Comment on Draft Report – Kentucky Utilities – Tyrone Generating Station

EPA:

Note - Information regarding structural adequacy and stability was not provided for the Former Secondary Pond.

State: None

Company: See letter dated January 26, 2011

VIA OVERNIGHT DELIVERY

Mr. Stephen Hoffman
U.S. Environmental Protection Agency
Two Potomac Yard
2733 South Crystal Drive
Fifth Floor, N-5237
Arlington, VA 22202-2733

January 26, 2011

Re: Kentucky Utilities' Comments for
DRAFT Report of Geotechnical Investigation Dam Safety Assessment of Coal Combustion Surface Impoundments Kentucky Utilities, a Subsidiary of E.ON U.S. Tyrone Generating Station, Tyrone, Kentucky

Dear Mr. Hoffman:

The U.S. Environmental Protection Agency (EPA) requested comments from Kentucky Utilities (KU) on a draft report regarding the coal combustion byproduct impoundment at KU's Tyrone Generating Station. AMEC, an engineering contractor for EPA, prepared the draft report dated September 2010 to provide results of their assessment of the structural stability of one impoundment at Tyrone Station, commonly referred to as the Tyrone Ash Pond.

The scope of AMEC's assessment included a site visit to perform visual observations of the impoundment and a review of documentation provided by KU. As part of the assessment, AMEC assigned a condition rating and a hazard rating to the Tyrone Ash Pond using their engineering judgment and understanding of criteria developed by the EPA.

In conducting its assessment, AMEC utilized impoundment guidelines issued by the Mine Safety and Health Administration (MSHA). However, the MSHA guidelines are aimed at coal slurry ponds at mine sites, rather than the CCR impoundments found at a power plant. The MSHA standards are not legally applicable to our impoundments and in fact differ substantially from the standards that are applicable to our facilities. As you know, over the past two years EPA has assessed impoundments at several other facilities owned by KU or its affiliates. None of the EPA contractors conducting assessments of our facilities has utilized MSHA guidelines in preparing its reports. In fact, of the dozens of assessments of power plant impoundments that EPA has conducted across the nation, we are unaware of any EPA contractor other than AMEC utilizing MSHA guidelines in preparing its reports. Consequently, we object to the use of MSHA guidelines for inspection of our facilities because they are legally inapplicable, inappropriate from a technical standpoint, and inconsistent with past EPA practice. In the present situation, where EPA is conducting nation-wide assessments to determine whether CCR impoundments pose any significant risk to the public, it is particularly inappropriate for EPA to apply differing standards depending on the EPA contractor that conducts the assessment.

We disagree with the "poor" condition rating which AMEC has assigned to each of our impoundments. Based on AMEC's site inspection in August of 2010, AMEC found "no major operational or maintenance issues that needed to be addressed." However, AMEC determined to assign a poor condition rating based on the absence of certain information specified under the MSHA guidelines. It is entirely permissible under the MSHA guidelines to consider methods and procedures and other information that falls outside the gambit of the MSHA program to verify the safety of an impoundment.

According to the preface of MSHA's *Engineering and Design Manual Coal Refuse Disposal Facilities*, Second Edition, May 2009: "*The guidance presented in this Manual represents information, methods and procedures that are recommended for consideration by designers, coal operators, and regulators. The guidance presented in this Manual is not regulation and cannot be enforced as such. It is not intended to preclude the application of other credible methods and procedures or the use of other and new information that will result in a safe and reliable coal refuse disposal facility.*"

Kentucky has established a dam safety regulatory program under KRS Chapter 151 which involves permitting and inspection of impoundments. KRS 150.295 directs the Secretary of the Energy and Environment Cabinet (EEC) to inspect dams and reservoirs on a regular schedule. KRS 151.100 defines the word dam to mean any artificial barrier, including appurtenant works, which does or can impound or divert water and which either (a) is or will be 25 feet or more in height or (b) has or will have an impounding capacity at maximum water storage elevation of 50 acre-feet or more. All such dams are subject to the provisions of KRS Chapter 151 and are regulated by the EEC, Department for Environmental Protection (KY DEP).

The Secretary of the EPC is empowered by KRS 151 to administer and enforce the law using methods and procedures such as adopting rules and regulations, routinely inspecting dams, issuing permits and certificates of inspection, requiring owners to take action to protect life and property, and conducting studies and investigations as necessary to ensure compliance. KY DEP maintains an experienced technical staff to enforce regulations and administer the methods and procedures of the Secretary.

The EPC's regulations incorporate two technical publications that provide methods and procedures for the design, construction and safe operation of dams. These publications are *The Division of Water Engineering Memorandum No. 5* and *Guidelines for Geotechnical Investigation and Analysis of New and Existing Earth Dams.* Kentucky professional engineers have historically used these publications for the design and construction of numerous projects which have been determined to be safe and reliable. These publications provide appropriately conservative methods and procedures for the design, construction and operation of safe CCR impoundments. MSHA impoundment guidelines are designed to regulate a broader array of potential dam integrity issues and materials with differing physical properties than CCRs. KU does not consider the strict application of MSHA impoundment guidelines to be necessary or appropriate for CCR impoundments. Nor does KU interpret the MSHA guidelines as precluding reliance on relevant information available under the Kentucky Dam Safety program or otherwise available to EPA.

According to Kentucky regulations, the Tyrone Ash Pond is classified as a Class A, Low Hazard dam. Kentucky regulations define Class A, Low Hazard dams as "structures located such that failure would cause loss of the structure itself but little or no additional damage to other property". Out of an abundance of caution and to assist KY DEP, EPA and AMEC, KU has conducted a suite of additional studies and investigations to confirm the safety of the Tyrone Ash Pond. The studies and investigations included a comprehensive geotechnical exploration, an instrumentation program, a geological laboratory testing program, a slope stability analysis, a hydrologic and hydraulic analysis, and a recent engineering condition assessment by an independent registered professional engineer. These further studies concluded that all four CCR impoundments at Green River are in acceptable condition.

KU has included these additional studies, clerical and technical corrections to AMEC's draft report as the following attachments to this letter.

Attachment 1 – KU's Comments - clerical and technical corrections to *DRAFT Report of Geotechnical Investigation Dam Safety Assessment of Coal Combustion Surface Impoundments Kentucky Utilities, a Subsidiary of E.ON U.S. Tyrone Generating Station, Tyrone, Kentucky*

Attachment 2 - *Report of Geotechnical Exploration and Slope Stability Analyses Kentucky Utilities (KU) Tyrone Power Station Ash Pond Tyrone, Woodford County, Kentucky,* September 29, 2010, Mactec Engineering and Consulting, Inc.

Addendum A, Report of Geotechnical Exploration and Slope Stability Analyses Kentucky Utilities (KU) Tyrone Power Station Ash Pond Tyrone, Woodford County, Kentucky, January 19, 2011, Mactec Engineering and Consulting, Inc.

Attachment 3 – *KU Tyrone Ash Pond: Hydrologic and Hydraulic Assessment,* January 20, 2011, LG&E and KU Services Company

Attachment 4 – Cover pages, cover letter, appendices A and D of *2011 Pond Inspections Visual Site Assessment Report Six Impoundment Facilities*, January 25, 2011, ATC Associates, Inc.

KU respectfully requests that EPA direct AMEC, in finalizing the report, to refrain from applying MSHA guidelines and to consider all information available under the Kentucky Dam Safety Program as well as the additional studies and investigations performed by KU. KU believes that the additional information clearly shows the CCR impoundments at Green River Station are in acceptable condition.

Also, please note that on November 1, 2010, the name of E.ON U.S. LLC was changed to LG&E and KU Energy LLC. Consequently, any references to E.ON U.S. should be changed to LG&E and KU Energy.

We appreciate the opportunity to comment. If you have any questions regarding these comments, please contact me using the information provided below.

Sincerely,

David J. Millay

David Millay, PE
Senior Civil Engineer, LG&E and KU Services Company
502-627-2468
david.millay@lge-ku.com

Attachments
Cc: James Kohler, PE, U.S. Environmental Protection Agency
Gary Wells, PE, Kentucky Department of Environmental Protection – Dam Safety Section
Michael Winkler, LG&E and KU Services Company
John Voyles, LG&E and KU Services Company

Attachment 1

KU Comments-clerical and technical corrections to
DRAFT Report of Geotechnical Investigation Dam Safety Assessment of Coal Combustion Surface Impoundments
Kentucky Utilities, a Subsidiary of E.ON U.S.
Tyrone Generating Station, Tyrone, Kentucky

AMEC Project No. 3-2106-0177.0003

Prepared by AMEC Earth & Environmental, Inc., September 2010

KU General comments:

In Kentucky, CCR impoundments are regulated by the Energy and Environmental Cabinet, Department of Environmental Protection, Division of Water. The U.S. Department of Labor, Mine Safety Health Administration (MSHA) does not regulate CCR impoundments in Kentucky. MSHA impoundment guidelines are designed to regulate a broader array of potential dam integrity issues and materials with differing physical properties than CCRs. KU does not consider the strict application of MSHA impoundment guidelines to be necessary or appropriate for CCR impoundments in Kentucky.

Page 1, *1.1 Introduction*
First paragraph, fourth line:
"…perform a site assessment of Kentucky Utilities (a wholly owned ~~S~~subsidiary of E.ON U.S.) Tyrone Generating…"

Page 1, *Table 1. Site Visit Attendees*

~~*E.ON U.S.*~~ Kentucky Utilities Barry Currens, Manager Tyrone Operations
E.ON U.S., Environmental Affairs Roger J. Medina, Senior Chemical Engineer
E.ON U.S., Generation Engineering David Millay, P.E., Civil Engineer

Page 2, section *1.2 Project Background*
Fourth paragraph, third and fourth line

"Copies if the ~~*ash*~~ CCW Impoundment Inspection Forms are provided in Appendix A. The CCW Impoundment Inspection…"

Page 2, section *1.2 Project Background*
Fourth paragraph, beginning at seventh line

"Based on the site visit evaluations of the impoundment, AMEC engineers assigned a "Significant Hazard Potential" classification to the Tyrone Ash Pond. As defined on the Inspection Form, dams assigned a "Significant Hazard Potential" classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns."

KU Notes:

KY DEP's staff of dam safety engineers conducted comprehensive design reviews and permitting for the Tyrone Ash Pond during the design, construction, and initial operation phase. The Tyrone Ash Pond was permitted as a Class A, Low Hazard dam, and is currently classified as a low hazard dam.

KY DEP engineers have conducted numerous routine site inspections of the Tyrone Ash Pond. KY DEP continues to classify the Tyrone Ash Pond as a Low Hazard, Class A dam.

Pages 2-3, section *1.2.1 State Issued Permits*
First paragraph

"The permit became effective of February 1, 2002 and expired on February 1, 2007. At the time of writing of this report, KDOW states the KPDES permit for Tyrone Generating Station was under review."

KU Note: The permit remains in effect under applicable state regulations.

Page 4, section *1.4.2 Tyrone Ash Pond*
Fourth paragraph, beginning at fourth line

"From 2009 to August 2010, the pond was not excavated. When dredging occurs, the dredged ash is placed in an ash stack located immediately adjacent to the eastern portion of the pond."

KU Note: In accordance with communication with KPDES permit writers, KU stockpiles ash within the drainage area of the Tyrone Ash Pond. The purpose of the stockpile is to have readily marketable material for potential beneficial reuse projects.

Page 7, section 2.2 Visual Observations-Tyrone Ash Pond
First paragraph, first line

"The Tyrone Ash Pond is currently active and receives/contains fly ash, bottom ash, ~~*boiler slag,*~~"

KU Note: The definition of Boiler Slag from the American Association of Coal Ash is as follows: a molten ash collected at the base of slag tap and cyclone furnaces that is quenched with water and shatters into black, angular particles having a smooth, glassy appearance."

Tyrone Generating Station does not operate slag tap or cyclone furnaces.

Page 7, section *2.2.1 Tyrone Ash Pond-Embankments and Crest*
First paragraph

KU Notes: The freeboard was measured as 4.26 feet in January, 2011 using differential leveling techniques. The lowest crest elevation was surveyed as 533.08.

Page 8, section *2.2.2 Tyrone Ash Pond-Outlet Control Structure*
First paragraph, third and fourth lines

"…adjustable skimmer and stop log unit which allows the water level/discharge rate to be adjust~~*ment*~~ed by facility personnel..."

Page 8, section *2.4 Monitoring Instrumentation*
Second paragraph, third line

KU Note: The Tyrone Ash Pond was designed and constructed with a weirbox structure and metal plate v-notch weir at the ash pond flow measurement structure. Weirs are instruments used to measure and monitor flow.

Pages 12-14, section *3.2.1 Tyrone Ash Pond*

KU Notes: The Tyrone Ash Pond is classified as a class A, low hazard dam by KY DEP. Kentucky regulations define a low hazard dam as "Structures located such that failure would cause loss of the structure itself but little or no additional damage to other property."

LG&E and KU Services Company conducted a Hydrologic and Hydraulic analysis of the Tyrone Ash Pond in January, 2011. The analysis concluded that the pond meets Kentucky regulations at the normal maximum operating pool of 529.9. See Attachment 3 for analysis report. KU believes KY DEP regulations apply appropriately conservative methods and procedures for safe and reliable projects.

Page 15, section *3.3 Structural Adequacy & Stability*

Table 4 heading "Minimum ~~*Required*~~ Dam Safety Factors"

KU suggests that AMEC should delete the word "required" as it does not apply to all three agencies published documents regarding minimum safety factors.

Page 18, section *3.5.1 Instrumentation*
Table 7

KU Notes: See attachment 2 for additional piezometer readings.

Page 18, section *3.5.2 Inspections*
First paragraph

"The *two* most recent inspection*s* performed by KDOW at Tyrone Generating Station ~~*was*~~ *were* June 9, 2005 *and January 6, 2011*.

KU Note: Two engineers from KDOW Dam Safety Section inspected the Tyrone Ash Pond on January 6, 2011. No safety issues were noted and KU expects KDOW will subsequently issue a Certificate of Inspection.

Page 22 section *4.1 Acknowledgement of Management Unit Conditions*

KU Notes: KU has provided additional information the Tyrone Ash Pond is not in poor condition. For the draft and final reports, KU suggests that AMEC adjust the assigned condition ratings to reflect the acceptable conditions.

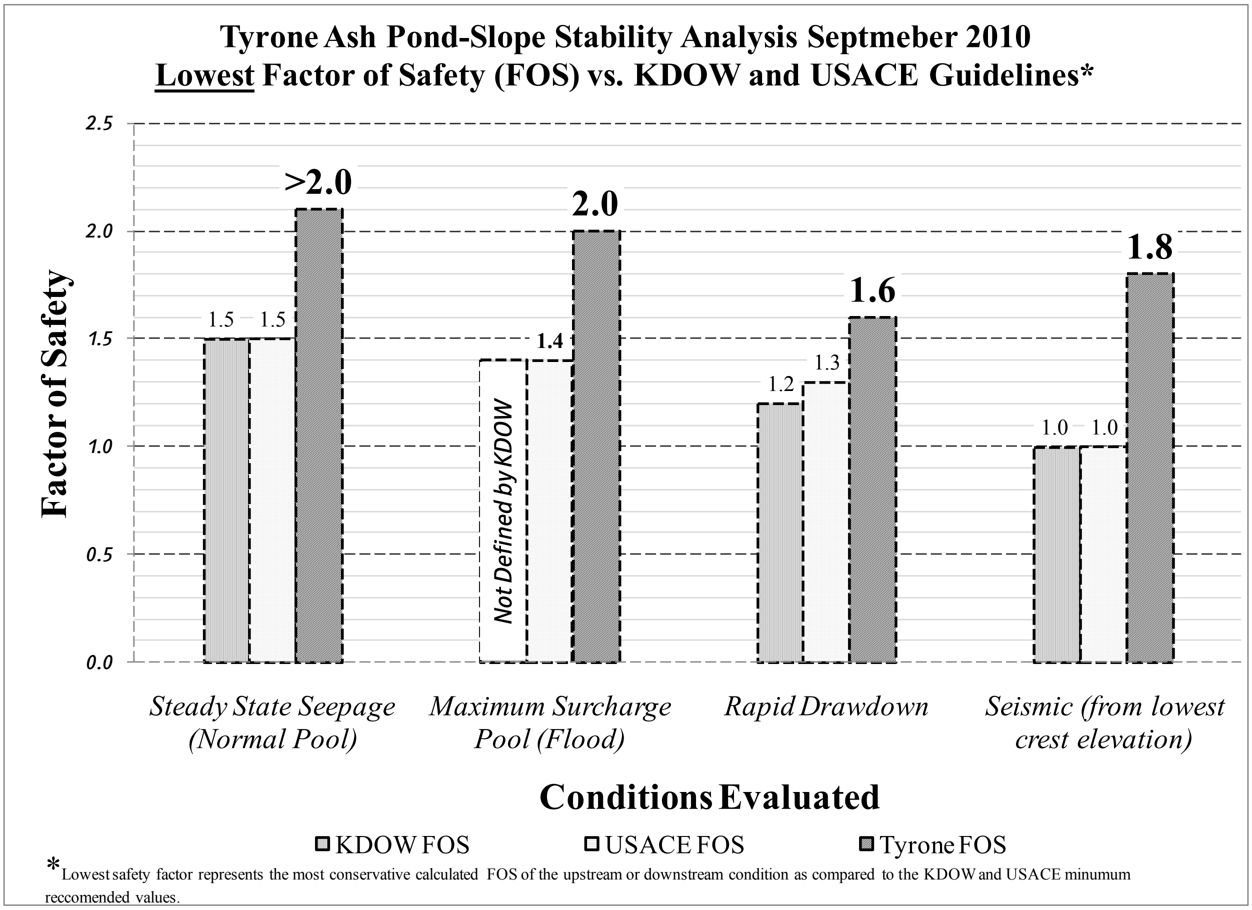
Page 23, section *4.2.1 Hydrologic and Hydraulic Recommendations*

KU Notes: A hydrologic and hydraulic study for the Tyrone Ash Pond was completed in January, 2011 and is included as attachment 3. The study concluded that the Tyrone Ash Pond meets Kentucky regulations for a Class A, Low Hazard dam.

Page 23 and 24, section *4.2.2 Geotechnical and Stability Recommendations*

KU Notes: A comprehensive geotechnical exploration and slope stability analysis report for the Tyrone Ash Pond was completed in September, 2010 and is included as attachment 2. The results of the analysis are summarized in Table 1.

Table 1



Page 24, section *4.2.3 Monitoring and Instrumentation Recommendations*

KU Notes: KU continues to periodically monitor instrumentation including piezometers and the principal spillway weir at the Tyrone Ash Pond.

Page 24, section *4.4.4 Inspection Recommendations*

KU Notes: ATC Associates conducted an independent third party inspection of the Tyrone Ash Pond in January, 2011. ATC do not recognize any dam safety deficiencies and noted only routine minor maintenance items. KU is developing plans to address the priority maintenance items in 2011.

Attachment 2

Report of Geotechnical Exploration and Slope Stability Analyses
Kentucky Utilities (KU) Tyrone Power Station Ash Pond
Tyrone, Woodford County, Kentucky

September 29, 2010
Mactec Engineering and Consulting, Inc.

Addendum A, Report of Geotechnical Exploration and Slope Stability Analyses
Kentucky Utilities (KU) Tyrone Power Station Ash Pond
Tyrone, Woodford County, Kentucky

January 19, 2011
Mactec Engineering and Consulting, Inc.

REPORT OF GEOTECHNICAL EXPLORATION AND SLOPE STABILITY ANALYSES

KENTUCKY UTILITIES (KU)
TYRONE POWER STATION ASH POND
TYRONE, WOODFORD COUNTY, KENTUCKY

Prepared For:

E. ON U.S. Services, Inc.
220 West Main Street
Louisville, Kentucky 40202

E.ON U.S. Contract Number 31528

Prepared By:

MACTEC ENGINEERING AND CONSULTING, INC.
13425 Eastpoint Centre Drive, Suite 122
Louisville, Kentucky 40222

MACTEC PROJECT 3143-10-1317.01

September 29, 2010

MACTEC

engineering and constructing a better tomorrow

September 29, 2010

Mr. David J. Millay, P.E.
E.ON U.S. Services, Inc.
220 West Main Street
Louisville, Kentucky 40202
Phone: 502-627-2468
Facsimile: 502-217-2850
Electronic mail: David.Millay@eon-us.com

SUBJECT: Report of Geotechnical Exploration and Slope Stability Analyses
KU Tyrone Power Station – Ash Pond
Tyrone, Woodford County, Kentucky
MACTEC Project Number 3143-10-1317.01

Dear Mr. Millay:

MACTEC Engineering and Consulting, Inc. (MACTEC) is pleased to submit this Report of Geotechnical Exploration and Slope Stability Analyses for the Ash Pond at the KU Tyrone Power Station in Tyrone, Woodford County, Kentucky. Our services were provided in general accordance with our Master Agreement Number 31528, Contract Number 495429 dated August 23, 2010 and our Proposal Number PROP10LVLE Task 162.

The attached report presents a review of the project information provided to us, a description of the site and subsurface conditions encountered, and a summary of our slope stability analyses and findings and conclusions for the existing Ash Pond at the KU Tyrone Power Station. The Appendix to the report contains site and boring location plans, the results of our field and laboratory testing, as well as the results of our slope stability analyses.

MACTEC appreciates this opportunity to provide our services to you and we look forward to serving as your geotechnical consultant throughout this project. Please contact us if you have any questions regarding the information presented.

Sincerely,

MACTEC ENGINEERING AND CONSULTING, INC.

April L. Brenneman, P.E.
Project Engineer
Licensed Kentucky 26750

STATE OF KENTUCKY
APRIL LASHLEY BRENNEMAN
26750
LICENSED
PROFESSIONAL ENGINEER

Nicholas G. Schmitt, P.E.
Senior Principal Engineer
Licensed Kentucky 10311

Attachment: Report of Geotechnical Exploration

1. EXECUTIVE SUMMARY

Kentucky Utilities (KU) retained MACTEC Engineering and Consulting, Inc. (MACTEC) to provide geotechnical engineering consulting services and to conduct geotechnical explorations and slope stability analyses on the Ash Pond at the KU Tyrone Power Station in Tyrone, Woodford County, Kentucky. MACTEC's engineering approach was based on 1) a systematic process of obtaining and reviewing available data; 2) developing an exploration approach to efficiently obtain additional data that is required to evaluate the stability of the structure, and 3) assigning a project team with all the requisite technical skills and experience necessary to fully evaluate the existing impoundment conditions, competency and stability.

MACTEC assembled a geotechnical engineering team that met with KU representatives to outline our engineering approach and geotechnical exploration. We reviewed various materials provided by KU, including aerial photographs, topographic mapping, design plans and previous studies provided by others. MACTEC developed a geotechnical exploratory drilling program, piezometer installation program and a geotechnical laboratory testing program. This data was collaboratively used to model the slope stability of the six selected cross-sections and deduce from those models the "critical" cross-sections based on the target Factors of Safety recommended in the regulatory guidelines for this type of impoundment.

The geotechnical exploration program was developed to obtain subsurface data along the 2,000 linear feet of embankments at areas we judged to be "critical" based on the topography and nature of the exposed slope. A total of 357 feet of exploratory drilling in twelve soil test borings were advanced on both the crest and toe of the dam. Three piezometers were installed in the crest borings to monitor the pieziometric water level(s) within the embankment. The geotechnical laboratory testing program consisted of extensive classification and strength tests. Generally, the dike was constructed of silty to sandy clay fill reportedly excavated from the incised portion of the pond. The clay fill was placed overlying existing alluvial soils comprised of clay and sandy soils.

Based on our geotechnical exploration, results of laboratory testing and slope stability analyses, we have concluded that the Ash Pond at the Tyrone Power Station is structurally stable from a geotechnical standpoint.

2. PURPOSE AND SCOPE OF EXPLORATION

The purpose of this exploration was to obtain site specific subsurface information for the development of slope models to analyze the stability of the existing Ash Pond at the KU Tyrone Power Station. The primary guidance documents for the development of our exploration and analyses included: Kentucky Environment and Energy Cabinet, Water Infrastructure Branch, Dam Safety Division Guidelines (primarily Engineering Memorandum Number 5 and KAR 401:030 – Design Criteria for Dams and Associated Structures and "Guidelines for Geotechnical Investigation and Analysis of New and Existing Earth Dams") and the U.S. Army Corps of Engineers Engineering Manual (USACE) EM 1110-2-1902. In addition, the "Engineering and Design Manual" (dated May 2009) by Mine Safety and Health Administration (MSHA) was referenced for seismic stability analyses. These guidance documents suggest a Factor of Safety (FOS) of 1.5 for long-term, steady-state conditions using maximum storage pool (EM 1110-2-1902 suggests a FOS of 1.4 for long-term, steady-state conditions using maximum surcharge pool); a FOS of 1.2 for rapid drawdown (EM 1110-2-1902 suggests a FOS in the range of 1.1-1.3); and a FOS of 1.0 for seismic conditions (MSHA suggests a FOS of 1.2 for seismic conditions).

Our scope of services included a review of aerial photographs and construction drawings provided by KU, a review of available geologic and topographic mapping, a review of explorations performed by others, performing site reconnaissance and field exploratory drilling, laboratory testing, performing slope stability analyses and providing conclusions specific to the Ash Pond. A total of twelve soil test borings were drilled to obtain subsurface data at six cross-sections along the embankments at areas we judged to be "critical" based on the topography and nature of the exposed slope. The cross-sections are spaced on approximate 150 to 400 foot intervals along the existing embankment to obtain subsurface geotechnical data along the crest and toe of the dike. Three piezometers in the embankment crest were installed to monitor piezometric levels within the dam. Water levels in the piezometers were recorded after installation on August 11-12, 2010 and again on August 25, 2010.

The scope of our services included an investigation of the geotechnical stability of the embankments and did not include an environmental assessment.

3. PROJECT INFORMATION

Project information for this exploration was provided by Mr. David J. Millay, P.E. and other representatives of KU during multiple telephone conversations, electronic mail transmittals, and a site visit held on August 9, 2010 between KU and MACTEC representatives.

KU retained MACTEC to provide geotechnical engineering consulting services on the Tyrone Power Station Ash Pond. This report presents a summary of our geotechnical exploration, slope stability analyses, findings and conclusions pertinent to the Ash Pond. Herein, the term "site" shall refer specifically to the Ash Pond at the KU Tyrone Power Station.

The Ash Pond at the Tyrone Power Station has a surface area of approximately 10 acres and was constructed in the late 1970s to manage fly ash collected from electrostatic precipitators. The impoundment is partially incised and partially diked, with a side-hill configuration consisting of three constructed embankments at the north, west and east pond limits, totaling approximately 2,000 linear feet of embankments. The reported crest elevation is 536 feet National Geodetic Vertical Datum of 1929 (NGVD) with a typical crest width of 12 feet. The bottom of pond elevation is 520 feet NGVD. The downstream toe elevation varies from 510 to 526 feet NGVD resulting in a maximum dam height of approximately 26 feet. The maximum operating pool elevation is 536 feet NGVD (principal spillway riser elevation). The downstream slope faces are nominally reported to be 2.5H:1V (horizontal to vertical) and the upstream slopes (wet side) are nominally 2.5H:1V.

The Tyrone Ash Pond meets the Kentucky Department for Environmental Protection's (DEP) "Low Hazard" dam classification. This classification defines that failure of the dam would not be expected to cause loss of human life and economic/environmental losses would be expected to be low.

3.1 FILE REVIEW

KU representatives provided MACTEC with the following documents and drawings specific to this project. MACTEC assembled a geotechnical engineering team who outlined an engineering approach and geotechnical exploration based on an extensive review of the provided data.

- *Ash Pond Seep Evaluation Report, Tyrone Power Station,* partial Report, dated September 11, 2009, prepared by ATC Associates, Inc.
- *Low Hazard Dams Assessment Report, Tyrone Main Ash Pond,* partial Report, dated February 05, 2009, prepared by ATC Associates, Inc.
- *Ash Pond Modification Study, Tyrone Generating Station, Report,* dated April 30, 1998, prepared by Fuller, Mossbarger, Scott & May Engineers, Inc (FMSM)
- *Plant and Ash Pond Area Plan, Drawing No: TY-C-00001, Tyrone Common,* dated January 3, 1977, revised January 6, 2006, prepared by Kentucky Utilities Company
- *Ash Pond Area – Section & Details, Drawing No: TY-C-00008, Tyrone Common,* dated January 3, 1977, revised January 17, 2006, prepared by Kentucky Utilities Company
- *Flow Measurement Structure –Plan & Section, Drawing No: TY-C-00009, Tyrone Common*, dated January 3, 1977, revised January 3, 1977, prepared by Kentucky Utilities Company
- *Ash Pond Outlet Structures – Water Pollution Control Facilities, Drawing No: TY-S-00017, Tyrone Unit 3,* dated February 16, 1973, revised January 24, 2006, prepared by Kentucky Utilities Company
- *E.ON Tyrone Mapping, dated January 28, 2010, prepared by L. Robert Kimball & Associates, LLC.*
- Several Aerial Images of Tyrone Power Station , untitled and undated, provided by KU

3.2 SITE VISIT

A site visit was held on August 9, 2010 at the Tyrone Power Station in Tyrone, Woodford County, Kentucky. Representatives were present from KU and MACTEC to discuss the Ash Pond and perform an initial reconnaissance of the facility. The purpose of the site visit was to develop an exploration approach to expediently obtain additional data that was required to evaluate the existing impoundment's conditions, competency and stability.

