty inches (20") in diameter and smaller shall be capable of passing a hard sphere whose diameter is equal to eighty one percent (81%) of the nominal valve size. Valve body seats shall be corrosion resistant nickel welded or mechanically retained in the body. The body and bonnet shall be provided with permanently lubricated, radial journal bearing of porous series 316 stainless steel. Thrust bearing shall be provided to support the closure element fabricated of Series 300 stainless steel and a Teflon backing ring at the operating shaft journal. The rotating element shall be of Buna N unless noted otherwise for the service. The stem seal shall be replaceable without removal of the valve bonnet and shall be the self-adjusting wear compensating multiple U cup, Chevron type of Buna N or double O-Ring. Thrust bearings of Teflon and stainless steel shall be provided.

3. "O" rings shall be contained in a replaceable cartridge.

4. The body port area of rectangular and/or oval ported eccentric seating valves shall be equal to or greater than the nominal connecting pipe area and be capable of passing a hard solid sphere with an outside diameter

equal to seventy-five (75%) percent of the nominal pipe diameter without interference from the closure element.

5. Each lever operated valve shall be furnished with a standard length lever or wrench which is removable except that the lever for valves three (3) inch size and smaller may be of non-removable type. Each chain operated valve shall be furnished with double end chain wrench and galvanized iron chain of sufficient length to fit the installation conditions for valves 7 ft. or more above finished floor. Buried valves shall have operating stem to ground level.

6. All plug valves 8-inches and larger shall have an enclosed rotary gear actuator. All plug valves smaller than 8-inches shall have an integral lever or a square nut for wrench or chain lever operation. The actuators shall comply with the latest revision of the applicable AWWA Specification and the following specifications:

   a. Enclosed Rotary Gear Actuator and Gearing

      1) The actuator shall be a worm and gear, single reduction design with provision for input, spur or bevel gear assemblies to meet the given rim pull or input torque requirement. The input shaft of the manual shall be hardened alloy steel. The worm shall also be hardened alloy steel, and the mating worm gear shall be alloy bronze, accurately cut by hobbing machines, and the combination of these shall be self-locking. All gearing shall be grease lubricated at the factory. Ball or roller bearings shall be used to provide smooth rotation of the worm shaft.

      2) The gear actuator shall be sized to provide bi-directional shut-off at the maximum operating pressure with a maximum pull of eighty pounds (80 lbs) on the rim of the hand wheel or chain wheel, or a maximum input torque of one hundred fifty foot-pounds (150 lbs) at the operating nut.

      3) All actuators shall be provided with a pointer assembly for valve position indication, except when used for buried service.

      4) All actuators shall be readily field adaptable to motor operation without disassembly of the manual actuator.

   b. Enclosures

      1) The actuators shall meet weatherproof, submersible, or buried service conditions as required. In no case shall actuators designed for submersible service be rated for less than 50 feet of head for 72 hours. Buried service and

submersible actuators shall be built with corrosion resistant input shaft and hardware.

c. Mechanical Stops

1) An integral adjustable mechanical stop device shall be provided to prevent over-travel. The stops shall allow valve travel of 90 degrees, with a minimum adjustability of ±5 degrees at each end of travel. All stops shall be of steel material.

2.04 Check Valves

A. Cushioned Swing Check Valves

1. Cushioned swing check valves shall be a single disc valve with an adjustable weight and lever. A cushion cylinder assembly shall be externally attached to the side of the valve body.

2. Materials of valve components unless otherwise designated, shall be:

a. Body, cover, disc, levers, and disc-arm: Cast Iron (ASTM A126 Class B) or cast steel (ASTM A216 Grade WCB)

b. Body seat ring: Bronze (ASTM B62) or stainless steel (ASTM 157 C-9)

c. Disc seat ring: Buna-N (80 durometer) if metal-to-metal seating is used, disc seat ring shall be compatible for use with body seat ring

d. Gasket: Buna-N or composition

e. Pivot shaft: Stainless Steel Type 303\

f. Stuffing box packing: Composition

3. Valve body shall withstand the system line pressure designated and the flanges shall conform in dimensions and drilling to ANSI B16.1.

4. The cushion cylinder shall be an hydraulic oil medium type with an accumulator and interconnecting hydraulic tubing. The cushioning action shall be adjustable by an integrally mounted adjustment device on the cushion cylinder or by an inline device in the closed loop hydraulic circuit. Air cushioned swing check valves with needle valve are also acceptable.

B. Rubber Flapper (sewage and sludge)

1. Rubber flapper swing check valves shall have a heavily constructed cast iron body and cover meeting ASTM A-48, Class 30. The body shall be long pattern design (not wafer), with integrally cast-on end flanges. The

flapper shall be Buna-N having an “O” ring seating edge and be internally reinforced with steel.

2. Flapper to be captured between the body and the body cover in a manner to permit the flapper to flex from closed to full open position during flow through the valve. Flapper shall be easily removed without need to remove valve from the line. Check valves to have full pipe size flow area. Seating surface to be on a 45 degree angle requiring the flapper to travel only 35 degrees from closed to full open position for minimum head loss and non-slam closure.

3. Buna-N flapper shall have an elastic spring, molded internally, to assist the flapper to close against a slight head to prevent slamming.

4. The valve shall be designed for 175 PSI working pressure for water or sewage. When the check valve is for buried service, stainless steel bolts shall be furnished.

5. Each check valve shall have an external backflow device.

6. Rubber flapper check valves shall be used on all raw wastewater and sludge applications unless otherwise noted on the drawings.

C. Wafer Style Check (Water)

1. The valve shall be a direct acting wafer style (flangless) swing check valve. The valve shall be spring assisted to close and closure shall be positive and drip tight. The valve shall have only one moving part. The seat material shall be resilient viton rubber located on the valve body away from the flow and replaceable. The clapper and spring shall be stainless steel. Minimum pressure rating shall be 250 psi. Valve body shall be cast iron ASTM A-48.

D. Wafer Style Check (Air)

1. The valve shall be suitable for mounting between 125 lb. class flanges. Valve shall have a cast iron body and shall be springless and seatless. Sealing members shall be silicone suitable for service to 500°F.

E. Swing Check

1. Swing check valves shall be a single disc valve with an adjustable weight and lever for horizontal applications in compliance with applicable parts of AWWA C508.

2. Swing check valves on vertical applications shall be gravity operated.

3. Lever and weight shall be adjustable for variable closure force.

4. Rubber seats shall be provided.

2.05 Lubricated Plug Valve (Gas Lines)

A. Lubricated plug valves shall be the cylindrical, parallel seat, Milliken design. The valve body (including end connections), rotating element (plug), and bottom cover (bonnet), shall be designed and rated in accordance with the applicable M.S.S. and/or A.P.I. and/or A.N.S.I. Standard(s) as required for the class, service, and materials of construction.

B. Valves shall be used only on digester gas and/or natural gas pipe lines and shall have G.G.A. and/or U.L. listing and/or be F.M. approved for the service.

C. The body, plug, and bottom cover of ANSI B16.1 and B16.1 Class 125 and 250 valves, unless noted or otherwise required for the service, shall be fabricated of cast iron (CI) ASTM A-126 Class B and/or ductile iron (DI) ASTM A-395. The body, plug and bottom cover of ANSI B16.5 Class 150 thru 900 valves, unless noted or otherwise required for the service, shall be fabricated of cast steel (CS) ASTM A-216 Grade WBC, forged carbon steel ASTM A-105 Grade 2 and/or Alloy Steel API 6A Type 2 as required for the service. The stem seal shall be reinforced tetrafluorethylene fluorocarbon (TFE) or other material suitable for the service.

D. The valve lubrication system shall be designed to accept both stick and gun lubrication, and be provided with a leak proof, spring loaded ball check, to retain lubricant and prevent product leakage. A minimum of ten (10) sticks of lubricant (suitable for the service) shall be provided with each valve.

2.06 Butterfly Valves

A. Standard Valve

1. All butterfly valves shall be of the tight-closing rubber seat type, and shall comply with AWWA Specification C 504, Latest Revision.

2. Bodies of all valves furnished shall have flanges drilled for ASA B 16.1, one hundred twenty-five (125) pound standard or mechanical joint per ANSI A21.11. The bodies shall be of cast iron ASTM A 126, Class B.

3. All shafting shall be of 18-8 stainless steel, Type 304 and have a minimum size as specified in Table 3 of AWWA Specifications, C 504.

4. Provide thrust bearing to hold the valve disc securely in the center of the valve seat regardless of valve position.

5. The valve discs shall be of cast iron ASTM A 48, Class 40 or ductile iron ASTM A-536, and shall seat in the rubber lining.

6. Interior wetted ferrous surfaces shall be coated with epoxy paint in conformance with AWWA C550.

B. Butterfly Valve Operators

1. Operators shall comply with AWWA C 504.

2. Electric Operator. Electric motor driven valves shall have an a operator capable of transmitting to the valve shaft the torque specified for this class of valve. The electric operator shall be equipped with a 120 volt, 60 cycle, single phase, explosion-proof motor capable of producing the necessary torque at the required time cycle of valve operation. Operation time from full-open to the full-closed position shall be thirty (30) seconds, unless noted otherwise. A pair of limit switches and a pair of torque switches shall be provided. All gear directly associated with the electric motor drive or the valve operator shall be totally enclosed and operate in a lubricating bath. Provision shall be made for manual operation in case of power failure.

   a. Limit switches shall be provided where required. Switches shall operate on 115 volts and be housed in a NEMA Type IV enclosure.

3. Pneumatic Operator. Pneumatic cylinders shall be of such size as to transmit, as a minimum, the torques as calculated in Appendix A of AWWA C 504 for the required size and Class of valve. Cylinder shall be designed for an operating air supply of 60 psi in response to a 3-15 psi air signal, unless noted otherwise.

   a. Cylinder bodies shall be of hard drawn brass with cadmium plated end caps. Cylinder pistons shall be of chrome plated steel with stainless steel rods.

   b. Provisions shall be made to control the speed of travel of the piston to minimize shock at the end of piston travel.

4. Hydraulic Cylinders. Cylinder bodies shall be of a low-zinc content bronze. Cylinder pistons and head and cap ends shall be corrosion resistant. Cylinder piston rods shall be of stainless steel.

C. Wafer Valve

1. The wafer valve shall meet AWWA C504 standards with a working pressure of 150 psi.

2. Body shall be cast iron ASTM A-126, Class B.

3. Disc shall be cast iron ASTM A-48, Class 40 with stainless steel edge.

4. Stem shall be stainless steel, Type 304.

5. Bearings shall be bronze, oil impregnated.

6. Seat shall be Buna-N with encapsulated steel support ring.

2.07 Mud Valves

A. Mud valves shall be provided where shown on the plans. Valves shall be flanged frame, non-rising stem with cast iron body, bronze seat and ring, sizes as shown. Provide extension stems, couplings and guides, operating nut and/or handwheel.

2.08 Plastic Valves

A. Ball Valve

Ball valves shall be PVC or CPVC as required by service. Ball valves shall be Union Type with end connections as required by drawings. Seals shall be Viton or EPDM as required by service with Teflon seats. Valves shall be full port design for low pressure loss and have a fine pitched threaded seal retainer for seat adjustment. Valve seats shall be reversible and self-lubricating. Valve shall be rated to 225 psi.

B. Ball Check Valve

Ball valves shall be PVC or CPVC as required by service. Ball valves shall be Union Type with end connections as required by drawings. Seals shall be Viton or EPDM as required by service with Teflon seats. Valves shall be full port design for low pressure loss and have a fine pitched threaded seal retainer for seat adjustment. Valve seats shall be reversible and self-lubricating. Valve shall be rated to 225 psi. Seat O-ring shall be square cut for positive sealing.

C. Wafer Butterfly Valve

Butterfly valves 1-1/2" through 8" shall be wafer type single piece body design rated at 150 psi bubble tight shut off. Valve body shall be molded of PVC (Polyvinyl Chloride) with disc molded of Polypropylene or PVC as required. The shaft shall be 416 stainless steel and blow out proof. Liner and O-ring seals shall be EPDM Viton or Nitrile as required by service. The liner shall have a V-notch retention design and an integrally molded flange face seal. Valves 1-1/2" through 8" shall have a plastic molded lever assembly.

2.09 Floor Stands

A. Floor Stands for valves, sluice gates and regulating or control valves, shall be wheel operated or gear type stands, as shown on the plans. They shall be of approved design suitable for operating the valve or sluice gate to which they are attached.

B. The direction of operation of the handwheel type floor stand shall be counterclockwise for opening. The stand shall be approximately thirty-six (36) inches high and shall be of the stationary stem type with indicator unless otherwise specified. The operating stem shall be made of bronze. The stands shall be made of the best quality cast iron with smooth exterior surfaces. The stands shall be cleaned and painted before leaving the shop.

C. All exterior rising stem type floor stands or stands exposed to the weather shall be provided with a clean plastic pipe weather proof housing secured in place over the rising stem which will protect it from dust, dirt and ice and still make it possible to see the position of the top of the gate stem.

D. Floor stands shall be solidly and accurately set to center over the valve or sluice gate. They shall be securely bolted down to the floor with anchor bolts.

2.10 Pressure Relief Valves

A. Where shown on the plans, the Contractor shall furnish and install Clow No. F 1492, Neenah R-5002 Type B, or equal, pressure relief valves which will automatically allow the entry of water into the tank during construction due to failure of the temporary dewatering equipment, and/or high water level before the tanks are filled with water. Valve length shall be as noted on the drawings.

B. The valves shall have a 4" diameter, by 12" length, 150 slot, Type 304, stainless steel well screen welded to the inlet side to prevent the passage of sand and gravel.

C. Upon completion of all work and prior to filling the tanks with water for testing, the pressure relief valves shall be checked to see that they are operating freely and will close tight. A bead of heavy grease shall be applied to the seats to assure a tight seal.

2.11 Heavy Duty Sluice Gate with Resilient Seats

A. Scope

This section covers all heavy duty sluice gates required on the project. Each gate shall be furnished and installed complete with wall thimble or anchor bolts, operating stem, gate lift operator and other appurtenances as specified or needed to make a complete and operable installation.

1. Performance

The resilient sluice gates must meet the performance requirements of AWWA C-501 (latest revision). The resilient seated sluice gate must be able to withstand 25 feet seating, and 25 feet unseating head.

2. General

Gates, stems, lifts and other appurtenances shall be the size, material and construction as shown on the drawings and specified herein. Gates shall meet the requirements of AWWA C-501 (latest revision), with the exception of the seats, as modified per these specifications. All component parts shall be of the type of material shown, and interchangeable where size and material are the same without grinding, chipping or special fitting in the field. All mating and sliding metal parts shall be fully machined. All sluice gate parts, including lift, shall be designed for the heads shown with a minimum safety factor of five. All

materials used in the construction of the gates and appurtenances shall be the best suited for the application.

3. Frame and Guide Rails

The frame and guide rails shall be cast one-piece construction or may have guides troweled and bolted to the frame. Frames shall be standard or extended flange type with round or rectangular opening as indicated on the plans and in the sluice gate schedule. Frames shall be of flush bottom design with a resilient seal attached to the frame so that it is flush with the invert. The frame shall be provided with cast-on pads which shall be machined, drilled, and tapped for the mounting of the wedge devices. The back of the frame flange shall be machined to a plane and drilled to match the wall thimble, pipe flange, or anchor bolt pattern. Guide rails shall be of such length as to retain at least one-half of the vertical height of the slide when it is in the fully opened position. A groove running the full length of the guide rail shall be accurately machined to receive the slide tongue with a nominal clearance of 1/16 inch.

4. Cover or Slide

The cover shall be of one piece cast construction with vertical and horizontal ribs, a reinforced pocket to receive the thrust nut, and pads to receive the wedges. All wedge pads shall be machined, drilled and tapped to receive the wedge devices. The cover shall have fully machined tongues running the full length of each side to properly engage the guide rail grooves. A thrust nut shall be provided to attach the slide to the stem. The nut shall be threaded and in the case of rising stems, provided with keys or two set screws locked into indents in the stem to prevent rotation of the stem. For non-rising stems, the stem shall turn freely in the thrust nut to open and close the slides as the stem is rotated.

5. Seating Faces

Seats shall be of a resilient material which is both abrasion and corrosion resistant. The seat material on both the frame and the cover (slide) shall be permanently attached.

6. Wedges

All wedges and wedge blocks shall be solid corrosion resistant material and shall be of sufficient number to provide a practical degree of watertightness. All wedge bearing surfaces and contact faces shall be machined to maximize contact and wedging action. Wedges shall be fully adjustable, but once set shall not rotate or move from the desired position. All fasteners and adjustment screws shall be corrosion resistant.

7. Testing, Shop

The gate shall be adjusted so that the seats are slightly compressed and there is no clearance at any point between frame and cover seating surfaces.

8. Wall Thimbles

Wall thimbles shall be heavy, one piece castings. The front flange shall be machined to a plane and shall be drilled and holes tapped to mate the drilling pattern of the gate frame. Holes shall be plugged as to prevent concrete from intruding into threaded area. The vertical centerline shall be clearly shown by permanent marks at the top and bottom of the machined face. The work "top" shall be marked permanently near the top centerline of the thimble opening. The surfaces to be cast into the concrete shall be free of paint, oil and grease. Corrosion resistant studs and nuts shall be provided for attaching the gate. Mastic shall be used to form a seal between the front face of the thimble and the back of the gate frame. Stainless steel anchor bolts shall be used.

2.12 Slide Gates

A. Description

Slide gates shall be either self-contained with yoke and bench stand actuator, or standard design with separate stem guides and wall bracket or floor stand mounted gate lift.

1. Slide gates shall be designed for the seating and unseating head as required by application and as shown on the drawings.

2. Slide gates shall be either standard or downward opening weir design as required by the drawings.

B. Construction

1. Frames and slides shall be aluminum ASTM B204 and ASTM B211 Alloy 6061-T6.

2. Rails and yokes shall be aluminum ASTM B209 and B211 Alloy 6061-T6 or B211 Alloy 6063-T5.

3. Fasteners and anchor bolts shall be stainless steel ASTM A193 18-8 or A276 Type 304 or 316.

4. Stems shall be stainless steel ASTM Type 304 or 316.

5. Flush bottom seals and "J" bulb seals shall be neoprene (CR), ASTM D-2000 BC610-615 or other suitable composition for extended use in water and sewage.