A drilling plan which included the advancement of a set of exploratory borings (one boring advanced on the crest and one boring advanced on the downstream toe of the dike) spaced on approximate 150 to 400 foot intervals was proposed by KU. Given that the length of the diked portion of the Ash Pond is approximately 2,000 feet, this spacing interval provided adequate coverage for the subsurface exploration. Further, cross-sections were selected at areas judged to be "critical" based on the topography and the nature of the exposed slope.

Based on our file review, discussions with KU and our site visit, MACTEC developed a geotechnical exploratory drilling program, a pieziometric monitoring program, a geotechnical laboratory testing program to assess the stability of the Ash Pond. This data was collaboratively used to model the slope stability of the three selected cross-sections and deduce from those models the "critical" cross-sections based on the target Factors of Safety recommended in the regulatory guidelines for this type of impoundment.

4. EXPLORATORY FINDINGS

4.1 SURFACE CONDITIONS

MACTEC conducted a site reconnaissance on August 11 and 12, 2010 during our drilling operations. The site surface conditions were observed and documented and the information gathered was used to interpret the subsurface data, and to detect conditions which could affect our recommendations.

The existing Ash Pond is located on the northeast side of the existing KU Tyrone Power Station in Tyrone, Woodford County, Kentucky. The Pond is approximately 100 feet south of the Kentucky River and is located about 0.5 miles north of Versailles Road / U.S. Route 62 / Tyrone Pike. The pond was constructed in the late 1970s to manage fly ash collected from electrostatic precipitators.

Surface cover consisted primarily of gravel along the crest of the embankment, which was used as an access road. Surface cover along the interior and exterior slopes and toe of the embankment consisted of ankle-high grass. Isolated areas with sparse vegetation were found within the pond.

4.2 SITE GEOLOGY

A review of the *Geologic Map of the Tyrone Quadrangle, Woodford County, Kentucky,* published by the United States Geological Survey (USGS), dated 1964, indicates the site is underlain by Alluvial deposits of Quaternary age, the Tyrone Limestone of the High Bridge Group of Ordovician age and artificial fill. Based on the USGS mapping, the underlying units are described as follows.

The alluvial deposits are located on the northern and western portions of the site and consist of sand, silt, clay and gravel along the Kentucky River and its tributaries. Up to 50 feet of alluvial deposits are exposed along the Kentucky River with a total thickness exceeding 70 feet. The deposit generally is less than 10 feet thick elsewhere.

The Tyrone Limestone is located on the eastern portion of the site and consists of thin to thick bedded, light brownish gray, lithographic, containing veins and pods of clear sparry calcite (bird's-eye limestone). The deposit contains some interbeds of thin bedded, yellowish-white, aphanitic limestone and shaly limestone. Laminae, intraformational breccia and mud cracks are common in the limestone. A bentonite bed up to 0.6 feet thick is present at the contact of the Tyrone and Lexington Limestones in the vicinity of Blackburn Memorial Bridge.

The artificial fill is shown within the limits of the power station and is assumed to be associated with earthwork activities from plant construction and operation.

4.3 SOIL SURVEY

According to the United States Department of Agriculture (USDA) Soil Survey of Jessamine and Woodford Counties (Natural Resource Conservation Service (NRCS) website), dated January, 2009. The soils beneath the subject site consist primarily of Elk Silt Loam (ElB), within the embankment and the northern portion of the Ash Pond.

The Elk Silt Loam consists of Elk (90%) and other minor components (10%) and is generally found on 2 to 6 percent slopes. This component is on stream terraces and river valleys. The parent material consists of mixed fine-silty alluvium. The depth to a root restrictive layer is greater than 60 inches. The natural drainage class is defined well drained. Water movement in the most restrictive layer is moderately high. The shrink-swell potential is low and the soil is rarely flooded. Organic matter content in the surface horizon is about 2 percent.

Figure 1 shows the distribution of the two primary soil series found in the project area (NRCS website).

Figure 1. USDA Soil Survey Map of Project Site
Source: Web Soil Survey – NRCS Website
Soil Survey Area: Jessamine & Woodford Counties, Kentucky
Survey Area Data: Version 7, June 26, 2009
Date aerial image was photographed: September 19, 2004

4.4 SUBSURFACE CONDITIONS

A comprehensive field exploration program was developed to evaluate the existing impoundment's conditions, competency and stability according to the scope of services developed by MACTEC and KU, the guidance documents previously referenced and MACTEC's experience in the region. Exploratory drilling and piezometer installations were performed in August 2010. Drilling was performed by Hoosier Drilling Contractors, LLC using a truck-mounted (CME-55) drill rig and by Tri-State Drilling, LLC using a track-mounted (Diedrich D-50) drill rig, each equipped with an automatic hammer. MACTEC representatives were on-site during the field work to direct drilling operations and collect and classify samples. Drilling operations were performed in general accordance with ASTM procedures for subsurface explorations as presented in the Appendix.

The subsurface conditions were explored with twelve soil test borings. Borings labeled with the suffix "C" represent borings drilled in the crest of the dike. Borings labeled with the suffix "T" represent borings drilled at the toe of the embankment. Six borings were drilled along the crest of the dike (herein referred to as B-1C through B-6C). Six borings were drilled along the toe of the dike (herein referred to as B-1T through B-6T). All borings (except borings in which piezometers were installed) were backfilled with a cement-Bentonite grout mixture.

The planned boring locations were determined in the field by MACTEC using a hand-held GPS unit for a total of six embankment cross-sections. The elevations of the borings were interpolated from topographic mapping provided by KU. The boring locations and elevations discussed in this report and shown in the Appendix should be considered accurate to the degree implied by the method used. The boring locations, depths and elevations are summarized in Table 1.

Table 1. Boring Location Summary

Boring ID	Latitude	Longitude	Top of Ground Elevation (ft) (NGVD)	Boring Termination Depth (ft)	Bottom of Boring Elevation (ft) (NGVD)
B-1C	38.04878	-84.84662	534.7	32.0*	502.7
B-1T	38.04872	-84.84668	524.7	12.0*	512.7
B-2C	38.04908	-84.84678	533.0	34.0*	499.0
B-2T	38.04910	-84.84687	524.3	20.5	503.8
B-3C	38.04987	-84.84598	534.3	35.0	499.3
B-3T	38.04991	-84.84607	526.0	20.5	505.5
B-4C	38.05102	-84.84550	534.5	50.5	484.0
B-4T	38.05106	-84.84558	515.4	20.5	494.9
B-5C	38.05150	-84.84446	534.4	45.5	488.9
B-5T	38.05164	-84.84443	510.6	20.5	490.1
B-6C	38.05119	-84.84415	533.5	45.5	488.0
B-6T	38.05127	-84.84401	513.6	20.5	493.1

* Auger refusal encountered in these borings.

Prepared By: VM

Checked By: ALB

The subsurface conditions encountered at the test boring locations are shown on the Test Boring Records in the Appendix. These Test Boring Records represent our interpretation of the subsurface conditions based on the field logs, visual examination of field samples by an engineer, and tests of the field samples. The interface between various strata on the Test Boring Records represents the approximate interface location. In addition, the transition between strata may be gradual. Water levels shown on the Test Boring Records represent the conditions only at the time of our exploration.

As previously stated, this Ash Pond is a partially incised and partially diked impoundment. Alluvial deposits from the interior of the pond were used to construct the northeast and northwest embankments. As with most deposits of this kind, the alluvial deposits at this site were observed to be lenticular in nature. Further, cyclic sequences of sand, silt and clay were observed. The natural intermingling of these materials along with the method of construction employed, make the interpolation of stratum breaks less precise than typically expected for standard geotechnical explorations. Extensive classification testing was performed on the samples collected in order to differentiate the alluvial/fill materials. The description of the general subsurface conditions and laboratory findings summarized below indicates a strong similarity of physical properties among the various strata encountered.

Surface Layer - Fill - The borings encountered a surficial fill layer consisting of gravel and topsoil. Gravel was observed in four of our crest borings (B-1C through B-4C) and one of our toe borings (B-1T), ranging in thickness from about 0.7 to 3 feet. The gravel consisted of well to poorly graded crushed stone, with fine to coarse grained sand, and trace amounts of organics. The remaining borings encountered a surficial layer of topsoil ranging in thickness from 0.3 to 0.5 feet.

Our borings generally encountered seven soil strata (designated as Stratum I through Stratum VII) consisting of fill material including: lean clay fill (Stratum I), clayey sand fill (Stratum II) and silty sand fill (Stratum III); and alluvial soils including: lean clay (Stratum IV), clayey sand (Stratum V), silty sand (Stratum VI) and silt (Stratum VII).

Stratum I – Lean Clay (Fill) – Fill material consisting of lean clay was encountered in crest borings, B-1C through B-4C and B-6C, and in toe boring B-1T. The material was generally first encountered below the surface gravel or topsoil layer (with the exception of Boring B-4C where it was encountered below a thin layer of silty sand fill). This material is assumed to be structural fill placed during the construction of the pond embankment. The fill extended to depths ranging from approximately 4 to 22 feet in the crest borings and to approximately 2 feet in toe boring B-1T.

In our crest and toe borings, this material generally consisted of red brown, brown and gray, silty and sandy, lean clay with trace amounts of gravel. The soils were visually classified as “CL” type soils, clayey soils of low plasticity, according to the United Soil Classification System (USCS). The standard penetration test values (N-values) ranged from 7 blows per foot (bpf) to greater than 50 bpf, with an average on the order of 17 bpf. Based on the consistency of the recovered soil samples and the recorded penetration resistance values, the consistency of the structural fill soils were judged to typically range from stiff to very stiff.

Laboratory tests were performed on selected samples of the Stratum I fill soils. Grain size distribution tests performed on selected undisturbed samples collected from Borings B-4C and B-6C indicated the samples consisted of approximately 43 to 50 percent sand and 50 to 57 percent silt and clay. Soil plasticity tests (Atterberg limits) performed on the above samples indicated Liquid Limit values ranging from 24 to 26 and Plasticity Indices of 8 to 10. These values correspond to "CL" type soils, according to the USCS. The unit weight determination tests performed on the above samples indicated wet densities of 128.3 (pounds per cubic foot (pcf) to 131.9 pcf. The natural moisture contents of the samples tested ranged from 7.1 to 19.5 percent, with an average on the order of 15.3 percent.

A consolidated undrained triaxial shear test with pore pressure monitoring was performed on an undisturbed (Shelby tube) sample collected from Boring B-6C (from a depth of 20 to 22 feet). The total stress indicated a cohesion of approximately 690 pounds per square foot (psf) and an internal angle of friction (phi) of 19 degrees and effective stress parameters indicating a cohesion of approximately 160 psf and a phi of 29 degrees.

Stratum II – Clayey Sand (Fill) – Boring B-1C (4 to 12 feet) and B-5C (beneath the surface layer to 18 feet) encountered fill material consisting of clayey sand. This material consisted of brown to red-brown, clayey sand with trace gravel. The SPT N-values in this material ranged from 9 to 17 bpf with an average on about 14 bpf. The consistency of this material was judged to be firm.

Laboratory tests were performed on selected samples of the Stratum II soils. Grain size distribution tests performed on selected undisturbed samples collected from Borings B-1C and B-5C indicated the samples consisted of approximately 9 to 17 percent gravel, 46 to 56 percent sand, and 35 to 37 percent silt and clay. Soil plasticity tests (Atterberg limits) performed on the above samples indicated Liquid Limit values ranging from 24 to 26 and Plasticity Indices ranging from 10 to 12. These values correspond to "SC" type soils, according to the USCS. The unit weight determination tests performed on the above samples indicated wet densities of 134.4 to 135.8 pcf. The natural moisture contents of the samples tested ranged from 12.3 to 21.9 percent, with an average of approximately 15.4 percent.

Stratum III – Silty Sand (Fill) – Stratum III was encountered in Boring B-4C from a depth of 3 to 7 feet. This material is described as red-brown, silty sand fill. SPT N-values were not obtained from this stratum (an undisturbed sample was collected from 3 to 5 feet).

Laboratory tests were performed on a select sample of the Stratum III soils. Grain size distribution tests performed on selected undisturbed sample indicated the sample consisted of approximately 4 percent gravel, 52 percent sand, and 44 percent silt and clay. Soil plasticity tests (Atterberg limits) performed on the above sample indicated a Liquid Limit value of 24 and a Plasticity Index of 3. These values correspond to "SM" type soils, according to the USCS. The unit weight determination tests performed on the above samples indicated wet densities of 131.8 to 134.9 pcf. The natural moisture content of the sample tested ranged from 14.1 to 15.3 percent, with an average of approximately 14.5 percent.

A consolidated undrained triaxial shear test with pore pressure monitoring was performed on the undisturbed (Shelby tube) sample collected from Boring B-4C (from a depth of 3 to 5 feet). The total stress indicated a cohesion of approximately 710 pounds per square foot (psf) and an internal angle of friction (phi) of 41 degrees and effective stress parameters indicating a cohesion of approximately 860 psf and a phi of 24 degrees.

S**tratum IV – Lean Clay (Alluvium) –** Alluvium consisting of lean clay was encountered in all of the crest borings (B-1C through B-6C) and all toe borings (B-1T through B-6T). This material extended to auger refusal depths ranging from 32 to 34 feet in the crest borings (B-1C and B-2C) and 12 feet in one toe boring (B-1T). A 4 foot layer of clayey sand was observed within Stratum IV in B-1C and a 2.5 foot layer of silty sand was observed within Stratum IV in B-2C. Stratum IV was observed to a termination depth of 35 feet in B-3C and to depths ranging from 37 to 42 feet in B-4C through B-6C. Boring B-2C encountered Stratum IV from the surface layer to a depth of 7 feet. Borings B-3T and B-4T encountered this stratum to boring termination depths of 20.5 feet. Stratum IV soils were observed in Borings B-5C and B-6C to depths of 13 to 17 feet.

This material consisted of tan, gray and brown, silty, lean clay with varying amounts of sand, occasional rock fragments and black oxides. The soils were visually classified as “CL” type soils, clayey soils of low plasticity, according to the USCS. The SPT N-values ranged from 2 bpf to greater than 50 blows foot, with an average on the order of 12 bpf. The consistency of this material was judged to typically range from firm to stiff.

Laboratory tests were performed on selected samples of the Stratum IV lean clay soils. Grain size distribution tests performed on three selected undisturbed samples collected from Borings B-1C, B-4C and B-5C and a split spoon sample collected from Boring B-6T indicated the samples consisted of approximately 0 to 2 percent gravel, 13 to 33 percent sand, and 65 to 87 percent silt and clay. Soil plasticity tests (Atterberg limits) performed on the above undisturbed samples indicated Liquid Limits in the range of 26 to 35 and Plasticity Indices in the range of 9 to 13. These values correspond to "CL" type soils, according to the USCS. The unit weight determination tests performed on the above undisturbed samples indicated wet density values of 113.4 to 128.3 pcf. The natural moisture contents of the samples tested ranged from 6.7 to 33.6 percent, with an average of approximately 18.1 percent.

A consolidated undrained triaxial shear test with pore pressure monitoring was performed on the undisturbed (Shelby tube) sample collected from Boring B-5C (from a depth of 36 to 38 feet). The total stress indicated a cohesion of approximately 900 pounds per square foot (psf) and an internal angle of friction (phi) of 14 degrees and effective stress parameters indicating a cohesion of approximately 310 psf and a phi of 28 degrees.

Stratum V – Clayey Sand (Alluvium) – Alluvium consisting of clayey sand was encountered in crest borings B-1C , B-3C through B-6C and toe boring B-5T. In Boring B-1C, the clayey sand material was encountered as a 4.5 foot zone within the Stratum IV soils. In Boring B-3C, the clayey sand was observed directly below the embankment materials extending to a depth of 22 feet. Stratum V was observed to boring termination depths ranging from 45.5 to 50.5 feet in Borings B-4C through B-6C. Stratum V was only observed in one toe boring (B-5T) to a termination depth of 20.5 feet.

This material consisted of red-brown, tan and gray, fine to medium grained, clayey sand. The soils were visually classified as “SC” type soils, clayey sands, according to the USCS. The SPT N-values ranged from 4 to 18 bpf, with an average of approximately 11 bpf. The consistency of this material was judged to range from loose to firm.

Laboratory tests were performed on selected samples of the Stratum V soils. Grain size distribution test performed on selected samples collected from Borings B-3C and B-4C indicate the samples consisted of approximately 0 to 1 percent gravel, 58 to 68 percent sand, and 32 to 41 percent silt and clay. Soil plasticity tests (Atterberg limits) performed on the above sample from B-3C indicated Liquid Limit value of 20 and Plasticity Index of 5. These values correspond to "SC" type soils, according to the USCS. The unit weight determination test performed on the above sample from Boring B-3C indicated a wet density value of 129.7 pcf. The natural moisture contents of the samples tested ranged from 6.1 to 20.6 percent, with an average on the order of 14.6 percent.

Stratum VI – Silty Sand (Alluvium) – Alluvial soils consisting of silty sand were encountered in thin layers in crest borings B-2C (from 22 to 24.5 feet) and B-6C (from 30 to 32 feet) and in toe boring B-2T. This material extended to a boring termination depth of 20.5 feet in the toe boring. Stratum VI soils consisted of brown, tan and gray, fine to medium grained, silty sand. The soils were visually classified as “SM” type soils, silty sands, according to the USCS. The SPT N-values ranged from 7 to 14 bpf, with an average of the 10 bpf. The consistency of this material was judged to typically range from loose to firm.

Laboratory tests were performed on a select sample of the Stratum VI soils. Grain size distribution test performed on one undisturbed sample collected at a depth of 10 to 12 feet from Boring B-2T indicated the sample consisted of approximately 0 percent gravel, 53 percent sand, and 47 percent silt and clay. Soil plasticity tests (Atterberg limits) performed on the above sample indicated a Liquid Limit value of 18 and a Plasticity Index of 2. These values correspond to "SM" type soils, according to the USCS. The unit weight determination test performed on the above sample indicated a wet density value of 132.9 pcf. The natural moisture contents of the samples tested ranged from 13.0 to 18.1 percent, with an average on the order of 15.0 percent.

Stratum VII – Silty (Alluvium) – Alluvial soils consisting of silt were encountered in Boring B-6T from a depth of 12 feet to a termination depth of 20.5 feet. Stratum VII soils consisted of gray to brown silt with clay. The soils were visually classified as “ML” type soils, silty sands, according to the USCS. The SPT N-values ranged from 15 to 16 bpf. The consistency of this material was judged to typically range from stiff to very stiff.

Laboratory tests were performed on a select split spoon sample of the Stratum VII soils. Grain size distribution tests performed on the sample collected from a depth of 14.0 to 15.5 feet from Boring B-6T indicated the sample consisted of approximately 2 percent gravel, 45 percent sand, and 53 percent silt and clay. Soil plasticity tests (Atterberg limits) performed on the above sample indicated a Liquid Limit value of 18 and a Plasticity Index of 2. The natural moisture content of the sample tested ranged was 19.9 percent.

4.5 GROUND AND SURFACE WATER CONDITIONS

Ground water levels were generally measured in each of the borings upon completion of drilling. All of our borings were dry upon completion of drilling except Borings B-3C (water at a depth of 30 feet) and B-2T (water at a depth f 19.5 feet). Ground water conditions at the time of drilling are noted on the Test Boring Records in Appendix. Some borings caved-in after completion of drilling to depths where true water levels could not be taken. Cave-in depths are noted on Test Boring Records, where observed.

4.5.1 PIEZOMETER INSTALLATION AND MONITORING

Three piezometers in the embankment crest borings (B-1C, B-3C and B-5C) were installed to monitor pieziometric levels within the dam. The target depths shown for our monitoring program were chosen to gain an understanding the pieziometric levels within and just below the embankment and toe of the dike. It is anticipated that ground water within these zones would have the greatest impact on the stability of the dike. The results of piezometer readings are summarized in Table 2 and are also shown on the Test Boring Records in the Appendix.

In addition, seeps were not observed during our site reconnaissance or during our exploratory drilling. Our borings, piezometer monitoring and the lack of seepage indicate that water infiltration into the existing dike is minimal. It can be inferred from the pieziometric monitoring that the ground water table is deeper than the target depths of our monitoring program.

Table 2. Summary of Piezometer Readings

Peizometer ID	Date of Installation	Screened Interval Depth (ft)	Top of Ground Elevation (ft) NGVD	Bottom of Piezometer Elevation (ft) NGVD	Date of Reading 8/25/10 Depth (ft)	Date of Reading 8/25/10 Elevation (ft)
B-1C	8/11/10	20-30	534.7	504.7	14.7	520.0
B-3C	8/11/10	25-35	534.3	499.3	28.9	505.4
B-5C	8/11/10	25-35	534.4	499.4	Dry	Dry

Prepared By: VM

Checked By: ALB

4.5.2 POND CONDITIONS

According to the construction drawings provided by KU and the report provided by ATC, the Ash Pond was designed to have a maximum operating pool elevation of 536 feet NGVD (principal spillway riser elevation). Topographic mapping (dated January 2010) shows a water surface elevation varying from 519.6 to 523 feet NGVD. Approximately one quarter of the pond has free water (in three separate areas of the pond) and ash varies in elevation from approximately 520.7 to 530.9 feet NGVD in the remaining portion of the pond. Hydrographic survey data for this pond was not provided.

4.6 LABORATORY TESTING

Samples obtained during drilling operations were examined in the field and visually classified by an engineer. The soils were classified according to consistency or relative density (based on SPT N-values), color, and texture. These classification descriptions are included on our Test Boring Records in the Appendix. The classification method discussed above is primarily qualitative; for detailed soil classification two laboratory tests are necessary: plasticity characteristics and grain size distribution. Using these test results, the soil can be classified according to the USCS (ASTM D2487).

Laboratory testing was performed on selected samples obtained from our borings. These tests consisted of natural moisture content, Atterberg limits (plasticity), grain size analyses, specific gravity and unit weight determinations. The field classifications, provided on the Test Boring Records, were adjusted to reflect the results of our laboratory testing. In addition, more sophisticated laboratory testing was performed to determine the strength of the existing dike materials. Specifically, we performed the following tests:

- 82 Natural Moisture Content Determinations
- 10 Atterberg Limits Tests
- 13 Grain Size Distribution Analyses
- 8 Specific Gravity Determinations
- 17 Unit Weight Determinations (Undisturbed samples)
- 3 Triaxial Shear Tests with Pore Pressures Monitoring

Detailed descriptions of these tests and the results of our testing are included in the Appendix.

5. SLOPE STABILITY ANALYSIS

5.1 INTRODUCTION

Based on a cross-sectional spacing interval of approximately 150 to 400 feet and considering the topography and nature of the exposed slopes observed, MACTEC developed a modeling approach to assess the global stability of the Ash Pond. Slope stability analyses were conducted using the computer program PCSTABL, developed by Purdue University. The program uses a two-dimensional limit equilibrium method of analysis and calculates the factor of safety based on the Modified Bishop Method of Slices. Our analyses were performed to model the overall stability of the existing dike including steady-state/ maximum surcharge pool (flood conditions), rapid drawdown and seismic (dynamic) conditions. Six cross-sections (Sections 1 through 6) located along the north, west and south sides of the dike have been analyzed, the locations of which are shown on the *Boring Location Plan and Stability Section* drawing provided in the Appendix. Modeling of the cross-sections is based on the results of our exploratory drilling and extensive laboratory testing program, the geometry of the upstream and downstream slope configurations, the information derived from our file review and our knowledge of CCW impoundments from past project experience.

The primary guidance documents for the development of our exploration and analyses included: Kentucky Environment and Energy Cabinet, Water Infrastructure Branch, Dam Safety Division Guidelines (primarily Engineering Memorandum Number 5 and KAR 401:030 – Design Criteria for Dams and Associated Structures and "Guidelines for Geotechnical Investigation and Analysis of New and Existing Earth Dams") and the U.S. Army Corps of Engineers Engineering Manual (USACE) EM 1110-2-1902. In addition, the "Engineering and Design Manual" (dated May 2009) by Mine Safety and Health Administration (MSHA) was referenced for seismic stability analyses. These guidance documents suggest a Factor of Safety (FOS) of 1.5 for long-term, steady-state conditions using maximum storage pool (EM 1110-2-1902 suggests a FOS of 1.4 for long-term, steady-state conditions using maximum surcharge pool); a FOS of 1.2 for rapid drawdown (EM 1110-2-1902 suggests a FOS in the range of 1.1-1.3); and a FOS of 1.0 for seismic conditions (MSHA suggests a FOS of 1.2 for seismic conditions).

5.2 GEOMETRY

The slope stability models are based on the geometric slope conditions (interior and exterior slopes) and the geometry of the subsurface soil strata. As previously stated, the Ash Pond is partially incised and partially diked with a side-hill configuration, with approximately 2,000 linear feet of embankment on the north, west and east sides of the pond. Our geotechnical exploration and modeling approach focused on the diked portion of the impoundment, with cross-sections for stability analyses at approximate 150 to 400 foot intervals. The typical crest elevation was reported to be 536 feet NGVD. Based on our interpolation of the boring locations from the provided topographic mapping, we found that the crest elevation ranges from 533.0 feet (Boring B-2C) to 534.7 feet (Boring B-1C). The typical crest width was reported to be 12 feet. The reported bottom of pond elevation of 520 feet NGVD was used in our analyses.

The downstream (exterior) and upstream (interior) slope faces were nominally reported to be 2.5H:1V (horizontal to vertical). Based on the topographic data provided, the upstream slopes for Sections 1 through 6 were observed to range from 1.6H:1V to 2.5H:1V and the downstream slopes ranged from 1.3H:1V to 3.0H:1V. The upstream slopes below the current water or ash levels were projected from the topographic data obtained in the field at each cross-section location from the portion of the upstream slope above the water/CCW level down to the bottom of pond elevation of 520 feet NGVD. Due to the variation in slopes observed, the specific topographic survey data at each cross-section location was used for modeling of that section. Slopes used for each section model are summarized in the *Results of Slope Stability Analyses* summary table located in the Appendix.

In addition to the upstream and downstream slopes, crest width and height, the geometry (layering) of the subsurface soil strata were developed for modeling purposes. Layering of the subsurface soils was based on the borings advanced at each cross-section location. One crest boring and one toe boring were used to extrapolate the geometry of the soil layer.

In general, the dike was constructed of silty to sandy clay fill reportedly excavated the incised potion of the pond. The clay fill was placed overlying existing alluvial soils comprised predominately of clay and sandy soils. Descriptions of the embankment and foundation soils are summarized in Section 4.4 of this report and detailed descriptions at each cross-section analyzed are shown on the Test Boring Records in the Appendix.

5.3 SOIL PARAMETER SELECTION

Once the cross-sections and soil layering were determined, each layer was assigned certain strength parameters required by the modeling software, including unit weight, saturated unit weight, cohesion and internal angle of friction. Soil parameters (shown in Table 3 below) selected for the slope stability analyses were chosen based on various resources including the results of the extensive laboratory testing described above, field testing and observations, published information on similar soil types and our experience. The soil strength parameters selected for each cross-section analyzed are shown on the PCSTABL plots submitted with this data package.

From a stability modeling standpoint, the soil strata identified in Section 4 were categorized into layers (represented as "Soil Type No." in the modeling software) based on consistency or relative density, for modeling purposes. A range in some unit weights and cohesion is shown in the table below based on the range of results in laboratory data and the relative density of the material observed in the field. Additionally, based on our past experience with CCWs and published data, we assigned classification and strength test values for the CCW (Soil Type No. 5 in Table 3).

Table 3 Soil Parameters

Soil Type No.	**Soil Description**	**Unit Weight**		**Effective Stress**	
		Total (pcf)	**Saturated (pcf)**	**Cohesion C' (psf)**	**Friction Angle Φ' (degrees)**
1	CL (fill)	130	135	160	29
2	SC (fill)	134	139	100	32
3	SM (fill)	135	140	200	24
4	CL (alluvium)	120	125	50-300	28
5	SC (alluvium)	130	135	50-100	30
6	SM (alluvium)	133	138	0	30
7	ML (alluvium)	118	123	200	28
8	CCW	90	95	0	30
9	Bedrock	150	150	2000	50

Calculated By: *ALB*
Checked By: *NGS*

5.4 PIEZOMETRIC SURFACES

Based on our borings and piezometer readings, the penetration of water from the impoundment into the existing dike appears to be minimal and the ground water table appears to be at or near the base of the embankment, within the foundation soils. For modeling purposes, water level readings obtained from the piezometers installed in the crest were used to model piezometric surfaces that extended across the pond through the embankments to simulate a "worst case" condition. Water levels in the installed piezometers are shown on the attached Test Boring Records.

For all three modeling scenarios, the unit weight of water contained within the pond was modeled as 62.4 pounds per cubic foot (pcf). For the steady-state/maximum surcharge pool (flood) conditions, the pool elevation was modeled to be equal to the crest elevation in our analyses (ranging from 533.0 to 534.7 feet). While that scenario is unlikely to occur and does not necessarily represent long term, steady-state conditions, it conservatively models a flood or "worst case" condition. For the rapid drawdown scenario, we modeled the pool elevation dropping rapidly from the long-term, steady-state condition (maximum flood condition) from the crest elevation to the bottom of pond elevation of 520 feet NGVD. The water surface was also taken from the top of crest elevation in the seismic (dynamic) condition. All three of these scenarios conservatively employ a "worst case" water level elevation.

5.5 SEISMIC CONDITIONS

Seismic conditions for this site were modeled under dynamic loading conditions using a peak ground acceleration value of 0.056g (horizontally) for a 2 percent probability of exceedance in 50 years. The value was obtained from published guidance (U.S. Geological Survey's 2008 NSHMP PSHA Interactive Deaggregation website) based on the site location.

5.6 RESULTS OF ANALYSES

The results of the analyses for each cross-section selected are shown in the *Results of Slope Stability Analyses* summary table included in the Appendix to this report. In addition, the PCSTABL Plots showing the models and probable failure circles are also included in the Appendix. Based on the guidance documents previously referenced, a slope stability target FOS for dam embankments of 1.5 is recommended for long-term, steady-state (effective stress) stability; a FOS of 1.4 is recommended for maximum surcharge pool/flood (effective stress) conditions; a FOS of 1.2 is recommended for rapid draw-down (effective stress) conditions and a FOS of 1.0 (FOS of 1.2 per MSHA guidance) is recommended for seismic (dynamic) loading (effective stress) conditions. Our analyses, performed using the parameters and geometry described above, indicate that the three cross-sections analyzed exceed the target factors of safety provided in the guidance criteria referenced herein. The ranges in values (minimum and maximum) for the upstream and downstream models, under all three conditions are summarized in the following table.

Table 4. Summary of Slope Stability Analyses

Target Slope	**Long-term, Steady-State/Flood Conditions**		**Rapid Drawdown**		**Seismic**	
	Min	Max	Min	Max	Min	Max
Upstream	2.9	6.6	1.6	4.7	2.2	3.8
Downstream	2.0	3.3	2.0	3.3	1.8	2.8

Calculated By: *ALB*
Checked By: *NGS*

Based on our modeling, the lowest factors of safety were observed for Sections 5 and 6, located on the north portion of the pond. Specifically, the upstream slope of Section 5 and the downstream slope of Section 6 yielded the lowest factors of safety. The models for these sections indicate they are the most "critical" cross-sections analyzed, yet still yield factors of safety exceeding the regulatory guidelines. It was anticipated that these sections would be the most "critical" sections based on the field observations made during the exploration and site reconnaissance.

Sections 5 and 6 exhibit the longest downstream slope faces and therefore the tallest portions of the dike. Based on the geometry, Section 5 has upstream and downstream slopes of 2.2H:1V, slightly steeper than the reported design slope of 2.5H:1V. Further, the upstream side of Section 5 is an area of the pond where the amount of CCW is lower in elevation that other sections analyzed which has the potential of increasing the affect of rapid drawdown in this area of the pond. The downstream slope of Section 6 exhibits lower factors of safety due to the steepness (1.6H:1V) and length of the slope. Of the three scenarios modeled, the lowest factors of safety were observed under the rapid drawdown scenario (upstream model of Section 5) and seismic scenario (downstream model of Section 6). The calculated safety factors for these critical cross-sections exceed regulatory guidelines.

6. CONCLUSIONS

Based on our knowledge of the site gained through our field review of historic documents, drawings and photographs, along with our extensive exploratory drilling, field and laboratory testing programs and the results of our stability analyses, we have concluded that the Ash Pond is structurally stable from a geotechnical standpoint. The results of the slope stability analyses indicate that the six cross-sections analyzed along the 2,000 feet of embankment meet or exceed the targeted factors of safety as set forth by the Kentucky Environment and Energy Cabinet, Water Infrastructure Branch, Dam Safety Division Guidelines (primarily Engineering Memorandum Number 5 and KAR 401:030 – Design Criteria for Dams and Associated Structures and "Guidelines for Geotechnical Investigation and Analysis of New and Existing Earth Dams"), the U.S. Army Corps of Engineers Engineering Manual (USACE) EM 1110-2-1902 and the "Engineering and Design Manual" (dated May 2009) by Mine Safety and Health Administration (MSHA).

6.1 BASIS FOR CONCLUSIONS

The conclusions provided are based in part on project information provided to MACTEC and only apply to the specific project and site discussed in this report. If the project information section in this report contains incorrect information or if additional information is available, you should convey the correct or additional information to us and retain us to review our conclusions. We can then modify our conclusions if they are inappropriate for the project.

The assessment of site environmental conditions or the presence of contaminants in the soil, rock, surface water or ground water of the site was beyond the scope of this exploration.

Regardless of the thoroughness of a geotechnical exploration, there is always a possibility that conditions between borings will be different from those at specific boring locations.

We wish to remind you that our exploration services include storing the samples collected and making them available for inspection for 60 days. The samples are then discarded unless you request otherwise.

APPENDIX:

Site Location Map

Boring Location Plan and Slope Stability Sections

Field Testing Procedures

Key to Symbols and Descriptions

Test Boring Records

Statistical Analysis of SPT Resistances

Laboratory Testing Procedures

Summary of Laboratory Test Data

Atterberg Limit Test Results

Grain Size Distribution Test Results

Triaxial Shear Test Results

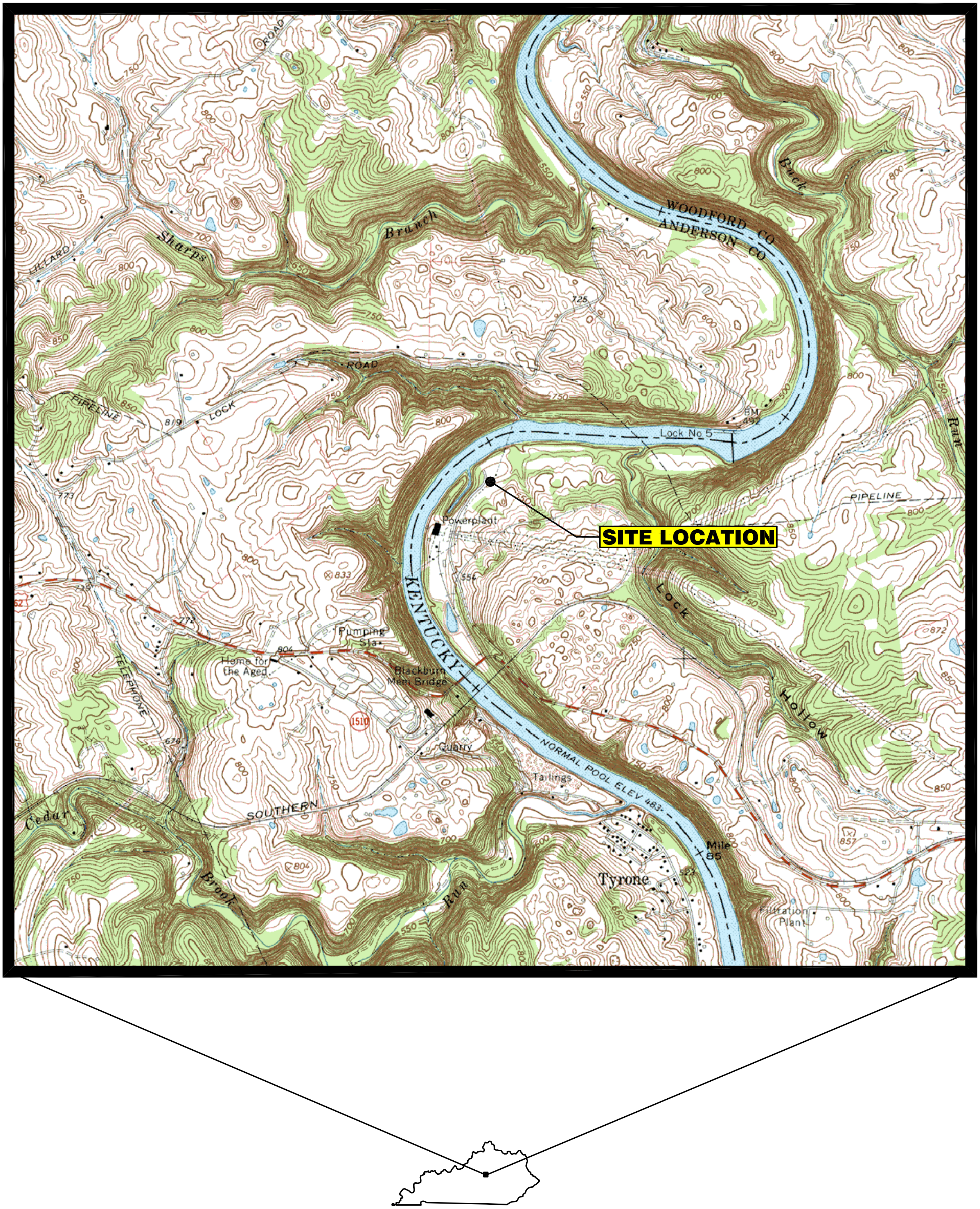
Summary of Slope Stability Results

PCSTABL Plots

SITE LOCATION MAP

SOURCE: MAPTECH TERRAIN NAVIGATOR, TYRONE QUADRANGLE, AERIAL SURVEY 1967, PHOTOINSPECTED 1984.

N



KENTUCKY
QUADRANGLE LOCATION

E.ON U.S. SERVICES, INC. KENTUCKY UTILITIES 220 WEST MAIN STREET LOUISVILLE, KENTUCKY 40202 PROJECT NO. 3143-10-1317	MACTEC 13425 Eastpoint Centre Drive, Ste 122 Louisville, KY. 40223 Phone: 502-253-2500 Fax: 502-253-2501 CHECKED BY: A.BRENNEMAN PREPARED BY: G.HAYS	SITE LOCATION MAP TYRONE POWER STATION TYRONE WOODFORD COUNTY, KENTUCKY CADD FILE:101317-01_SLM.dwg PLOT DATE: 8/26/10 FIGURE 1

BORING LOCATION PLAN AND SLOPE STABILITY SECTIONS

Source: Original drawing provided by Kimball Corp.

REV	DATE	BY	DESCRIPTION

SEAL

DESIGNED A.BRENNEMAN
DRAWN G.HAYS
CHECKED A.BRENNEMAN
IN CHARGE N.SCHMITT
DATE 8/10/10

E.ON U.S. SERVICES, INC.
KENTUCKY UTILITIES
220 WEST MAIN STREET
LOUISVILLE, KENTUCKY 40202

MACTEC
13425 Eastpoint Centre Drive, Ste 122
Louisville, KY. 40223
Phone: 502-253-2500 Fax: 502-253-2501

BORING LOCATION PLAN AND SLOPE STABILITY SECTIONS
TYRONE POWER STATION
TYRONE
WOODFORD COUNTY, KENTUCKY

SCALE GRAPHIC
MACTEC PROJECT NO. 3143-10-1317-01
DWG. NO. 2
CADD FILE: 101317-01_Tyrone.dwg
PLOT DATE: 8/10/10

KEY TO SYMBOLS AND DESCRIPTIONS

LOGS OF BORINGS

FIELD TESTING PROCEDURES

Field Operations: The general field procedures employed by MACTEC are summarized in ASTM D420 which is entitled "Investigating and Sampling Soils and Rocks for Engineering Purposes." This recommended practice lists recognized methods for determining soil and rock distribution and ground water conditions. These methods include geophysical and in situ methods as well as borings.

Borings are drilled to obtain subsurface samples using one of several alternative techniques depending upon the subsurface conditions. These techniques are:

a. Continuous 2½ or 3¼ inch inside diameter (I.D.) hollow stem augers;
b. Wash borings using roller cone or drag bits (using drilling mud or water);
c. Continuous flight augers (ASTM D1425).

These drilling methods are not capable of penetrating through material designated as "refusal materials." Refusal, thus indicated, may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

The subsurface conditions encountered during drilling are reported on a field test boring record by the chief driller. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as coarse gravel, cobbles, etc., and observations between samples. Therefore, these boring records contain both factual and interpretive information. The field boring records are on file in our office.

The soil and rock samples plus the field boring records are reviewed by a geotechnical engineer. The engineer classifies the soils in general accordance with the procedures outlined in ASTM D2488 and prepares the final boring records which are the basis for all evaluations and recommendations.

The final boring records represent our interpretation of the contents of the field records based on the results of the engineering examinations and tests of the field samples. These records depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the subsurface soil and ground water conditions at these boring locations. The lines designating the interface between soil or refusal materials on the records and on profiles represent approximate boundaries. The transition between materials may be gradual. The final boring records are included with this report.

The detailed data collection methods used during this exploration are discussed below.

Soil Test Borings: Soil test borings were made at the site at locations shown on the attached Boring Plan. Soil sampling and penetration testing were performed in accordance with ASTM D1586.

The borings were made by mechanically twisting a hollow stem steel auger into the soil. At regular intervals, soil samples obtained with a standard 1.4 inch I.D., 2 inch outside diameter (O.D.), split tube sampler. The sampler was first seated 6 inches to penetrate any loose cuttings, then driven an additional foot with blows of a 140-pound hammer free falling 30 inches. The number of hammer blows required to drive the sampler the final foot was recorded and is designated the "penetration resistance". The penetration resistance, when properly evaluated, is an index to the soil strength and foundation supporting capability.

Representative portions of the soil samples, thus obtained, were placed in glass jars and transported to the laboratory. In the laboratory, the samples were examined to verify the driller's field classifications. Test Boring Records are attached which graphically show the soil descriptions and penetration resistances.

Undisturbed Sampling: Split tube samples are suitable for visual examination and classification tests but are not sufficiently intact for quantitative laboratory testing. For quantitative testing, relatively undisturbed samples are obtained by pushing sections of 3 inch O.D., 16 gauge, steel or brass tubing (Shelby tube) into the soil at the desired sampling levels. This procedure is described by ASTM D1587. Each tube, together with the encased soil, is carefully removed from the ground, made airtight and transported to the laboratory. Locations and depths of undisturbed samples are shown on the Test Boring Record.

Water Level Readings: Water table readings are normally taken in conjunction with borings and are recorded on the "Test Boring Records". These readings indicate the approximate location of the hydrostatic water table at the time of our field investigation. Where impervious (more clayey) soils are encountered the amount of water seepage into the boring is small, and it is generally not possible to establish the location of the hydrostatic water table through water level readings. The ground water table may also be dependent upon the amount of precipitation at the site during a particular period of time. Fluctuations in the water table should be expected with variations in precipitation, surface run-off, evaporation and other factors.

The time of boring, water level reported on the boring records is determined by field crews as the drilling tools are advanced. The time of boring water level is detected by changes in the drilling rate, soil samples obtained, or by measurement after the drilling tools are withdrawn. Additional water table readings may be obtained after the borings are completed. A time lag of 24 hours may allow stabilization of the ground water table which has been disrupted by the drilling operations. The readings are taken by dropping a weighted line down the boring or using an electrical probe to detect the water level surface.

Occasionally, the borings will cave-in, preventing water level readings from being obtained or trapping drilling water above the caved-in zone. The cave-in depth is also measured and recorded on the boring records.

Piezometers: Water level readings taken during the field operations do not provide information on the long term fluctuations of the water table. When this information is required, piezometers are necessary to prevent the borings from caving. The piezometers are constructed by inserting 1.5-inch-diameter PVC plastic pipe to the desired depth in the borings. A slotted PVC well screen is attached to the bottom of the plastic pipe to allow subsurface water to enter the piezometer. Clean sand is backfilled around the bottom of the well screen. The remainder of the hole is backfilled with an impervious material, using a bentonite cap to seal out surface water. The top of the PVC pipe has a removable cover to seal out rainwater.

MACTEC KEY TO SYMBOLS AND DESCRIPTIONS

Group Symbols	Typical Names
GW	Well graded gravels, gravel - sand mixtures, little or no fines.
GP	Poorly graded gravels or gravel - sand mixtures, little or no fines.
GM	Silty gravels, gravel - sand - silt mixtures.
GC	Clayey gravels, gravel - sand - clay mixtures.
SW	Well graded sands, gravelly sands, little or no fines.
SP	Poorly graded sands or gravelly sands, little or no fines.
SM	Silty sands, sand - silt mixtures
SC	Clayey sands, sand - clay mixtures.
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts and 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.
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
CH	Inorganic clays of high plasticity, fat clays
CL-CH	Inorganic clays ranging from low to high plasticity (combination of CL and CH above)
OH	Organic clays of medium to high plasticity
PT	Peat and other highly organic soils.
Top-Soil	The upper portion of a soil, usually dark colored and rich in organic material.
FILL	Fill soils are materials that have been transported to their present location by man.
Lime-stone	A sedimentary rock consisting predominantly of calcium carbonate
Sand-stone	A sedimentary rock consisting of sand consolidated with some cement (clay or quartz etc.)
Silt-stone	A fine-grained rock of consolidated silt.
Shale	A fine-grained sedimentary rock consisting of compacted and hardened clay, silt, or mud.
PWR	Partially Weathered Rock

Boundary Classifications:
Soils possessing characteristics of two groups are designated by combinations of group symbols.

Undisturbed Sample (UD or SH)	Auger Cuttings (AU)
Split Spoon Sample (SS or SPT)	Bulk Sample (BK) or Grab Sample (GS)
Rock Core (RC)	No Recovery (NR)
Water Table at time of drilling	Water Table after drilling
WOH - Weight of Hammer	C Cave Depth

Correlation of Penetration Resistance (N) with Relative Density and Consistency

SAND & GRAVEL		SILT & CLAY	
Relative Density	No. of Blows	Consistency	No. of Blows
Very Loose	0 to 4	Very Soft	0 to 1
Loose	5 to 10	Soft	2 to 4
Firm	11 to 20	Firm	5 to 8
Very Firm	21 to 30	Stiff	9 to 15
Dense	31 to 50	Very Stiff	16 to 30
Very Dense	Over 50	Hard	Over 30

Standard Penetration Resistance The Number of Blows of a 140 lb. Hammer Falling 30 in. Required to Drive a 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586. Also commonly referred to as an "N" value.

Estimated Relative Moisture Condition

Visual classification relative to assumed optimum moisture content (OMC) of standard proctor

Dry:	Air dry to dusty
Slightly Moist:	Dusty to approximately -2% OMC
Moist:	Approximately between ±2% OMC
Very Moist:	From approximately +2% to nearly saturated
Wet:	Contains free water or nearly saturated

Relative Hardness of Rock

Very Soft:	Can be broken with fingers
Soft:	Can be scratched with fingernail; Only edges can be broken with fingers
Moderately Hard:	Can be easily scratched with knife; Cannot be scratched with fingernail
Hard:	Difficult to scratch with knife; Hard hammer blow to break specimen
Very Hard:	Cannot be scratched with knife; Several hard hammer blows to break specimen

Rock Continuity

Core Recovery	Description
0 - 40%	Incompetent
40 - 70%	Competent
70 - 90%	Fairly Continuous
90 - 100%	Continuous

Rock Quality Designation

RQD	Rock Quality Classification
< 25%	Very Poor
25 - 50%	Poor
50 - 75%	Fair
75 - 90%	Good
90 - 100%	Very Good

REC Recovery - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%

RQD Rock Quality Designation - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks excluded) Divided by the Total Length of the Core Run Times 100%.

SILT OR CLAY	SAND			GRAVEL		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

No.200 No.40 No.10 No.4 3/4" 3" 12"

U.S. STANDARD SIEVE SIZE

Reference: The Unified Soil Classification System, Corps of Engineers, U.S. Army Technical Memorandum No. 3-357, Vol. 1, March, 1953 (Revised April, 1960)

DEPTH (ft)	DESCRIPTION (SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.)	ELEV MSL (ft)	Sample Number	RECOV (in.)	N-COUNT 1st 6" 2nd 6" 3rd 6" / RQD % REC	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Unconfined Compression (psf-soil; psi-rock)	Percent Passing #200 Sieve	REMARKS (Note: *No information on the borings should be used without considering the entire content of the main document.*)
0	GRAVEL; FILL	534.7									SURFACE COVER: GRAVEL
	VERY STIFF, Brown and gray, silty, lean CLAY (CL), trace sand and gravel, moist: FILL		SS-1	18	5-7-10 (N = 17)	15.7					
5	FIRM, Brown with oxide nodules, clayey SAND (SC), moist: FILL	529.7	SS-2	18	8-7-10 (N = 17)	14.4					
	FIRM, Red brown, clayey SAND (SC), moist; FILL		UD-1	24		12.3	26	14		37	
10		524.7	SS-3	18	4-8-8 (N = 16)	21.9					
	FIRM, Light brown and gray, silty, lean CLAY (CL), with sand, moist; ALLUVIUM										
15		519.7	SS-4	16	3-3-3 (N = 6)	15.3					DEPTH OF WATER IN PZ AT 14.7 FEET ON 08/25/10
	SOFT, Brown, silty, lean CLAY (CL), trace sand, moist; ALLUVIUM		UD-2	7							
20		514.7	SS-5	16	1-1-1 (N = 2)	20.5					
	LOOSE, Gray, fine to medium grained, clayey SAND (SC) wet; ALLUVIUM										PIEZOMETER INSTALLED WITH SCREENED INTERVAL FROM 20-30 FEET
25	FIRM to STIFF, Dark brown, silty, lean CLAY (CL), moist, wet; ALLUVIUM	509.7	SS-6	18	3-3-4 (N = 7)	31.7					
			UD-3	7		19.8	26	17		65	
30		504.7	SS-7	16	4-4-6 (N = 10)	31.6					WATER ON DRILLING TOOLS AT 31 FEET
	HARD, Dark brown, silty, lean CLAY (CL), wet; ALLUVIUM										
	AUGER REFUSAL AT 32.0 FEET		SS-8		50/1" (N = 50/1")						WEATHERED SANDSTONE AT 32.0 FEET IN SS-8
35		499.7									BORING DRY UPON COMPLETION OF DRILLING
40		494.7									

START DATE: 8/11/2010
CONTRACTOR: Hoosier Drilling
DRILLER: Gary Taylor
EQUIPMENT: CME55
METHOD: HSA
HOLE DIA.: 3¼" ID
HAMMER: Automatic
LOGGED BY: Nick Jones
PREPARED BY: Sarah Sheilley
REMARKS:

TEST BORING RECORD

Project: E.ON U.S. - Tyrone Power Station
Project No: 3143-10-1317.01
Checked By: [signature] **Boring No.: B-1C**

MACTEC

MACTEC SOIL-ROCK (SITE MAP) 314310317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 9/9/10

DEPTH (ft)	DESCRIPTION (SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.)	LEGEND	ELEV MSL (ft)	Sample Number	Sample Type	RECOV (in.)	N-COUNT 1st 6" 2nd 6" 3rd 6" / RQD % REC	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Unconfined Compression (psf-soil; psi-rock)	Percent Passing #200 Sieve	REMARKS (Note: No information on the borings should be used without considering the entire content of the main document.)
0	GRAVEL; FILL		524.7										
	HARD, Brown, silty, lean CLAY (CL), dry; FILL			SS-1		16	20-17-16 (N = 33)						
	STIFF, Olive gray and brown, silty, lean CLAY (CL), trace sand, moist; ALLUVIUM												
5			519.7	SS-2		18	7-6-5 (N = 11)	16.0					
				UD-1		0							
10		C	514.7										BORING CAVED IN AT A DEPTH OF 10.0 FEET UPON COMPLETION OF DRILLING
	AUGER REFUSAL AT 12.0 FEET												BORING DRY UPON COMPLETION OF DRILLING
15			509.7										
20			504.7										
25			499.7										

START DATE:	8/12/2010
CONTRACTOR:	Hoosier Drilling
DRILLER:	Gary Taylor
EQUIPMENT:	CME55
METHOD:	HSA
HOLE DIA.:	3¼" ID
HAMMER:	Automatic
LOGGED BY:	Nick Jones
PREPARED BY:	Sarah Sheilley
REMARKS:	

TEST BORING RECORD

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

Checked By: ________ **Boring No.: B-1T**

MACTEC

MACTEC SOIL-ROCK (SITE MAP) 314310131 7.GPJ MACTEC DATABASE TEMPLATE 01.GDT 9/8/10

DEPTH (ft)	DESCRIPTION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV MSL (ft)	Sample Number	Sample Type	RECOV (in.)	N-COUNT 1st 6" 2nd 6" 3rd 6" / RQD % REC	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Unconfined Compression (psf-soil; psi-rock)	Percent Passing #200 Sieve	REMARKS **Note:** *No information on the borings should be used without considering the entire content of the main document.*
0	GRAVEL; FILL		533.0	SS-1		18	7-8-10 (N = 18)						SURFACE COVER: GRAVEL
	VERY STIFF, Red brown, silty, lean CLAY (CL), trace sand, moist; FILL												
5	HARD, Dark brown and gray, silty, lean CLAY (CL), moist; FILL		528.0	SS-2		10	8-50/5" (N = 50/5")	19.5					
				UD-1		24							
	VERY STIFF, Gray and tan, sandy, lean CLAY (CL), with rock fragments, moist; FILL												
10			523.0	SS-3		12	5-7-11 (N = 18)	10.9					
	VERY STIFF, Red brown and light gray, sandy, lean CLAY (CL), moist; ALLUVIUM			UD-2		12							
15			518.0	SS-4		16	7-8-8 (N = 16)	13.5					
20			513.0	UD-3		6							
	FIRM, Light gray, fine to medium grained, silty SAND (SM), moist; ALLUVIUM												
25	STIFF, Red brown, sandy, lean CLAY (CL), with oxide nodules; ALLUVIUM		508.0	SS-5		18	4-7-5 (N = 12)	6.7					
	STIFF, Orange brown and tan, silty, lean CLAY (CL), moist; ALLUVIUM			UD-4		4							
30	∇		503.0	SS-6		12	9-7-8 (N = 15)	18.5					BORING CAVED IN AT A DEPTH OF 33 FEET UPON COMPLETION OF DRILLING
	C												
	AUGER REFUSAL AT 34.0 FEET			SS-7		0	50/1" (N = 50/1")						WATER ON DRILLING TOOLS AT 33 FEET
35			498.0										
40			493.0										

START DATE: 8/11/2010
CONTRACTOR: Hoosier Drilling
DRILLER: Gary Taylor
EQUIPMENT: CME55
METHOD: HSA
HOLE DIA.: 3¼" ID
HAMMER: Automatic
LOGGED BY: Nick Jones
PREPARED BY: Sarah Sheilley
REMARKS:

TEST BORING RECORD

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

Checked By: [signature] **Boring No.: B-2C**

MACTEC

MACTEC SOIL-ROCK (SITE MAP) 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 8/26/10

DEPTH (ft)	DESCRIPTION (SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.)	ELEV MSL (ft)	Sample Number	RECOV (in.)	N-COUNT (1st 6" / 2nd 6" / 3rd 6") RQD / % REC	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Unconfined Compression (psf-soil; psi-rock)	Percent Passing #200 Sieve	REMARKS (Note: *No information on the borings should be used without considering the entire content of the main document.*)
0	TOPSOIL	524.3									SURFACE COVER: GRASS
	VERY STIFF, Tan and brown, silty, lean CLAY (CL), dry; ALLUVIUM		SS-1	16	4-11-6 (N = 17)	11.3					
5		519.3	SS-2	18	7-8-8 (N = 16)	12.7					
	FIRM to LOOSE, Brown and tan, silty SAND (SM), moist; ALLUVIUM										
			SS-3	18	5-7-7 (N = 14)	14.6					
10		514.3	UD-1	24		13.0	18	16		47	
	C										BORING CAVED IN AT A DEPTH OF 13.0 FEET UPON COMPLETION OF DRILLING
15		509.3	SS-4	18	3-5-5 (N = 10)	14.3					
	▽										
20		504.3	SS-5	18	2-3-4 (N = 7)	18.1					
	BORING TERMINATED AT 20.5 FEET										
25		499.3									

START DATE: 8/12/2010
CONTRACTOR: Hoosier Drilling
DRILLER: Gary Taylor
EQUIPMENT: CME55
METHOD: HSA
HOLE DIA.: 3¼" ID
HAMMER: Automatic
LOGGED BY: Nick Jones
PREPARED BY: Sarah Sheilley
REMARKS:

TEST BORING RECORD

Project: E.ON U.S. - Tyrone Power Station
Project No: 3143-10-1317.01
Checked By: [signature] **Boring No.: B-2T**

MACTEC

MACTEC SOIL-ROCK (SITE MAP) 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 9/23/10