6. Frame and Guides

a. The gate frame shall be a rigid, welded unit, composed of guide rails, cross bars, invert of top seal support housing (on gate with resilient seals) and head rails (self-contained only) with a clear opening the same size as the waterway, unless otherwise specified.

b. The frame, guides, yoke and cross bars shall be capable of withstanding the thrust forces created during seating and unseating of the gate against the hydraulic head without exceeding one fifth (1/5) the tensile strength or one third (1/3) the yield of the materials and the deflection shall not exceed the lesser of 1/360 of the span or 0.25 inches.

c. Frame shall be flatback, spigotback or embedded type as required or as shown on the drawings.

d. All surfaces in contact with concrete shall be provided with an asphaltum varnish or bituminous coating not less than seven (7) mils thick.

e. The guide frame shall incorporate a dual slot.

f. The primary slot of the guide frame and all cross bars shall be provided with high density (linear) polyethylene (HDPET) bearing bars to support and guide the slide gate plate (disc) unless noted otherwise.

g. The secondary slot will allow the slide gate plate reinforcing structural members to be extended to the edge of the primary guide slot.

h. The guides shall be of sufficient length to insure the support of not less than two thirds (2/3) of the height of the slide gate plate (disc) when the gate is in the full open position.

i. The guides, or self contained slide gates, shall have sufficient cross section to withstand all the hydraulic and dynamic load imposed by the yoke.

j. The yoke shall be fabricated of structural aluminum members welded or bolted to the top of the guides and the design shall allow the removal of the slide gate plate (disc) and stem without removal of the yoke.

C. Slide Gate Plate (Disc or Weir)

1. The slide gate plate (disc or weir) shall be reinforced and the deflection under the rated head of the gate shall not exceed the lesser of 1/360th of the span or a maximum of 0.25 inches.

D. Stem Connection

1. The stem connection shall be either the clevis type with structural members welded to the slide gate plate (disc or weir) with a series 300 stainless steel pin or bolt to act as a connector, or a bronze thrust nut supported in a weld nut pocket.

E. Stem

1. The stem shall be sized to withstand the thrust or torque developed by the lift or gear actuator with an input torque of one hundred (100) foot pounds.

2. The unsupported length (L) to radius of gyration (r) L/r of the stem shall not exceed 200.

F. "J" Bulb Seals (JBS)

1. "J" bulb seals (JBS) shall be mounted either on the frame or gate slide plate (disc), but the seal shall not protrude into or reduce the specified opening.

2. Anchor and Assembly Bolts or Studs

a. All assembly bolts, nuts, washers and including anchor bolts shall be stainless steel ASTM A193, 18-8 or ASTM A276 Type 304 or 316.

G. Actuators and Accessories

1. General

a. Actuators and accessories (gate lifts, gear actuator, hand cranks, etc.) shall be furnished as required.

2. Direct Manual Actuators

a. Manual actuators, lift nut or gear type shall be sized for a maximum input torque of fifty (50) foot pounds.

b. Handwheel type lifts shall be without gear reduction.

c. Gear type lift actuators may be either single or double reduction type depending on the lift or torque requirements.

d. Lift nuts shall be ASTM B584 Alloy 865.

e. Lift nuts on rising stem valves shall be flanged and be supported on non-metallic thrust washers, roller or ball bearing, sized to take the thrust and lift loads during operation.

f. All gears shall be fabricated of bronze, steel or ductile iron with machine cut teeth. The gear housing shall be weather proof construction, fabricated of cast iron ASTM A126 Class B, or equal. The housing shall be provided with lubrication fittings to permit lubrication of all gear and bearings.

g. Rising stem actuator shall be provided with a stem cover of clear plastic with an indicator strip.

3. Motor Driven Actuator

a. Operators shall be floor stand or frame mounted. Gear reduction shall be fully enclosed with mechanical seals around the operating nut and around the pinion shafts.

b. All pinion shafts shall operate on roller bearings.

c. Units shall be interconnected by means of steel tubing or shafting with flexible couplings at each connection.

d. Motor drives shall be mounted between the interconnected operators or at either end of the shaft. The unit shall include electric 260/460v motor drive reduction gearing. Drive shall include limit and torque switches, emergency handwheel with declutching device, and reversing controller.

e. Drive shall be designed for local operation. The local control station shall be housed in a NEMA 4 enclosure and include hand-off auto switch, pushbutton station with indicating lights.

f. For other service conditions see Section 2.13.4.

2.13 Actuators and Accessories

A. Actuator and accessories (i.e. cylinders, diaphragms, motors, gears, limit switches, extensions, pilots, etc.) shall be furnished and mounted as herein specified and as required by the drawings.

B. Manually Lever Actuated — Direct manually actuated valves eight inches (8") and smaller shall be supplied with an integral lever or a square nut for wrench or chain lever operation.

C. Manually Gear Actuated — Direct manually actuated valves ten inches (10") and larger, and all four inch (4") and larger valves installed as the first isolation (shut off) valve on the discharge of pump, shall be provided with an enclosed rotary gear actuator. Gear actuator shall be sized to provide bi-directional shut off at the maximum operating pressure with a maximum pull of eighty pounds (80#) on the rim of the hand wheel or chain wheel, or a maximum input torque of one hundred fifty foot pounds (150'#) at the operating nut.

D. Electric Motor Actuators

1. Electric motor actuators shall be furnished and constructed in accordance with ANSI/AWWA C540 except as hereinafter modified.

2. The actuator shall include a position indicator.

3. The controls for manual positioning shall include, but not be limited to, the reversing starters (with overload protection), control power transformer, local remote selector switch, open-stop-close push buttons and position indication lights, as specified under AWWA C504 (Section 3.14.1, parts 1 thru 4).

4. The controls for modulating service shall be as listed in AWWA C504, Section 3.14.2, parts 1 thru 4, and be compatible with the controller and control loop response requirements. A position potentiometer, independent of feedback potentiometer (in the case of modulating service), shall be supplied for each control valve. It shall be mechanically driven by gearing from the valve stem and in step at all times whether the unit is being electrically or manually operated.

5. All actuators shall be shop-wired as specified in AWWA C504, Section 3,14.4, Wiring.

2.14 Stop Gates

A. FRP Gates

1. All stop gates should be molded of fiberglass reinforced polyester to the exact size as indicated on the drawings, assuring resin rich sealed edges. Both sides of the plate shall be faced with a ten (10 mil) C-veil and finished smoothed with a layer of ultraviolet inhibited resin.

   a. Deflectors shall be limited to no more than 1/360 of the plate width at maximum aerating head. Stop plates shall be laminated with a sandwich center core having a high density polyurethane, closed cell foam for high rigidity, high strength and water resistant integrity.

   b. Stop plates shall be manufactured in accordance with the applicable portion of NBS15-69 and ASTM C-582 and inspected in accordance with ASTM D-2563.

   c. Frames shall be constructed of the same material and shall have a embedded flush bottom seal of neoprene rubber.

   d. Each gate should be furnished with a heavy duty handle of cast aluminum alloy 356-T6 with a clear opening of 4" x 2" where required by the drawings.

B. Aluminum Stop Gates

1. Guides shall be of extruded aluminum. The invert of the frame shall be an angle welded to the bottom of the frame. A neoprene seal shall be attached to the angle and held in place with a bolted retainer bar. The guides shall be designed for maximum rigidity and shall have a weight of not less than four pounds per foot for face mounted gates and two and one-half pounds per square foot for channel mounted and embedded frame gates.

2. The disc or sliding member shall be of aluminum plate reinforced with "U" shaped aluminum extrusions welded to the plate not more than 16" apart.

   The disc shall not deflect more than 1/360 of the span of the gate under the design head.

3. Single pipe reinforced handles shall be provided for gates up to 3 feet in width. Dual handle shall be provided for gates over three fee in width. Special pipe extensions handle available on request.

4. All parts of the gate shall have a minimum thickness of ¼ inch. Guide frames assembled from aluminum plate or structural shapes or which require field welding are not acceptable. All necessary fasteners and anchor bolts shall be furnished by the slide gate manufacturer.

5. Materials:

Components	Material	
Frames - Disc - Invert:	Aluminum 6061-T-6	ASTM B-209 ASTM B-211
Fasteners & Anchor Bolts:	Stainless Steel Type 304	ASTM A-276
Invert Seal:	Neoprene	ASTM D-2000

Finish: Mill finish on aluminum. Provide bitumastic paint on all surfaces adjacent to concrete.

2.15 Hydrants

A. Yard Hydrants

Install where shown on the plans a 1-1/4" freezeless yard hydrant with a brass nozzle (3/4 IPS). Each hydrant on non-potable water systems shall have a 3" x 6" metal or FRP sign securely attached to it with the phrase "NON POTABLE WATER" permanently and clearly printed in black letters on a white background.

Hydrants shall be Woodford Model Y-1, Water Source LLC, or equal.

B. Fire Hydrants

1. The fire hydrants shall be 5 ¼ inch (main valve opening) with 6 inch auxiliary valve and connection pipe with breakoff flange and coupling

assembly. The fire hydrants shall have two (2) 2 ½" hose nozzles and one (1) 4 ½" pumper nozzle threaded to meet the requirements of the local Fire Department. Nozzle caps shall be equipped with chains. All fire hydrants shall be arranged for operation with operating nut of size and shape which is the same as that of the existing fire hydrants, or as specified by the local Fire Department. Pumper nozzle shall have a nominal setting of between eighteen (18) and twenty-four (24) inches above the curb or centerline of road, and if necessary, the Contractor shall furnish extensions. Hydrant color shall be per the Owner's request.

2. Hydrants shall have 6 inch mechanical joint inlets and auxiliary gate valves shall be mechanical joint.

3. Hydrant barrels shall be constructed in such a manner that it is not necessary to cut off the water or to excavate to make repairs. The barrel of the hydrant shall be constructed in sections which are to be jointed in such a manner that the upper section of the barrel extending above the ground may be separated from the lower, section by impact without injury to the stem or the barrel.

4. The main valve construction at the bottom of the hydrant shall be such as to permit the water to drain from the hydrant barrel when the main valve is closed. The main valve stem seats and packing glands to be of bronze or approved rust resisting metal and to be constructed in such a manner as to be easily replaced without excavating. The main valve facing shall be made of rubber.

5. Hydrants shall be located in such a manner as to provide complete accessibility, and in such a manner that the possibility of damage from vehicles or injury to pedestrians will be minimized. When set in the space between the curb or sidewalk or between the sidewalk and property line, no portion of the hydrant or nozzle cap shall be within six (6) inches of the sidewalk. All hydrants shall stand plumb and shall have their nozzles parallel or at right angles to the curb.

6. Hydrants shall be thoroughly cleaned of dirt and other foreign matter before setting, and the bowl of each hydrant shall be well braced against unexcavated earth at the end of the trench with stone slabs or concrete backing, or it shall be tied to the pipe with suitable rods or clamps. All hydrants are to be properly supported and braced and surrounded with approximately 1/2 cubic yard of washed gravel.

C. Flushing Hydrants

1. Flushing hydrants shall be 2-1/8" size with 3" connection. All working parts of the flushing hydrants shall be brass. Flushing hydrants shall be provided with one (1) 2-1/2" hose nozzle threaded to meet the requirements of the local Fire Department. Nozzle caps shall be equipped with chains. The flushing hydrant shall be self-draining with non-freeze barrel provided with cast iron top stock. Flushing hydrants shall be as manufactured by Kupferle, Mueller, Kennedy, M & H, or equal.

2. Flushing hydrants shall be 3" mechanical joint inlets and shall be provided with auxiliary 3" M.J. gate valves with box.

3. Hydrant color shall be per the Owner's request.

D. Installation

1. A drainage pocket two feet in diameter and two feet in height shall be excavated above the base of each hydrant. The pocket shall be filled and compacted with coarse gravel or broken stone mixed with coarse sand, under and around the base of the hydrant to a level above the waste opening. No hydrant drainage pocket shall be connected to a sewer.

2. A reaction or thrust blocking shall be provided at the base of each hydrant and shall not obstruct the drainage outlet of the hydrant. The size and shape of concrete thrust blocking and the number and size of restraining rods shall be approved by the Engineer.

2.16 Valve/Gate Tags

All non-buried valve(s) and all gates shall be marked with a brass tag. Each tag shall be minimum of 1" diameter and be stamped with the appropriate identification number provided by the Owner.

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(SECTION WM 18)

STRUCTURAL STEEL

PART 1 GENERAL

1.01 Description

A. Extent of structural steel work is shown on the contract drawings, including schedules, notes and details to show size and location of members, typical connections, and type of steel required.

B. Structural steel is that work defined in American Institute of Steel Construction (AISC) “Code of Standard Practice” and as otherwise shown on drawings.

C. Source Quality Control: Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.

1. Promptly remove and replace materials or fabricated components which do not comply.

D. Design of Members and Connections: Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site whenever possible without causing delay in the work.

1. Promptly notify Structural Engineer whenever design of members and connections for any portion of structure are not clearly indicated.

E. Related work specified elsewhere:

1.	Miscellaneous and Metal and Aluminum	Section WM-19
2.	Painting	Section WM-25

Loose Lintels are furnished under Section WM-19, Miscellaneous Metals.

F. Work furnished but not installed: Anchor bolts and other embedded connection components.

1.02 Quality Assurance

A. The latest editions of the following standard specifications shall govern the fabrication and erection of the structural steel, except as modified by the contract drawings or this specification:

1. American Institute of Steel Construction (AISC) “Code of Standard Practice for Steel Buildings and Bridges”:

a. Paragraph 4.2.1 of the above code is hereby modified by deletion of the following sentence: “This approval constitutes the owner’s acceptance of all responsibility for the design adequacy of any connections designed by the fabricator as a part of his preparation of these shop drawings.”

2. American Institute of Steel Construction (AISC) “Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings”, including “Commentary” and supplements thereto as issued.

3. American Institute of Steel Construction (AISC) “Specifications for Structural Joints using ASTM A 325 or A 490 Bolts” approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.

4. American Welding Society (AWS) D1.1 “Structural Welding Code - Steel”.

5. ASTM A6 “General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Pilling and Bars for Structural Use”.

6. Steel Structures Painting Council specifications SSPC.

B. Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with AWS “Standard Qualification Procedure”.

1. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests.

a. If recertification of welders is required, re-testing will be Contractor’s responsibility.

C. Environmental Standards: Steel primer paint shall comply with provisions of the following:

1. Environmental Protection Agency (EPA) requirements for less than 350 grams per liter of Volatile Organic Compounds (VOC).

D. Fabricator and erector shall have continuous business operation for at least 5 years and by evidence of past projects indicate capability of conducting work of a similar nature; have sufficient well maintained equipment to perform the work; maintain an adequate stockpile of materials; qualified labor to fabricate or erect without delay the materials required for this project.

1.03 Submittals

A. Product Data: Submit producer’s or manufacturer’s specifications and installation instructions for following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).

1. Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.

2. High-strength bolts (each type), including nuts and washers.

B. Shop Drawings: Submit shop drawings prepared under supervision of a registered Professional Engineer, including complete details and schedules for fabrication and assembly of structural steel members, procedures and diagrams. Fabrication of structural steel members shall not begin until the shop drawings have been reviewed.

1. Include details of cuts, connections, camber, holes and other pertinent data. Indicate welds by standard AWS A2.1 and A2.4 symbols, and show size, length, and type of each weld.

a. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed as work of other sections.

C. Test Reports:

1. Submit all test reports regarding welding, bolting, and headed studs per Section 3.03.

1.04 Product Handling

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground using pallets, platforms or other supports. Protect steel members and packaged materials from erosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Anchor bolts and other anchorage devices which are embedded in cast-in-place concrete shall be delivered to the project site in time to be installed before the start of concrete operations.

PART 2 PRODUCTS

2.01 Materials

A. Metal Surfaces, General: For fabrication of work which will be exposed to view, use only materials which are smooth and free of surface blemishes, including pitting, rust and scale seam marks, roller marks, rolled trade names and roughness. Remove such blemishes by grinding, or by welding and grinding prior to cleaning, treating and application of surface finishes.

B. Steel Shapes, Bars and Plates: ASTM A36 unless noted otherwise on the Contract Drawings. High strength steel is noted on the Contract Drawings as “Gr50" denotes ASTM A 572 material (Fy = 50 ksi).

C. Structural steel tubing: ASTM A500, Grade B, Fy = 46 ksi.

D. Structural steel pipe: ASTM A53, Type E or S, Grade B, Fy = 35 ksi or ASTM A501, Fy = 36 ksi.

E. Connection bolts: ASTM A325N (bearing bolts).

F. Anchor bolts: ASTM A36.

G. Drilled-in anchors (expansion bolts): KWIK-Bolt II stud anchor by Hilti Fastening Systems, Red Head, or approved equal.

H. Welding rods: AWS E70XX for ASTM A35 and ASTM A572 steel.

I. Headed studs (used as anchor studs or as shear connectors): ASTM A108, Grade 105 or 1020.

1. KSM Fastening Systems, Omark Industries, Nelson Stud Welding, TRW Nelson Division, Blue Arc Welding Studs, Erico Products, or approved equal.

J. Deformed bar anchors: ASTM A496.

1. KSM Fastening Systems, Omark Industries, Nelson Stud Welding, TRW Nelson Division, or approved equal.

The use of manually welded anchors, rods, bars, straps, or reinforcing bars is <u>not</u> acceptable as a substitute for headed studs or deformed bar anchors.

K. Malleable Iron Wedge Inserts: Hohman-Barnard, Peerless Hardward, or approved equal.

L. Grout: non-metallic, non-shrink, high-strength grout (minimum 5000 psi compressive strength at 28 days).

1. Five Star, Kemset, Masterflow 713, Quikrete, or approved equal.

M. Shop paint: Per Section WM-18, 2.03.

2.02 <u>Fabrication</u>

A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated.

1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.

2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of

members exposed in final structure free of markings, burns, and other defects.

B. Connections: Weld or bolt shop connections, as indicated.

1. Bolt field connections, except where welded connections or other connections are indicated.

a. Provide high-strength threaded fasteners for all bolted connections.

C. High-Strength Bolted Construction: Install high-strength threaded fasteners in accordance with AISC “Specifications for Structural Joints using ASTM A325 or A490 Bolts” (RCRBSJ).

D. Welded Construction: Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.

E. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld shear connectors, spaced as shown, to beams and girders in composite construction. Use automatic end welding of headed stud shear connectors in accordance with manufacturer’s printed instructions.

F. Holes for Other Work: Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on final shop drawings.

1. Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.

2. Cut, drill or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.

G. Connections:

1. Unless otherwise noted, beam connections shall be simple connections.

2. The steel supplier shall design the connections for at least the reactions indicated on the framing plans, but never less than 50% of the total allowable uniform load on the span.

3. Connection angles shall be 5/16" in thickness (Minimum).

4. Minimum connection strength shall not be less than that of two 3/4" diameter A325 bolts.

5. Beam connections shall consist of double web angles unless detailed otherwise on the drawings.

H. Welds shall be tested as outlined in Section 3.03. The correction of faulty welds shall be in accordance with AWS "Structural Welding Code D1.1".

I. Steel members of different grades but of the same size and length shall be marked and detailed to prevent misplacement during erection. Varying connection gages between grades of steel is an acceptable means of prevention.

2.03 Shop Painting

A. Shop paint all structural steel except the following:

1. Contact surfaces in connections using high strength friction bolts,

2. Surfaces to be field welded,

3. Structural steel that will receive sprayed-on fireproofing,

4. Steel encased in concrete,

5. Embedded steel items (surfaces in contact with concrete),

6. The top surface of the top flange for all composite beams,

7. Crane rails.

B. Shop Primer:

1. Material: As specified in WM-25

2. Volume solids: 55.0 ± minimum

3. Shop primer shall be compatible with the specified finish paint.

C. Surface Preparation:

1. SSPC - SP6 Commercial Blast Cleaning

D. Application:

1. Structural steel shall receive one coat of shop paint except surfaces inaccessible after assembly shall receive a second coat.