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

DEPTH (ft)	DESCRIPTION	ELEV MSL (ft)	Sample Number	RECOV (in.)	N-COUNT (1st 6" / 2nd 6" / 3rd 6") RQD / % REC	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Unconfined Compression (psf-soil; psi-rock)	Percent Passing #200 Sieve	REMARKS
0	GRAVEL; FILL	534.3	SS-1	16	4-8-7 (N = 15)						SURFACE COVER: GRAVEL
	STIFF, Red brown, silty, lean CLAY (CL), with rock fragments, moist; FILL										
	STIFF, Gray, sandy, lean CLAY (CL), moist; FILL										
5		529.3	SS-2	16	3-5-5 (N = 10)	16.2					
			UD-1	20							
	STIFF, Red brown and gray, silty, lean CLAY (CL), trace sand, moist; FILL										
10		524.3	SS-3	0	4-4-8 (N = 12)						
	FIRM, Red brown and gray, clayey SAND (SC), moist; ALLUVIUM										
15		519.3	SS-4	18	5-8-10 (N = 18)	13.6					
	FIRM, Red brown, clayey SAND (SC), moist; ALLUVIUM		UD-2	18		13.6	20	15		41	
20		514.3	SS-5	18	5-7-6 (N = 13)	14.6					
	FIRM, Red brown and tan, sandy, lean CLAY (CL), moist; ALLUVIUM										
25		509.3	SS-6	18	4-4-4 (N = 8)	15.5					PIEZOMETER INSTALLED WITH SCREENED INTERVAL FROM 25-35 FEET
	STIFF, light gray, silty, lean CLAY (CL), moist; ALLUVIUM		UD-3	24							
30	STIFF, Red brown, sandy, lean CLAY (CL), with rock fragments and oxide nodules, moist; ALLUVIUM	504.3	SS-7	18	8-7-8 (N = 15)	15.7					DEPTH OF WATER IN PZ AT 28.9 FEET ON 08/25/10
	STIFF, Brown, silty, lean CLAY (CL), moist; ALLUVIUM										
35	BORING TERMINATED AT 35.0 FEET	499.3	SS-8	18	4-5-7 (N = 12)	25.7					BORING DRY UPON COMPLETION OF DRILLING
40		494.3									

START DATE: 8/11/2010
CONTRACTOR: Hoosier Drilling
DRILLER: Gary Taylor
EQUIPMENT: CME55
METHOD: HSA
HOLE DIA.: 3¼" ID
HAMMER: Automatic
LOGGED BY: Nick Jones
PREPARED BY: Sarah Sheilley
REMARKS:

TEST BORING RECORD

Project: E.ON U.S. - Tyrone Power Station
Project No: 3143-10-1317.01
Checked By: [signature] **Boring No.: B-3C**

MACTEC

DEPTH (ft)	DESCRIPTION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV MSL (ft)	SAMPLES: Sample Number	Sample Type	RECOV (in.)	N-COUNT (1st 6" / 2nd 6" / 3rd 6") RQD / % REC	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Unconfined Compression (psf-soil; psi-rock)	Percent Passing #200 Sieve	REMARKS Note: *No information on the borings should be used without considering the entire content of the main document.*
0	TOPSOIL		526.0										SURFACE COVER: GRASS
	FIRM, Light brown and tan, silty, lean CLAY (CL), moist; ALLUVIUM			SS-1		18	7-4-4 (N = 8)	15.8					
5			521.0	SS-2		18	2-4-4 (N = 8)	16.7					
	FIRM, Brown and gray, silty, lean CLAY (CL), moist; ALLUVIUM												
10			516.0	SS-3		16	3-4-3 (N = 7)	15.5					
	FIRM, Brown and gray, silty, lean CLAY (CL), with trace oxides, moist; ALLUVIUM												
15			511.0	SS-4		18	2-3-5 (N = 8)	17.5					
	STIFF, Brown and tan, silty, lean CLAY (CL), moist; ALLUVIUM												
		C											BORING CAVED IN AT A DEPTH OF 19.0 FEET UPON COMPLETION OF DRILLING
20			506.0	SS-5		18	4-5-6 (N = 11)	13.4					
	BORING TERMINATED AT 20.5 FEET												BORING DRY UPON COMPLETION OF DRILLING
25			501.0										

START DATE: 8/14/2010
CONTRACTOR: Tri-State
DRILLER: Shannon Snow
EQUIPMENT: Diedrich D-50
METHOD: HSA
HOLE DIA.: 3¼" ID
HAMMER: Automatic
LOGGED BY: Nick Jones
PREPARED BY: Sarah Sheilley
REMARKS:

TEST BORING RECORD

Project: E.ON U.S. - Tyrone Power Station
Project No: 3143-10-1317.01
Checked By: [signature] **Boring No.: B-3T**

MACTEC

MACTEC SOIL-ROCK (SITE MAP) 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 8/26/10

Depth (ft)	DESCRIPTION (See key symbol sheet for explanation of symbols and abbreviations below.)	Elev MSL (ft)	Sample Number	Recov (in.)	N-Count (1st 6" / 2nd 6" / 3rd 6") RQD % REC	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Unconfined Compression (psf-soil; psi-rock)	Percent Passing #200 Sieve	REMARKS (Note: No information on the borings should be used without considering the entire content of the main document.)
0	GRAVEL: FILL	534.5									SURFACE COVER: GRAVEL
	LOOSE, Red brown, silty SAND (SM), moist; FILL		UD-1	24		14.2	24	21		44	
5		529.5									
	FIRM to STIFF, Red brown, silty, lean CLAY (CL), moist; FILL		SS-1	18	3-3-4 (N = 7)	15.4					
10		524.5									
			UD-2	7		15.0	24	16		50	
			SS-2	16	4-4-5 (N = 9)						
	FIRM, Light brown and gray, silty, lean CLAY (CL), moist; FILL		SS-3	18	2-3-4 (N = 7)	19.3					
15	FIRM, Gray, silty, lean CLAY (CL), with trace sand, moist; FILL	519.5									
	FIRM, Brown and gray, silty, lean CLAY (CL), moist; FILL										
20	FIRM, Gray, clayey GRAVEL, moist; FILL VERY STIFF, Gray, silty, lean CLAY (CL), moist; ALLUVIUM	514.5	SS-4	18	7-11-5 (N = 16)	12.7					
	VERY STIFF, Brown and gray, silty, lean CLAY (CL), with trace organics at 25', moist; ALLUVIUM		UD-3	8		18.7	35	22		87	
25		509.5	SS-5	18	11-17-9 (N = 26)	17.6					
	STIFF to FIRM, Brown and gray, silty, lean CLAY (CL), with trace sand, moist; ALLUVIUM										
30		504.5	SS-6	18	6-6-7 (N = 13)	21.2					
			UD-4	24							
35		499.5	SS-7	18	3-4-4 (N = 8)	20.8					
	LOOSE, Red brown and tan, clayey SAND (SC), moist; ALLUVIUM										
40	LOOSE to VERY LOOSE, Gray, fine to medium grained, clayey SAND (SC), moist; ALLUVIUM	494.5	SS-8	18	3-4-6 (N = 10)	20.6					
45		489.5	SS-9	18	2-2-2 (N = 4)	17.9				32	
	FIRM, Tan, fine to medium grained, clayey SAND (SC), dry; ALLUVIUM										BORING CAVED IN AT A DEPTH OF 47 FEET UPON COMPLETION OF DRILLING
50		484.5	SS-10	18	6-7-7 (N = 14)						
	BORING TERMINATED AT 50.5 FEET										BORING DRY UPON COMPLETION OF DRILLING
55		479.5									

START DATE: 8/11/2010
CONTRACTOR: Hoosier Drilling
DRILLER: Gary Taylor
EQUIPMENT: CME55
METHOD: HSA
HOLE DIA.: 3¼" ID
HAMMER: Automatic
LOGGED BY: Nick Jones
PREPARED BY: Sarah Sheilley
REMARKS:

TEST BORING RECORD

Project: E.ON U.S. - Tyrone Power Station
Project No: 3143-10-1317.01
Checked By: [signature] **Boring No.: B-4C**

MACTEC

DEPTH (ft)	DESCRIPTION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	ELEV MSL (ft)	Sample Number	RECOV (in.)	N-COUNT 1st 6" 2nd 6" 3rd 6" / RQD % REC	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Unconfined Compression (psf-soil; psi-rock)	Percent Passing #200 Sieve	REMARKS Note: *No information on the borings should be used without considering the entire content of the main document.*
0	TOPSOIL	515.4									SURFACE COVER: GRASS
	FIRM to STIFF, Brown and tan, silty, lean CLAY (CL), moist; ALLUVIUM		SS-1	18	3-2-3 (N = 5)	16.4					
5		510.4	SS-2	18	5-7-5 (N = 12)	19.1					
			UD-1	0							
10	STIFF to FIRM, Brown, silty, lean CLAY (CL), moist; ALLUVIUM	505.4									
15		500.4	SS-3	18	3-4-5 (N = 9)	21.3					
	C										BORING CAVED IN AT A DEPTH OF 17.0 FEET UPON COMPLETION OF DRILLING
20		495.4	SS-4	18	1-3-5 (N = 8)	23.0					
	BORING TERMINATED AT 20.5 FEET										BORING DRY UPON COMPLETION OF DRILLING
25		490.4									

START DATE:	8/14/2010
CONTRACTOR:	Tri-State
DRILLER:	Shannon Snow
EQUIPMENT:	Diedrich D-50
METHOD:	HSA
HOLE DIA.:	3¼" ID
HAMMER:	Automatic
LOGGED BY:	Nick Jones
PREPARED BY:	Sarah Sheilley
REMARKS:	

TEST BORING RECORD

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

Checked By: [signature] **Boring No.: B-4T**

MACTEC

MACTEC SOIL-ROCK (SITE MAP) 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 8/26/10

DEPTH (ft)	DESCRIPTION (SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.)	ELEV MSL (ft)	Sample Number	RECOV (in.)	N-COUNT 1st 6" 2nd 6" 3rd 6" / RQD % REC	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Unconfined Compression (psf-soil; psi-rock)	Percent Passing #200 Sieve	REMARKS (Note: *No information on the borings should be used without considering the entire content of the main document.*)
0	TOPSOIL; FILL	534.4									SURFACE COVER: GRASS
	FIRM, Dark brown and red brown, clayey SAND (SC), with organics, trace gravel, moist; FILL		SS-1	16	5-6-7 (N = 13)	16.5					
5		529.4	UD-1	14		14.5	24	14		35	
	FIRM to LOOSE, dark brown and red brown, clayey SAND (SC), trace gravel, moist; FILL		SS-2	8	8-7-6 (N = 13)	14.0					
10		524.4	UD-2	20							
15		519.4	SS-3	18	3-4-5 (N = 9)	14.5					
	LOOSE, Brown and red brown to gray, clayey SAND (SC), moist; FILL										
	STIFF, Brown and gray, silty, lean CLAY (CL), moist; ALLUVIUM		UD-3	20							
20		514.4									
25		509.4	SS-4	18	5-6-9 (N = 15)	20.9					PIEZOMETER INSTALLED WITH SCREENED INTERVAL FROM 25-35 FEET
			UD-4	24							
30		504.4									
	STIFF, Brown and tan, lean CLAY with SAND (CL), moist; ALLUVIUM										
35		499.4	SS-5	18	4-4-6 (N = 10)	12.6					
			UD-5	24							
	LOOSE, Tan, fine to medium, clayey SAND (SC), dry; ALLUVIUM										
40		494.4	SS-6	18	3-4-5 (N = 9)	8.8					
	FIRM, Tan and red, clayey SAND (SC), dry; ALLUVIUM										PZ DRY ON 08/25/10
45		489.4	SS-7	16	5-6-6 (N = 12)	15.8					
	BORING TERMINATED AT 45.5 FEET										BORING DRY UPON COMPLETION OF DRILLING
50		484.4									
55		479.4									

START DATE: 8/12/2010
CONTRACTOR: Hoosier Drilling
DRILLER: Gary Taylor
EQUIPMENT: CME55
METHOD: HSA
HOLE DIA.: 3¼" ID
HAMMER: Automatic
LOGGED BY: Nick Jones
PREPARED BY: Sarah Sheilley
REMARKS:

TEST BORING RECORD

Project: E.ON U.S. - Tyrone Power Station
Project No: 3143-10-1317.01
Checked By: [signature] **Boring No.: B-5C**

MACTEC

MACTEC SOIL-ROCK (SITE MAP) 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 8/26/10

DEPTH (ft)	DESCRIPTION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	ELEV MSL (ft)	Sample Number	RECOV (in.)	N-COUNT 1st 6" 2nd 6" 3rd 6" / RQD % REC	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Unconfined Compression (psf-soil; psi-rock)	Percent Passing #200 Sieve	REMARKS Note: *No information on the borings should be used without considering the entire content of the main document.*
0	TOPSOIL FIRM to STIFF, Brown and tan, silty, lean CLAY (CL), moist; ALLUVIUM	510.6	SS-1	18	3-3-4 (N = 7)	20.0					SURFACE COVER: GRASS
5		505.6	SS-2	18	4-4-5 (N = 9)	20.2					
	FIRM, Brown, sandy, lean CLAY (CL), moist; ALLUVIUM										
10		500.6	SS-3	16	3-4-4 (N = 8)	17.1					
	FIRM, Brown, lean CLAY (CL) with SAND, moist; ALLUVIUM										BORING CAVED IN AT A DEPTH OF 14.0 FEET UPON COMPLETION OF DRILLING
15		495.6	SS-4	16	3-3-4 (N = 7)	19.9					
	LOOSE, Tan, fine to medium grained, clayey SAND (SC), dry; ALLUVIUM										
20		490.6	SS-5	10	2-3-5 (N = 8)	6.1					
	BORING TERMINATED AT 20.5 FEET										BORING DRY UPON COMPLETION OF DRILLING
25		485.6									

START DATE: 8/12/2010
CONTRACTOR: Hoosier Drilling
DRILLER: Gary Taylor
EQUIPMENT: CME55
METHOD: HSA
HOLE DIA.: 3¼" ID
HAMMER: Automatic
LOGGED BY: Nick Jones
PREPARED BY: Sarah Sheilley
REMARKS:

TEST BORING RECORD

Project: E.ON U.S. - Tyrone Power Station
Project No: 3143-10-1317.01
Checked By: [signature]
Boring No.: B-5T

MACTEC

MACTEC SOIL-ROCK (SITE MAP) 314310317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 9/8/10

DEPTH (ft)	DESCRIPTION (SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.)	ELEV MSL (ft)	Sample Number	Sample Type	RECOV (in.)	N-COUNT 1st 6" 2nd 6" 3rd 6" / RQD % REC	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Unconfined Compression (psf-soil; psi-rock)	Percent Passing #200 Sieve	REMARKS (Note: *No information on the borings should be used without considering the entire content of the main document.*)
0	TOPSOIL VERY STIFF, Brown, sandy, lean CLAY (CL), dry; FILL	533.5	SS-1	Split spoon	16	11-12-13 (N = 25)	7.1					SURFACE COVER: GRASS
			UD-1	Undisturbed	24							
5		528.5										
	STIFF, Brown, sandy, lean CLAY (CL), dry; FILL											
10		523.5	SS-2	Split spoon	16	7-6-7 (N = 13)	13.4					
			UD-2	Undisturbed	24							
15		518.5										
20		513.5	SS-3	Split spoon	18	5-6-6 (N = 12)	14.6					
			UD-3	Undisturbed	24							
	VERY STIFF to FIRM, Dark brown, silty, lean CLAY (CL), with sand and oxide nodules, moist; ALLUVIUM											
25		508.5	SS-4	Split spoon	8	6-9-7 (N = 16)	12.5					
30	LOOSE, Tan, silty SAND (SM), moist; ALLUVIUM	503.5	SS-5	Split spoon	18	2-2-3 (N = 5)	16.9					
	FIRM, Tan and gray, sandy, lean CLAY (CL), moist; ALLUVIUM		UD-4	Undisturbed	24							
35		498.5	SS-6	Split spoon	18	2-3-4 (N = 7)	16.4					
	STIFF, Tan and gray, sandy, lean CLAY (CL), moist; ALLUVIUM											
40		493.5	SS-7	Split spoon	18	3-4-5 (N = 9)	16.1					
			UD-5	Undisturbed	24							
	LOOSE, Orange brown, clayey SAND (SC), wet; ALLUVIUM											
45		488.5	SS-8	Split spoon	18	3-4-5 (N = 9)	20.0					
	BORING TERMINATED AT 45.5 FEET											BORING DRY UPON COMPLETION OF DRILLING
50		483.5										
55		478.5										

START DATE: 8/12/2010
CONTRACTOR: Hoosier Drilling
DRILLER: Gary Taylor
EQUIPMENT: CME55
METHOD: HSA
HOLE DIA.: 3¼" ID
HAMMER: Automatic
LOGGED BY: Nick Jones
PREPARED BY: Sarah Sheilley
REMARKS:

TEST BORING RECORD

Project: E.ON U.S. - Tyrone Power Station
Project No: 3143-10-1317.01
Checked By: [signature] **Boring No.: B-6C**

MACTEC

TEST BORING RECORD

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

DEPTH (ft)	DESCRIPTION	ELEV MSL (ft)	Sample Number	RECOV (in.)	N-COUNT (1st 6" / 2nd 6" / 3rd 6") RQD % REC	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Unconfined Compression (psf-soil; psi-rock)	Percent Passing #200 Sieve	REMARKS
0	TOPSOIL	513.6									SURFACE COVER: GRASS
	STIFF, Brown and gray, silty, lean CLAY (CL), with sand; ALLUVIUM		SS-1	16	5-6-7 (N = 13)	13.5					
5	SOFT to STIFF, Dark gray, silty, lean CLAY (CL), wet; ALLUVIUM	508.6	SS-2	18	1-1-1 (N = 2)	14.4					
			UD-1	0							
10		503.6	SS-3	18	10-12-2 (N = 14)	33.6				65	
	STIFF, Gray, SILT (ML) with CLAY wet; ALLUVIUM										BORING CAVED IN AT A DEPTH OF 12.0 FEET UPON COMPLETION OF DRILLING
15		498.6	SS-4	18	9-9-6 (N = 15)	19.9				53	
	VERY STIFF, Brown, SILT (ML) with CLAY wet; ALLUVIUM										
20		493.6	SS-5	18	7-8-8 (N = 16)						
	BORING TERMINATED AT 20.5 FEET										BORING DRY UPON COMPLETION OF DRILLING
25		488.6									

Note: *No information on the borings should be used without considering the entire content of the main document.*

START DATE: 8/12/2010
CONTRACTOR: Hoosier Drilling
DRILLER: Gary Taylor
EQUIPMENT: CME55
METHOD: HSA
HOLE DIA.: 3¼" ID
HAMMER: Automatic
LOGGED BY: Nick Jones
PREPARED BY: Sarah Sheilley
REMARKS:

Project: E.ON U.S. - Tyrone Power Station
Project No: 3143-10-1317.01
Checked By: [signature]
Boring No.: B-6T

MACTEC

MACTEC SOIL-ROCK (SITE MAP) 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 9/23/10

STATISTICAL ANALYSIS OF STANDARD PENETRATION RESISTANCES

STATISTICAL ANALYSIS OF SPT N-VALUES

Minimum (Min.): The lowest SPT N-value recorded in a set of borings at a given depth during our field exploration.

Maximum (Max.): The highest SPT N-value recorded in a set of borings at a given depth during our field exploration.

Standard Deviation (Std. Dev.): The standard deviation is a measure of how widely SPT N-values are dispersed from the average value (the mean) in a set of borings at a given depth. A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data are spread out over a large range of values.

Standard Deviation uses the following formula:

$$\sqrt{\frac{\sum (x-\bar{x})^2}{(n-1)}}$$

where x is the sample mean (average) and n is the sample size.

Variance (Var.): The variance is a measure of the amount of variation within the recorded SPT N-values, taking account of all possible values and their probabilities.

Variance uses the following formula:

$$\frac{\sum (x-\bar{x})^2}{(n-1)}$$

where x is the sample mean (average) and n is the sample size.

Average (Avg.): Average is the Arithmetic Mean of SPT N-value recorded in a set of borings at a given depth during our field exploration. The arithmetic mean is calculated by adding a group of numbers and then dividing by the count of those numbers. The resulting value is then rounded to the nearest whole number.

MACTEC

Project:	Tyrone Power Station		
Project No.:	3143-10-1317.01		
Prepared By:	NRJ	Date:	09/08/10
Checked By:	ALB	Date:	09/08/10

Statistical Analysis of Standard Penetration Test (SPT) Resistances (N-values)

Depth (feet)	SPT N-values (bpf)						Statistical Analysis				
	B-1C	B-2C	B-3C	B-4C	B-5C	B-6C	Min.	Max.	Std. Dev.	Var.	Avg.
0.0		18	15		13	25	13	25	5	27	17
4.0	17	50	10	7			7	50	19	391	21
9.0	16	18	12	9	13	13	9	18	3	9	13
14.0	6	16	18	7	9		6	18	5	29	11
19.0	2		13	16		12	2	16	6	36	10
24.0	7	12	8	26	15	16	7	26	6	47	14
29.0	10	15	15	13		5	5	15	4	17	11
34.0	50	50	12	8	10	7	7	50	21	445	22
39.0				10	9	9	9	10	0	0	9
44.0				4	12	9	4	12	4	16	8
49.0				14			14	14			14
							2	50	10	120	14

KEY

- Lean CLAY (CL), FILL
- Clayey SAND (SC), FILL
- Lean CLAY (CL), ALLUVIUM
- Clayey SAND (SC), ALLUVIUM
- Silty SAND (SM), ALLUVIUM
- SILT (ML), ALLUVIUM

MACTEC

Project:	Tyrone Power Station		
Project No.:	3143-10-1317.01		
Prepared By:	NRJ	Date:	09/08/10
Checked By:	ALB	Date:	09/08/10

Statistical Analysis of Standard Penetration Test (SPT) Resistances (N-values)

Depth (feet)	SPT N-values (bpf)						Statistical Analysis				
	B-1T	B-2T	B-3T	B-4T	B-5T	B-6T	Min.	Max.	Std. Dev.	Var.	Avg.
0.0	33	17	8	5	7	13	5	33	10	107	13
4.0	11	16	8	12	9	2	2	16	4	21	9
9.0		14	7		8	14	7	14	3	14	10
14.0		10	8	9	7	15	7	15	3	9	9
19.0		7	11	8	8	16	7	16	3	13	10
20.0											
							2	33	5	33	11

KEY

Lean CLAY (CL), FILL
Clayey SAND (SC), FILL
Lean CLAY (CL), ALLUVIUM
Clayey SAND (SC), ALLUVIUM
Silty SAND (SM), ALLUVIUM
SILT (ML), ALLUVIUM

SUMMARY OF LABORATORY RESULTS

LABORATORY TESTING PROCEDURES

Soil Classification: Soil classifications provide a general guide to the engineering properties of various soil types and enable the engineer to apply past experience to current situations. In our investigations, samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests), color and texture. These classification descriptions are included on our "Test Boring Records."

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary: grain size tests and plasticity tests. Using these test results the soil can be classified according to the AASHTO or Unified Classification Systems (ASTM D2487). Each of these classification systems and the in-place physical soil properties provide an index for estimating the soil's behavior. The soil classification and physical properties determined are presented in this report.

Atterberg Limits: Portions of the samples are taken for Atterberg Limits testing to determine the plasticity characteristics of the soil. The plasticity index (PI) is the range of moisture content over which the soil deforms as a plastic material. It is bracketed by the liquid limit (LL) and the plastic limit (PL). The liquid limit is the moisture content at which the soil becomes sufficiently "wet" to flow as a heavy viscous fluid. The plastic limit is the lowest moisture content at which the soil is sufficiently plastic to be manually rolled into tiny threads. The liquid limit and plastic limit are determined in accordance with ASTM D4318.

Grain Size Tests: Grain Size Tests are performed to determine the soil classification and the grain size distribution. The soil samples are prepared for testing according to ASTM D421 (dry preparation) or ASTM D2217 (wet preparation). The grain size distribution of soils coarser than a number 200 sieve (0.074 mm opening) is determined by passing the samples through a standard set of nested sieves. Materials passing the number 200 sieve are suspended in water and the grain size distribution calculated from the measured settlement rate. These tests are conducted in accordance with ASTM D422.

Moisture Content: The Moisture Content is determined according to ASTM D2216.

Physical Soil Properties: The in-place physical properties are described by the specific gravity, wet unit weight, moisture content, dry unit weight, void ratio, and percent saturation of the soil. The specific gravity and moisture content are determined according to ASTM D854 and D2216, respectively. The wet unit weight is found by obtaining a known volume of the soil and dividing the wet sample weight by the known volume. The dry unit weight, void ratio and percent saturation are calculated values.

Triaxial Shear Tests: Triaxial shear tests are used to determine the strength characteristics and friction angle of a given soil sample. Triaxial tests are also used to determine the elastic properties of the soil specimen. Triaxial shear tests are performed on several sections of a relatively undisturbed sample extruded from the sampling tube. The samples are trimmed into cylinders 1.4 to 2.8 inches in diameter and encased in rubber membranes. Each is then placed in a compression chamber and confined by all around water pressure. Samples are then subjected to additional axial and/or lateral loads, depending on the soil and the field conditions to be simulated. The test results are typically presented in tabular form or in the form of stress-strain curves and Mohr envelopes or p-q plots.

LABORATORY TESTING PROCEDURES (continued)

Three types of triaxial tests are normally performed. The most suitable type of triaxial test is determined by the loading conditions imposed on the soil in the field and the soil characteristics.

1. Consolidated-Undrained (designated as a CU or R Test).
2. Consolidated-Drained (designated as a CD or S Test).
3. Unconsolidated-Undrained (designated as a UU or Q Test).

Borehole	Depth	Sample Type	Atterberg Limits			USCS Class-ification	Natural Moisture Content (%)	Unconfined Compress. Strength (Soil-psf)	Unconfined Compress. Strength (Rock-psi)	Unit Weight (pcf)		Maximum Dry Density (pcf)	Optimum Moisture Content (%)	Specific Gravity	Rock Core		% Finer #200
			Liquid Limit	Plastic Limit	Plasticity Index					Dry Density	Wet Density				RQD	Percent Recovery	
B-1C	2.5	SS					15.7										
B-1C	4.0	SS					14.4										
B-1C	6.0	UD	26	14	12	SC	12.3			121.0	135.8			2.70			37
B-1C	9.0	SS					21.9										
B-1C	14.0	SS					15.3										
B-1C	19.0	SS					20.5										
B-1C	24.0	SS					31.7										
B-1C	26.0	UD	26	17	9	CL	19.8			107.1	128.3			2.68			65
B-1C	29.0	SS					31.6										
B-1T	4.0	SS					16.0										
B-2C	4.0	SS					19.5										
B-2C	9.0	SS					10.9										
B-2C	14.0	SS					13.5										
B-2C	24.0	SS					6.7										
B-2C	29.0	SS					18.5										
B-2T	0.0	SS					11.3										
B-2T	4.0	SS					12.7										
B-2T	8.5	SS					14.6										
B-2T	10.0	UD	18	16	2	SM	13.0			117.6	132.9			2.65			47
B-2T	14.0	SS					14.3										
B-2T	19.0	SS					18.1										
B-3C	4.0	SS					16.2										
B-3C	14.0	SS					13.6										
B-3C	16.0	UD	20	15	5	SC	13.6			114.2	129.7			2.69			41
B-3C	19.0	SS					14.6										
B-3C	24.0	SS					15.5										

Remarks:

* SPT/SS = Split-spoon   BG = Bulk / bag sample
UD/SH = Undisturbed sample   RC = Rock core

Summary of Laboratory Results

Project: E.ON U.S. - Tyrone Power Station
Project No: 3143-10-1317.01
Checked By: ______

MACTEC

MACTEC_LAB-SUMMARY LANDSCAPE (SP GRAV) 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 9/23/10

Borehole	Depth	Sample Type	Atterberg Limits			USCS Class-ification	Natural Moisture Content (%)	Unconfined Compress. Strength (Soil-psf)	Unconfined Compress. Strength (Rock-psi)	Unit Weight (pcf)		Maximum Dry Density (pcf)	Optimum Moisture Content (%)	Specific Gravity	Rock Core		% Finer #200
			Liquid Limit	Plastic Limit	Plasticity Index					Dry Density	Wet Density				RQD	Percent Recovery	
B-3C	26.0	UD				CL											
B-3C	29.0	SS					15.7										
B-3C	34.0	SS					25.7										
B-3T	0.0	SS					15.8										
B-3T	4.0	SS					16.7										
B-3T	9.0	SS					15.5										
B-3T	14.0	SS					17.5										
B-3T	19.0	SS					13.4										
B-4C	3.0	UD	24	21	3	SM	14.2			115.4	131.8			2.68			44
B-4C	7.0	SS					15.4										
B-4C	10.0	UD	24	16	8	CL	15.0			114.7	131.9			2.63			50
B-4C	14.0	SS					19.3										
B-4C	19.0	SS					12.7										
B-4C	22.0	UD	35	22	13	CL	18.7			103.9	123.3			2.64			87
B-4C	24.0	SS					17.6										
B-4C	29.0	SS					21.2										
B-4C	34.0	SS					20.8										
B-4C	39.0	SS					20.6										
B-4C	44.0	SS				SC	17.9										32
B-4T	0.0	SS					16.4										
B-4T	4.0	SS					19.1										
B-4T	14.0	SS					21.3										
B-4T	19.0	SS					23.0										
B-5C	0.5	SS					16.5										
B-5C	4.0	UD	24	14	10	SC	14.5			117.4	134.4			2.73			35
B-5C	8.5	SS					14.0										

Remarks:

* SPT/SS = Split-spoon   BG = Bulk / bag sample
UD/SH = Undisturbed sample   RC = Rock core

Summary of Laboratory Results

Project: E.ON U.S. - Tyrone Power Station
Project No: 3143-10-1317.01
Checked By: [signature]

MACTEC

Borehole	Depth	Sample Type	Atterberg Limits			USCS Class-ification	Natural Moisture Content (%)	Unconfined Compress. Strength (Soil-psf)	Unconfined Compress. Strength (Rock-psi)	Unit Weight (pcf)		Maximum Dry Density (pcf)	Optimum Moisture Content (%)	Specific Gravity	Rock Core		% Finer #200
			Liquid Limit	Plastic Limit	Plasticity Index					Dry Density	Wet Density				RQD	Percent Recovery	
B-5C	14.0	SS					14.5										
B-5C	24.0	SS					20.9										
B-5C	34.0	SS					12.6										
B-5C	36.0	UD															
B-5C	39.0	SS					8.8										
B-5C	44.0	SS					15.8										
B-5T	0.0	SS					20.0										
B-5T	4.0	SS					20.2										
B-5T	9.0	SS					17.1										
B-5T	14.0	SS					19.9										
B-5T	19.0	SS					6.1										
B-6C	0.0	SS					7.1										
B-6C	9.0	SS					13.4										
B-6C	18.5	SS					14.6										
B-6C	24.0	SS					12.5										
B-6C	29.0	SS					16.9										
B-6C	34.0	SS					16.4										
B-6C	38.5	SS					16.1										
B-6C	44.0	SS					20.0										
B-6T	0.0	SS					13.5										
B-6T	4.0	SS					14.4										
B-6T	9.0	SS				CL	33.6										65
B-6T	14.0	SS				ML	19.9										53

Remarks:

* SPT/SS = Split-spoon
UD/SH = Undisturbed sample
BG = Bulk / bag sample
RC = Rock core

Summary of Laboratory Results

Project: E.ON U.S. - Tyrone Power Station
Project No: 3143-10-1317.01
Checked By: [signature]

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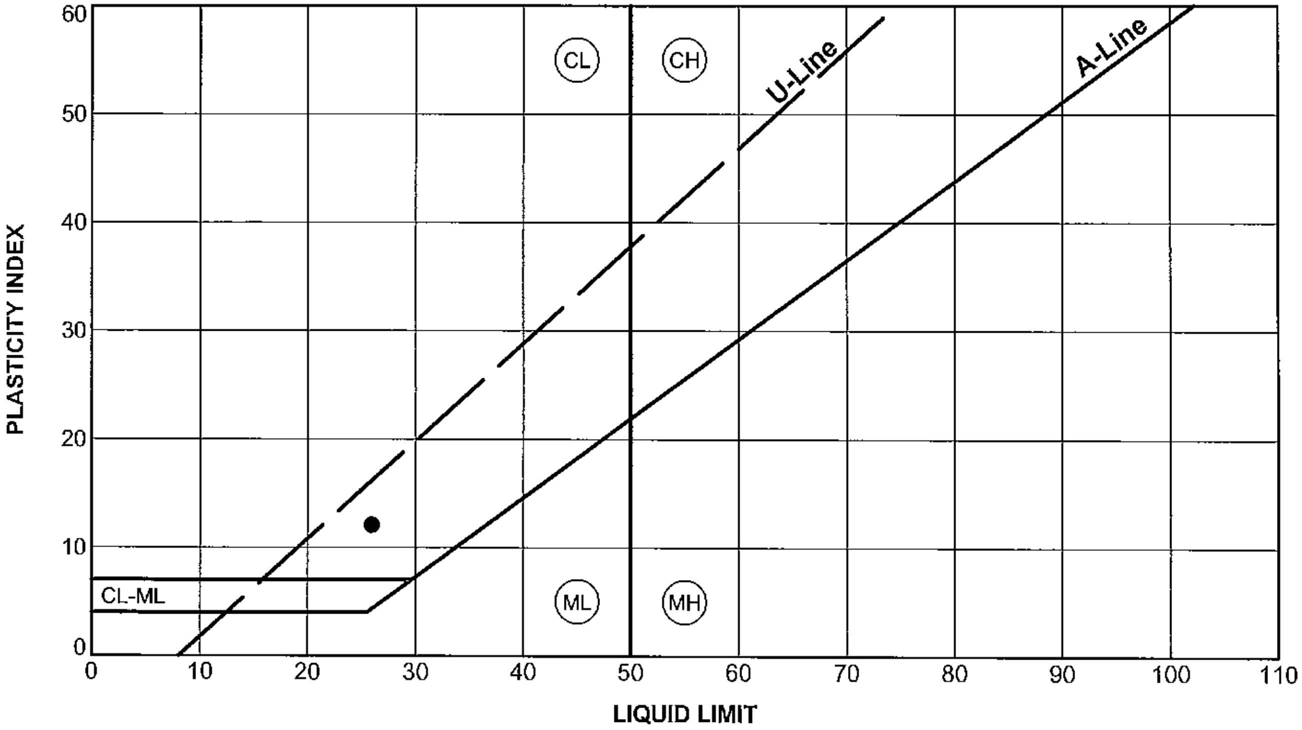
ATTERBERG LIMITS TEST RESULTS



Symbol	Location	Depth, feet	LL	PL	PI	Natural Moisture Content, %	LI	USCS	Soil Classification
●	B-1C	6.0-8.0	26	14	12	12.3	-0.1	SC	Brown, clayey SAND

Remarks:

Test Method - ASTM D4318

LL=Liquid Limit; PL= Plastic Limit; PI=Plasticity Index; LI=Liquidity Index

ATTERBERG LIMITS RESULTS

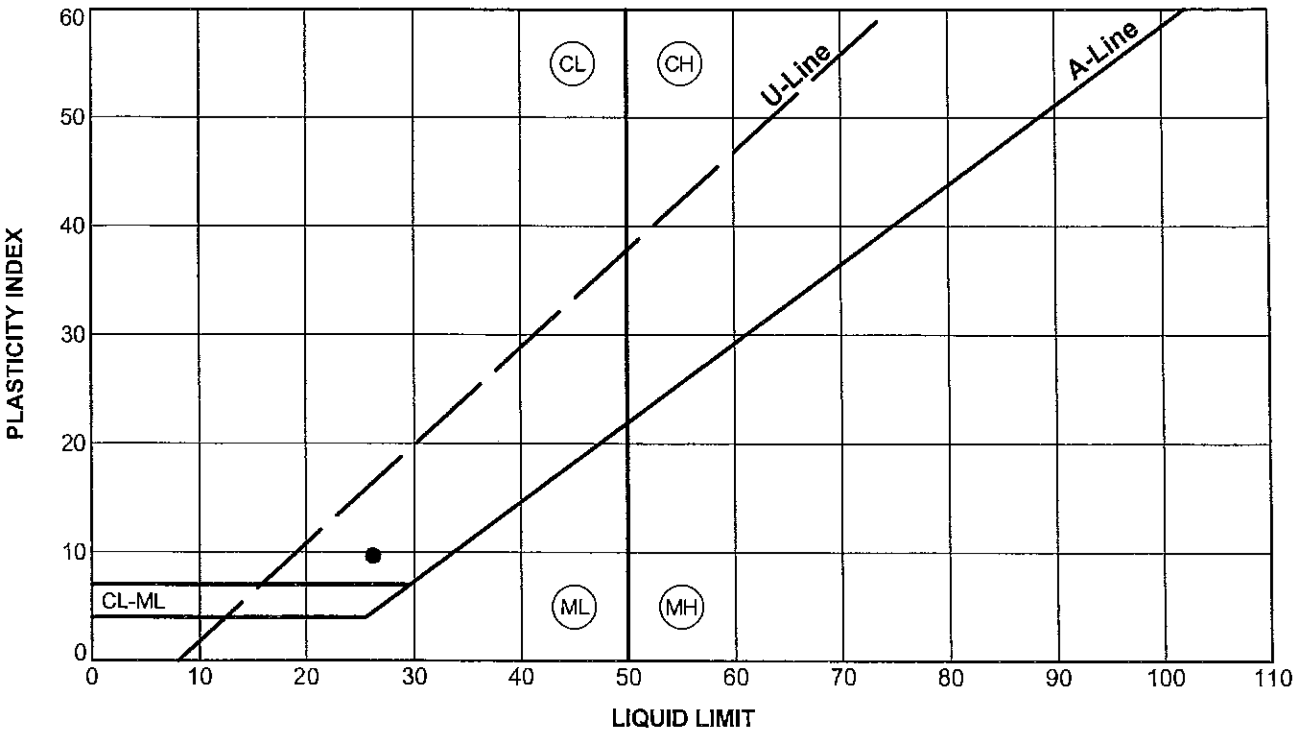
Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

Checked By: [signature]

MACTEC

MACTEC_ATTERBERG_LIMITS 314310131 7.GPJ MACTEC DATABASE TEMPLATE 01.GDT 9/9/10



Symbol	Location	Depth, feet	LL	PL	PI	Natural Moisture Content, %	LI	USCS	Soil Classification
●	B-1C	26.0-28.0	26	17	9	19.8	0.3	CL	Yellow, silty lean CLAY

MACTEC_ATTERBERG_LIMITS 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 8/24/10

Remarks:

Test Method - ASTM D4318

LL=Liquid Limit; PL= Plastic Limit; PI=Plasticity Index; LI=Liquidity Index

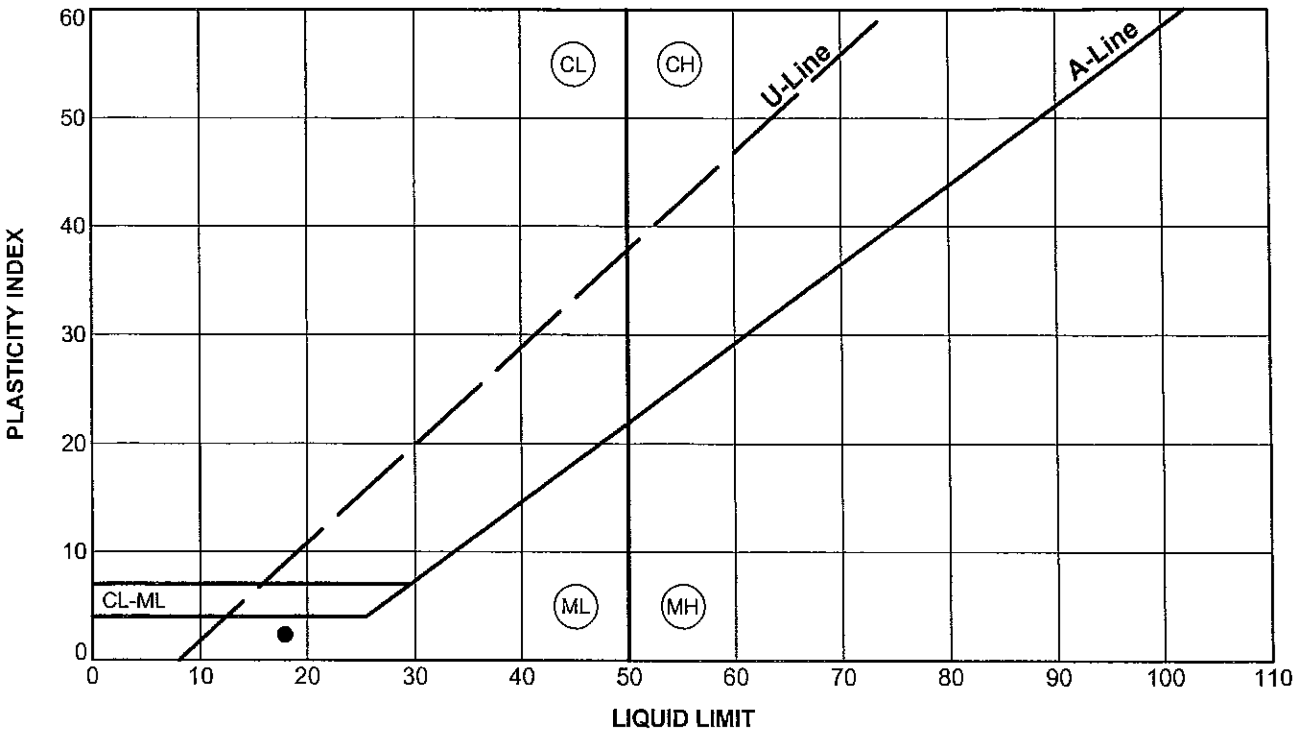
ATTERBERG LIMITS RESULTS

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

Checked By: [signature]

MACTEC



Symbol	Location	Depth, feet	LL	PL	PI	Natural Moisture Content, %	LI	USCS	Soil Classification
●	B-2T	10.0-12.0	18	16	2	13.0	-1.1	SM	Reddish brown, silty SAND

Remarks:

Test Method - ASTM D4318

LL=Liquid Limit; PL= Plastic Limit; PI=Plasticity Index; LI=Liquidity Index

ATTERBERG LIMITS RESULTS

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

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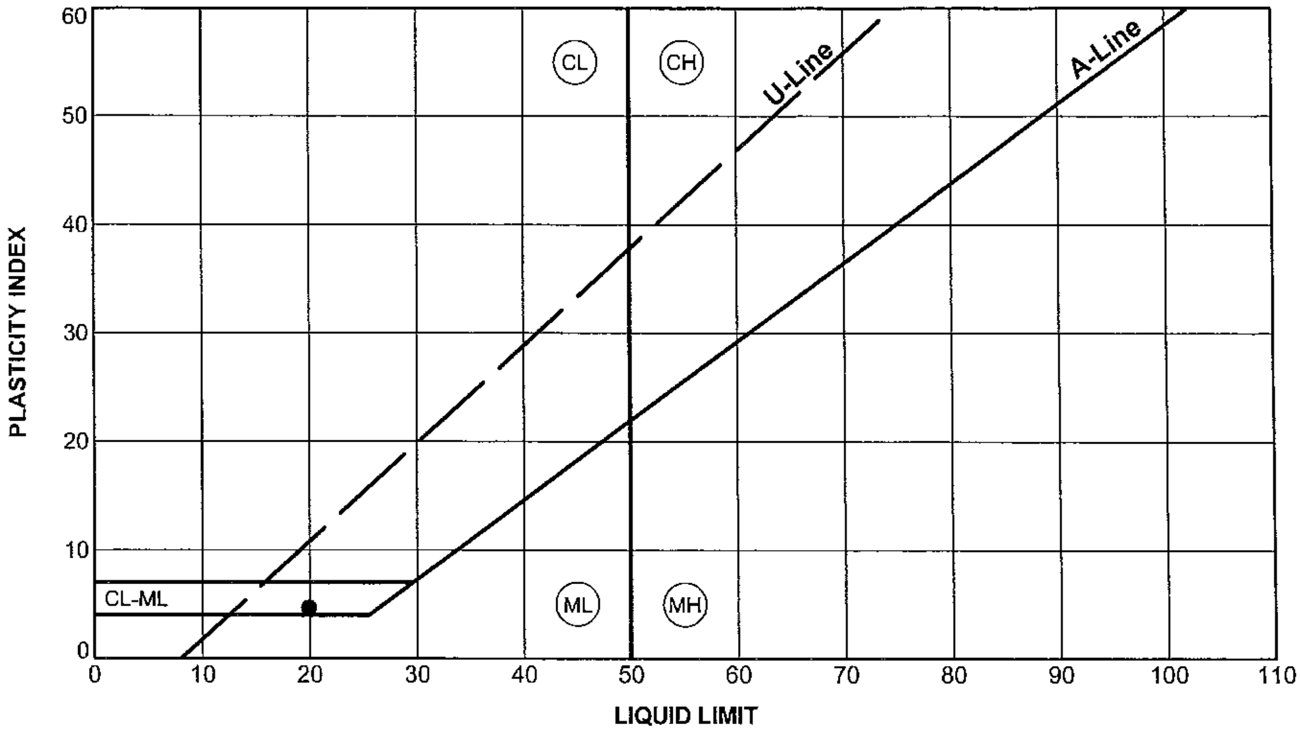
MACTEC_ATTERBERG_LIMITS 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 8/24/10



Symbol	Location	Depth, feet	LL	PL	PI	Natural Moisture Content, %	LI	USCS	Soil Classification
●	B-3C	16.0-18.0	20	15	5	13.6	-0.3	SC	Brown, clayey SAND

MACTEC_ATTERBERG_LIMITS 314310317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 8/24/10

Remarks:

Test Method - ASTM D4318

LL=Liquid Limit; PL= Plastic Limit; PI=Plasticity Index; LI=Liquidity Index

ATTERBERG LIMITS RESULTS

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

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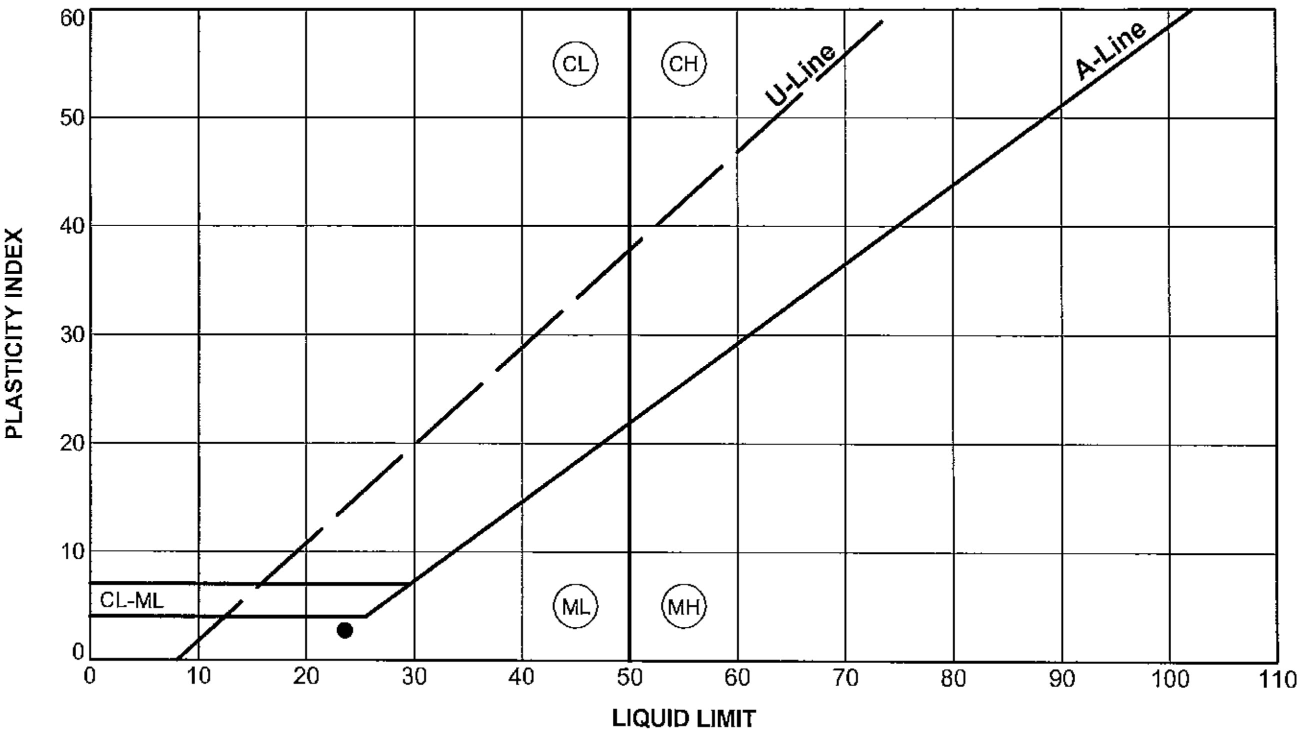


Symbol	Location	Depth, feet	LL	PL	PI	Natural Moisture Content, %	LI	USCS	Soil Classification
●	B-4C	3.0-5.0	24	21	3	14.2	-2.4	SM	Brown, silty SAND

Remarks:

Test Method - ASTM D4318

LL=Liquid Limit; PL= Plastic Limit; PI=Plasticity Index; LI=Liquidity Index

ATTERBERG LIMITS RESULTS

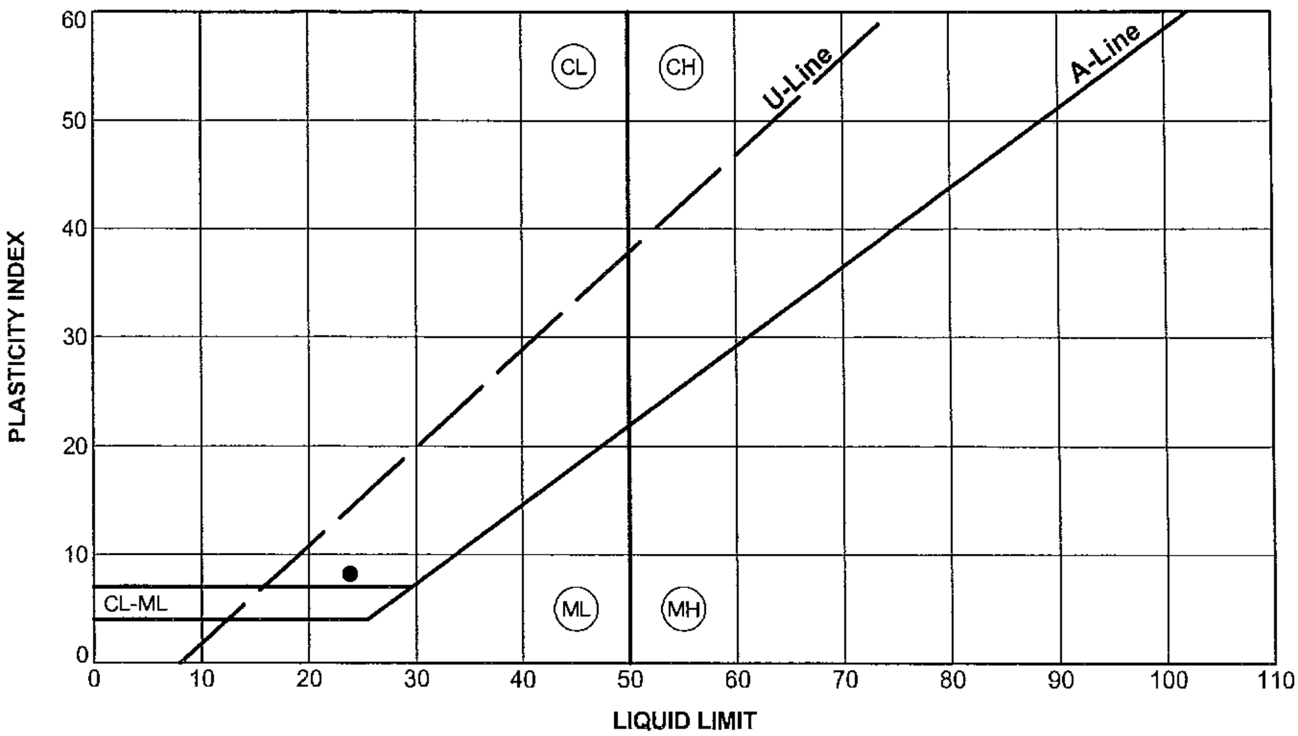
Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

Checked By: ____

MACTEC

MACTEC_ATTERBERG_LIMITS 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 9/9/10



Symbol	Location	Depth, feet	LL	PL	PI	Natural Moisture Content, %	LI	USCS	Soil Classification
●	B-4C	10.0-12.0	24	16	8	15.0	-0.1	CL	Brown, silty lean CLAY

MACTEC_ATTERBERG_LIMITS 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 8/24/10

Remarks:

Test Method - ASTM D4318

LL=Liquid Limit; PL= Plastic Limit; PI=Plasticity Index; LI=Liquidity Index

ATTERBERG LIMITS RESULTS

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

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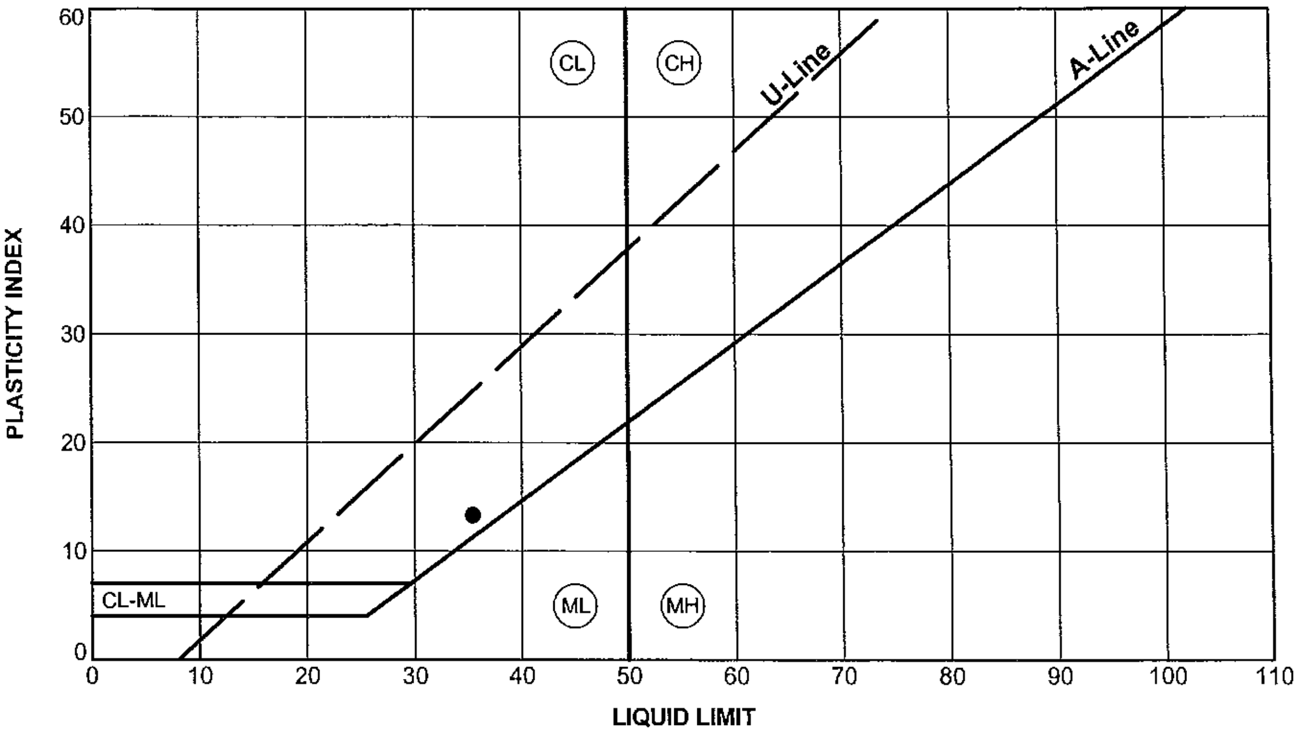

Symbol	Location	Depth, feet	LL	PL	PI	Natural Moisture Content, %	LI	USCS	Soil Classification
●	B-4C	22.0-24.0	35	22	13	18.7	-0.3	CL	Brown, silty lean CLAY

MACTEC_ATTERBERG_LIMITS 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 8/24/10

Remarks:

Test Method - ASTM D4318

LL=Liquid Limit; PL= Plastic Limit; PI=Plasticity Index; LI=Liquidity Index

ATTERBERG LIMITS RESULTS

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

Checked By: [signature]