2. Dry film thickness: 2.0 mils minimum.

3. Follow coating manufacturer's printed directions.

PART 3 EXECUTION

3.01 Erection

A. Erect in accordance with the AISC "Specifications for Design, Fabrication and Erection of Structural Steel for Buildings".

B. Field connections shall be made using A325 high strength bolts, bearing type, except where welded connections are called for on the Contract Drawings.

C. Bolt Tightening:

1. High Strength Bolts shall be "friction" type fasteners when used in the following connections:

    a. Connections subjected to loosening.
    b. Connections subject to fatigue due to vibrations.
    c. Connections subject to stress reversals.
    d. Wind bracing connections.
    e. Fasteners in oversized, short or long slotted holes.

    "Friction" type fasteners shall be tensioned in accordance with Table 3 of the "Specification for Structural Joints using ASTM A325 or A490 Bolts". The contact surfaces in a "friction" type connection shall be left unpainted as noted in section 2.03, A, 1.

2. High Strength bolts shall be designed as "bearing" type fasteners and tensioned in accordance with Table 3 of the "Specification for Structural Joints using ASTM A325 or A490 Bolts" when used in the following connections.

    a. Connections subject to tension loads.
    b. Column splices in structures over 100 feet in height.
    c. Beam to Column connections in structures over 125 feet in height.

3. High strength bolts that are not covered by sections 3.01, C, 1 & 2 shall be "bearing" type fasteners. These fasteners need only be tighten to a "snug-tight" condition. "Snug-tight" shall be as defined in the "Specification for Structural Joints using ASTM A325 or A490 Bolts".

4. High strength bolts described by sections 3.01, C, 1 & 2 may be tightened by any method found acceptable by the "Specification for Structural Joints using ASTM A325 or A490 Bolts" unless otherwise noted on the drawings.

D. Set all structural steel accurately to lines and grades. Connect temporarily with sufficient high strength bolts to insure complete safety of the structure until permanent connections are made. Erection tolerances shall be in accordance with the AISC Code of Standard Practice.

E. Provide temporary guy lines, bracing, and shoring as required, to maintain stability and alignment until the entire system (including metal deck erection) is erected, permanently connected, braced and set.

F. Any and all misfits shall be reported to the Engineer for resolution. Burning of new or unfair holes or cutting with a torch will not be permitted without the approval of the Engineer. Reamers, twist drills and saws shall be employed where burning is prohibited.

G. Any member that has assumed a bend or buckle in its final position due to forced fit shall have one or both ends and any intermediate connections unbolted and re-drilled or reamed to relieve such bowing to the satisfaction of the Engineer.

H. No piece that has been bent, broken, twisted or otherwise damaged shall be incorporated into the work. Such pieces shall be repaired or corrected on the ground to the satisfaction of the Engineer or replaced with a new piece. Failure to observe this will be cause for rejection of the piece in place.

I. Prior to the erection of any steel, the Contractor shall verify the location, elevation and plumbness of all anchor bolts and concrete surfaces. The Contractor shall report immediately to the Engineer in writing any condition which he finds unacceptable or that would prevent erection of the structural steel within AISC tolerance for plumbness and elevation. The Contractor shall be responsible for all corrections, and all corrections shall be made in a manner acceptable to the Engineer.

J. The erector shall acquaint himself with all conditions at the site which can affect his methods and sequence of operations. Abide by Owner's regulations concerning traffic, parking and construction material delivery.

K. FIELD TOUCH-UP BY STEEL ERECTOR: Field bolts, field welds and abrasions to the shop coat shall be repaired and painted by the structural steel erector using the same paint and care as for shop coat. All such surfaces shall be washed with a suitable degreasing solvent. This contractor shall also remove any and all accumulations of mud, clay, rust, scale, grease, etc. that have been acquired, for any reason, during shipment, storage and erection and the shop coat restored to its original condition.

L. Sub base (leveling) plates under column base plates will not be permitted.

M. Install headed studs using manufacturer approved equipment in accordance with the manufacturer's instructions.

N. Furnish all anchor bolts for anchorage of structural steel at an advance date for incorporation into the concrete foundation by others. Provide heavy hex nuts and washers for each bolt. Anchor bolts shall not be installed until shop drawings have been reviewed.

O. Observe all federal, state and local laws and area trade rules in the erection and handling of structural steel.

3.02 Cleaning Up

A. Upon completion of erection, promptly remove all tools, equipment and rubbish caused by or resulting from the erection work.

3.03 Testing

A. All testing shall be by a testing agency approved by the Engineer, performed by registered/qualified technicians. The Contractor will employ the testing agency.

B. Test shop and field welds as indicated below:

1. All complete penetration welds shall be tested for 100% of the total weld length using ultrasonic testing apparatus.

2. All partial penetration welds shall be tested for 50% of the total weld length using the magnetic particle method.

3. 20% of all fillet welds shall be tested using the magnetic particle method.

4. All welds shall be visually inspected.

C. Inspect and test bolted connections; (see Section WM-18, 3.01C). A minimum of 10 percent of the bolts (and no less than 2 bolts in each connection) that are tightened per paragraph 3.01C, 2 shall be tested.

D. Inspect and test headed anchor studs and shear connector studs in accordance with the provisions for quality control of shear connectors, "Structural Welding Code", AWS D1.1.

E. Test reports shall be prepared by the testing agency giving the following:

1. The type and location of test conducted.

2. The test results.

3. Interpretation of the test results stating whether they comply with the Specification requirements.

4. Procedure taken if the test results are not acceptable.

5. Test results of re-tests after corrective measures have been completed. The cost of all re-testing of faulty welds shall be borne by the Contractor.

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(SECTION WM 21)

EXPANSION AND CONSTRUCTION JOINTS AND WATERSTOPS

PART 1 GENERAL

1.01 Waterstops

A. Coil Waterstop - shall be manufactured from bentonite waterproofing compound. Waterstop shall be 1" X 3/4" flexible strips. The coil waterstop shall be installed in strict compliance with manufacturer's recommendations, including hydrating all in place material with potable water prior to exposure to wastewater. On vertical surfaces the waterstop shall be installed with adhesive primer. For horizontal surfaces waterstop shall be installed with either adhesive primer or nailing. Coil waterstops shall be Waterstop-Rx as manufactured by CETCO, Hydro-Flex Waterstop as manufactured by Henry Company, or equal.

B. Plastic waterstops - shall be manufactured from virgin polyvinyl chloride plastic compound and shall not contain any scrap or reclaimed material. It shall be of the ribbed style not less than three-eighths by nine (3/8 X 9) inches, unless otherwise noted on the plans. Other dimension and style or type shall be as shown on the plans or as specified, except that center bulb type shall be provided where the joint is subject to traverse or shearing movement.

C. See Section WM 5.2, "Cast-in-Place Concrete", for submittal requirements and for related materials.

1.02 Backing Rod

A. Backing rod shall be an extruded closed-cell polyethylene foam rod such as Minicel backer rod, manufactured by Industrial Systems Dept., Plastic Products Group of Hercules, Inc., Middletown, DE; Ethafoam SB, as manufactured by Dow Chemical Company, Midland, MI; or equal. The rod shall be one eight (1/8) inch larger in diameter than the joint width except that a one (1) inch diameter rod shall be used for a three fourths (3/4) inch wide joint. Where possible, full length sections shall be provided for the joint; splices shall be minimized.

1.03 Preformed Joint Filler

A. For tank walls and slabs, joint filler shall be ASTM D 1752, Type III. Filler shall be granulated cork particles specially treated, dehydrated and compressed, designed to expand in the presence of moisture. Cork joint filler shall be self expanding cork by W.R. Meadows, Inc., A.P.S. Cork, or equal.

B. Asphalt filler shall be used for unsealed expansion or isolation joints in sidewalks, driveways, floor slabs on-grade or elsewhere as indicated on the drawings. Filler shall be ASTM D 994. Asphalt filler shall be Sealtight asphalt expansion joint filler manufactured by W.R. Meadows, Inc., Construction Materials International, or equal.

1.04 Poured Joint Filler

A. Hot-poured elastic joint filler shall meet ASTM D1190. Filler shall be Sealtight No. 164 manufactured by W. R. Meadows, Inc., Construction Materials International, or equal.

1.05 Sealants for Caulked Joints

A. Only the materials from a single manufacturer shall be used for the same joint. Use of other than one material for the same joint shall not be allowed unless approved by the sealant manufacturer.

B. Sealants shall be self-leveling (S/L) for horizontal and sloping joints with a slope less than two percent (2%). Nonsag sealants (N/S) shall be used for steeper sloped joints, vertical joints, and overhead joints.

C. Primer shall be the type recommended by the sealant manufacturer.

D. Color of the sealant shall be gray, or shall match the color of unpainted exposed surfaces, except that submerged may be either black or gray.

1.06 Nonsubmerged Joints

A. Joints one (1) inch or less in width shall utilize the following sealants: Isoflex 814, Sikaflex 427, or equal.

B. Joints greater than one (1) inch wide shall utilize the following sealants: Isoflex 814 (S/L), Sikadur CJR, or equal for horizontal joints. Isoflex 2000, Sikadur Combiflex, or equal for vertical joints.

1.07 General Sealants

A. Except where otherwise shown or specified, sealants shall be as follows:

B. Submerged Sealants:

1. Sikaflex la or 427 - Sika Chemical Co., Lyndhurst, NJ; or Isoflex 908 or 814 - H.S. Peterson Co., Pontiac, MI; or PRC 210, 220, or 270 - Products Research and Chemical Corp., Burbank, CA; or Vulkem 116 or 45 - Master Mechanics Co., Cleveland, OH; or equal.

C. Nonsubmerged Sealants:

1. Flexible sealants shall be provided for all joints not exposed to water which are subject to structural movement.

2. Joints one (1) inch or less in width shall utilize the following sealants: PRC 210 (N/S), PRC 220 (S/L), PRC 270; or equal.

3. Joints subject to pedestrian or vehicular traffic shall utilize PRC 230; Isoflex 814; Vulkem 45 (S/L); Vulkem 245; or equal.

1.08 Coal Tar Tape

A. Coal tar tape shall be Protecto Wrap 200, manufactured by Protecto Wrap Co., Denver, CO; Tapecoat CT, manufactured by Tapecoat Company, Inc., Evanston, IL; or equal.

1.09 Steel Expansion Joint Dowels

A. Double-Coat polyethylene coated steel bar dowel, as manufactured by Republic Steel, Cleveland, OH; or equal. Dowel bars in any size and number are readily available by contacting Republic Steel Corp., P.O. Box 6778, Cleveland, OH 44101, All-States Construction Supply Co., Inc., 6009 Sixth Avenue South, Seattle, WA 98108, or approved equal.

1.10 Installation of Waterstops

A. Join waterstops at all intersections so that a continuous seal is provided. Center the waterstop on the joint. Hold waterstop positively in correct position. In the event of damage to the waterstop, repair the waterstop in an acceptable manner. Vibrate concrete to obtain impervious concrete in the vicinity of all joints.

B. In horizontal joints, insure that the areas below the waterstop are completely filled with concrete. Make a visual inspection of the entire waterstop area during the concrete placement.

1.11 Plastic Waterstop

A. Install in accordance with the details shown and the instructions of the manufacturer. At least ten (10) minutes shall be allowed before the new splice shall be pulled or strained in any way. The finished splices shall provide a cross section that is dense and free of porosity with tensile strength of not less than eighty percent (80%) of the unspliced materials.

1.12 Construction Joints

A. Prior to placing the abutting concrete, the contact surface shall be cleaned and roughened by approved means to remove all laitance and expose the aggregate. The exposed portion of the reinforcing steel shall be cleaned of all concrete. The cleaning method shall be conducted so as not to damage the waterstop, if one (1) is present. Grout for horizontal construction joints shall be of the Metallic NonShrink Aggregate Type.

1.13 Joint Preparation

A. The joints shall be accurately located and constructed to produce straight joints and shall be vertical or horizontal except where walls intersect sloping floors.

B. The concrete pour shall not commence until after the joint preparation has been inspected and approved by the Engineer.

1.14 Location

A. Joints as shown on the plans, or as approved.

1.15 Time Between Pours

A. At least two (2) hours must elapse after depositing concrete in the columns or walls before depositing in beams, girders, or slabs supported thereon. Beams, girders, brackets, column capitals, and haunches shall be considered as part of the floor or roof system and shall be placed monolithically therewith.

1.16 Expansion Joints

A. The premolded joint filler shall be of sufficient width to completely fill the joint space. If a waterstop is in the joint, the premolded joint filler shall be accurately cut to butt tightly against the waterstop and the side forms.

B. At locations where joint sealant is to be applied, the premolded joint filler shall be precut to the required depth.

C. Cavities for joint sealant shall be formed with either precut premolded joint filler or smooth accurately shaped material that can be removed.

D. Concrete shall be thoroughly vibrated along the joint form to produce a dense, smooth surface. Surface irregularities along the joint sealant cavity due to improper concrete consolidation or faulty form removal shall be repaired with an approved compound compatible with the joint sealant in a manner that is satisfactory to the sealant manufacturer.

1.17 Bituminous Type Premolded Joint Filler

A. Drive nails at about one (1) foot on centers through the filler to provide anchors into the concrete when it is placed. Place premolded joint filler in the forms in the proper position before concrete is poured.

1.18 Pourable Joint Filler

A. Install pourable joint fillers in accordance with the manufacturer's instructions. Thoroughly clean joints by sandblasting the concrete surfaces of each side of the joint from the plastic waterstop to the top of the joint, dry the joint, and remove all dust and foreign material, and prime before pouring the filler. Avoid damaging the waterstop by sandblasting operations. Primer shall be compatible with the filler material.

1.19 Rubber Asphalt Type

A. Heat rubber asphalt filler material in a double-walled boiler and place in the joint by means of a nozzle. Prevent spillage outside of the joint. Begin pouring joint filler at the bottom of the horizontal joint and proceed upwards in a manner that will preclude the possibility of trapping air in the joint. Use masking tape at each side of joint to assist in cleaning all spillage.

1.20 Sealants

A. Just prior to installing the joint sealant, the joint cavity shall be cleaned by sandblasting or power wire brushing. Install bond breaker tape per manufacturer's instructions.

B. After the joints have been prepared as described above, the joint sealant shall be applied. The primer, if required, and joint sealant shall be applied only with the equipment and methods recommended by the joint sealant manufacturer.

C. Application criteria for the sealant materials such as temperature and moisture requirements, and primer cure time shall be in strict accordance with the recommendations of the sealant manufacturer.

D. Exposed joints shall have masking tape applied along the edges of the exposed surface. The joints shall be troweled smooth with a tuck pointing tool wiped with a solvent recommended by the manufacturer.

E. After the sealant has been applied, the masking tape and any sealant spillage shall be removed.

1.21 Preformed Control Joints

A. The preformed control joint shall be installed straight, flush, or slightly below the top of the slab and with equipment and methods approved by the manufacturer of the joint material.

B. Steel preformed tongue and groove type shall be adequately braced to withstand pressure of wet concrete.

1.22 Steel Expansion Joint Dowels

A. Install parallel to wall or slab face and in true horizontal position by securing tightly in forms with rigid ties. Dowels shall be oriented to permit joint movement.

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(SECTION WM 22)

ROADWAYS AND PARKING AREAS

PART 1 GENERAL

1.01 Scope

A. The Contractor shall furnish all materials, equipment and labor to construct and/or reconstruct new and existing roadway, alley, driveway, parking area and other pavement areas including those removed or damaged as a result of construction. These include access roads, approaches and entrances.

B. The Contractor shall furnish all materials and labor necessary to install a compacted aggregate base for all traffic areas to receive subsequent hard surface pavements (concrete or hot mix asphalt) and those areas to receive just the compacted aggregate pavement as specified and as ordered by the Engineer.

C. The Contractor shall be responsible for any damage to drives, roads, sidewalks, culverts, and other structures whether existing and/or new as constructed as part of the Contractor's work. Any repairs made due to damage caused by the Contractor shall be at his expense. This includes pavements for shoulders.

D. The Contractor shall keep all pavements completely clean from mud, loose aggregate and other debris and objectionable materials by the end of each workday.

E. Note: If local standards, specifications or other regulations require a higher strength/depth pavement section, this will supersede what is specified in these Workmanship and Materials Specifications, unless specifically noted otherwise in the specifications.

1.02 Product Handling

A. The Contractor shall store and protect miscellaneous items on the Project site so it does not interfere with other property owners or the general public.

1.03 Submittals Required Prior to the Commencement of Work

A. The Contractor shall submit copies of current materials certificates signed by the material producer and the Contractor certifying that each pavement material item complies with, or exceeds, the specified requirements.

B. The Contractor shall submit hot mix asphalt mix designs for this item.

C. The Contractor shall submit concrete mix designs for this item.

D. A paving joint plan shall be submitted for concrete pavements.

1.04 Related Specifications

A. Comply with applicable portions of the following WM Specifications:

WM-2	Excavation
WM-3	Backfill, Fills and Embankments

PART 2 PRODUCT

2.01 Pavement Materials

A. Hot Mix Asphalt (HMA) Pavement

The Indiana Department of Transportation (INDOT) Standard Specifications, Section 402, shall apply with the exceptions as noted herein. The current version of the INDOT Specifications, Recurring Special Provisions, and Supplemental Specifications are applicable.

1. Description: This work shall consist of one or more courses of HMA base, intermediate, surface mixtures or other miscellaneous HMA material, produced from an INDOT Certified HMA producer, in accordance with Indiana Test Method (ITM) 583.

2. Design Mix Formula and Mixture Type: The design mix formula, prepared in accordance with 402.04, shall be based on the following table and as may be amended from time to time:

Mixture Type	***Type A***	***Type B***	***Type C***
Design ESAL	*200,000*	*2,000,000*	*9,000,000*
Surface	*4.75, 9.5, 12.5* mm*	*4.75, 9.5, 12.5* mm*	*4.75, 9.5, 12.5* mm*
Surface - PG Binder	*64-22*	*64-22*	*70-22*
Intermediate	*9.5, 12.5,19.0, 25.0 mm*	*9.5, 12.5,19.0, 25.0 mm*	*9.5, 12.5,19.0, 25.0 mm*
Intermediate - PG Binder	*64-22*	*64-22*	*64-22*
Base	*25.0 mm*	*25.0 mm*	*25.0 mm*
Base - PG Binder	*64-22*	*64-22*	*64-22*

** Surface 12.5 mm ≥ 195 lbs/sq.yd. min.*

3. Recycled Asphalt Pavement: (RAP): Recycled asphalt pavement, up to 25%, may be used as a substitute for a portion of the new material required to produce HMA mixtures. See INDOT SS 402.08

3. Surface Aggregate Type: For Type C mixtures, surface aggregates shall meet the requirements for less than 10,000,000 ESAL in 904.03(d).

4. Acceptance of Mixtures: Acceptance shall be based on 402.09. The Type D Certification shall include the PG Binder Grade sent to the project.