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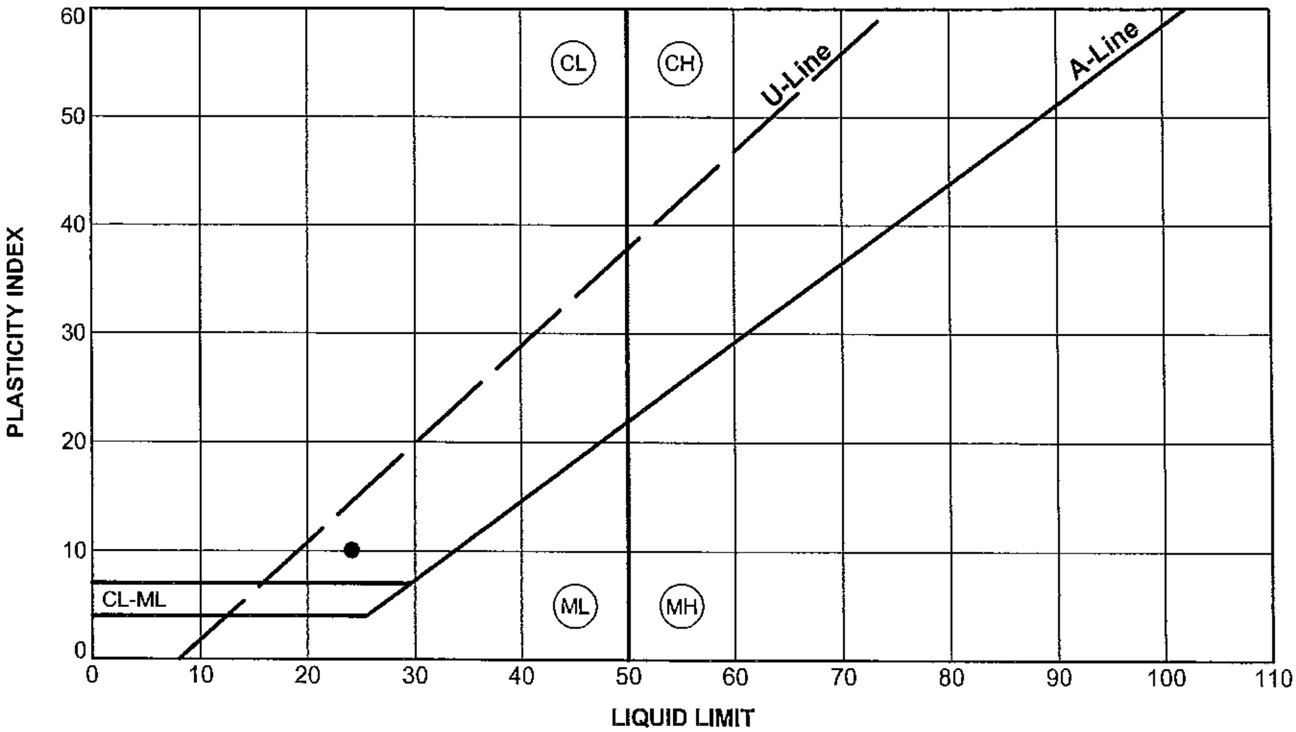

Symbol	Location	Depth, feet	LL	PL	PI	Natural Moisture Content, %	LI	USCS	Soil Classification
●	B-5C	4.0-6.0	24	14	10	14.5	0.0	SC	Reddish brown, clayey SAND

MACTEC_ATTERBERG_LIMITS 3143101317.GPJ MACTEC DATABASE TEMPLATE 01.GDT 8/24/10

Remarks:

Test Method - ASTM D4318

LL=Liquid Limit; PL= Plastic Limit; PI=Plasticity Index; LI=Liquidity Index

ATTERBERG LIMITS RESULTS

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

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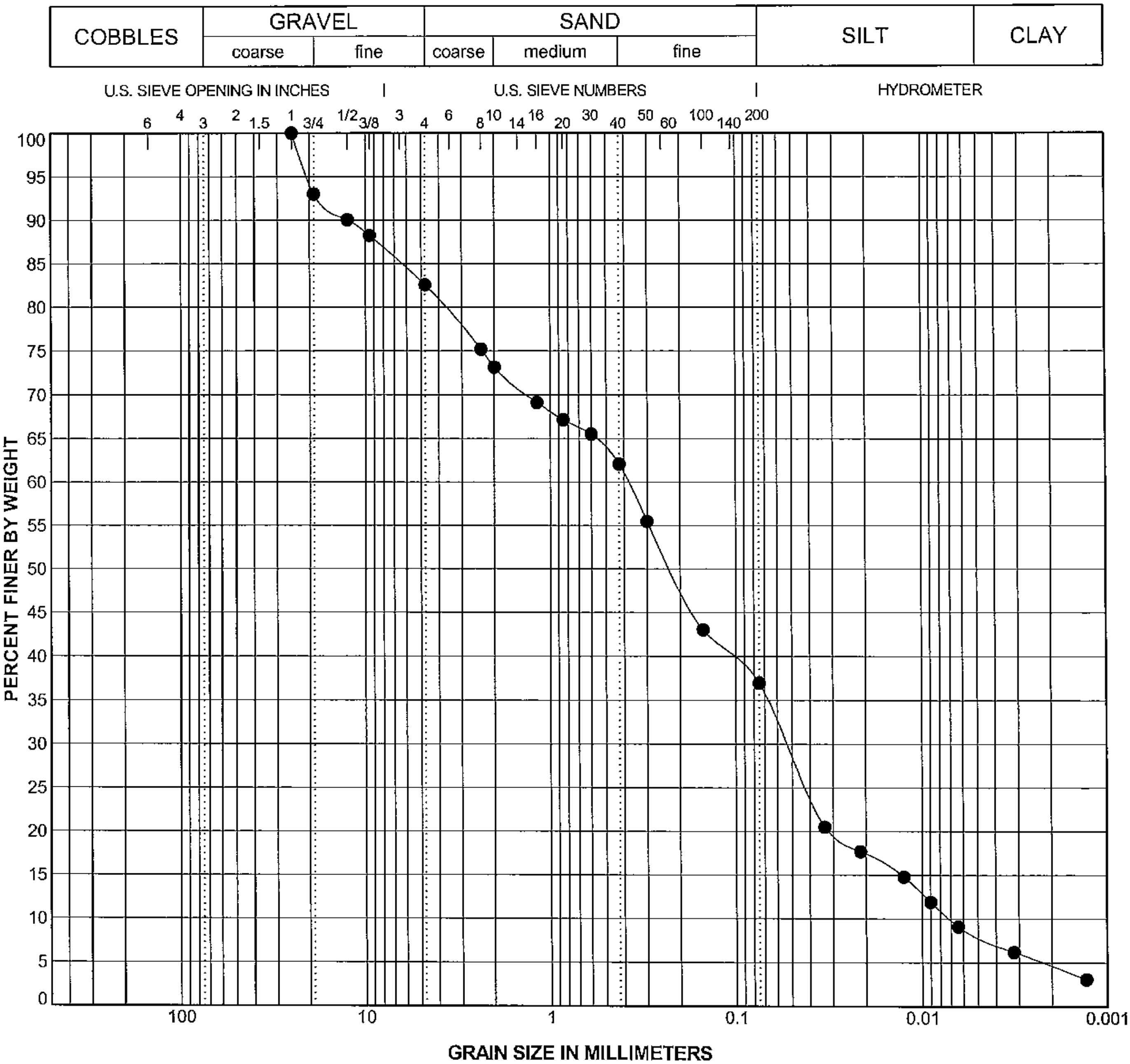
GRAIN SIZE DISTRIBUTION TEST RESULTS



Symbol	Location	Depth, feet	Soil Classification	USCS	D_{100}, mm	D_{60}, mm	D_{30}, mm	D_{10}, mm	C_c	C_u
●	B-1C	6.0-8.0	Brown, clayey SAND	SC	25	0.381	0.053	0.007	1.04	53.31

Remarks:

Test Method - ASTM D422

GRAIN SIZE DISTRIBUTION

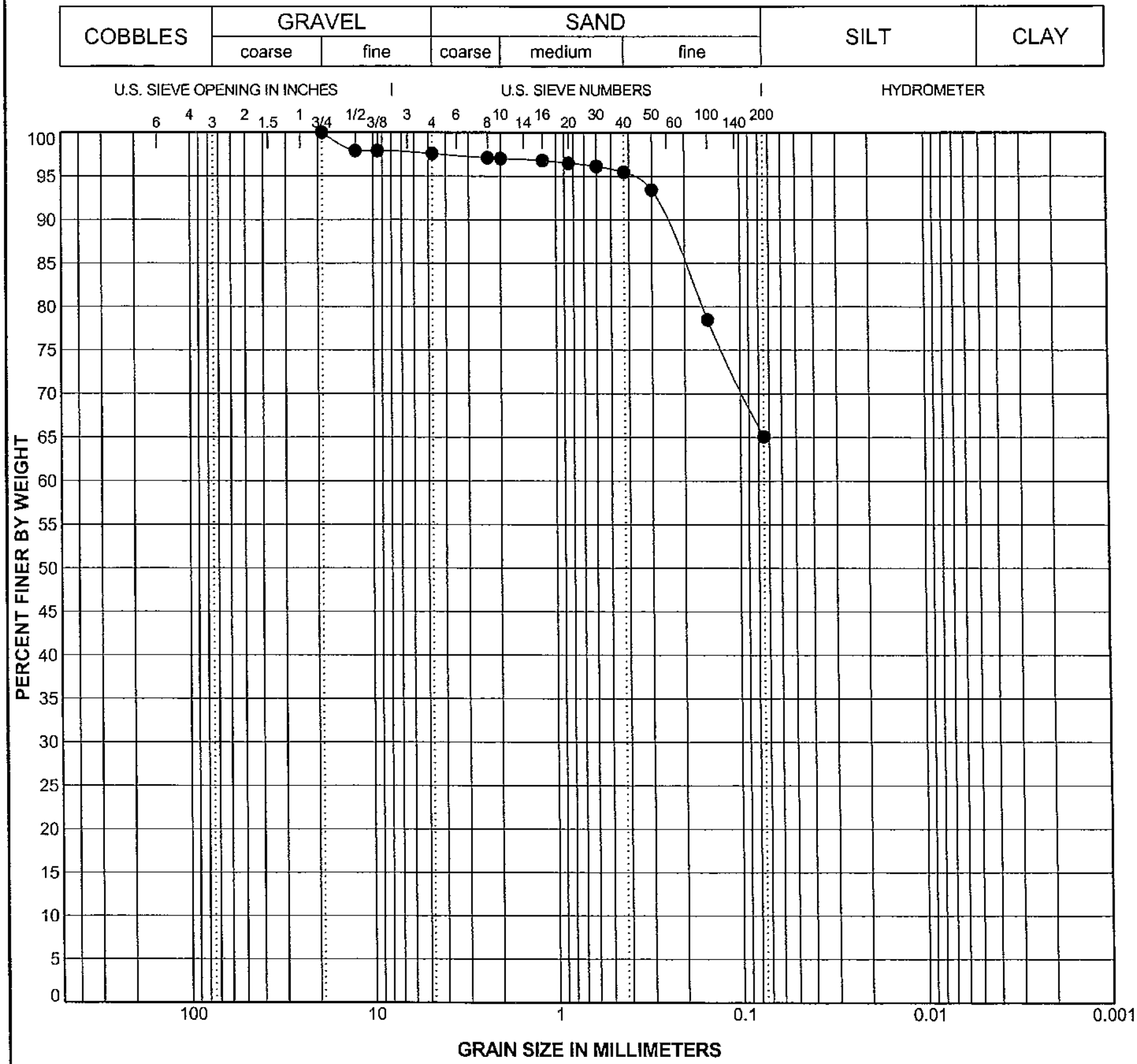
Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

Checked By: [signature]

MACTEC

MACTEC_GRAIN_SIZE 3143101317.GPJ LAW_GIBB.GDT 9/6/10



Symbol	Location	Depth, feet	Soil Classification	USCS	D_{100}, mm	D_{60}, mm	D_{30}, mm	D_{10}, mm	C_c	C_u
●	B-1C	26.0-28.0	Brownish gray, silty lean CLAY	CL	19					

Remarks:

Test Method - ASTM D422

GRAIN SIZE DISTRIBUTION

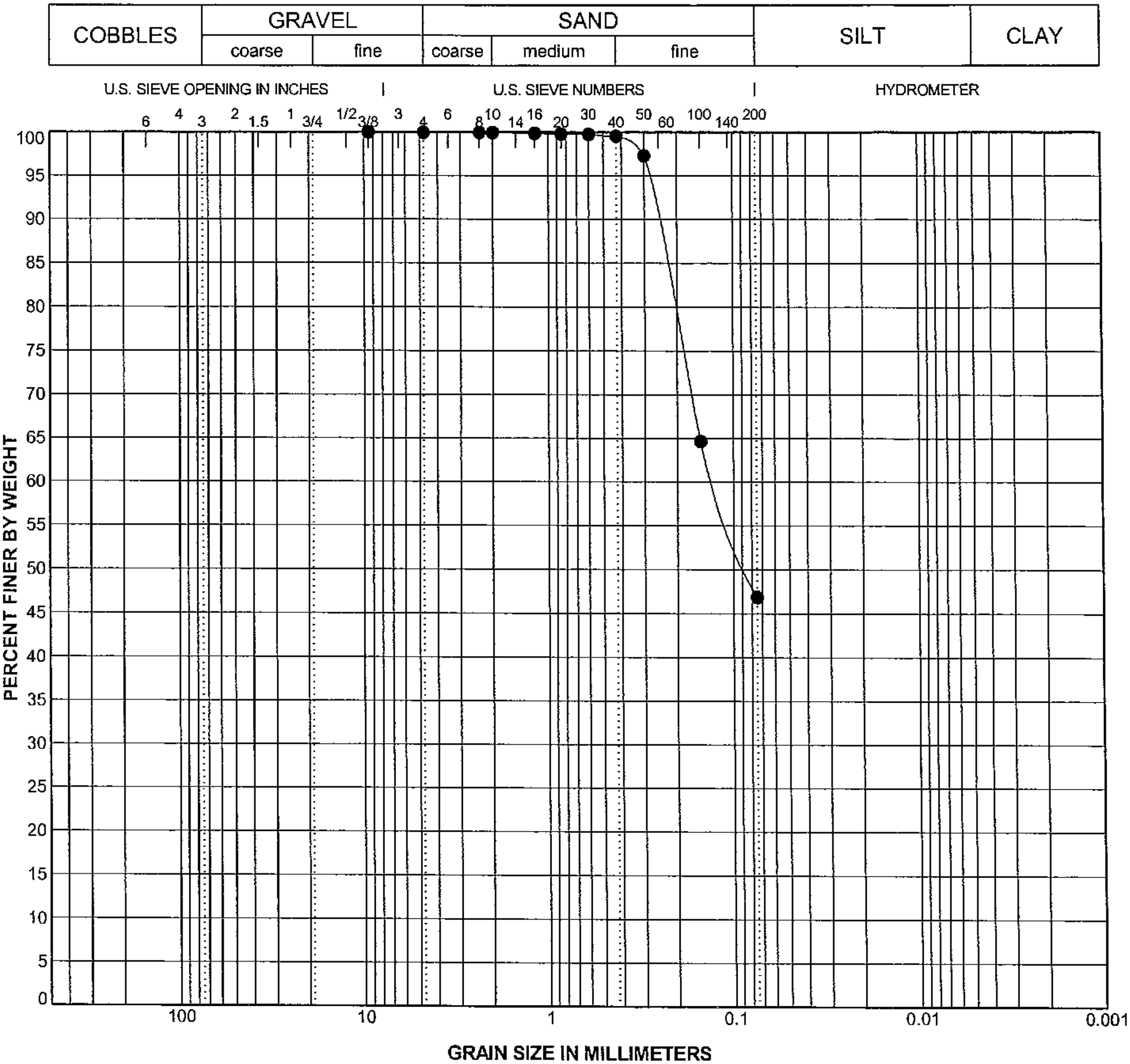
Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

Checked By: [signature]

MACTEC

MACTEC_GRAIN_SIZE 3143101317.GPJ LAW_GIBB.GDT 8/24/10



Symbol	Location	Depth, feet	Soil Classification	USCS	D_{100}, mm	D_{60}, mm	D_{30}, mm	D_{10}, mm	C_c	C_u
●	B-2T	10.0-12.0	Reddish brown, silty SAND	SM	9.5	0.125				

Remarks:

Test Method - ASTM D422

GRAIN SIZE DISTRIBUTION

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

Checked By: ______

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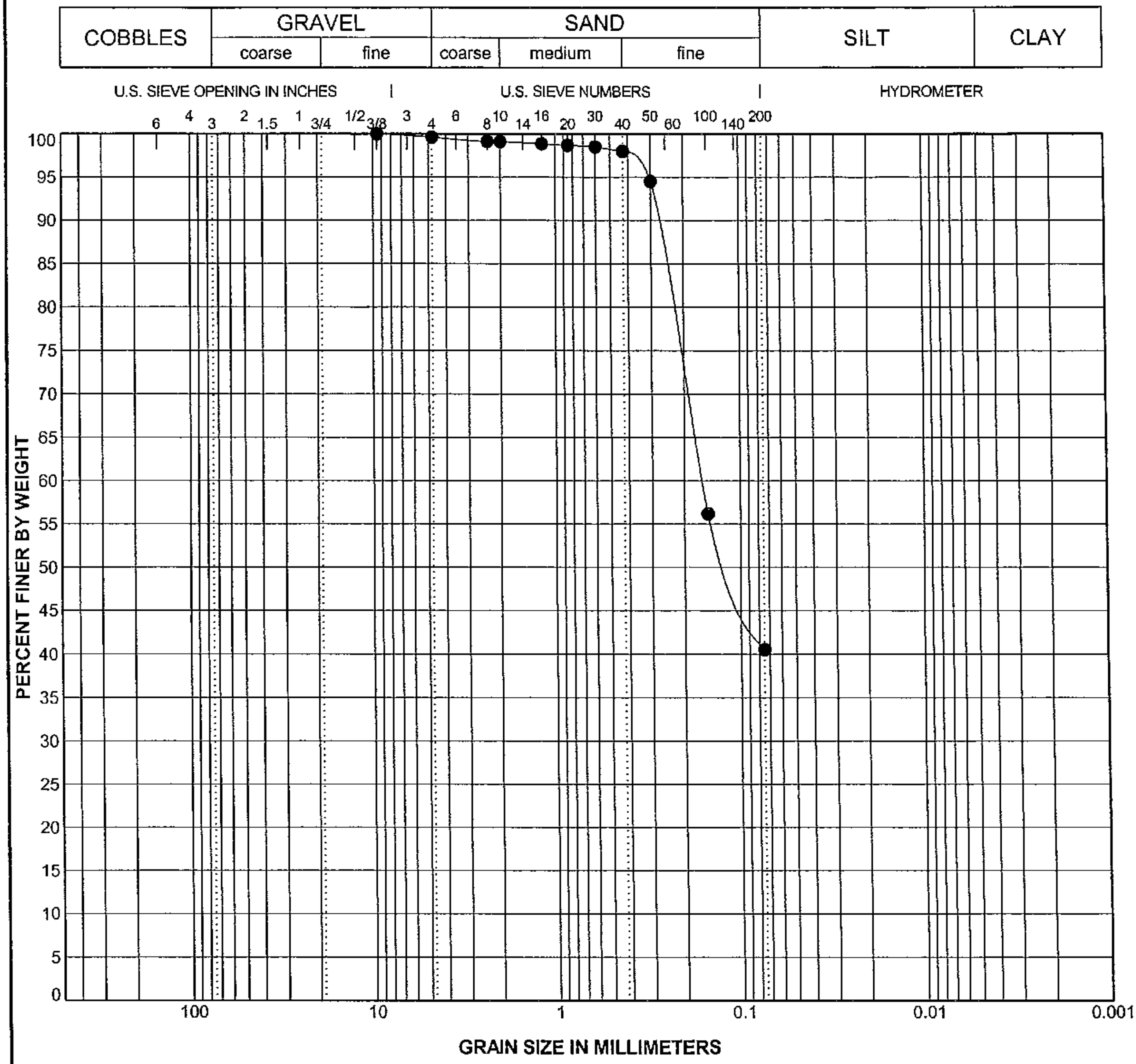
MACTEC_GRAIN_SIZE 3143101317.GPJ LAW_GIBB.GDT 8/24/10



Symbol	Location	Depth, feet	Soil Classification	USCS	D_{100}, mm	D_{60}, mm	D_{30}, mm	D_{10}, mm	C_c	C_u
●	B-3C	16.0-18.0	Brown, clayey SAND	SC	9.5	0.161				

Remarks:

Test Method - ASTM D422

GRAIN SIZE DISTRIBUTION

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

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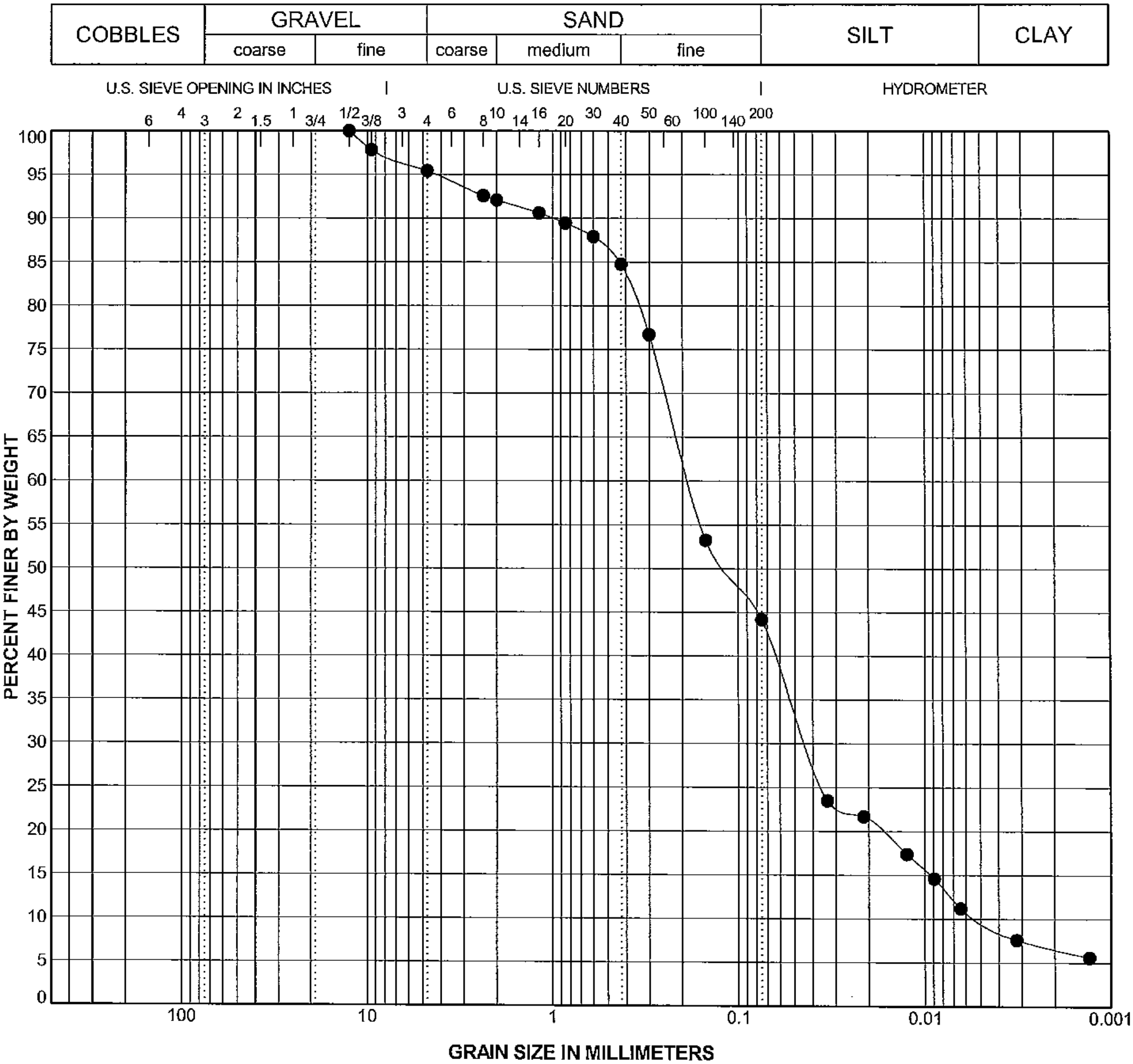
MACTEC_GRAIN_SIZE 3143101317.GPJ LAW_GIBB.GDT 8/24/10



Symbol	Location	Depth, feet	Soil Classification	USCS	D_{100}, mm	D_{60}, mm	D_{30}, mm	D_{10}, mm	C_c	C_u
●	B-4C	3.0-5.0	Brown, silty SAND	SM	12.5	0.183	0.043	0.005	1.99	36.04

MACTEC_GRAIN_SIZE 3143101317.GPJ LAW_GIBB.GDT 9/9/10

Remarks:

Test Method - ASTM D422

GRAIN SIZE DISTRIBUTION

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

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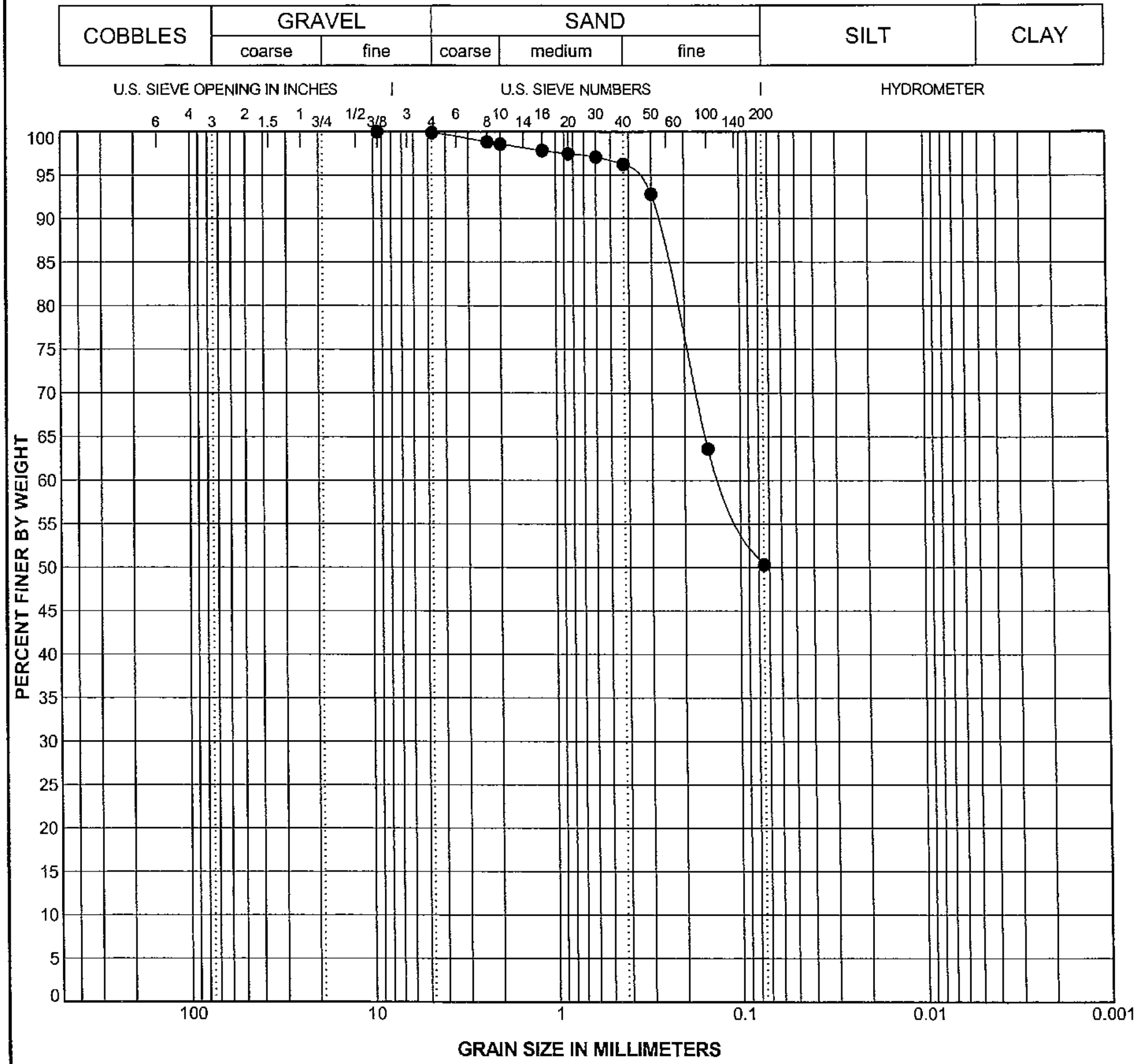

Symbol	Location	Depth, feet	Soil Classification	USCS	D_{100}, mm	D_{60}, mm	D_{30}, mm	D_{10}, mm	C_c	C_u
●	B-4C	10.0-12.0	Brown, silty lean CLAY	CL	9.5	0.124				

MACTEC_GRAIN_SIZE 3143101317.GPJ LAW_GIBB.GDT 8/24/10

Remarks:

Test Method - ASTM D422

GRAIN SIZE DISTRIBUTION

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

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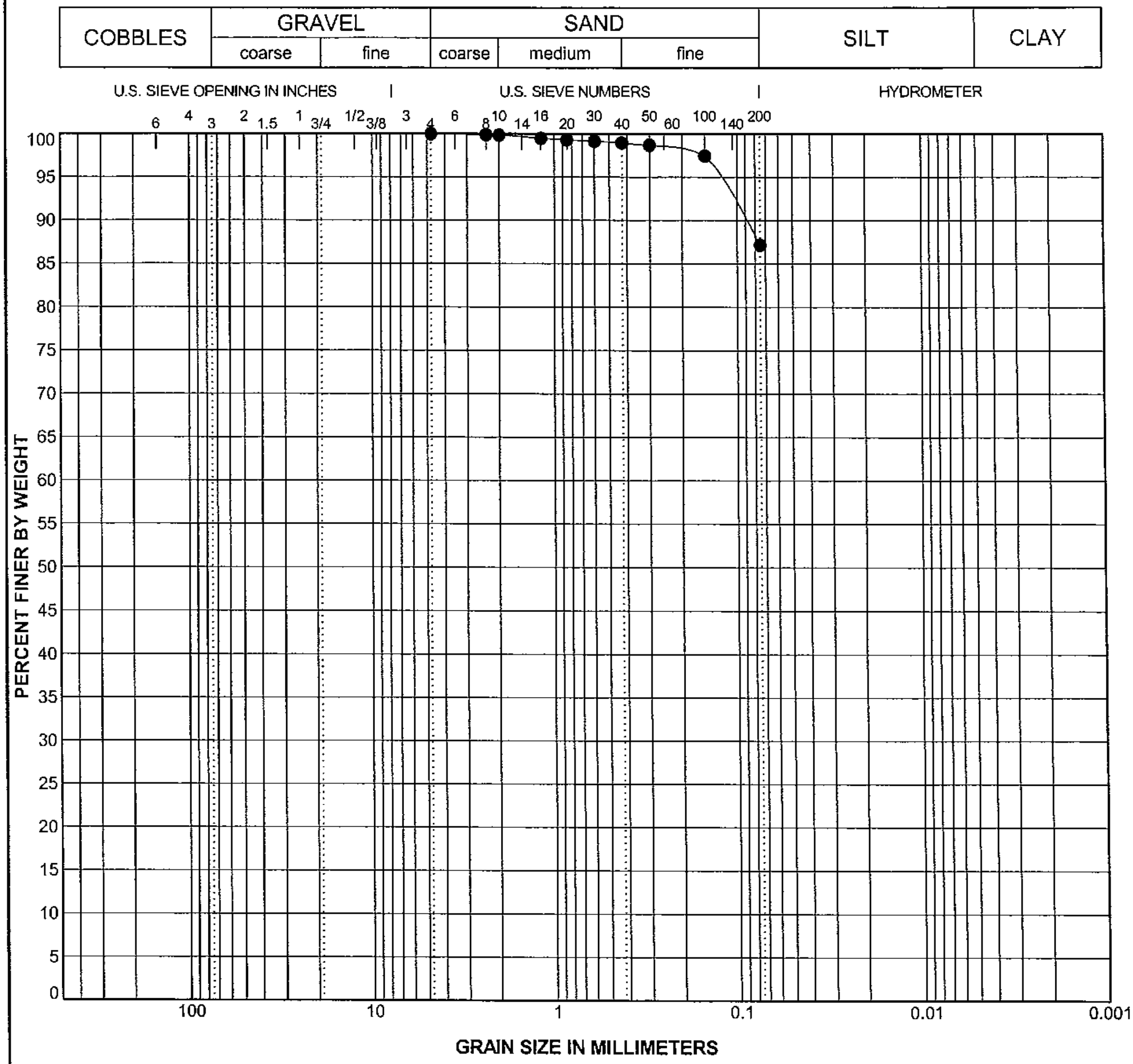

Symbol	Location	Depth, feet	Soil Classification	USCS	D_{100}, mm	D_{60}, mm	D_{30}, mm	D_{10}, mm	C_c	C_u
●	B-4C	22.0-24.0	Brown, silty lean CLAY	CL	4.75					

Remarks:

Test Method - ASTM D422

GRAIN SIZE DISTRIBUTION

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

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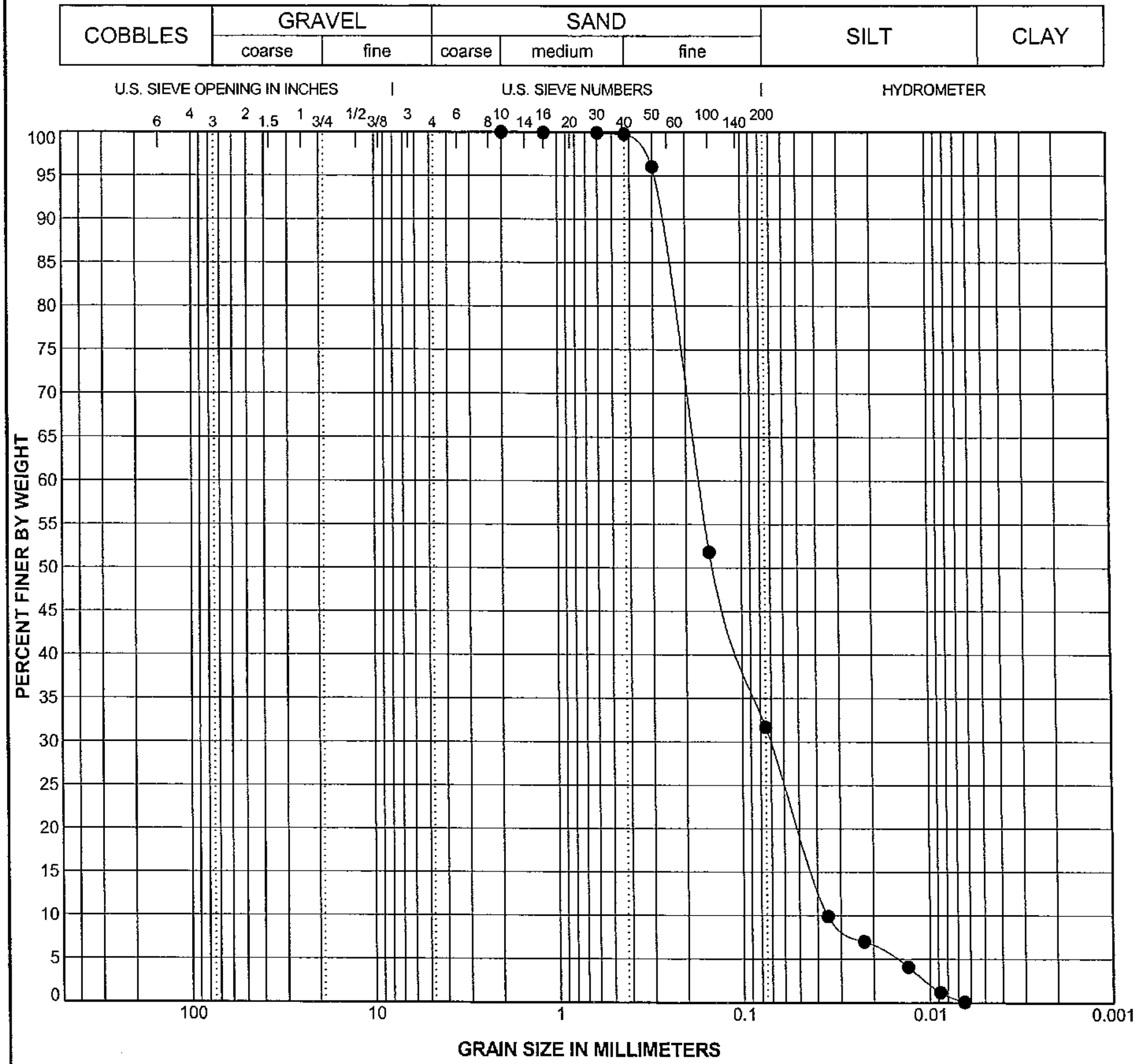
MACTEC_GRAIN_SIZE 3143101317.GPJ LAW_GIBB.GDT 8/24/10



Symbol	Location	Depth, feet	Soil Classification	USCS	D_{100}, mm	D_{60}, mm	D_{30}, mm	D_{10}, mm	C_c	C_u
●	B-4C	44.0-50.5	Brown, clayey SAND	SC	2	0.171	0.071	0.035	0.83	4.83

Remarks:

Test Method - ASTM D422

GRAIN SIZE DISTRIBUTION

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

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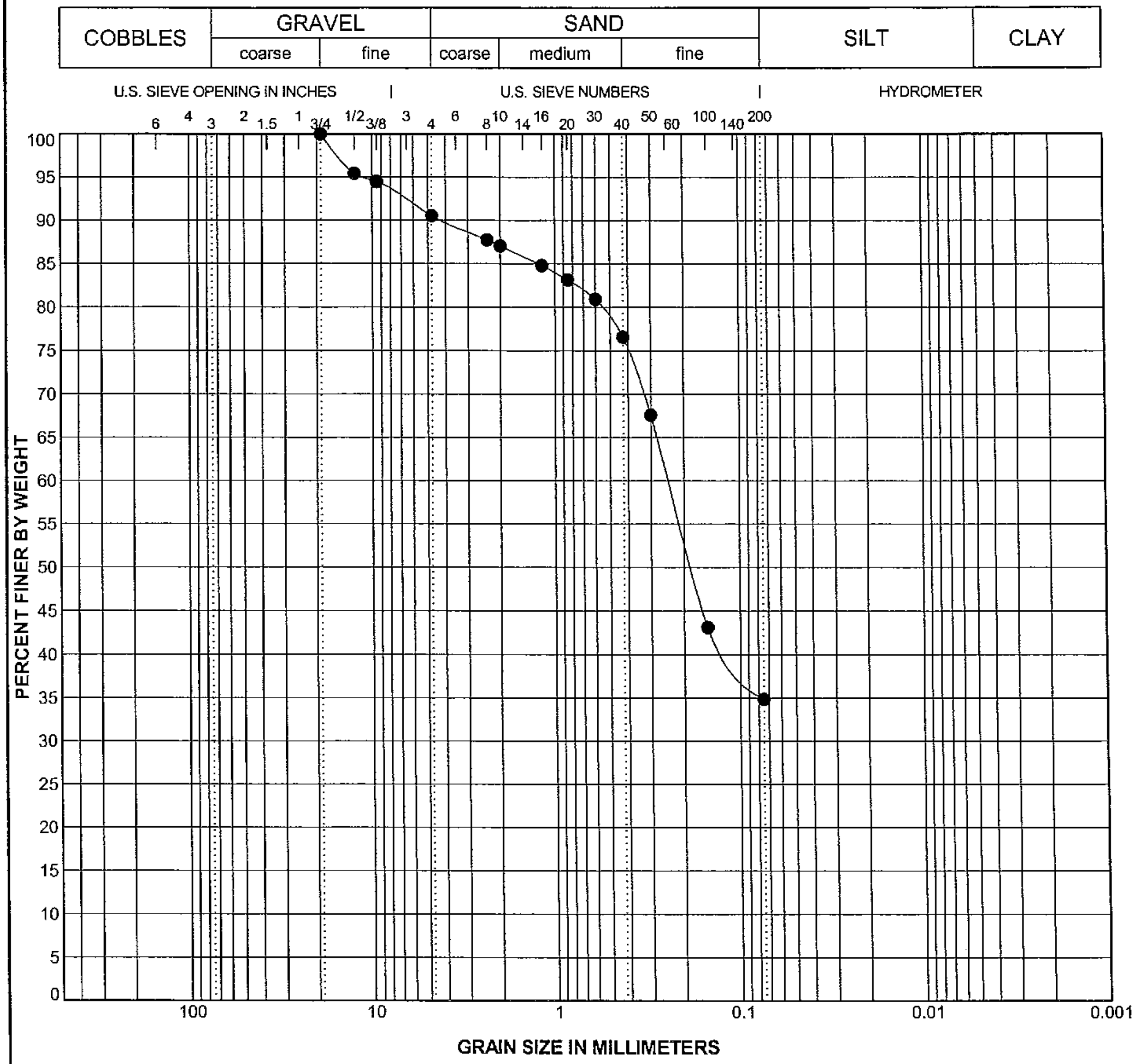
MACTEC_GRAIN_SIZE 3143101317.GPJ LAW_GIBB.GDT 8/24/10



Symbol	Location	Depth, feet	Soil Classification	USCS	D_{100}, mm	D_{60}, mm	D_{30}, mm	D_{10}, mm	C_c	C_u
●	B-5C	4.0-6.0	Reddish brown, clayey SAND	SC	19	0.242				

MACTEC_GRAIN_SIZE 314310317.GPJ LAW_GIBB.GDT 8/24/10

Remarks:

Test Method - ASTM D422

GRAIN SIZE DISTRIBUTION

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

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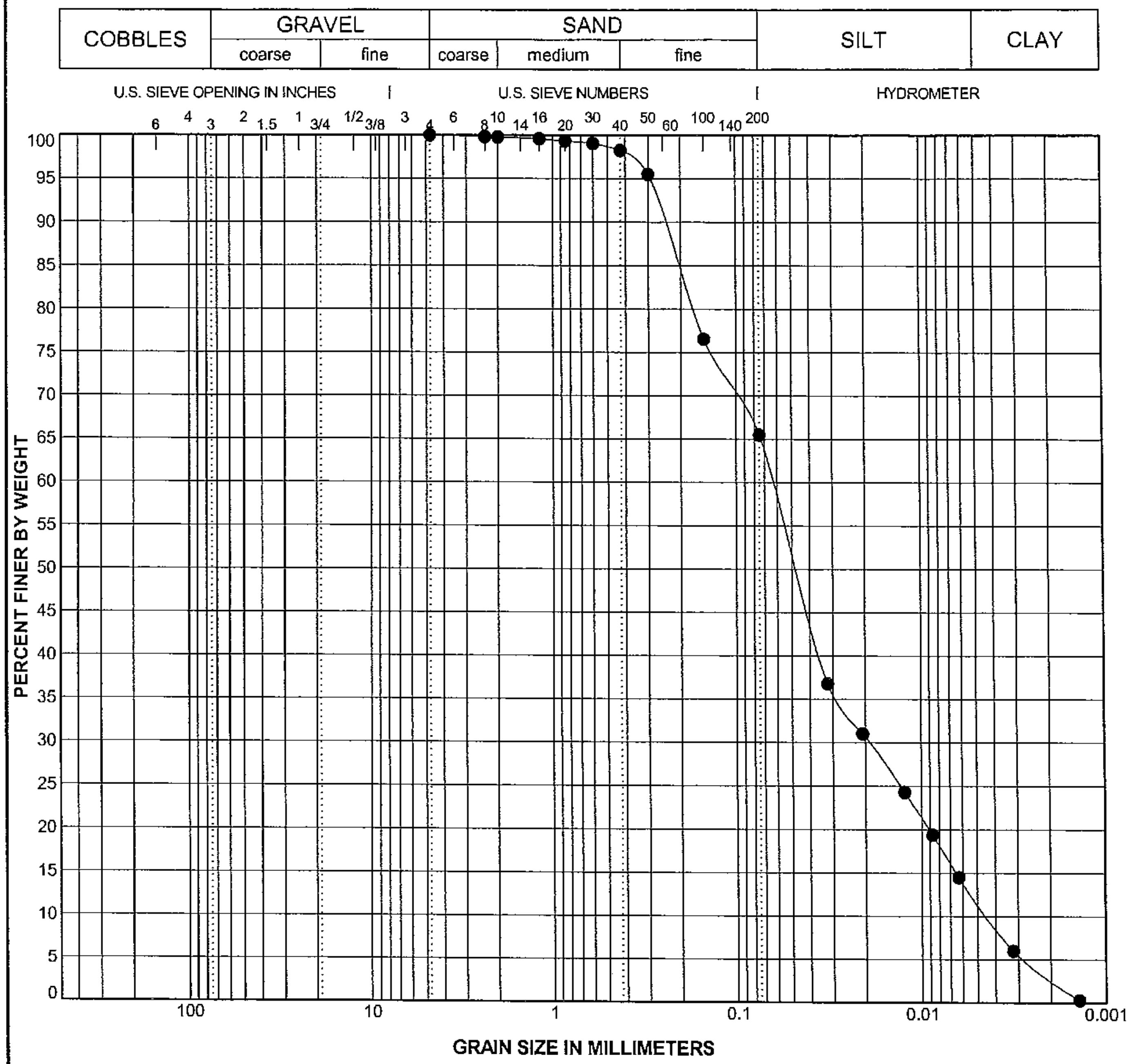

Symbol	Location	Depth, feet	Soil Classification	USCS	D_{100}, mm	D_{60}, mm	D_{30}, mm	D_{10}, mm	C_c	C_u
●	B-6T	9.0-10.5	Gray brown, silty lean CLAY	CL	4.75	0.064	0.019	0.004	1.31	14.49

Remarks:

Test Method - ASTM D422

GRAIN SIZE DISTRIBUTION

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

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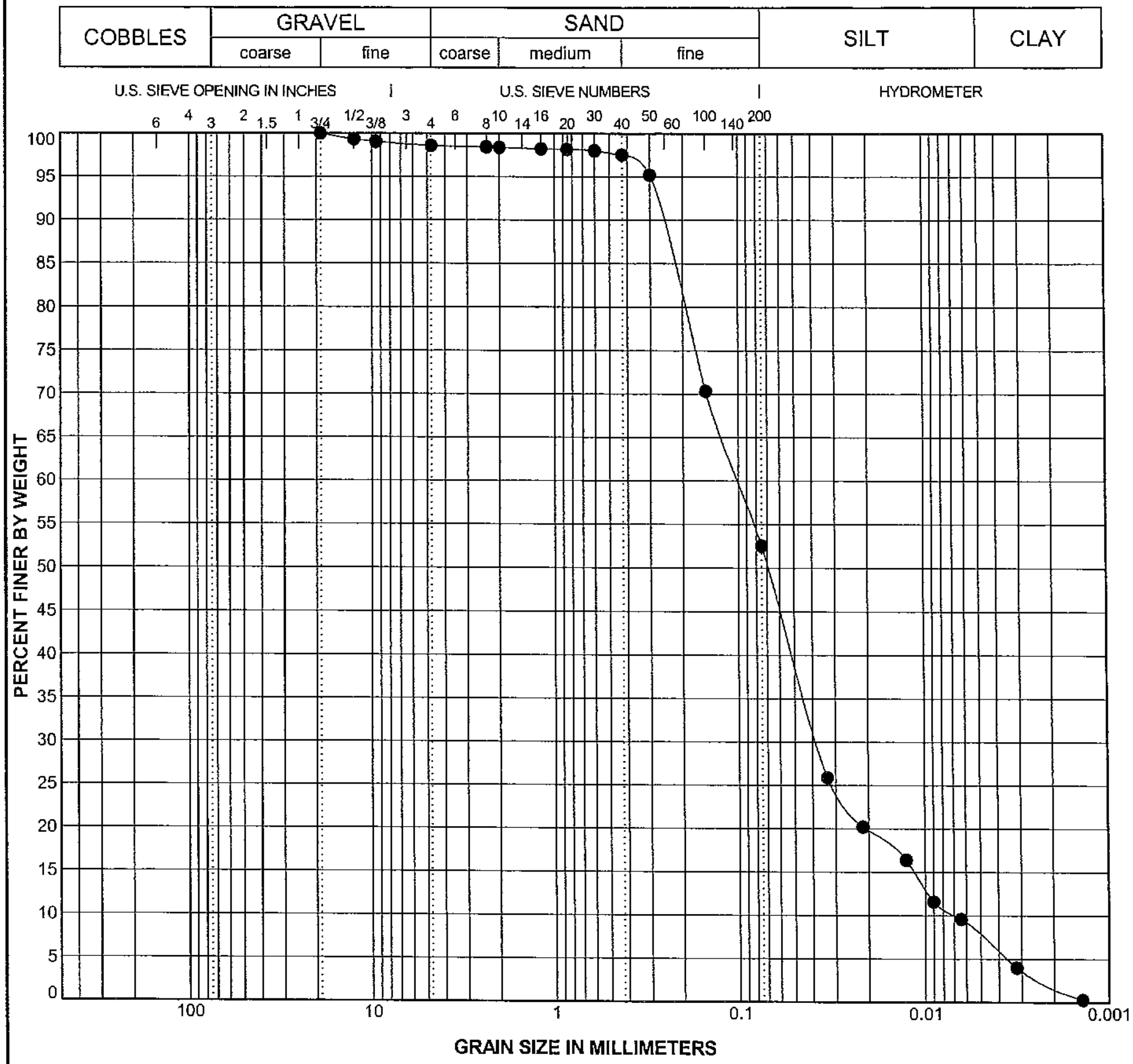
MACTEC_GRAIN_SIZE 3143101317.GPJ LAW_GIBB.GDT 8/24/10



Symbol	Location	Depth, feet	Soil Classification	USCS	D_{100}, mm	D_{60}, mm	D_{30}, mm	D_{10}, mm	C_c	C_u
●	B-6T	14.0-20.5	Light brown, SILT with CLAY	ML	19	0.1	0.038	0.007	2.07	14.64

Remarks:

Test Method - ASTM D422

GRAIN SIZE DISTRIBUTION

Project: E.ON U.S. - Tyrone Power Station

Project No: 3143-10-1317.01

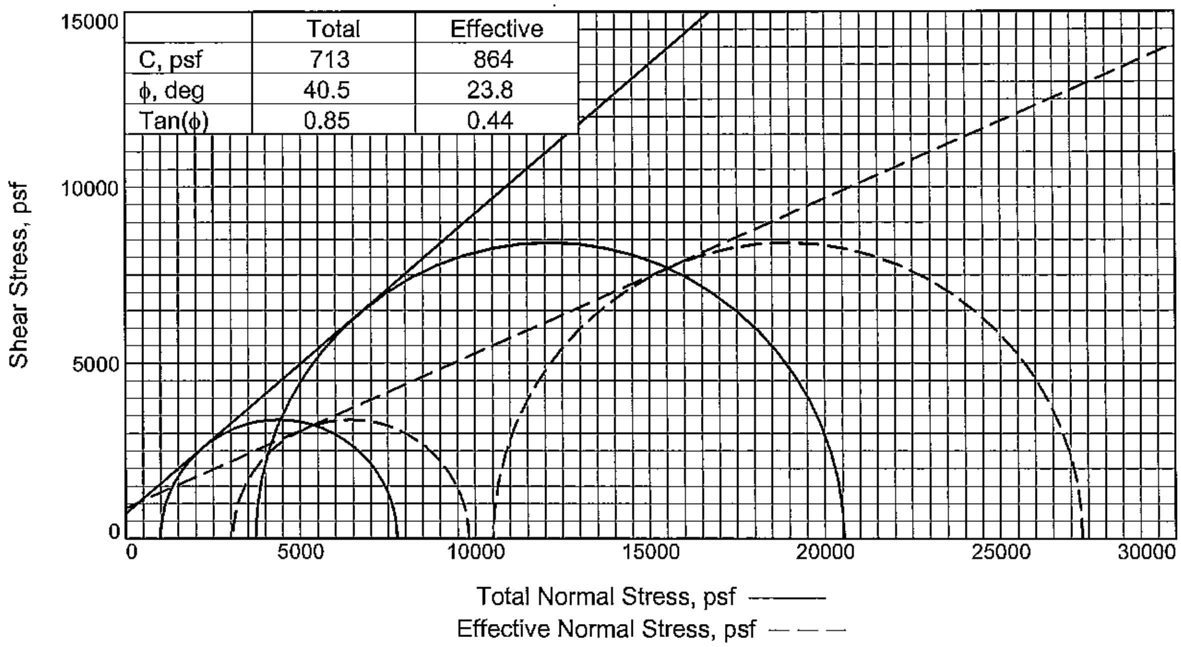
Checked By: [signature]

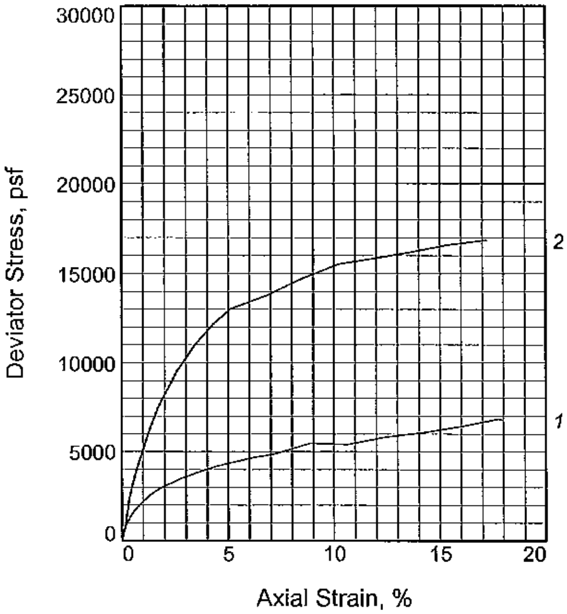
MACTEC

MACTEC_GRAIN_SIZE 3143101317.GPJ LAW_GIBB.GDT 8/24/10

TRIAXIAL SHEAR TEST RESULTS

	Total	Effective
C, psf	713	864
ϕ, deg	40.5	23.8
Tan(ϕ)	0.85	0.44





Sample No.		1	2
Initial	Water Content, %	15.3	14.1
	Dry Density, pcf	114.4	118.2
	Saturation, %	87.4	89.5
	Void Ratio	0.4737	0.4265
	Diameter, in.	2.86	2.87
	Height, in.	5.65	5.89
At Test	Water Content, %	16.8	15.2
	Dry Density, pcf	115.8	119.4
	Saturation, %	100.0	100.0
	Void Ratio	0.4549	0.4116
	Diameter, in.	2.85	2.86
	Height, in.	5.63	5.87
Strain rate, in./min.		0.00	0.00
Back Pressure, psi		63.10	70.60
Cell Pressure, psi		70.00	96.40
Fail. Stress, psf		6766	16827
Total Pore Pr., psf		7027	3370
Ult. Stress, psf		2929	16830
Total Pore Pr., psf		8683	3341
$\bar{\sigma}_1$ Failure, psf		9818	27339
$\bar{\sigma}_3$ Failure, psf		3053	10512

Type of Test:
CU with Pore Pressures

Sample Type: UNDISTURBED

Description: Grayish brown, silty SAND

Specific Gravity= 2.7

Remarks: ASTM D4767

Figure ________

Client: E.ON US

Project: Tyrone Power Station

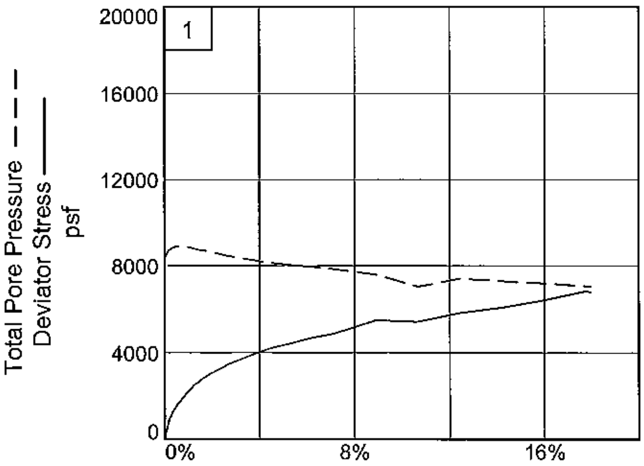
Location: Tyrone Power Station Depth: 3.0-5.0 Feet

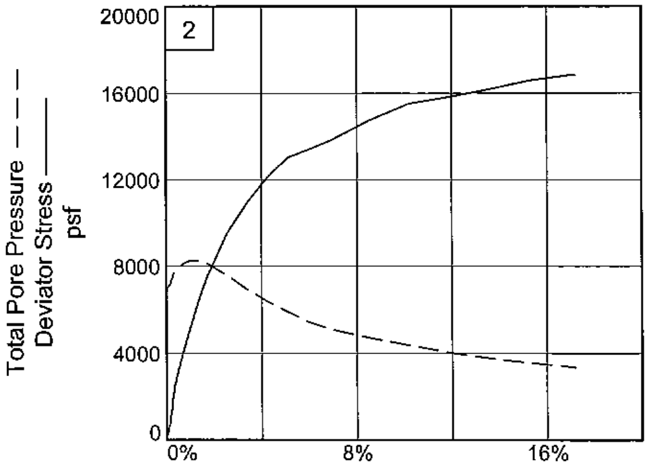
Sample Number: B-4C **Depth:** 3.0-5.0 Feet

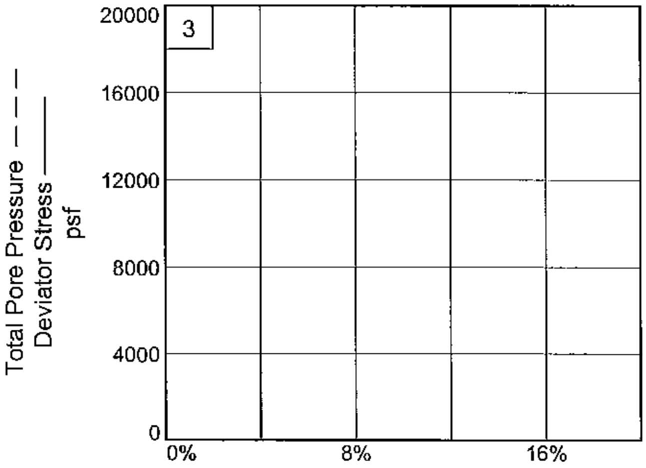
Proj. No.: 3143-10-1317.01 **Date Sampled:** 08/16/2010