B. A tack coat per Section 902, “Asphalt Materials” in accordance with the latest INDOTSS shall be applied on a clean surface before placing the surface course. All HMA or concrete pavements shall be tacked at a rate of no less than 0.03 to 0.08 gallons per square yard prior to placement of subsequent HMA mixtures.

C. If a prime coat is required on new and existing compacted aggregated bases, all compacted aggregate bases shall be primed at a rate of no less than 0.25 to 0.80 gallons per square yard prior to placement of subsequent HMA mixtures.

D. Concrete Pavement

1. Concrete pavements shall comply with Section 502, "Portland Cement Concrete Pavement, PCCP" in accordance with the latest INDOTSS. Compressive strengths shall be no less than 4,000 psi and shall include air entrainment additives to provide 5 percent air entrainment (+/- 1 percent). Cold weather (below 45 degrees F) placement will not be permitted without an approved plan for cold weather concrete work and at the approval of the Engineer.

E. Compacted Aggregate Base

1. Compacted aggregate base meeting the requirements of Section 301, "Aggregate Base" in accordance with the latest INDOTSS shall be provided. Aggregate shall meet the requirements for No. 53 coarse aggregate in Article 904, "Aggregates" of the INDOTSS.

F. Geotextiles and Geogrids

1. Woven and non-woven geotextile fabrics and HDPE geogrids per INDOTSS Section 913, "Miscellaneous", may be used as a separation layer between unstable soils and the placement of compacted aggregate base (subbase) materials. Supportive documentation shall be required and submitted to the Engineer for approval prior to their use.

G. Hydrated Lime (Quick Lime)

1. The Contractor may elect to submit an alternate plan for stabilizing the subgrade by use of hydrated lime per INDOTSS Section 215, "Chemical Modification of Soils". In such a case a licensed geotechnical engineer or professional geologist will be required to outline the proposed method and process.

PART 3 EXECUTION

3.01 Installation

A. The placement of all pavement materials shall be in accordance with the latest INDOTSS. All road cuts shall be saw-cut in a uniform, straight line prior to removal of the pavement. If, after saw-cutting, the exposed pavement becomes cracked as a result of construction loads, additional saw-cutting and removal or milling will be required. The thickness of all pavements to be placed under this specification shall be no less than existing pavement thickness found. The thickness of pavements and base materials shown herein is intended for those areas where a minimum thickness is not specified.

B. New construction and driveways and parking areas disturbed by construction shall be constructed and restored to the original or better condition. Unless noted otherwise, it is not the intent to repave entire drives and parking areas in the project area, but rather to repave and repair the trench width and any areas damaged during construction, so long as they are completed in a uniform and neat manner. No irregular, jagged or raveled patch repairs are permitted. The existing pavement shall be saw cut along that portion to be removed. If local standards or specifications require thicker pavement sections, then the local standards and/or specifications shall be followed.

1. Hot Mix Asphalt Pavement

a. Asphalt drives and parking areas outside of the public right-of-way shall consist of no less than a 1 ½ inches HMA surface, Type A on 3 ½ inches of HMA base, Type A on 6 inches of compacted aggregate, #53 in accordance with the INDOTSS.

b. Local asphalt pavements, including roads, drives and parking areas within the public right-of-way shall consist of no less than 1 ½ inches HMA surface, Type A on 4 inches of HMA Base, Type A on 8 inches of compacted aggregate, #53 base in accordance with the INDOTSS,.

c. Collector asphalt pavements, including major municipal streets, drives and parking areas within the public rights-of-way, shall consist of no less than 1 ½ inches of HMA surface, Type A on 2 ½ inches of HMA Intermediate, Type A on 4 inches of HMA Base,, Type A on 8 inches of compacted aggregate, #53 in accordance with the INDOTSS,.

d. Arterial asphalt pavements, including major municipal streets, drives and parking areas within the public rights-of-way, shall consist of no less than 1 ½ inches of HMA surface, Type B on 2 ½ inches of HMA Intermediate, Type B on 6 inches of HMA Base, Type B on 8 inches of compacted aggregate, #53 in accordance with the INDOTSS, unless specified otherwise in the Detailed Specifications.

e. HMA pavements shall be prepared, placed, compacted, and finished in accordance with Section 402, “Hot Mix Asphalt, HMA, Pavement”. The Contractor's particular attention is directed to the requirement of cutting or sawing of pavement removal areas to neat, straight lines prior to actual pavement removal. This requirement applies to all sewer trenches, service line trenches and force main trenches.

f. The existing pavement shall be saw cut along that portion to be removed.

2. Compacted Aggregate Surfaces and Bases

a. Unless noted otherwise, all road repairs shall consist of no less than 8 inches of compacted aggregate, #53 base. During construction, all pavement crossings shall be filled with compacted surfaces and bases and maintained to minimize the development of objectionable pavement depressions.

b. The surface course material shall be deposited and spread uniformly upon the prepared subgrade, in a single layer no less than six (6) inches in thickness measured after compacting. The material shall be free of lumps of clay and shall be of uniform mixture and density when placed. Portions of the layer in which the aggregates become segregated in spreading shall be removed and replaced with satisfactory material. Material shall not contain free water or frost, and shall not be placed in snow or on soft or frozen subgrade.

c. Compacted aggregated base shall be shaped, graded and compacted using vibratory rollers and compactors. The Contractor shall maintain the compacted aggregate base until the temporary or a permanent pavement is placed.

d. After being uniformly spread, the surfacing material shall be harrowed with a spike tooth harrow and floated with a road drag or grader until the surface is free from waves or irregularities. Harrowing and floating shall be continued until the surface has the required grade, line and cross section as shown on the plans, except that the harrowing shall not be carried on at such time or to such extent that the fine material will be separated from the coarse material. If the surfacing material is not thoroughly compacted by traffic before final acceptance or placement of hot asphaltic concrete pavement, then it shall be accomplished by means of suitable roller and wetting or drying to obtain maximum density.

e. Compacted aggregate base is to be placed as a base for the permanent pavement replacement for streets maintained by the Owner. All existing paved streets, roads, alleys, driveways, etc., cut for sewers and pipelines will require an 8-inch compacted aggregate base as part of the pavement replacement.

f. Additional aggregate required in trenches to maintain safe traffic flow, before placement of pavement shall be at the Contractor's expense. All excess aggregate removed to fit the placement of pavement shall be hauled from the site. When the trenches are prepared for replacement of a permanent pavement and the top portion of the compacted aggregate base is cut away, a full 8" of compacted aggregate base shall be remaining.

g. Compacted aggregate used for construction traffic shall be removed and the subgrade removed and re-compacted. Additional compacted aggregate shall be added to meet the lines and grades required for the pavement section.

3. Areas Receiving Pavement

a. Additional aggregate shall be required in all trenches in order to maintain safe traffic flow before placement of final pavements and shall be at the Contractor's expense. All excess aggregate removed to fit the placement of pavement shall be removed from the project area. When the trenches are prepared for replacement of a permanent pavement and the top portion of the compacted aggregate base is cut away, a full 8" of compacted aggregate base shall be remaining.

b. The surface of the compacted aggregate surface course shall be graded to the required elevations and cross sections as shown and/or as established by the Engineer. All soft spots and/or unstable or unsatisfactory base material shall be removed and replaced with suitable material to provide a satisfactory base beneath all areas to be paved. The newly placed or previously placed base material shall be scarified, brought to optimum moisture condition and thoroughly compacted ahead of the paving operations.

4. Concrete Pavements

a. Concrete surfaces shall be repaired as indicated on the drawings. Concrete pavements shall comply with Section 502, "Portland Cement Concrete Pavement, PCCP" in accordance with the latest INDOTSS. A broom or tined finish is required.

b. The minimum pavement thickness shall be 6 inches. For urban and commercial areas the minimum thickness shall be 8 inches in low volume truck areas and 9 inches when the amount of truck traffic exceeds 10 %. Also, concrete pavements that need to be removed shall be removed to the nearest existing pavement joint.

c. A paving joint plan shall be submitted to the Engineer for approval prior to placing the concrete pavement.

5. Curb and Gutter

All permanent restoration of street curb and gutter shall be of the same type and thickness as the existing curb and gutter. The grade of the restored curb and gutter shall conform to the grade of the existing adjacent curb and gutter. Curbs and gutter shall be saw cut at approximately 10-ft. intervals but shall match adjacent joints in sidewalks.

6. Driveways and Sidewalks

a. All permanent restoration of driveways and sidewalks shall conform to the manner of construction as originally placed and to the lines and grades as given by the Engineer. Replacement of concrete shall be from joint to joint. No patching of concrete shall be permitted. One-half (½) inch expansion joint material shall be installed wherever new concrete is placed against any existing or newly-cured concrete surfaces (vertical concrete surfaces only).

b. New sidewalks shall be installed in minimum widths of 48 inches or of the same width as existing sidewalks and minimum lengths of 60 inches. All new sidewalks shall be 4 inches thick using Class A concrete on 6 inches of compacted aggregate No. 53, except at driveways where the concrete shall be 6 inches thick. The new walk shall slope less than 2.0% (1.5% preferred) across the width of the walk toward the street unless otherwise noted and broom finished at right angles to the walkway. A ½ inch expansion joint and preformed joint filler material shall be installed at no more than 30-foot intervals. Tooled contraction joints shall be placed on the new sidewalk at 5 foot intervals.

c. Where sidewalks are replaced, the replacement sidewalk shall be installed the full width of the walk and from joint to joint. All sidewalk ramps to a public street or alley shall conform to the latest ADA regulations.

d. All ADA ramps shall be in conformance with the latest INDOTSS unless superseded by ADA regulations. All finished slopes exceeding maximum ADA slopes shall be considered unacceptable.

C. Subgrades

1. The construction of subgrades shall be outlined in the Contractor's Plan of Operation and is to be submitted to the Owner prior to initiation of the actual work.

2. The subgrade of roadways and parking areas shall be shaped either by cutting or filling as the plans may show or as directed by the Engineer. The area between the lines shown on the plans or necessary for construction shall be cleared of all topsoil, vegetation, brush, logs or other perishable material. During construction, the subgrade shall be formed and maintained in such a manner that the surface water will readily flow off the surface. The subgrade shall be brought to the correct grade on cuts and to approximate grade on fills with the proper allowance for settlement and shall then be allowed to settle. The subgrade shall be brought to the true shape and grade before the surfacing is placed.

3. All subgrade areas to receive a compacted aggregate base shall first be brought to optimum moisture conditions and shall be compacted to an

optimum condition as determined by results of soils testing by a geotechnical testing company provided by the contractor. Subgrades shall be compacted to a minimum of 95 percent of the maximum dry density as determined in accordance with ASTM D 1557 (Modified Proctor) using Method A for soil and Method C for granular materials.

4. The Contractor shall be responsible for compaction testing using a licensed geotechnical engineer or professional geologist.

5. Should weather conditions cause the subgrade to become wet and/or saturated, muddy, spongy or frozen or unusually dry for extremely dry conditions, the contractor shall again bring the subgrade up to optimum moisture conditions and retest the compacted subgrade. In frozen subgrades, the temporary pavement materials shall be used if the disturbed areas must remain open to traffic or will otherwise create a potential public hazard.

6. Soft and/or yielding or other unsuitable subgrade materials shall be removed if corrective measures are not effective. Proof rolling with the use of a pneumatic tire, two or three-axle tandem rollers or loaded dump truck shall be used to confirm if compacted subgrades exhibit soft and/or yielding properties.

7. Excavated materials to be later used for fill or topsoil shall be stockpiled and used to make the fills and embankments as shown on the plans and in compliance with the Workmanship and Materials Specifications. Backfilling shall be done in a manner to avoid any undue structural loading on structures. Stockpiles shall be located so as to avoid interference with access to project areas and to least interfere with other contractors performing work on behalf of the Owner in the same vicinity and as approved by the Engineer.

3.02 Shoulders and Existing Traffic Areas Not Receiving Hard-Surfaced Pavements

A. Compacted aggregate No. 53 base is to be placed as a base and surface for shoulders and the permanent replacement for off-street parking, drives, parking lots and other areas not receiving hard-surfaced pavements. All existing off-street parking, drives, parking lots and other areas, etc., cut for sewers and pipelines will require a minimum 8-inch compacted aggregate base and surface replacement. The depth of shoulders shall be as shown on the plans.

3.03 Proof Rolling Before Final Paving

A. Before placement of any hard surfaced materials such as hot mix asphalt or concrete pavements, the compacted subbase shall be proof-rolled with the use of a pneumatic tire, two or three-axle tandem rollers or loaded dump truck to confirm if compacted subbases exhibit soft and/or yielding properties. If they exhibit soft and/ or yielding properties they shall be removed and the subgrade and aggregate base re-compacted and proof-rolled again until it is acceptable for final paving courses.

B. Use of Roadway During Construction

1. The Contractor may prepare the subgrade of the roads at the start of construction and use them throughout the construction period either with or without placing the surfacing material. If the aggregate is placed and the road used during construction period, then the Contractor shall perform all necessary patrol maintenance at frequent intervals and add any additional aggregate required to maintain the road. Before the final acceptance of the work, the roads and parking areas including shoulders shall be brought to the grade and cross section shown on the plans and left in a condition satisfactory to the Engineer.

2. The prepared subgrade shall be protected by the Contractor to prevent undue rutting from truck or other equipment. If such damage does occur, the subgrade shall be reshaped and compacted prior to placing the aggregate courses.

C. Roadway Ditches

1. All open ditches and channel changes parallel to and adjacent to the road shall be performed as a part of the roadway work. Lines, grades and cross sections of ditches shall be as shown on the plans unless otherwise required by the Engineer to obtain proper drainage.

3.04 Traffic Control

A. The CONTRACTOR shall carry out the WORK in a manner which will cause a minimum of interruption to traffic, and may close to through travel not more than two (2) consecutive blocks, including the cross street intersected. Where traffic must cross open trenches, the CONTRACTOR shall provide suitable bridges to street intersections and driveways. The CONTRACTOR shall post suitable signs indicating that a street is closed and necessary detour signs for the proper maintenance of traffic. Prior to closing of any streets the CONTRACTOR shall notify responsible municipal authorities.

B. The CONTRACTOR shall plan construction activities to minimize impact to traffic. Local traffic access must be maintained at all times. To maintain traffic movement, appropriate traffic control devices shall be used. Such traffic control devices shall comply with the latest edition of the Indiana Manual on Uniform Traffic Control Devices. The CONTRACTOR shall follow the requirements of the INDOTSS Traffic Control Plans when no other plan is submitted for review.

C. The Local Highway Department shall be notified no less than five (5) calendar days prior to any construction activities occurring within the right-of-way.

3.05 Testing

A. All materials provided under this Specification shall meet the requirements of the applicable standards of the INDOTSS, latest edition. The Contractor shall provide current certifications of such compliance, and the cost for such testing shall be borne by the Contractor.

B. Contractor's *Plan of Operation* indicating how work will be completed, what testing will be provided, what equipment will be used and what provisions will be made to protect existing property and utilities.

C. Soil compaction tests will be required for each 800 linear feet per lift of embankments constructed. The Contractor's licensed geotechnical engineer or professional geologist making these tests shall provide written reports with these tests. The contractor may only reduce the number of tests required based on a written quality control plan and performance-based test results from the geotechnical engineer or professional geologist who will also provide recommendations for the frequency of tests needed.

(SECTION WM 23)

CHAIN LINK FENCE AND GATES

PART 1 GENERAL

1.01 Description

A. The Contractor shall erect the fencing in such a manner that it will follow the general contours of the ground or so that the top rail will show only gradual or sweeping curves.

B. The Contractor shall construct the fencing and gates as indicated on the drawings.

1.02 Quality Assurance

A. Code and Standards

American Society for Testing & Materials (ASTM) Standards:

A90/A90M	Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
A 121	Zinc-Coated (Galvanized) Steel Barbed Wire
A 123	Zinc (Hop-Dip Galvanized) Coatings on Iron and Steel Products
A 392	Zinc-Coated Steel Chain Link Fence Fabric
A 428	Test Method for Weight of Coating on Aluminum-Coated Iron or Steel Articles
F 668	Polyvinyl Chloride (PVC) Coated Steel Chain Link Fence Fabric
F 900	Industrial and Commercial Swing Gates
F 934	Standard Colors for Polymer Coated Chain Link Fence Materials
F 1043	Specifications for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework
F 1083	Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded for Fence Structures
F 1183	Aluminum Alloy Chain Link Fence Fabric
F 1184	Industrial and Commercial Horizontal Slide Gate
F 1345	Zinc - 5% Aluminum Mischmetal Alloy Coated Steel Chain Link Fence Fabric
F 1665	PVC Coated Steel Barbed Wire

1.03 Submittals

A. Shop Drawings

The Contractor shall submit drawings for all materials.

PART 2 PRODUCTS

2.01 Metallic Coated Steel Chain Link Fabric

A. Base Metal

The base metal of the fabric shall be a good commercial quality of steel wire of standard gages.

B. Zinc Coating

The zinc coating on the fabric may be either Class 1 — the weight of zinc coating shall not be less than 1.20 oz./ft.^{2} (366 gm/m^2) of uncoated wire surface; or Class 2 — the weight of zinc coating shall not be less than 2.0 oz./ft.^{2} (610 gm/m^2) of uncoated wire surface as determined from the average of results of two or more specimens, and not less than 1.8 oz./ft.^{2} (500 g/m^2) of uncoated wire surface for any individual specimen.

C. Zinc — 5% Aluminum Mischmetal Alloy Coating

The metallic coating on the fabric may be either Class 1 — the weight of metallic coating shall not be less than 0.60 oz./ft.^{2} (183 gm/m^2) or Class 2 — the weight of metallic coating shall not be less than 1.00 oz./ft.^{2} (305 gm/m^2) of uncoated wire surface as determined from the average of results of two or more specimens, and not less than 0.90 oz./ft.^{2} (250 gm/m^2) of uncoated wire surface for any individual specimen. The zinc 5% aluminum mischmetal alloy used for the coating shall conform to the grades specified in ASTM designation B-750, Standard Specification for Zinc 5% Aluminum Mischmetal Alloy (UNSZ38510) in Ingot Form Hot-Dip Coatings.

D. Fabric Sizes

The height, diamond count, size of mesh, and wire diameters of chain link fabric shall be 72" height, diamond count 20 ½, gauge 9 or 11, and wire diameter 0.120" or 0.148".

E. Height of Fabric

The height of the fabric shall be the overall dimension from ends of twists or knuckles. The tolerance of the nominal height shall be plus or minus one inch (± 25mm).

F. Mesh Sizes

The permissible variation from the specified size of mesh shall be ±1/8 in. (±3.2mm) for all mesh sizes over 1 in. (25mm) and ±1/16 in. (±1.6mm) for all mesh sizes 1 in. (25mm) and under.

G. Wire Diameter

The diameter of the coated wire shall be determined as the average of two readings measured to the nearest 0.001 inch (0.025 mm) taken at right angles to each other on the straight portion of the parallel sides of the mesh. The tolerance in the diameter of the coated wire shall be plus or minus 0.005 inch (±0.13mm).

H. Selvage

Fabric 72 inches (1830mm) high and over shall be knuckled at one selvage and twisted at the other.

2.02 PVC Coated Steel Chain Fence

A. Base Metal

The base metal shall be steel of such quality and purity that, when drawn to the size of wire required and coated with PVC, the finished fencing shall be of uniform quality and have properties and characteristics as prescribed in the specification.

B. PVC Coated Wire

1. Wire used for the manufacture of fabric shall meet the requirements of this specification and shall be capable of being woven into fabric without the PVC coating cracking or peeling. PVC shall be plasticized and thoroughly compounded so that this is full dispersement of pigments, stabilizer and other components.

2. Class 1 PVC coated wire shall have the PVC coating extruded onto wire that is zinc coated or zinc 5% aluminum alloy coated by the hot-dip method, zinc coated by the electrolytic process or aluminum coated by the hot-dip method.

3. Class 2a PVC coated wire shall have the PVC coating extruded and adhered to wire that is zinc coated or zinc 5% aluminum alloy coated by the hot-dip method, zinc coated by the electrolytic process or aluminum coated by the hot-dip method.

4. Class 2b PVC coated wire shall have the PVC coating fused and adhered to a primer that is thermally cured onto wire that is zinc coated or zinc 5% aluminum alloy coated by the hot-dip method, zinc coated by the electrolytic process, or aluminum coated by the hot-dip method.

5. The type of metallic coating on the steel wire substrate shall be the choice of the manufacturer unless otherwise specified.

C. Mesh and Fabric

1. The wire shall be woven throughout in the form of approximately uniform square mesh, having parallel sides and horizontal and vertical diagonals of approximately uniform dimensions. The top and bottom of the fabric shall be knuckled or twisted as specified.

   The size of mesh shall be 2".

   The permissible variation from the specified size of mesh shall be ±1/8 in. (3.2mm) for all mesh sizes over 1 in. (25mm) and ±1/16 in. (1.6mm) for all mesh sizes 1 in. (25 mm) and under.

2. Typical diamond count for standard height is 20 ½".

3. Chain link fabric shall be fabricated from wire diameters as necessary to meet the requirements. The diameter shall be determined as the average of two readings taken at right angles to each other on the straight portion of the parallel sides of the mesh and measured to the nearest 0.001 inches (0.03mm).

4. The permissible variation from the specified diameter of core wire shall be ±0.005 inch (0.13mm) for a core wire diameter over 0.105 in. (2.67mm) and ±0.004 in. (0.10mm) for a core wire diameter of 0.105 in. (2.67mm) or less.

5. Diameter shall be either 0.120" or 0.148".

6. Chain link fabric, unless otherwise noted, shall be furnished in the standard heights. The height of fabric shall be the overall dimensions from ends of twists or knuckles. Permissible variation from the specified height shall be ±1 inch (25mm) for standard selvage on fabric with mesh sizes 1 in. (25mm) and over and ± ½ in. (13mm) for all fabric with mesh sizes less than 1 inch (25mm).

D. Strength

1. Wire constituting the fabric shall meet the minimum breaking strength as determined according to A 370 (870 lbs. for 0.120" and 1250 lbs. for 0.148").

2. Specimens to establish conformance to this requirement shall comprise individual pickets from a section of the fence fabric. The specimens shall be of sufficient length so as to be firmly gripped in the testing machine after straightening. PVC coating may be removed from the sample by chemical or mechanical means before testing. The actual gage length (distance between jaws) of the specimen shall be limited to the underformed length of wire between the two adjacent bends.

E. Metal Coating

1. For Class 1 or Class 2 fabric, the weight of metallic coating shall conform to the following table:

Specified Diameter of Core Wire		Weight of Metallic Coatings Minimum Weight of Zinc or Zinc 5% Aluminum Alloy Coating		Minimum Weight of Aluminum Coating	
Inches	(mm)	oz./ft^2	(g/m$^{2)}$	oz./ft^2	(g/m^2)
0.148	(3.76)	0.30	(92)	0.20	(61)
0.120	(3.05)	0.30	(92)	0.20	(61)

2. The weight of coating shall be determined on an individual piece of wire removed from the fabric. This specimen may be any length of wire over 12 inches (305mm) and shall include both bends and straight sections, but shall not include either twists or knuckles.

3. The weight of zinc, or zinc 5% aluminum alloy coating shall be determined by the method contained in Test Method A90/A90M after stripping the PVC.

4. The weight of aluminum coating shall be determined by the method contained in Test Method A 428, after stripping the PVC coating.

F. PVC Coating

1. The thickness of the PVC coating shall be in accordance with the following table:

Thickness of PVC Coating				
	Class 1, Class 2a		Class 2b	
	Inches	(mm)	Inches	(mm)
Minimum Thickness at Any Point	0.015	(0.38)	0.006	(0.15)
Maximum Thickness at Any Point	0.025	(0.64)	0.010	(0.25)
Note: Thickness of zinc coat can be estimated using 1 ounce of zinc per square foot (305 g/m^2) equivalent to a coating thickness of 0.0017 inch (0.043mm)				

2. The thickness of the PVC coating shall be determined on an individual piece of wire removed from the fabric. This specimen may be any length of wire over 12 inches (305mm) and shall include both bends and straight sections, but shall not include either twists or knuckles.

3. For Class 1 or Class 2a material, mechanically strip the PVC coating from the wire and measure the minimum and maximum thickness of the PVC coating with a suitable micrometer.

4. For Class 2b material, strip the PVC coating by chemical means and determine the diameter of the bare wire. Scrape the coating from one side of the wire and measure the reduced diameter with a micrometer. The thickness of coating at this point is the difference between the measurement thus obtained and the measured diameter of the bare wire.

In a similar manner, determine the thickness of coating at right angles to the first determination.

G. PVC Properties

The PVC coated wire from which the fabric is woven shall have a demonstrated ability to conform to the following requirements.

1. Adhesion Tests

a. Class 2a

Three (3) specimens from each lot shall be tested. Measure a distance of 3/4 inch (19mm) from the end of the specimen. With a regular hand grip wire stripper exert maximum hand pull parallel to the axis of the wire. Attempt to remove the measured portion of the vinyl sleeve from the core wire. The lot shall be acceptable if the vinyl sleeve is not capable of being removed from the core wire on all three samples.

b. Three (3) specimens from each lot shall be tested. Make two (2) cuts parallel to the axis of the wire through the coating, approximately 1/16 inch (1.6mm) apart, at least ½ inch (12.7mm) long. With a knife, peel back a section of the coating between 1/8 inch (3.2mm) and ¼ inch (6.4mm) long, to produce a tab. Attempt to remove the 1/16 inch (1.6mm) strip of coating by pulling the tab. The lot shall be acceptable if the coating breaks rather than separates from the core wire on all three specimens.

2. Accelerated Aging

PVC coated wire from which the fabric is woven shall withstand exposure for 1000 hours without failure at a black panel temperature of 145°F (63°C) when tested in accordance with ASTM D 1499. Type D, E or F apparatus described in ASTM G 23 or Type BH apparatus described in ASTM G 26 shall be used for the test.

The product shall be construed to have failed the test if:

a. The wire fails to withstand the mandrel bend test.

b. Shrinkage of the PVC coating is greater than 1/16 inch per ft. (5.2mm/m) of wire.

c. There is a significant change in color or gloss of the PVC surface as determined by visual inspection.

3. Mandrel Bend

a. PVC coated wire when subjected to a single bend at -20°F (-29°C) around a mandrel no larger than ten times the diameter of the wire shall not exhibit breaks or cracks in the PVC coating.

b. The mandrel bend test shall be performed on an individual piece of wire removed from the fabric. This specimen may be any length of wire over 12 inches (305mm) and shall include both bends and straight sections, but shall not include either twists or knuckles.

4. Color

a. Unless otherwise stipulated, the color of the PVC in Class 1, 2a and 2b fabric shall be either green, brown or black in accordance with the standard colors and ASTM F 934.

b. Compliance with this requirement shall be determined by comparison of specimens of the PVC coated wire to standard flat specimens of fused film of approximately the thickness specified for the PVC coating to be applied to the wire, and measuring at least 1-1/2 x 1-1/2 inch (38mm x 38mm).

c. Standard flat specimens for the evaluation of color of Class 1 or Class 2a coatings shall be prepared by milling, calendering, or compression molding PVC pellets, using temperatures approximating those to be used in the extrusion process.

d. Standard flat specimens for the evaluation of Class 2b coatings shall be prepared by thermally fusing PVC powder onto a suitable base, using temperatures approximating those to be used in the powder coating process.

e. The color of the standard flat specimens shall be determined in accordance with ASTM D 2244 and D 1729. The color of the specimens shall not vary more than 6 Delta E when exposed to 500,000 Langleys accelerated weathering operated in accordance with Practice G 90 with both day and night spray cycles.

H. PVC Coated Tension Wire

1. PVC coated tension wire shall be manufactured in accordance with ASTM 1664 which requires either a (1) heavy duty 7 gage, 0.177 in. (4.50mm) metallic coated core wire having a breaking strength of 1950 lbf (8670 N) or a (2) light duty 9 gage 0.148 in. (3.76mm) metallic coated core wire having a breaking strength of 1290 lbf (5740 N). The PVC coating shall be Class 1 extruded, Class 2a extruded and adhered or Class 2b fused and adhered.

I. PVC Coated Barb Wire

1. PVC coated barb wire shall be manufactured in accordance with ASTM F 1665 which requires two strands of 14 gage, 0.080 in. (2.03mm) metallic coated core wire with four-point 14 gage, 0.080 in. (2.03mm) zinc coated or aluminum alloy barbs. The PVC coating shall be Class 1 extruded, Class 2a extruded and adhered or Class 2b fused and adhered. The spacing of the barbs shall be Type I, 5 in. (125mm) on center or Type II, high security 3 in. (75mm) on center.

2.03 Steel Fence Rails, Posts, Gates, and Accessories

A. Materials

1. Posts, gate frames, braces, rails, stretcher bars, truss rods and tension wire shall be of steel. Gate hinges, post caps, barbed wire supporting arms, stretcher bar bands, and other parts shall be of steel, malleable iron, ductile iron or equal except that post tops, rail ends, ties and clips may be of aluminum.

2. Where required to match fence fabric, supplemental color coating shall be provided, 10 mils (0.25mm) of polyvinyl chloride or 2 mils (0.8mm) of polyester should be obtained in conjunction with all coatings as indicated. Unless otherwise indicated, color of the coating shall be in accordance with ASTM F934, Green, Olive Green, Brown, and Black. Moveable and threaded fittings need not be coated but field coated per manufacturer's recommendations.

3. Intermediate posts shall be Type I or Type II round pipe or "C" roll formed sections conforming to the dimensions and weights shown in Table 1.

TABLE 1 — Dimensions and Weights

Use and Section	**Nominal Outside Demeter Inches**	**(Millimeters)**	**Nominal Weight Per Foot (± 10% Tolerance)** Type I Lbs/Ft	(kg/m)	Type II Lbs/Ft	(kg/m)
End, corner and pull posts fabric	2.375	(60.0)	3.65	(5.43)	3.12	(4.64)
height 6'0" (1.83m):round square	2.00	(50.8)	2.60	(3.87)		
	2.875	(73.0)	5.79	(8.62)	4.64	(6.90)
Over 6'0" (1.83 m): round square	2.50	(63.5)	5.10	(7.60)		
Rails and post braces	1.66	(42.0)	2.27	(3.38)	1.83	(2.72)

Intermediate Posts for Fabric Heights			**Nominal Weight Per Foot (± 10% Tolerance)** Type I Lbs/Ft	(kg/m)	Type II Lbs/Ft	(kg/m)	C Sections Lbs/Ft	(kg/m)
6'0" (1.83 m) and less; round C Section	1.90	(48.3)	2.72	(4.05)	2.28	(3.39)	2.28	(3.39)
	1.875" (47.6mm) x 1.625" (41.3mm)							
Over 6'0" (1.83m); round C Section	2.375	(60.0)	3.65	(5.43)	3.12	(4.64)	2.64	(3.93)
	2.25" (57.1mm) x 1.70" (43.2mm)		3.65	(5.43	3.12	(4.64)	2.64	(3.93)

4. Type I round post shall be hot dipped galvanized with a minimum average zinc coating of 1.8 oz./ft.^{2} (0.55 kg/m^2) meeting ASTM F-1083 for standard weight (Schedule 40) galvanized pipe.

5. Type II round post shall be steel pipe cold-formed and welded per ASTMF1043, Group IC, having a minimum yield strength of 50,000 psi (344mPa). The external zinc coating shall be Type B, zinc with polymer film, 0.90 oz./ft.^{2} (275g/m^2) minimum zinc coating with a chromate conversion and a verifiable polymer film. The internal coating shall be Type B, zinc 0.90 oz./ft.^{2} (275g/m^2) minimum or type D, zinc pigmented, 81% nominal coating with 0.30 mils (0.008mm) minimum thickness.

6. Roll formed "C" Section steel shapes shall be produced from steel having a minimum yield strength of 45,000 psi (10mPa) and meet the strength and protective coating requirements of ASTM F-1043.

7. Terminal posts, braces and rails shall be round or square Type I or round Type II and shall conform to dimensions and weights as shown in Table 1.

B. Zinc Coating

All Type I and Type II steel framework and other iron parts shall be zinc coated by the hot-dipped method, using zinc Grade E. The weight of zinc coat on Type I rail, post and brace shall have not les than 1.8 oz./ft/^{2} (0.55Kg/m^2) coating as listed in 1.1.1. Type II steel rails, posts and braces shall have an average weight of not less than 0.90 oz./ft.^{2}) as listed in 1.1.2 Zinc weight shall be determined in accordance with ASTM A-90.

C. Post Braces

Shall be provided for each gate, corner, pull, and end post for use when top rail is omitted or with fabric 6 feet (1.80m) or more in height, and shall consist of a round tubular brace extending to each adjacent line post at approximately mid height of the fabric, and a truss consisting of a rod not less than 5/16 inch (7.90mm) nominal diameter from the line post back to the gate, corner, pull, or end post, with a turnbuckle or other equivalent provision for adjustment. Truss rods may be eliminated in any line of fence where there is a continuous center rail.

D. Post Tops

Shall consist of ornamental tops or combination tops with barbed wire supporting arms, as required. When so required, or when a top rail is to be provided, the top shall be provided with a hole suitable for the through passage of the top rail. The post tops shall fit over the outside of posts and shall exclude moisture from posts.

E. Barbed Wire Supporting Arms

When required to be furnished, shall be at an angle of approximately 45^0 arms the top wire shall be approximately twelve inches horizontally from the fence line

and the other wires spaced uniformly between the top of the fence fabric and the outside strand. Barbed wire arm shall be of sufficient strength to withstand a weight of 250 pounds (113.3kg) applied at the outer strand of barbed wire.

F. Top Rails

Shall be in lengths not less than 18 feet (5.5m), and shall be fitted with couplings or swedged for connecting the lengths into a continuous run. The couplings shall be not less than 6 inches (152.4mm) long, with 0.070 inches (1.75mm) minimum wall thickness, and shall allow for expansion and contraction of the rail. Open seam outside sleeves shall be permitted only with a minimum wall thickness of 0.100 inches (2.50mm). Suitable ties or clips hall be provided in sufficient number for attaching the fabric securely to the top rail at intervals not exceeding 24 inches (610mm). Means shall be provided for attaching the top rail to each gate, corner, pull and end post.

G. Tension Bars

Shall not be less than 3/16 inch (4.76mm) by 3/4 inch (19.05mm) and not less than 2 inches (50mm) shorter than the normal height of the fabric with which they are to be used. One tension bar shall be provided for each end and gate post, and two for each corner and pull post.

H. Ties or Clips

Of adequate strength shall be provided in sufficient number for attaching the fabric to all line post at intervals not exceeding 15 inches (380mm); and not exceeding 24 inches (610mm) when attaching fabric to top rail or tension wire.

I. Bands or Clips

Of galvanized steel or aluminum alloy per ASTM F-626 shall be provided in sufficient number for attaching the fabric and stretcher bars to all terminal posts at intervals not exceeding 15 inches (380mm). Tension bands shall be formed from flat or beveled steel and shall have a minimum thickness after galvanizing of 0.078 inch (1.98mm); and minimum width of 3/4 inch (19.05mm) for posts 4: O.D. (101.60mm).or less and 0.108 inch (2.74mm) thickness by 7/8 inch (22.23mm) for posts larger than 4" O.D. (101.60mm). Brace bands shall be formed from flat or beveled steel and shall have a minimum thickness of 0.108 inch (2.74mm) after galvanizing; and minimum width of 3/4 inch (19.05mm) for post 4" O.D. (101.60mm). Standard mill tolerances of $\pm$ 0.005 inch ($\pm$0.127mm) on thickness and 0.010 inch (0/25mm) on width shall apply - attachment bolts shall be 5/16 (7.94mm) width shall apply - attachment bolts shall be 5/16 (7.94mm) x 1-1/4 inch (31.76mm) galvanized carriage bolts with nuts.

J. Tension Wire

Shall be Marcelled (spiralled or crimped) #7 gage, 0.177 inches (4.50mm) $\pm$ 0.005 inches ($\pm$0.127mm) in diameter, conforming to ASTM A-824.

1. Tension Wire Coating - shall conform to ASTM A-824 Type I, Aluminum-coated, 0.40 oz/ft (122g/m^2) or Type II Zinc-coated Class 2, 1.20 oz/ft. ^{2}(366g/m)

K. Barbed Wire

1. Shall consist of two strands of twisted wire with 4 point barbs on 5 inch (127mm) spacing. The following listed barbed wires are acceptable for use with chain link fencing:

Line Wire Gage	Line Wire Coating Weight	Barb Gage	Barb Coating Weight
12 ½	ZN 0.80 oz/ft.^{2}(245g/m ^{2})	14	ZN0.65 oz/ft.^{2}(200g/m ^{2})
12 ½	AL 0.30 oz/ft. ^{2}(90g/m ^{2})	14	Aluminum Alloy, or Aluminum Coated AL 0.25 oz/ft.^{2}(75g/m ^{2})
12 ½	Aluminum Alloy	14	Aluminum Alloy

2. Zinc-coated barbed wire shall conform to ASTM A-121, Chain link fence grade. Aluminum-coated barbed wire shall conform to ASTM A-585, Type I, 5 inch (127mm) or Type II, 3 inch (76mm) barb spacing.

L. Swing Gates

1. Materials

Swing gates shall conform to ASTM F 900.

Materials - The base materials of the gate frame shall be round or rectangular tubular members, welded at all corners or assembled with corner fittings. Gates assembled with corner fittings shall have adjustable truss rods 5/16 in. (7.9mm) minimum diameter on panels 5 ft. (1.5m) wide or wider. Truss rods shall be the same base metal and finish as the gate frames.

The Interior Bracing - when needed shall be the same metal and shape tubular material and finish as the gate frame, but need not be the same size. Gate leaves shall have vertical interior bracing at maximum intervals of 8 feet (2.4m) and shall have a horizontal interior member if the fabric height is 8 feet (2.4m) or more.

Zinc-Coated Steel Frames - shall be in accordance with ASTM Specifications F 1043 of F 1083, or a combination thereof, and shall match that selected for any adjoining fence framework. Welded joints shall be coated in accordance with Practice A780, employing a zinc-rich paint.

Aluminum Alloy Gate Frames - shall be in accordance with Specification F 1043.

Polymer-Coated Steel or Polymer-Coated Aluminum Frames - shall be in accordance to paragraphs 3 and 4. Welded joints shall be top-coated to match the frame color.

Gate Fabric - shall be the same type as used in fence construction. The fabric shall be attached securely to the gate frame at intervals not exceeding 15 in. (357mm).

Barbed Wire Top - shall have the end members of the gate frame extended in height to accommodate three strands of barbed wire.

2. Dimensions, Mass, and Permissible Variations

   a. Size of the gate opening shall be measured from the inside face to inside face of gate posts.

   b. Dimensions and weights of gate frame members and posts shall be in accordance with Tables 2 and 3.

   c. Gate frame shall be designed for the width and built so that the outer members shall not sag in excess of the lesser of 1% of the gate leaf width of 2 in. (50.8mm).

3. Gate Accessories

   a. Gate Hinges - Hinges shall be structurally capable of supporting the gate leaf and allow the gate to open and close without binding. The hinges shall be so designed to permit the gate to swing a full 180^0.

   b. Single Gate Latch - Gate latch shall be capable of retaining the gate in a closed position and shall have provision for a padlock.

   c. Double Gate Latch - Gate latch shall be a drop rod or plunger bar arranged to engage the gate stop. Locking devices shall be constructed so that the center drop rod or plunger bar cannot be raised when the gate is locked. The latching devices shall have provision for a padlock.

   d. Gate Stops - Gate stops shall be provided for all double gates.

   e. Keepers - shall be provided for each gate leaf over 5 ft. (1.5m wide).

Table 2
Gate Frame Members, Dimensions and Weights

Gate Fabric Height	Outside Dimensions in. (mm)		Minimum Weight lb/ft (kg/m)	
6 ft (1.8m) or less:				
Round tubular (steel)	1.66	(42.2)	1.83	(2.72)
Rectangular tubular (steel)	1.50	(38.1)	1.84	(2.74)
Round tubular (aluminum)	1.90	(48.3)	0.91	(1.35)
Rectangular tubular (aluminum)	2.00	(50.8)	0.91	(1.35)
Over 6 ft. (1.8m):				
Round tubular (steel)	1.90	(48.3)	2.28	(3.39)
Rectangular tubular (steel)	2.00	(50.8)	2.52	(3.75)
Round tubular (aluminum)	1.90	(48.3)	0.91	(1.35)
Rectangular tubular (aluminum)	2.00	(50.8)	0.91	(1.35)
Interior Bracing:				
Round pipe (steel)	1.66	(42.2)	1.83	(3.39)
Rectangular pipe (steel)	1.50	(38.1)	1.84	(2.74)
Round tubular (aluminum)	1.90	(48.3)	0.91	(1.35)
Rectangular tubular (aluminum)	2.00	(50.8)	0.91	(1.35)

Note: Gate leaf shall have vertical interior bracing at maximum intervals of 8 ft. and shall have a horizontal interior or member if fabric height is 8 ft. or more. Additional horizontal, vertical or diagonal member or diagonal truss rods may be needed to comply with requirements of 2.c.

Table 3
Dimensions and Weight of Gate Posts

Gate Leaf Width		**Outside Diameter of Pipe in. (mm)**		**Minimum Weight lb/ft (kg/m)**	
For Gate Fabric Height of 6 ft. (1.8m) or less: Up to and including 4 ft. (1.2m)	Steel	2.375	(60.3)	3.11	(4.63)
	Aluminum	2.375	(60.3)	1.22	(1.81)
Over 4 to 10 ft. (1.2 to 3.7m)	Steel	2.875	(73.0)	4.64	(6.91)
	Aluminum	2.875	(73.0)	1.94	(2.89)
Over 10 to 18 ft. (3.7 to 5.5m)	Steel	4.000	(101.6)	8.65	(12.88)
	Aluminum	4.000	(101.6)	2.99	(4.45)
For Gate Fabric Height of 6 ft. (1.8m): Up to and including 6 ft. (1.8m)	Steel	2.875	(73.0)	4.64	(7.04)
	Aluminum	2.875	(73.0)	1.94	(2.89)
Over 6 to 12 ft. (1.8 to 3.7m)	Steel	4.000	(101.6)	8.65	(12.88)
	Aluminum	4.000	(101.6)	2.99	(4.45)
Over 12 to 18 ft. (3.7 to 5.5m)	Steel	6.625	(168.3)	18.02	(26.82)
Over 18 to 24 ft. (5.5 to 7.3m)	Steel	6.625	(219.1)	27.12	(40.36)

Note: All gate posts shall be of sufficient strength so that the total deflection of the gate frame and the gate post at the end of the gate leaf shall not exceed the lesser of 2% of the gate leaf width or 4 in. When necessary to meet this requirement due to the total weight of the gate leaf, the next larger size post listed in the above Table shall be used.

M. Sliding Gates

Sliding gates shall comply with ASTM F 1184 which provides for overhead slide gates which are horizontal slide gates supported only from above and cantilever slide gates which are horizontal slide gates spanning an opening without a top or bottom support

within that opening. Cantilever slide gates shall be supplied with steel or aluminum frames using eternal or internal rollers. Safety guide posts and roller guards shall be required for cantilever slide gates using external rollers.

PART 3 EXECUTION

3.01 Installation

A. Installation of fencing and gates shall meet the requirements of ASTM F 567 which are not intended to preclude any practice that has a proven performance equal to or better under varying conditions nor do they support to address all of the safety problems involved. It is the responsibility of the contractor to provide appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Site Preparation shall involve the location of fence lines, gates, terminal posts, underground utility locations, USC&G benchmarks, property monuments and underground structures by the contractor who shall also provide for site cleaning and grading with adequate clearance on both sides of the fence line.

C. Post Location shall be as required spaced equidistant at intervals not exceeding 10 ft. (3.05m). Measure the interval parallel to the grade of the proposed fence and in the line of the fence from center to center of the posts.

D. Terminal Posts (end corner and gate posts) shall be set at the beginning and end and end of each continuous length of fence and at abrupt changes in vertical and horizontal alignments.

E. Post Foundations shall be concrete with hole diameters dug or drilled a minimum of four times the largest cross direction of the post and a minimum depth of 24 in. (609.6mm) plus an additional 3 in. (76.2mm) for each 1 ft. (305mm) increase in the fence height over 4 ft. (1.22m).

F. Set Posts in a vertical position, plumb and align while concrete 2500 psi (17.2 mPa), is backfilled into the excavation and extended 2 in. (50mm) above grade and crowned to shed water or to 2 in. (50mm) below grade if a cover of sod, blacktop, or other material is provided.

G. Mechanical Devices can be used in place of concrete for the setting of fence posts provided the device strength in the ground is equal or superior to the strength developed by the concrete footing.

H. Solid Rock or Concrete can be encountered where overburden of soil is not present. In this case set posts in the solid rock or concrete to a depth three times the largest cross section of the posts. The diameter of the hole shall be ½ in. (13mm) greater than the largest cross section of the post.

I. Sleeves can be used in order to leave voids in new concrete construction. Half-fill the void with nonshrinkable hydraulic cement and force the post to the bottom of the hole and plumb. Thoroughly work additional grout into the hole so as to leave no voids. Crown the grout to shed water.

J. Drive Posts are to be driven by mechanical means to a minimum depth of 36 in. (914.4mm) or 6 in. (152.4mm) grater than what is required for posts set in concrete for a given fence height except where soil conditions are unstable or rock or concrete is encountered. In the case of the latter, the depth should be in keeping with standard fence construction practices for the local area or utilize the solid rock or concrete requirements previously outlined. When driving posts the tops must be protected to prevent distortion of the exposed end. The use of a drive cap is required.

K. Gate Posts - shall be set in concrete footings. Swing gate posts shall be set in footings as listed in Table 4. Cantilever slide gate post footings shall have a minimum diameter of 12 in. (304mm) and a minimum depth of 42 in. (1066mm). Overhead slide gate posts shall be set in a 12 in. (304mm) diameter hole with a depth of 38 in. (1.2m) for gate openings up to 24 ft. (7.3m). For openings 24 ft. (7.3m) to 40 ft. (12.19m), a 4 in. (101.6mm) outside diameter double post shall be set in a 24 in. (610mm) by 16 in. (406.4mm) sized hole, with a depth of 48 in. (1.2m).

L. Terminal Post - bracing is required on all fabric over 6 ft. (1.83m) and on fabric over 12 ft. (3.66m) in height a center rail is required. Securely fasten diagonal braces to the terminal post and the adjacent line post or its footing or a footing of equal size. There should be no more than a 50^{0} angle between the brace and the ground. Securely fasten horizontal braces (if used in place of diagonal braces) with truss rods from the bottom of the terminal post to the adjacent line post where the brace rail terminates. Attach the brace at the halfway point of the terminal post above grade.

M. Top Rail - must be supported at each post so that a continuous brace from end to end of each stretch of fence is formed. Securely fasten the top rail to the terminal posts and join with sleeves or coupling to allow for expansion and contraction.

N. Tension Wire - should be stretched from end to end of each stretch of fence. Bottom tension wire should be fastened within the bottom 6 in. (150mm) of the fabric. The tension wire should be taut and fee of sag.

O. Chain-Link Fabric - shall be placed on the outside of the area enclosed or as directed. Place the fabric by securing one end, applying sufficient tension to remove all slack before making attachments elsewhere. Tighten the fabric to provide a smooth uniform appearance free from sag. The fabric may be cut by untwisting a picket and attaching each span independently at all terminal posts. Stretcher bars shall be used with tension bands or other suitable devices at 15 in. (380mm) maximum intervals. The fence fabric shall be installed 2 in. (50mm) above ground level. Measure clearance at the post with a tolerance of $\pm$ 3 in. ($\pm$76mm). The fabric shall be fastened to the line posts at intervals not exceeding 15 in. (380mm). Fasten the fabric to the rail or tension wire at intervals not exceeding 24 in. (610mm). Rolls of wire fabric may be joined by weaving a single picket into the ends of the rolls to form a continuous mesh.

P. Barbed Wire - where required, shall be pulled taunt to remove all sag. Firmly install in the slots of extension arms, and secure it to a terminal post utilizing terminal post band arms or brace bands or other suitable devices.

Q. Proper Gate Operation - and design requires consideration of opening direction, grade clearance, and possible obstructions.

R. Work areas - shall be left neat and free of any debris caused by the erection of the fence. All work shall be performed in a safe and orderly fashion in accordance with the Williams-Steiger Occupational Safety and Health Act of 1970.

A padlock shall be provided for each gate or set of gates with duplicate keys. All padlocks provided shall operate with the same key.

The Contractor shall furnish and install all materials to construct mow strips centered under the fence fabric when indicated on the drawings. Strips shall have an exposed runner width of not less than 24-inches of 4" thick crushed stone with a size range of 1/2-inch to 3/4-inch over a minimum of 6 mil. polyvinyl weed barrier. The Contractor shall also apply a weed control agent to the stone strip.

Table 4
Minimum Requirements for Setting Industrial and Commercial Swing Gate Posts

Gate Leaf Width	Height	Post Size	Size of Hole			
		Specification F 900	**Diameter**		**Depth**	
			Dirt	Solid Rock or Concrete	Dirt	Solid Rock or Concrete
4 ft. or less (1.2m)	6ft. or less (1.8M)	Steel 2.375 (60.3mm) Aluminum 2.375 (60.3mm)	10 in. (254mm)	Post O.D. + ½ in. (+13mm)	30 in. (762mm)	Post O.D. x 3
Over 4 ft. to 10 ft. (1.2m to 3.7m)	6ft. or less (1.8m)	Steel 2.875 (73.0mm) Aluminum 2.875 (73.0mm)	12 in. (304mm)	Post O.D. + ½ in. (+13mm)	36 in. (914.5mm)	Post O.D. x 3
Over 10 ft. to 18 ft. (3.7m to 5.5m)	6ft. or less (1.8m)	Steel 4.0 (101.6mm) Aluminum 4.0 (101.6mm)	14 in. (356.4mm)	Post O.D. + ½ in. (+13mm)	36 in. (914.5mm)	Post O.D. x 3
6 ft. or less (1.8m)	Over 6 ft. (1.8m)	Steel 4.0 (101.6mm) Aluminum 4.0 (101.6mm)	10 in. (254mm)	Post O.D. + ½ in. (+13mm)	36 in. (914.5mm)	Post O.D. x 3
Over 6 ft. to 12 ft. (1.8m to 3.7m)	Over 6 ft. (1.8m)	Steel 4.0 (101.6mm) Aluminum 4.0 (101.6mm)	12 in. (304mm)	Post O.D. + ½ in. (+13mm)	36 in. (914.5mm)	Post O.D. x 3
Over 12 ft. to 18 ft. (3.7m to 5.5m)	Over 6 ft. (1.8m)	Steel 6.625 (168.3mm)	16 in. (406.4mm)	Post O.D. + ½ in. (+13mm)	42 in. (1066mm)	Post O.D. x 3
Over 18 ft. to 24 ft. (5.5m to 7.3m)	Over 6 ft. (1.8m)	Steel 8.625 (219.1mm)	18 in. (457.2mm)	Post O.D. + ½ in. (+13mm)	48 in. (1.2m)	Post O.D. x 3

(SECTION WM 24)

SEEDING AND SODDING

PART 1 GENERAL

1.01 Description

A. The areas to be seeded shall be those areas which are shown on the plans or as specified in the Detailed Specifications.

1.02 Prepared Seedbed

A. It must be recognized that preparing a seedbed in residential areas and public places requires that it be free from objectionable materials and be left in a smooth and uniform appearance that is aesthetically pleasing to the Owner.

B. Prior to start of preparation of seeding the Contractor shall remove all debris, sheds, tools, equipment and other objects larger than 3/4 inches (19 mm) in greatest diameter from the area to be seeded. The areas to be seeded shall be loosened and reworked by means of discing, harrowing, and rolling; or reworked by means of powered rotary tiller; so that the ground will be left in a satisfactory manner ready for seeding. The surface of the area to be seeded shall be left smooth and uniform which conforms to the finished grades and cross sections as shown on the plans and without depressions or irregularities, or as otherwise specified.

C. After the seed has been sown, and prior to compacting, the lawn area shall be cleared of all construction materials and debris, stones or other objects larger than 3/4 inches (19 mm) in greatest diameter, and all wire, roots, brush, stumps or other objects that may interfere with subsequent mowing operations.

1.03 Time of Seeding

A. Spring seeding shall be done between March 1 and May 15, and Fall seeding between August 15 and October 15. During these periods, the time of seeding shall be determined by the Engineer whose decisions shall be based on the moisture content of the soil, and weather conditions. The Engineer may, at his option, extend the seeding season. (Mulched seeding may be done between March 1 and October 15 or possibly later in the fall.)

PART 2 PRODUCTS

2.01 Lime, Fertilizer and Seed

A. Lime: Agricultural hydrated lime shall be uniformly applied at a rate of one (1) ton per acre over the area to be seeded unless otherwise specified. The Contractor may substitute one and one half (1 ½) tons of agricultural ground limestone for one (1) ton of agricultural hydrated lime.

B. Fertilizer: Fertilizer of the 10-20-10 grade shall be uniformly applied over the area to be seeded at the rate of 0.44 ton for each acre to be seeded unless otherwise specified. The above fertilizer is equivalent to four hundred (400) pounds ammonium sulphate, 20%N; three hundred fifty-five (355) pounds triple super phosphate, forty-five percent (45%) P_2O_5; one hundred thirty-three (133) pounds murate of potash, sixty percent (60%).

C. Spreading Method: The lime and fertilizer shall be spread uniformly over the area to be seeded, and shall be mixed into the top two (2) inches of soil with a disc harrow, rotary tiller, mixer or hand raking.

D. Seed: Unless otherwise specified, the following Pure Live seeds shall be mixed and applied at the rate of one hundred twenty (120) pounds per acre (2.8 pounds per 1,000 square feet):

Kentucky Bluegrass - Pao Pratenis ----------70 lb.
Kentucky 31 Fescue - Festuca Elatior,
var. arundiancea ----------30 lb.
Red Fescue - Festurca rubra ----------20 lb.

PART 3 EXECUTION

3.01 Seeding Method

A. The Contractor shall employ the broadcasting method for seeding. The sowing seed mixtures shall be kept thoroughly mixed during the sowing operations to prevent separation of species and the subsequent lack of uniform distribution of species. The sowing shall be stopped when satisfactory results are not likely to be obtained due to excessive moisture, high winds, or other unfavorable conditions.

B. Seed shall be broadcast by either hand or by approved sowing equipment at a rate which will provide not less than the minimum quantity of pure live seed as specified. The seed shall be uniformly distributed over the designated areas. If sowing is by hand methods, one half (½) the seed shall be sown when the sower is moving in one (1) direction and the remainder sown with the sower moving in right angles to the first direction. Where seed is sown by means of approved broadcasting equipment, the seed may be sown with a single pass of the equipment. Broadcast sowing shall not be done during windy weather. The seed shall be covered by means of a brush harrow, spike tooth harrow, chain harrow, cultipacker, or other approved device, so that most of the seed will be placed within a satisfactory depth range.

C. After the seed has been sown, and prior to compacting, the lawn area shall be cleared of all construction materials and debris, stones or other objects larger than 3/4 inches (19 mm) in greatest diameter, and all wire, roots, brush, stumps or other objects that may interfere with subsequent mowing operations.

3.02 Mulched Seeding

A. General

1. When specified in the Detailed Specifications, the required mulch seeding shall consist of seeding as specified hereinbefore under the heading of "Seeding", and then covering the seeded areas with mulch.

B. Mulch

1. The mulching material may consist of straw, chaff, clover, timothy, alfalfa, peppermint or soy bean hay, shredded fodder or clover chaff. All mulch shall be free from primary noxious weeds as set forth under Section 913.04 of the Indiana Department of Transportation Standard Specification.

2. The mulching material at the time of delivery to the site of the work shall not contain more than fifty percent (50%) moisture. The mulching material shall be applied uniformly in a continuous blanket to a depth of approximately two (2) inches. After being held down, the mulch shall be thoroughly wetted, care being taken not to displace the seed or soil underneath.

C. Holding Mulch in Place

1. Unless otherwise specified, the mulch shall be held in place in accordance with INDOT Standard Specifications. Regardless of the method used, the mulching material shall be satisfactorily maintained in place until final completion and acceptance of the work.

3.03 Sodding

A. General

1. The areas to be sodded shall be those areas which are shown on the plans or as specified in the Detailed Specifications. Sod shall be fibrous, well rooted bluegrass, or other approved sod, with the grass cut to a height of not more than three (3) inches. Edges of sod shall be cleanly cut, either by hand or machine, to a uniform thickness of not less than one and one half (1 1/4) inches, to a uniform width of not less than sixteen (16) inches, and in strips of not less than three (3) feet in length.

2. Sod shall be free from all primary noxious weeds as defined by the Indiana State Seed Law.

B. Preparation of Ground before Sodding

1. The area to be sodded shall be smooth and uniform, and shall conform with the cross section required by the Plans or as directed. Grades prepared for sod shall be of sufficient depth below adjacent unsodded areas so that newly laid sod will conform with the surrounding surface.

2. After the grade has been prepared, and the topsoil has been spread, three fourths (3/4) lb. of agricultural hydrated lime and one fifth (1/5) lb. of 10-20-10 fertilizer shall be applied to each square yard, and thoroughly mixed into the top two (2) inches of soil. The area shall then be raked, and all clods, stones and debris removed.

C. Laying Sod

1. Sod strips shall be carefully laid by hand in the direction designated by the Engineer. At the edges of sodded areas the sod shall be carefully fitted into the grade, if excavated.

2. The sod strips shall be butted closely together to avoid any open joints. After laying and the initial watering, the sod shall be firmly tamped or rolled to insure firm contact with the soil underneath and shall conform with the surrounding surface. After compaction, the sod shall present a smooth, even surface, free from lumps and depressions.

3. Sod placed on slopes shall be pegged if directed by the Engineer. Pegs shall be driven down until not more than one (1) inch protrudes above the sod surface. The number of pegs shall be sufficient to hold the sod in place.

D. Watering Sod

1. The sod shall be thoroughly watered immediately after placing, and the watering continued for at least seven (7) days. If, at the end of thirty (30) days the sod is in good growing condition, the Contractor will not be required to repair or replace any sod which may thereafter be injured or damaged because of drought, unless written agreement for out of season sodding provides otherwise. The Contractor shall furnish the water at his expense.

E. Seasonal and Temperature Limitations for Sodding

1. No sod shall be laid during the months of June, July and August, unless written permission is obtained from the Engineer. When such permission is received the Contractor shall, before laying the sod out of season, agree in writing to the following provisions:

   a. Sod shall be in good, live and growing conditions;

   b. Sod shall be placed within thirty-six (36) hours after cutting and during that period be protected from damage;

   c. Sod shall be watered sufficiently, and otherwise maintained so that it will be in a live, growing condition at the time other items of the contract are accepted, provided the period between placing sod and acceptance is greater than thirty (30) days.

Winter sodding will be permitted when the temperature is above thirty-five degrees Fahrenheit (35 F). No frozen sod shall be laid and no sod shall be laid on frozen soil. Sod shall be properly protected from drying out or freezing and shall be laid within forty-eight (48) hours after cutting.

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(SECTION WM 25.1)

COATINGS FOR WASTEWATER TREATMENT PLANT AND RELATED STRUCTURES

PART 1 GENERAL

1.01 Description

A. This section covers preparation of surfaces, standard for materials, application standards for interior, exterior, immersed and non-immersed surfaces to be painted. The Contractor shall furnish materials, equipment, tools and labor necessary for total completion. This section is intended to include all work and materials necessary for completion of the work, any incidental item of material, labor or detail required for the proper execution and completion of the work and omitted from this section but obviously required by governing codes, local regulations, trade practices or operational functions, shall be provided as a part of the work without extra charge, even though not specifically detailed or mentioned.

B. The object of these specifications is to describe the materials and workmanship necessary to provide complete protection of the surface to be coated and to provide a neat finished appearance. Coating shall be done at such times as the Contractor and Engineer may agree upon in order that dust-free and neat work be obtained. All surfaces shall be prepared and all coatings shall be applied strictly in accordance with the most recent manufacturer's printed instructions and shall be performed in a manner satisfactory to the Engineer.

C. The Contractor shall arrange and conduct a job site conference between the coating manufacturer's representative, the Engineer's representative, and the Contractor’s personnel or sub-contractor assigned this work prior to any field surface preparation or coating application.

1.02 References

A. Reference Standards (all latest versions shall apply)

1. SSPC - The Society for Protective Coatings
2. NFPA - National Fire Prevention Association
3. NAPF – National Association of Pipe Fabricators
4. ASTM - American Standard Testing Materials, D16, D4258, D4259, D4261, & D4263
5. NACE International - National Association of Corrosion Engineers International
6. PDCA - Painting and Decorating Contractors of America
7. ICRI - International Concrete Repair Institute
8. PDCA P5-94 « Benchmark Sample Procedures for Paint
9. SSPC-PA-2 Measurement of Dry Paint Thickness with Magnetic Gauge
10. SWAT – Rapid Evaluation of Coatings and Linings by Severe Wastewater Analysis Test

B. Qualifications

1. All coating and surface preparation shall be completed by the Painting Contractor or prior approved sub-contractor. The painter shall be specialized in industrial or heavy commercial painting. For small projects, the Contractor may be allowed to apply the specified coatings if approved by the Owner and Engineer.

C. Quality of Materials

1. Materials applied to each surface shall be compatible and complete system. Any incompatible primers or barrier coats shall be removed and re-primed. The Contractor shall notify the Engineer in writing of any anticipated problems using the specified coating systems with substrates primed by others.

D. Sample Areas

1. Paint sample areas to establish standard on quality workmanship per *PDCA P5 Benchmark Sample Procedures for Paint*, as directed by the Engineer and to establish a basis for acceptability of the coating work. Job mock-ups and samples approved by the Engineer shall stay in place the remainder of the project to provide a standard of quality to which production work will be compared.

E. Submittals

1. Submit Manufacturer's Technical Data Sheets including paint label analysis and application instructions for each material proposed for use. Equivalent materials of other manufacturers may be substituted on approval by the Engineer. Submittals shall include performance data as certified by a qualified testing laboratory. Substitutions that decrease the film thickness, the number of coats applied, change the generic type of coating, or fail to meet the performance criteria of the specified material will not be approved. Prime, intermediate and finish coats on all surfaces shall be furnished by the same manufacturer.

2. For High H_2S Exposed Coatings, submittals shall include performance data as certified by www.RAEEngineering.ca or www.CorrosionLab.com for SWAT (EIS) testing for Engineer's evaluation.

F. Color Samples

1. Submit 4 samples of manufacturer's standard color range.

1.03 Product Delivery, Storage & Handling

A. All materials delivered to the job site shall be in original sealed and labeled containers of the paint manufacturer. Each container shall provide labels with the following information: manufacturer's name, contents by volume for major pigment and vehicle constituents, expiration date after which material should not be used;

thinning instructions and application instructions. Containers which are broken, opened, water marked or contain caked, lumpy or otherwise damaged materials are unacceptable and shall be removed from the work site immediately.

B. The Contractor shall exercise every precaution in the storage of paints, solvents, cleaning fluids, rags and similar materials as to eliminate the risk of spontaneous combustion or other hazardous conditions. Portable fire extinguishing equipment shall be provided in a convenient location for emergency access. All painting materials stored on the job site shall be stored in a location consistent to the manufacturer's storage requirements. The Contractor shall take all safety precautions in accordance with NFPA Bulletin No. 101.

1.04 Environmental Requirements

A. Weather

1. Air and Surface Temperatures: Prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with manufacturer's instructions.
2. Surface Temperature: Minimum of 5 degrees F (3 degrees C) above dew point.
3. Relative Humidity: Prepare surfaces and apply and cure coatings within relative humidity range in accordance with manufacturer's instructions.
4. Precipitation: Do not prepare surfaces or apply coatings in rain, snow, fog, or mist.
5. Wind: Do not spray coatings if wind velocity is above manufacturer's limit.

B. Ventilation:

1. Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with AWWA D 102.

C. Dust and Contaminants:

1. Schedule coating work to avoid excessive dust and airborne contaminants.
2. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

1.05 Protection

A. Provide all required forms of protection necessary to safeguard work of other trades. If necessary, mask and/or cover adjacent surfaces, fixtures, equipment, etc., by suitable means. Method of protection is a contractor's option.

PART 2 PRODUCTS

2.01 Manufacturer

A. All materials specified herein are manufactured by the Tnemec Company, Inc., Kansas City, MO. and the Sherwin Williams Co. (SW), **or approved equal**. These products are specified to establish minimum standards of quality and are approved

for use on this project. All products for High H_2S Coatings shall furnish testing data as required in Paragraph 1.02.E.2. The listing or description of these products shall not be constructed so as to eliminate from competition other materials of equal performance which are similar in design, function and performance. Materials by other Manufacturer's shall be approved for use on a submittal basis as described in this section. Within the submittal process, a three-year limited warranty agreement that includes both labor and material for premature coating failure shall be presented for review and approval.

2.02 Coating Requirements

A. Steel - Structural, Tanks, Pipe, Equipment, and Miscellaneous

1. Submerged

   a. System Type: MCU or Amine-Cured Epoxy
   b. Surface Preparation: SSPC-SP10 Near-White Metal Blast Clean
   c. OPTIONAL Primer: Shop Primer Tnemec Series 1 @ 2.5 – 3.5 DFT
   d. Intermediate Coat: Tnemec Series 446 @ 7.0 - 10.0 DFT or SW Tank Clad HS @ 7.0 - 10.0 DFT
   e. Finish Coat Tnemec Series 446 @ 7.0 – 10.0 DFT or SW Tank Clad HS @ 7.0 - 10.0 DFT
   f. Total DFT: 16.0 – 25.0 mils

2. High H2S Gas Exposed

   a. System Type: MCU or 100% Solids Epoxy.
   b. Surface Preparation: SSPC-SP 10 Near-White Metal Blast Clean
   c. OPTIONAL Primer: TNEMEC Series 1 @ 2.5 to 3.5 DFT or SW Copoxy or Dura-Plate 235 @ 3.0 - 5.0 DFT
   d. Intermediate Coat: TNEMEC Series 446 @ 7.0 – 10.0 DFT or SW Dura-Plate 5800 @ 15.0 to 20.0 DFT
   e. Finish Coat: TNEMEC Series 446 @ 7.0 – 10.0 DFT or *SW Dura-Plate 5800 @ 15.0 to 20.0 DFT
   f. Total DFT: Tnemec 16.5 to 23.5 mils or 30.0 to 45.0 mils (*Intermediate and Finish may be applied in one coat)

3. Interior Exposed

   a. System Type: Epoxy
   b. Surface Preparations: SSPC-SP6 Commercial Blast Clean
   c. Shop Primer: TNEMEC Series 1 @ 2.5 – 3.5 DFT or SW Copoxy or Macropoxy 646 @ 3.0 - 5.0 DFT
   d. Intermediate Coat: TNEMEC SERIES N69-1255 or SW Macropoxy 646 @ 3.0 - 5.0 DFT
   e. Finish Coat: TNEMEC SERIES N69-1255 or SW Macropoxy 646 @ 3.0 - 5.0 DFT
   f. Total DFT: 9.0 – 15.0 mils

4. Exterior Exposed

    a. System Type: Epoxy/Polyurethane
    b. Surface Preparations: SSPC-SP6 Commercial Blast Clean
    c. Shop Primer: TNEMEC Series 1 @ 2.5 – 3.5 DFT or SW Copoxy or Macropoxy 646 @ 3.0 - 5.0 DFT
    d. Intermediate Coat: TNEMEC SERIES N69-1255 or SW Macropoxy 646 @ 3.0 - 5.0 DFT
    e. Finish Coat: TNEMEC SERIES 1075 or SW Acrolon 218HS or Hi-Solids Polyurethane @ 3.0 - 5.0 DFT
    f. Total DFT: 9.0 – 15.0 mils

B. Concrete – Precast, Cast-in-Place, and Dense Concrete Masonry Units

1. Submerged

    a. System Type: Amine-Cured Epoxy
    b. Surface Preparation: SSPC-SP 13 to achieve a surface profile of ICRI CSP 2 or 3
    c. OPTIONAL Primer: 3/32” parge coat uniformly applied to fill holes, pits, voids and cracks with Tnemec Series 218 or SW Dura-Plate 235 @ 3.0 - 5.0 DFT
    d. Intermediate Coat: SW Sher-Glass FF @ 8.0 - 10.0 DFT
    e. Finish Coat: TNEMEC Series 435 @ 16.0 – 25.0 DFT or SW Sher-Glass FF @ 8.0 - 10.0 DFT
    f. Total DFT: 16.0 – 25.0 mils (Intermediate and Finish may be applied in one coat

2. High H2S Gas Exposed

    a. System Type: 100% Solids Epoxy.
    b. Surface Preparation: SSPC-SP 13 to achieve a surface profile of ICRI CSP 3 or 5
    c. Filler/Surface 3/32” parge coat uniformly applied to fill holes, pits, voids and cracks with TNEMEC Series 218 or SW Steel-Seam FT-190oz Ceramtec Thin Patch
    d. Intermediate Coat: SW Cor-Cote SC @ 20.0 to 30.0 DFT
    e. Finish Coat: TNEMEC SERIES 436 @ 50.0 – 60.0 DFT or SW Cor-Cote SC @ 20.0 to 30.0 DFT
    f. Total DFT: 40.0 to 65.0 mils (Intermediate and Finish may be applied in one coat)

3. Interior Exposed

    a. System Type: Waterborne Epoxy
    b. Surface Preparations: SSPC-SP 13 to achieve a surface profile of ICRI CSP 2 or 3
    c. Primer: TNEMEC SERIES 113 or SW ProIndustrial Hi-Bild WB Catalyzed Epoxy @ 4.0 – 6.0 DFT. Roll or backroll.
    d. Finish Coat: TNEMEC SERIES 113 or SW ProIndustrial Hi-Bild WB Catalyzed Epoxy @ 4.0 – 6.0 DFT

e. Total DFT: 8.0 – 12.0 mils

4. Exterior Exposed

a. System Type: Elastomeric Acrylic
b. Surface Preparations: SSPC-SP 13 to achieve a surface profile of ICRI CSP 2 or 3
c. Primer: TNEMEC SERIES 156 or SW Loxon XP @ 6.0 - 8.0 DFT
d. Finish Coat: TNEMEC SERIES 156 or SW Loxon XP @ 6.0 - 8.0 DFT
e. Total DFT: 12.0 – 16.0 mils

5. Exterior Below Grade (basement & pit walls which must be dry on the inside)

a. System Type: Elastomeric Polyurethane
b. Surface Preparations: SSPC-SP 13 to achieve a surface profile of ICRI CSP 3 or 5
c. OPTIONAL Primer: TNEMEC SERIES N69-1255 or SW Dura-Plate 235 @ 3.0 - 5.0 DFT
d. Finish Coat: TNEMEC SERIES 262 or SW Sher-Flex @50.0 -60.0 mils DFT

6. Below Grade (Soil Side)

a. System Type: Coal Tar Epoxy
b. Surface Preparation: SSPC-SP 13/NACE 6 to achieve a surface profile of ICRI CSP 2 or 3. Clean and dry.
c. Primer: None
d. Finish Coat: Tnemec Series 46H – 413 Tneme-Tar or SW Hi-Mil Sher-Tar Epoxy. DFT 14.0 to 20.0 mils
e. Total DFT: 14.0 to 20.0 mils
f. Finish Color: Black

C. Porous Concrete Masonry Units (CMU)

1. Interior Exposed

a. System Type: Waterborne Epoxy
b. Surface Preparations: SSPC-SP 13. Clean and dry
c. Primer / Block Filler: TNEMEC SERIES 130-6602 Waterborne Cementitious Acrylic or SW Cement-Plex 875 at 100 square feet per gallon
d. Intermediate Coat: TNEMEC SERIES 113 or SW ProIndustrial Hi-Bild WB Catalyzed Epoxy @ 4.0 – 6.0 DFT.
e. Finish Coat: TNEMEC SERIES 113 or SW ProIndustrial Hi-Bild WB Catalyzed Epoxy @ 4.0 – 6.0 DFT
f. Total DFT: 8.0 – 12.0 mils over block filler

2. Exterior Exposed Coating

a. System Type: Elastomeric Acrylic
b. Surface Preparations: SSPC-SP 13. Clean and dry
c. Primer: TNEMEC SERIES 156 or SW Loxon XP @ 6.0 - 8.0 DFT
d. Finish Coat: TNEMEC SERIES 156 or SW Loxon XP @ 6.0 - 8.0 DFT
e. Total DFT: 12.0 – 16.0 mils

3. Exterior Exposed Sealer

a. Surface Preparations: SSPC-SP 13. Clean and dry
b. Minimum 7% modified siloxane in water solution such as Tnemec Prime-A-Pell H20 or SW Loxon Siloxane Water Repellant or equivalent.

D. Wood

1. Interior Exposed

a. System Type: HDP Acrylic Polymer or Waterborne Epoxy
b. Surface Preparations: Clean and dry
c. Primer: Tnemec Series 151 @ 0.7 – 1.5 DFT or SW PrepRite ProBlock Interior/Exterior Latex Primer Sealer B51 Series @ 1.0 – 2.0 DFT
d. Intermediate Coat: TNEMEC SERIES 1029 @ 2.0 to 3.0 DFT or SW ProIndustrial Hi-Bild WB Catalyzed Epoxy @ 3.0 – 5.0 DFT.
e. Finish Coat: TNEMEC SERIES 1029 @ 2.0 to 3.0 DFT or SW ProIndustrial Hi-Bild WB Catalyzed Epoxy @ 3.0 – 5.0 DFT
f. Total DFT: 6.5 – 12.0 mils

2. Exterior Exposed

a. System Type: Acrylic
b. Surface Preparations: Clean and dry
c. Primer: Tnemec Series 151 @ 0.7 – 1.5 DFT or SW PrepRite ProBlock Interior/Exterior Latex Primer Sealer B51 Series @ 1.0 – 2.0 DFT
d. Intermediate Coat: Tnemec Series 1029 or SW SuperPaint Exterior Latex Gloss A84-100 Series @ 1.0 – 2.0 DFT
e. Finish Coat: Tnemec Series 1029 or SW SuperPaint Exterior Latex Gloss A84-100 Series @ 1.0 – 2.0 DFT

E. Gypsum Wallboard

1. Interior Exposed (Process Areas)

a. System Type: Latex/ Epoxy
b. Surface Preparations: Clean and dry
c. Primer: TNEMEC SERIES 151 or SW PrepRite ProBlock Interior/Exterior Latex Primer Sealer B51 Series @ 1.0 – 2.0 DFT

d. Intermediate Coat: TNEMEC SERIES 113 or SW ProIndustrial Hi-Bild WB Catalyzed Epoxy @ 3.0 – 5.0 DFT.
e. Finish Coat: TNEMEC SERIES 113 or SW ProIndustrial Hi-Bild WB Catalyzed Epoxy @ 3.0 – 5.0 DFT
f. Total DFT: 6.5 – 12.0 mils

2. Interior Exposed (Office & Occupied Areas)

a. System Type: Latex/Vinyl-Acrylic.
b. Surface Preparation: Clean and dry.
c. Primer: Tnemec Series 151 @ 0.7 – 1.5 DFT or Prep-Rite 200 Interior Latex Primer. DFT 1.0 to 1.5 mils.
d. Intermediate Coat: Tnemec Series 6 or Promar 200 Eggshell. DFT 1.5 to 2.0 mils.
e. Finish Coat: Tnemec Series 6 or Promar 200 Eggshell. DFT 1.5 to 2.0 mils.
f. Total DFT: 4.0 to 5.5 mils.

F. Ductile Iron Pipe [NOTE – DO NOT paint over Bituminous Shop Coat]

1. Submerged

a. System Type: Amine-Cured Epoxy
b. Surface Preparation: NAPF 500-03-04 Abrasive Blast Cleaning
c. OPTIONAL Primer: TNEMEC SERIES N69-1255
d. Intermediate Coat: TNEMEC SERIES N104 or SW Tank Clad HS @ 8.0 - 10.0 DFT
e. Finish Coat: TNEMEC SERIES N104 or SW Tank Clad HS @ 8.0 - 10.0 DFT
f. Total DFT: 16.0 – 25.0 mils

2. High H2S Gas Exposed

a. System Type: 100% Solids Epoxy.
b. Surface Preparation: NAPF 500-03-04 Abrasive Blast Cleaning
c. OPTIONAL Primer: TNEMEC SERIES N69-1255 or SW Copoxy or Dura-Plate 235 @ 3.0 - 5.0 DFT
d. Intermediate Coat: TNEMEC SERIES 435 or SW Cor-Cote SC @ 15.0 to 20.0 DFT
e. Finish Coat: TNEMEC SERIES 435 or SW Cor-Cote SC @ 15.0 to 20.0 DFT
f. Total DFT: 30.0 to 45.0 mils (Intermediate and Finish may be applied in one coat)

3. Interior Exposed

a. System Type: Epoxy
b. Surface Preparations: NAPF 500-03-04 Abrasive Blast Cleaning
c. Primer: TNEMEC SERIES N69-1255 or SW Copoxy or Macropoxy 646 @ 3.0 - 5.0 DFT

d. Intermediate Coat: TNEMEC SERIES N69-1255 or SW Macropoxy 646 @ 3.0 - 5.0 DFT
e. Finish Coat: TNEMEC SERIES N69-1255 or SW Macropoxy 646 @ 3.0 - 5.0 DFT
f. Total DFT: 9.0 – 15.0 mils

4. Exterior Exposed

a. System Type: Epoxy/Polyurethane
b. Surface Preparations: NAPF 500-03-04 Abrasive Blast Cleaning
c. Primer: TNEMEC SERIES N69-1255 or SW Copoxy or Macropoxy 646 @ 3.0 - 5.0 DFT
d. Intermediate Coat: TNEMEC SERIES N69-1255 or SW Macropoxy 646 @ 3.0 - 5.0 DFT
e. Finish Coat: TNEMEC SERIES 1075 or SW Acrolon 218HS or Hi-Solids Polyurethane @ 3.0 - 5.0 DFT
f. Total DFT: 9.0 – 15.0 mils

G. Galvanized Metal

1. Interior Exposed (SPECIAL CONDITIONS ONLY WERE IDENTIFIED)

a. System Type: Epoxy
b. Surface Preparations: SSPC-SP 16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel
c. Primer: TNEMEC SERIES N69-1255 or SW Macropoxy 646 @ 3.0 - 5.0 DFT
d. Finish Coat: TNEMEC SERIES N69-1255 or SW Macropoxy 646 @ 3.0 - 5.0 DFT
e. Total DFT: 6.0 – 10.0 mils

2. Exterior Exposed (SPECIAL CONDITIONS ONLY WERE IDENTIFIED)

a. System Type: Epoxy/Polyurethane
b. Surface Preparations: SSPC-SP 16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel
c. Primer: TNEMEC SERIES N69-1255 or SW Macropoxy 646 @ 3.0 - 5.0 DFT
d. Finish Coat: TNEMEC SERIES 1075 or SW Acrolon 218HS or Hi-Solids Polyurethane @ 3.0 - 5.0 DFT
e. Total DFT: 6.0 – 10.0 mils

H. PVC Pipe Coating

1. Interior Exposed

a. System Type: HDP Acrylic Polymer or Epoxy
b. Surface Preparations: Scarify
c. Primer: TNEMEC SERIES 1029 @ 2.0 – 3.0 DFT or SW Macropoxy 646 @ 3.0 - 5.0 DFT

d. Finish Coat: TNEMEC SERIES 1029 @ 2.0 – 3.0 DFT or SW Macropoxy 646 @ 3.0 - 5.0 DFT
e. Total DFT: 4.0 – 10.0 mils

2. Exterior Exposed

a. System Type: Acrylic
b. Surface Preparations: Scarify
c. Primer: TNEMEC SERIES 1029 or SW Metalatex @ 2.0 - 4.0 DFT
d. Finish Coat: TNEMEC SERIES 1029 or SW Metalatex @ 2.0 - 4.0 DFT
e. Total DFT: 4.0 - 8.0 mils

I. Concrete Floors

1. Mild Exposure: (F-1)

a. System Type: Silicate Blend.
b. Surface Preparation: Clean & Dry. No curing compounds.
c. Primer: Tnemec Series 629 C T Densifyer or Sher-Crete Lithium Silcate Concrete Hardener. 300-350 sq. ft./gal.
d. Finish Coat: Tnemec Series 629 C T Densifyer or Sher-Crete Lithium Silcate Concrete Hardener. 350-400 sq. ft./gal.
e. Total DFT: N/A.
f. Finish Color: N/A.

2. Heavy Traffic and Chemical Exposure: (F-2)

a. System Type: Aggregate-filled epoxy/epoxy.
b. Surface Preparation: SSPC-SP 13/NACE 6 to achieve a surface profile of ICRI CSP 5 or 6.
c. Primer for concrete: Tnemec Series 201 or General Polymers 3579 Standard Primer / Binder. DFT 6.0 to 8.0 mils.
d. First Coats: Tnemec Series 281 or General Polymers 3561 Epoxy Resin Glaze, double broadcast. DFT 1/8 inch.
e. Finish Coat: Tnemec Series 291 @ 2.0 – 3.0 DFT or General Polymers. 3744. High Performance CR Epoxy. DFT 6.0 to 8.0 mils.
f. Total DFT: Greater than 1/8 inch.
g. Finish Color: As indicated on the drawings. [Limited Color Selection]
h. Finish Texture: As required by the Engineer.

3. Decorative: (F-3)

a. System Type: Ceramic-filled epoxy. Ceramic Carpet.
b. Surface Preparation: SSPC-SP 13/NACE 6 to achieve a surface profile of ICRI CSP 5 or 6.
c. Primer for concrete: Tnemec Series 201 or General Polymers 3579 Standard Primer / Binder. DFT 6.0 to 8.0 mils.
d. First Coats: Tnemec Series 222 or General Polymers 3561 Epoxy Resin Glaze Clear, double broadcast with decorative quartz. DFT 1/8 inch.

e. Grout Coat: Tnemec Series 284 or General Polymers 3744 High Performance CR Epoxy Clear. DFT 8.0 to 10.0 mils.
f. Finish Coat: Tnemec Series 291 or General Polymers 4638 HS Polyurethane Floor Enamel. DFT 2.0 to 3.0 Mils
g. Total DFT: Greater than 1/8 inch.
h. Finish Color: As indicated on the drawings.
i. Finish Texture: As required by the Engineer.

4. High-Build Epoxy/Urethane Floor Coating. Mosaic Decorative Flake. (F-4)

a. Surface Preparation: SSPC-SP 13/NACE 6 to achieve a surface profile of ICRI CSP 4 or 5.
b. Primer for concrete: Tnemec Sereies 201 or General Polymers 3579 Standard Primer / Binder. DFT 6.0 to 8.0 mils.
c. Base Coat: Tnemec Series 224 or General Polymers 3589 Smooth Epoxy Floor Coating (broadcast flake to refusal or as directed by Engineer). Liquid DFT 8.0 to 10.0 Mils.
d. Grout Coat: Tnemec Series 284 or General Polymers. 3744. High Performance CR Epoxy. DFT 8.0 to 10.0 Mils.
e. Finish Coat: Tnemec Sesries 291 or General Polymers 4638 HS Polyurethane Floor Enamel. DFT 2.0 to 3.0 Mils
f. Total DFT: 24.0 to 31.0 Mils.
g. Finish Color & Pattern: As selected by Architect from manufacturer's standard colors.

PART 3 EXECUTION

3.01 Examination

A. Examine areas and conditions under which coating systems are to be applied. Notify Engineer of areas or conditions not acceptable. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.

3.02 Protection of Surfaces Not Scheduled to be Coated

A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.

B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

3.03 Surface Preparation of Steel

A. Prepare steel surfaces in accordance with manufacturer's instructions.

B. Fabrication Defects:

1. Correct steel and fabrication defects revealed by surface preparation.
2. Remove weld spatter and slag.
3. Round sharp edges and corners of welds to a smooth contour.

4. Smooth weld undercuts and recesses.
5. Grind down porous welds to pinhole-free metal.
6. Remove weld flux from surface.

C. Ensure surfaces are dry.

D. Immersion or Below Grade Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 10/NACE 2. Create a blast profile of 1.5 to 2.5 mils.

E. Exterior Exposed or Interior Exposed Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 6/NACE 3. Create a blast profile of 1.5 to 2.5 mils.

F. Abrasive Blast-Cleaned Surfaces: Coat abrasive blast-cleaned surfaces with primer before visible rust forms on surface. Do not leave blast-cleaned surfaces uncoated for more than 8 hours.

G. Shop Primer: Prepare shop primer to receive field coat in accordance with manufacturer's instructions. Removal all unknown shop primers and re-prime in accordance with this specification.

3.04 Surface Preparation of Galvanized Steel and Nonferrous Metal

A. Prepare galvanized steel and nonferrous metal surfaces in accordance with SSPC-SP 16 and the coating manufacturers instructions.

B. Check for post treatment of galvanizing using a copper sulfate solution in accordance with ASTM B201.

C. Ensure surfaces are dry.

3.05 Surface Preparation of Ductile or Cast Iron

A. Prepare ductile or cast iron surfaces in accordance with NAPF 500-03-04 Abrasive Blast Cleaning or NAPF 500-03-03 Power Tool Cleaning and the coating manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

3.06 Surface Preparation of PVC

A. Prepare PVC surfaces in accordance with manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Scarify PVC surfaces.

3.07 Surface Preparation of Insulated Pipe

A. Prepare insulated pipe surfaces in accordance with manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

3.08 Surface Preparation of Concrete

A. Interior, Wet Substrate:

1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 310.2.
2. Allow concrete to cure for a minimum of 28 days.
3. Test concrete for moisture in accordance with ASTM D 4263 and, if necessary, F 1869.
4. Abrasive blast surface to remove laitance and solid contaminants and to provide clean, sound substrate with uniform anchor profile.
5. Verify that the pH of the cleaned concrete surfaces to be coated is within the range of to 8 to 11. Application of coating materials outside this range will not be permitted without written approval from the Engineer.
6. Fill holes, pits, voids, and cracks with manufacturer approved surface (TNEMEC Series 218, SW Steel Spam FT-190, CEMTEC Thin Patch or Approval equal.)
7. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.

B. Exterior and Interior Dry:

1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 310.2.
2. Allow concrete to cure for a minimum of 14 days.
3. Test concrete for moisture in accordance with ASTM D 4263 and, if necessary, F 1869.
4. Level concrete protrusions and mortar spatter
5. Verify that the pH of the cleaned concrete surfaces to be coated is within the range of to 8 to 11. Application of coating materials outside this range will not be permitted without written approval from the Engineer.
6. Fill hairline cracks less than 1/64 inch (0.4 mm) in accordance with manufacturer's instructions.
7. Prepare cracks wider than 1/64 inch (0.4 mm), moving cracks, gaps, and expansion joints in accordance with manufacturer's instructions.
8. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.

3.09 Surface Preparation of Concrete Floors

A. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 310.2.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Allow concrete to cure for a minimum of 28 days before coating.

D. Test concrete for moisture in accordance with ASTM D 4263 and, if necessary, F 1869.

E. Verify that the pH of the cleaned concrete surfaces to be coated is within the range of to 8 to 11. Application of coating materials outside this range will not be permitted without written approval from the Engineer.

3.10 Surface Preparation of Secondary Containment

A. Prepare secondary containment surfaces in accordance with manufacturer's instructions.

B. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 310.2.

C. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

D. Allow concrete to cure for a minimum of 28 days before coating.

E. Test concrete for moisture in accordance with ASTM D 4263 and, if necessary, F 1869.

F. Verify that the pH of the cleaned concrete surfaces to be coated is within the range of to 8 to 11. Application of coating materials outside this range will not be permitted without written approval from the Engineer.

3.11 Surface Preparation of Porous Concrete Masonry Units

A. Prepare porous concrete masonry unit surfaces in accordance with manufacturer's instructions and SSPC-SP 13/NACE 6.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Allow mortar to cure for a minimum of 28 days before coating.

D. Level protrusions and mortar spatter.

3.12 Surface Preparation of Plaster

A. Prepare plaster surfaces in accordance with manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Allow plaster to cure and dry out for a minimum of 28 days before coating.

D. Do not coat over plaster containing free water, lime, or other soluble alkaline salts.

E. Remove plaster nibs and other protrusions.

F. Patch voids and cracks with approved materials and after dry, sand flush with surface.

3.13 Surface Preparation of Gypsum Board

A. Prepare gypsum board surfaces in accordance with manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Sand joint compound smooth and feather edge.

D. Avoid heavy sanding of adjacent gypsum board surfaces, which will raise nap of paper covering.

E. Do not apply putty, patching pencils, caulking, or masking tape to drywall surfaces to be painted.

F. Lightly scuff-sand tape joints after priming to remove raised paper nap. Do not sand through primer.

3.14 Surface Preparation of Wood

A. Prepare wood surfaces in accordance with manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, surface deposits of sap or pitch, and other contaminants.

C. Seal knots and pitch pockets.

D. Sand rough spots with the grain.

E. Fill cracks and holes with approved materials after primer is dry. Sand flush with surface when filler is hard.

F. Lightly sand between coats.

3.15 Application

A. Apply coatings in accordance with manufacturer's instructions.

B. Mix and thin coatings, including multi-component materials, in accordance with manufacturer's instructions.

C. Keep containers closed when not in use to avoid contamination.

D. Do not use mixed coatings beyond pot life limits.

E. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer's instructions.

F. Uniformly apply coatings at spreading rate required to achieve specified DFT.

G. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

H. Stripe paint with brush critical locations on steel such as welds, corners, and edges using specified primer. Apply and additional strip coat of the intermediate coating material in immersion areas.

I. Roll or backroll the first coat of epoxy or block filler applied to concrete or interior block substrates to work the material into the substrate.

3.16 Repair

A. Materials and Surfaces Not Scheduled To Be Coated: Repair or replace damaged materials and surfaces not scheduled to be coated.

B. Damaged Coatings: Touch-up or repair damaged coatings. Touch-up of minor damage shall be acceptable where result is not visibly different from adjacent surfaces. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color.

C. Coating Defects: Repair in accordance with manufacturer's instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.17 Field Quality Control

A. Required Inspections and Documentation:

1. Verify coatings and other materials are as specified.
2. Verify environmental conditions are as specified.
3. Verify surface preparation and application are as specified.
4. Verify DFT of each coat and total DFT of each coating system are as specified using wet film and dry film gauges. DFT's shall be measured in accordance with SSPC-PA-2.
5. Coating Defects: Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.

    a. Check for holidays on interior steel immersion surfaces using holiday detector in accordance with NACE SP0188.

6. Report:

    a. Prepare inspection reports daily.

b. Submit written reports describing inspections made and actions taken to correct nonconforming work.
c. Report nonconforming work not corrected.
d. Submit copies of report to Engineer and Contractor.

B. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.18 Cleaning

A. Remove temporary coverings and protection of surrounding areas and surfaces.

3.19 Protection of Coating Systems

A. Protect surfaces of coating systems from damage during construction.

3.20 One-Year Inspection

A. Owner will set date for one-year inspection of coating systems.

B. Inspection shall be attended by Owner, Contractor, Engineer, and manufacturer's representative.

C. Repair deficiencies in coating systems as determined by Engineer in accordance with manufacturer's instructions.

3.21 Schedules

A. Coating System Schedule:

1. Refer to the drawings for coating system schedules.

B. Color Schedule:

SERVICE	SCHEDULE	SYSTEM COLOR	BANDS
Water Lines			
Raw Water	Olive Green	Generator Green	
Settled or Clarified Water	Aqua	Alloy Aqua	
Finished or Potable Water	Dark Blue	Safety Blue	
Sprinklers	Dark Red	Safety Red	
Suction Line (Pump Stations)	Mid Blue	Robotic Blue	
Pressure Line (Pump Stations)	Safety Blue	Safety Blue	
Waste Lines			
Backwash Waste	Light Brown	Pallet Tan	
Sludge	Dark Brown	Walnut Brown	

SERVICE	SCHEDULE	SYSTEM COLOR	BANDS
Sanitary Sewer or Other	Dark Gray	Anchor Gray	
Sewage Effluent	Clay	Mason Brick	
Raw Sludge	Brown/Black	Bolt Brn	Black
Sludge Recirc	Brown/Yellow	Bolt Brn	Safety Yellow
Sludge Draw Off	Brown/Orange	Bolt Brn	Safety Orange
Sludge Recirc Dischg	Brown	Bolt Brown	
Sludge Gas	Orange-Red	International Orange	
Natural Gas	Orange Red/Black	Intl Orange	Black
NonPotable Water	Blue/Black	Safety Blue	Black
Potable Water	Blue	Safety Blue	
Chlorine	Yellow	Safety Yellow	
Sulfur Dioxide	Yellow/Red	Safety Yellow	Safety Red
Sewage	Gray	Slate Gray	
Compressed Air	Green	Rain Forest	
Chemical Lines			
Alum or Primary Coagulant	Orange	Safety Orange	
Ammonia	White	White	
Carbon Slurry	Black	Black	
Caustic	Yellow with Green	Safety Yellow	Safety Green
Chlorine	Yellow	Safety Yellow	
Fluoride	Light Blue with Red	Hydro Blue	Safety Red
Lime Slurry	Light Green	Emerald Ice	
Ozone	Yellow with Orange	Safety Yellow	Safety Orange
Phosphate Compounds	Light Green with Red	Emerald Ice	Safety Red
Polymers or Coagulant Aids	Orange with Green	Safety Orange	Safety Green
Potassium Permanganate	Violet	Plumb	
Soda Ash	Light Green with Orange	Emerald Ice	Safety Orange
Sulfuric Acid	Yellow with Red	Safety Yellow	Safety Red
Sulfur Dioxide	Light Green with Yellow	Emerald Ice	Safety Yellow
Other Lines			
Compressed Air	Dark Green	Rain Forest	
Gas	Red	Deck Red	
Other Lines	Light Gray	Flint Gray	
Hoists, Trolleys	Yellow	Safety Yellow	
Fire Protection	Red	Safety Red	
Steam	Orange	Safety Orange	
Oil	Ivory	Mill Ivory	

END OF SECTION