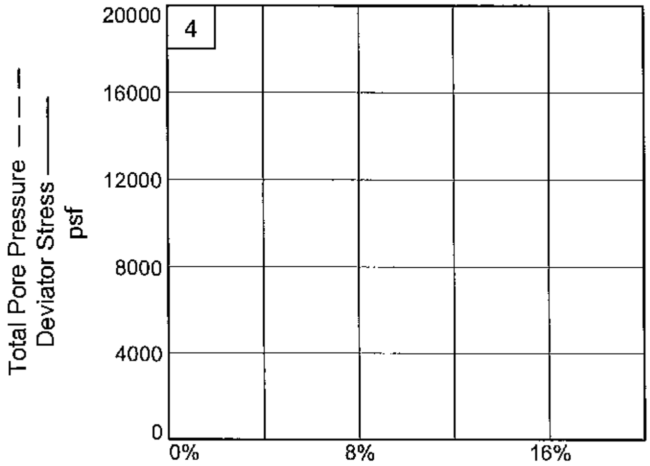
TRIAXIAL SHEAR TEST REPORT
MACTEC Engineering and Consulting, Inc.
Louisville, Kentucky

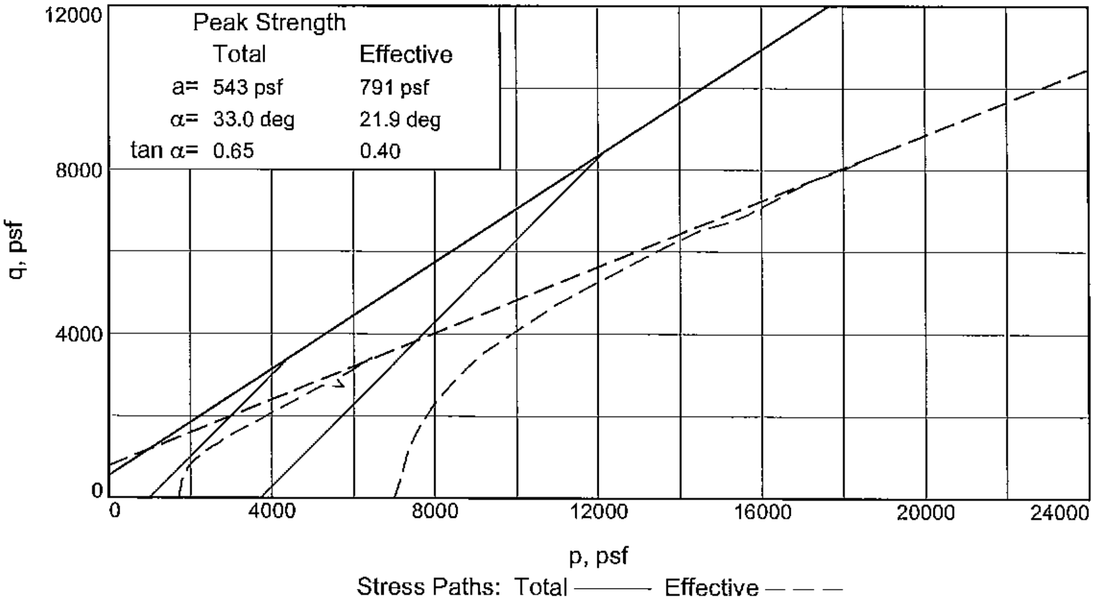
Tested By: MRD







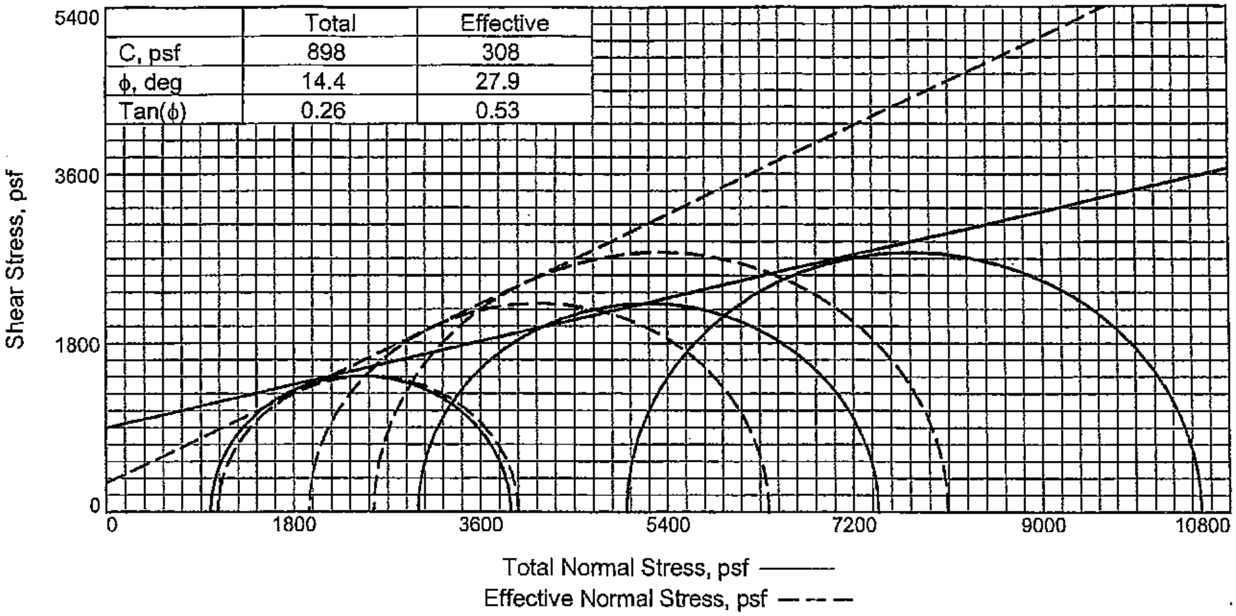




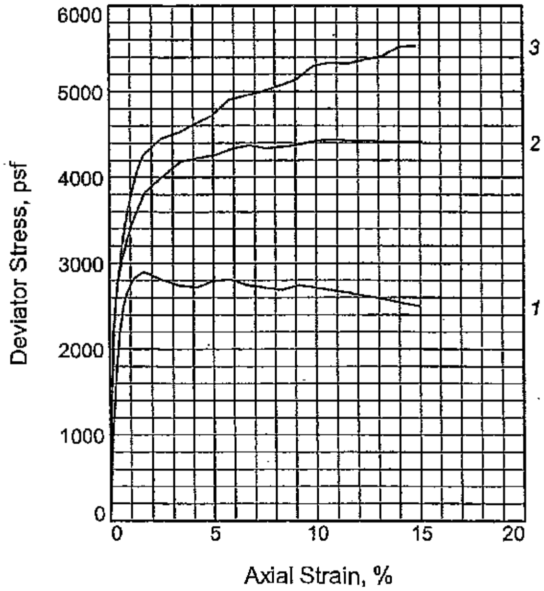
Peak Strength	Total	Effective
a=	543 psf	791 psf
α=	33.0 deg	21.9 deg
tan α=	0.65	0.40

Client: E.ON US
Project: Tyrone Power Station
Location: Tyrone Power Station Depth: 3.0-5.0 Feet **Depth:** 3.0-5.0 Feet **Sample Number:** B-4C
Project No.: 3143-10-1317.01 **Figure** ________ **MACTEC Engineering and Consulting, Inc.**

Tested By: MRD



	Total	Effective
C, psf	898	308
ϕ, deg	14.4	27.9
Tan(ϕ)	0.26	0.53



	Sample No.	1	2	3
Initial	Water Content, %	15.2	18.0	18.9
	Dry Density, pcf	98.5	103.8	103.7
	Saturation, %	59.2	80.5	84.2
	Void Ratio	0.6796	0.5935	0.5957
	Diameter, in.	2.81	2.83	2.81
	Height, in.	6.04	6.04	6.18
At Test	Water Content, %	21.1	21.9	21.4
	Dry Density, pcf	106.1	104.7	105.6
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.5586	0.5800	0.5665
	Diameter, in.	2.72	2.84	2.81
	Height, in.	6.02	5.95	6.08
	Strain rate, in./min.	0.01	0.01	0.01
	Back Pressure, psf	7200	7200	7200
	Cell Pressure, psf	8194	10195	12197
	Fail. Stress, psf	2896	4442	5530
	Total Pore Pr., psf	7128	8251	9634
	Ult. Stress, psf			
	Total Pore Pr., psf			
	$\bar{\sigma}_1$ Failure, psf	3961	6386	8093
	$\bar{\sigma}_3$ Failure, psf	1066	1944	2563

Type of Test: CU with Pore Pressures

Sample Type: Undisturbed

Description: lean clay with sand

LL= 30 **PL=** 18 **PI=** 12

Assumed Specific Gravity= 2.65

Remarks:

Client: E. ON U.S. Services, Inc.

Project: Tyrone Power Station

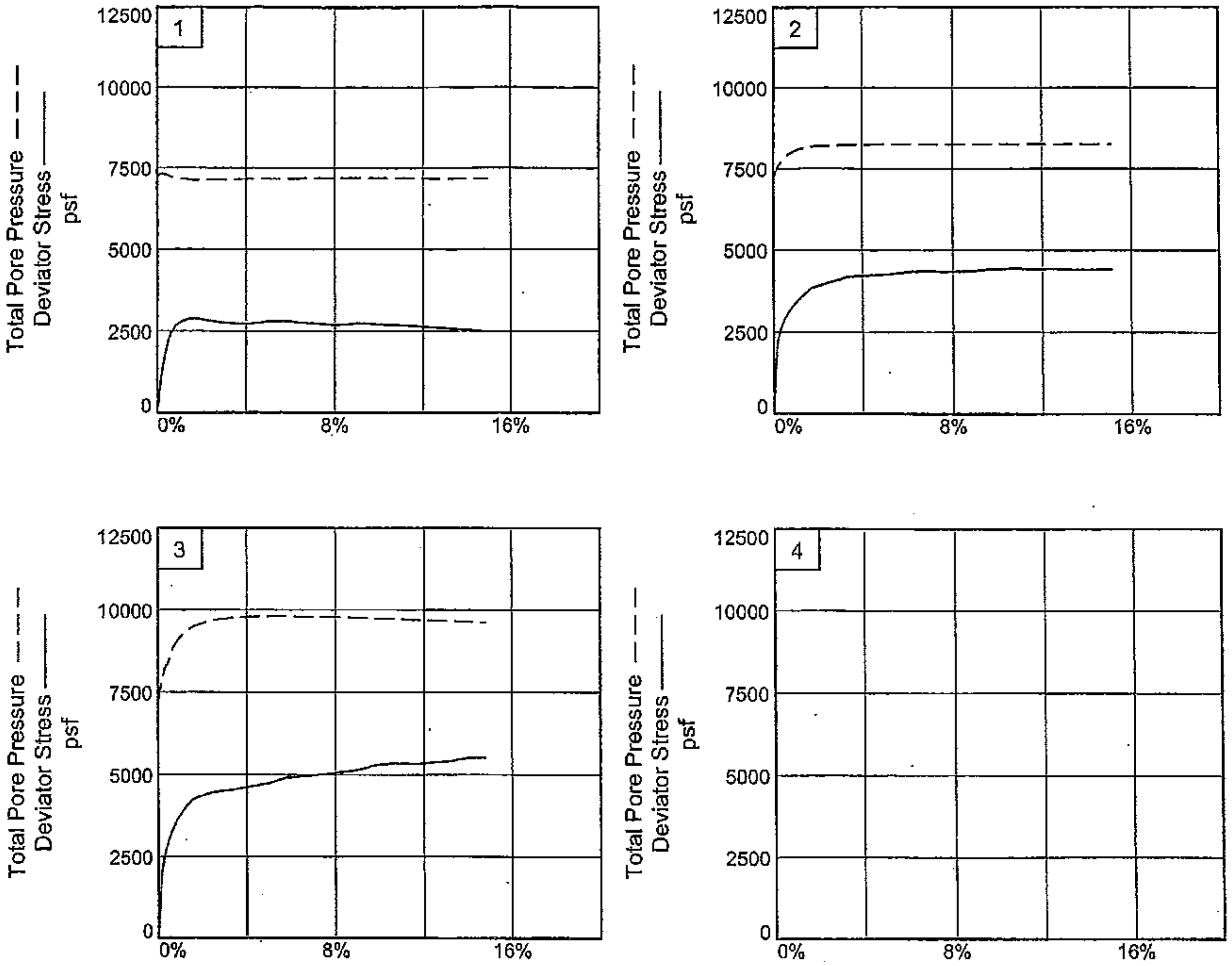
Location: B-5C

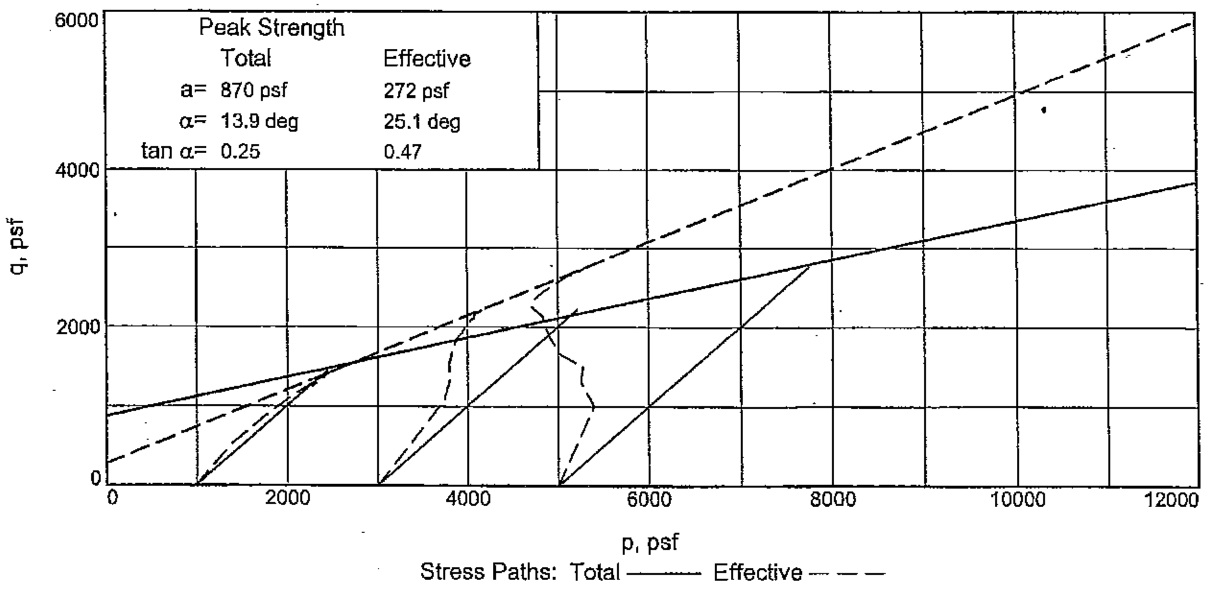
Depth: 36-38

Proj. No.: 314310131701 **Date Sampled:** 8-20-10

TRIAXIAL SHEAR TEST REPORT
MACTEC Engineering and Consulting, Inc.
Charlotte, North Carolina

Tested By: J. Alexander **Checked By:** D. Kopitsky



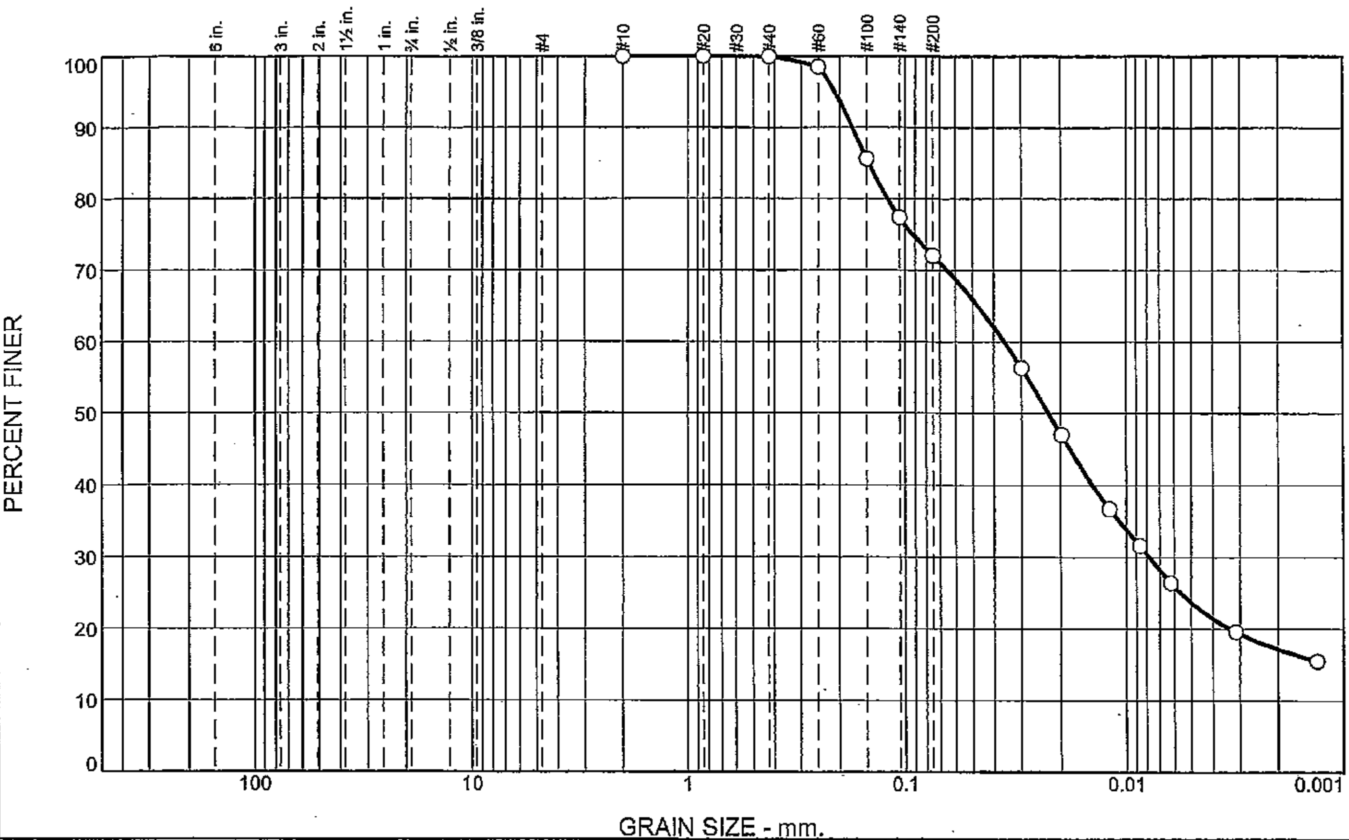


Client: E. ON U.S. Services, Inc.
Project: Tyrone Power Station
Location: B-5C **Depth:** 36-38
Project No.: 314310131701

MACTEC Engineering and Consulting, Inc.

Tested By: J. Alexander **Checked By:** D. Kopitsky

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	27.9	48.4	23.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	100.0		
#60	98.5		
#100	85.6		
#140	77.4		
#200	72.1		
0.0299 mm.	56.3		
0.0198 mm.	47.0		
0.0119 mm.	36.7		
0.0086 mm.	31.6		
0.0062 mm.	26.5		
0.0031 mm.	19.6		
0.0013 mm.	15.5		

* (no specification provided)

Soil Description

lean clay with sand

Atterberg Limits

PL= 18 LL= 30 PI= 12

Coefficients

D_{90}= 0.1747 D_{85}= 0.1467 D_{60}= 0.0359
D_{50}= 0.0226 D_{30}= 0.0078 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(7)

Remarks

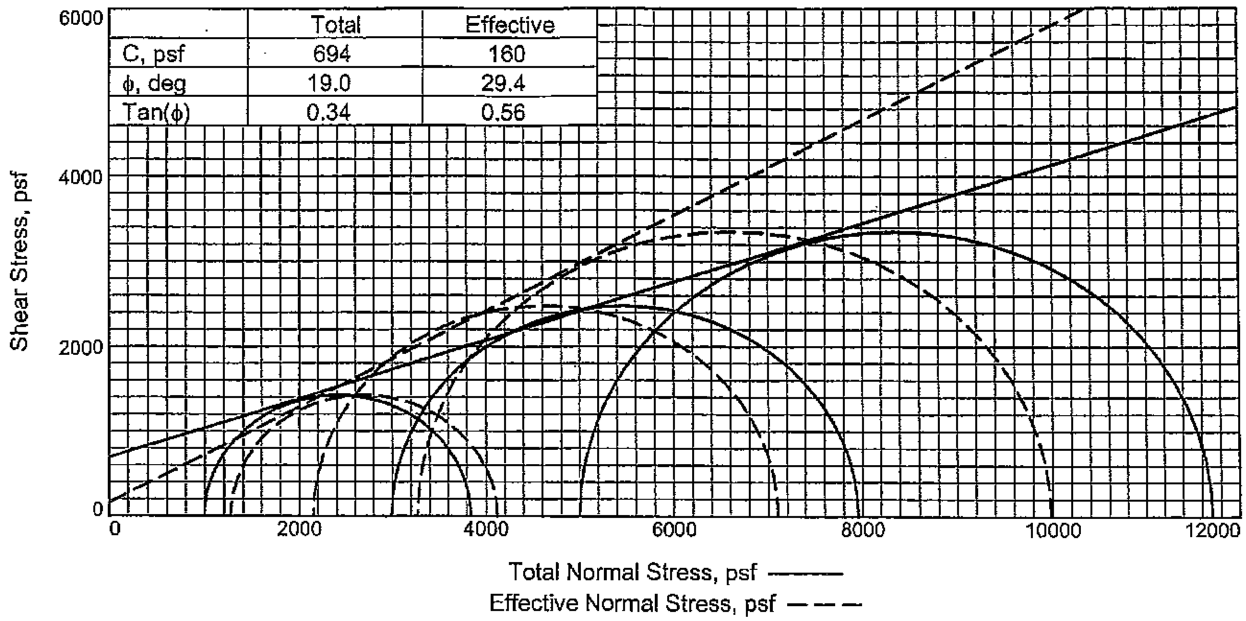
Location: B-5C
Depth: 36-38

Date: 8-20-10

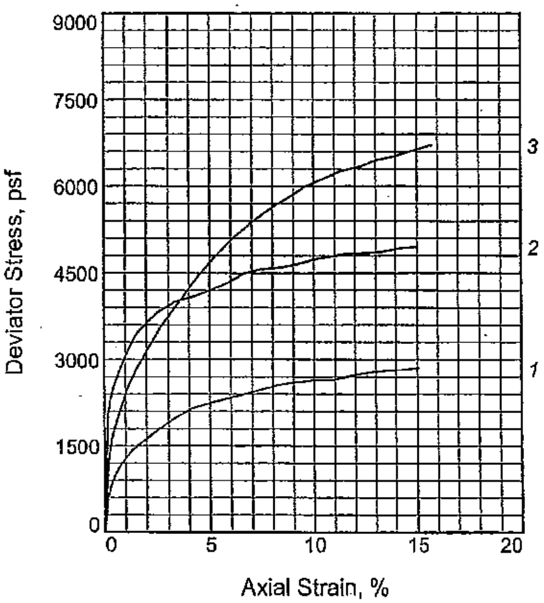
MACTEC Engineering and Consulting, Inc.
Charlotte, North Carolina

Client: E. ON U.S. Services, Inc.
Project: Tyrone Power Station
Project No: 314310131701

Tested By: J. Alexander **Checked By:** D. Kopitsky



	Total	Effective
C, psf	694	160
ϕ, deg	19.0	29.4
Tan(ϕ)	0.34	0.56



Sample No.		1	2	3
Initial	Water Content, %	17.8	18.6	17.9
	Dry Density, pcf	110.9	108.2	111.7
	Saturation, %	95.9	93.3	98.5
	Void Ratio	0.4915	0.5294	0.4804
	Diameter, in.	2.83	2.85	2.81
	Height, in.	6.02	6.06	5.82
At Test	Water Content, %	18.3	18.2	16.5
	Dry Density, pcf	111.3	111.5	115.0
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.4859	0.4836	0.4383
	Diameter, in.	2.83	2.82	2.79
	Height, in.	5.98	6.00	5.73
Strain rate, in./min.		0.01	0.00	0.00
Back Pressure, psf		7200	7200	7200
Cell Pressure, psf		8194	10195	12197
Fail. Stress, psf		2850	4957	6712
Total Pore Pr., psf		6926	8050	8928
Ult. Stress, psf				
Total Pore Pr., psf				
$\bar{\sigma}_1$ Failure, psf		4117	7103	9981
$\bar{\sigma}_3$ Failure, psf		1267	2146	3269

Type of Test:
CU with Pore Pressures

Sample Type: Undisturbed

Description: sandy lean clay

LL= 26 **PL=** 16 **PI=** 10

Assumed Specific Gravity= 2.65

Remarks:

Client: E. ON U.S. Services, Inc.

Project: Tyrone Power Station

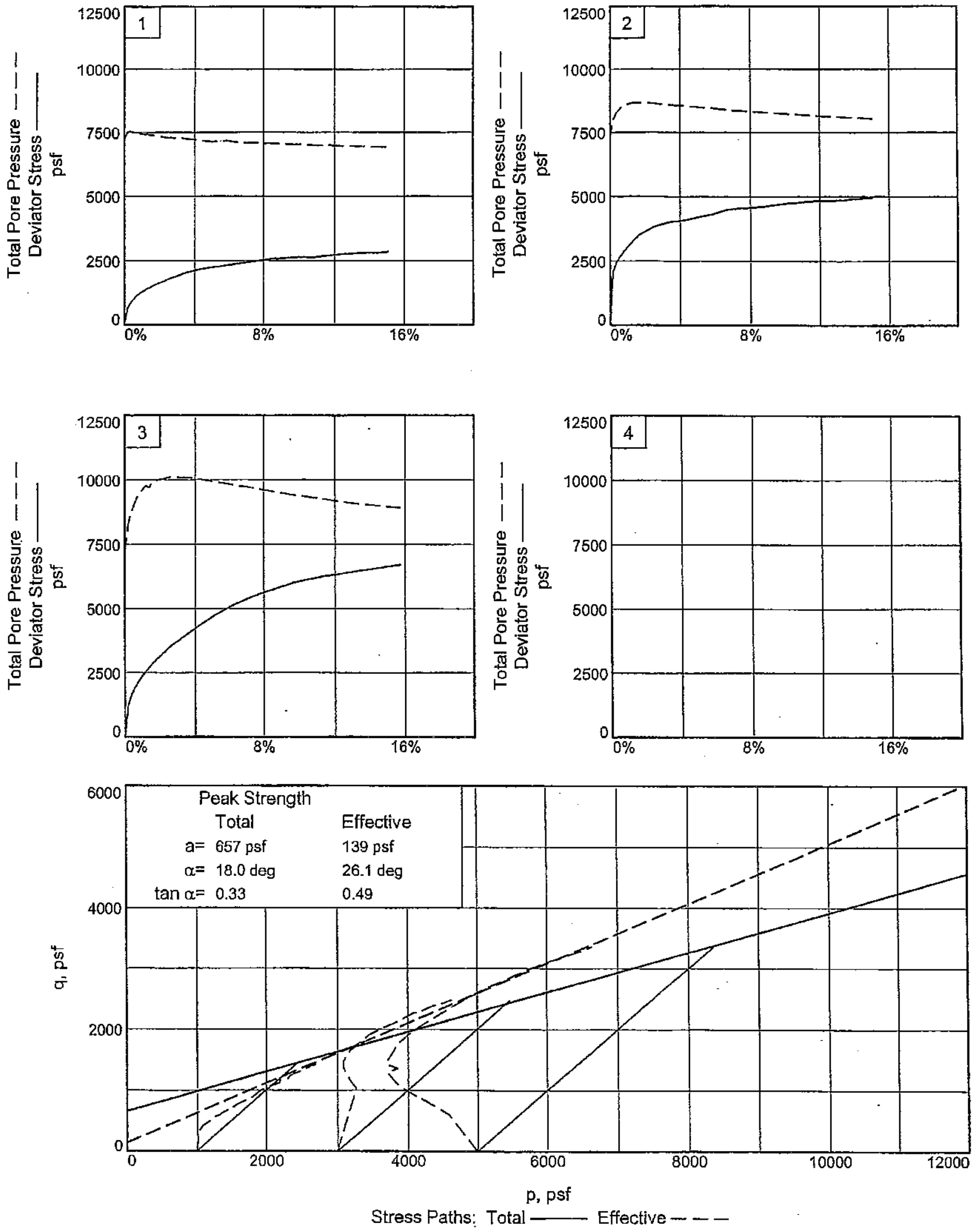
Location: B-6C

Depth: 20-22

Proj. No.: 314310131701 **Date Sampled:** 8-16-10

TRIAXIAL SHEAR TEST REPORT
MACTEC Engineering and Consulting, Inc.
Charlotte, North Carolina

Tested By: J. Alexander **Checked By:** D. Kopitsky

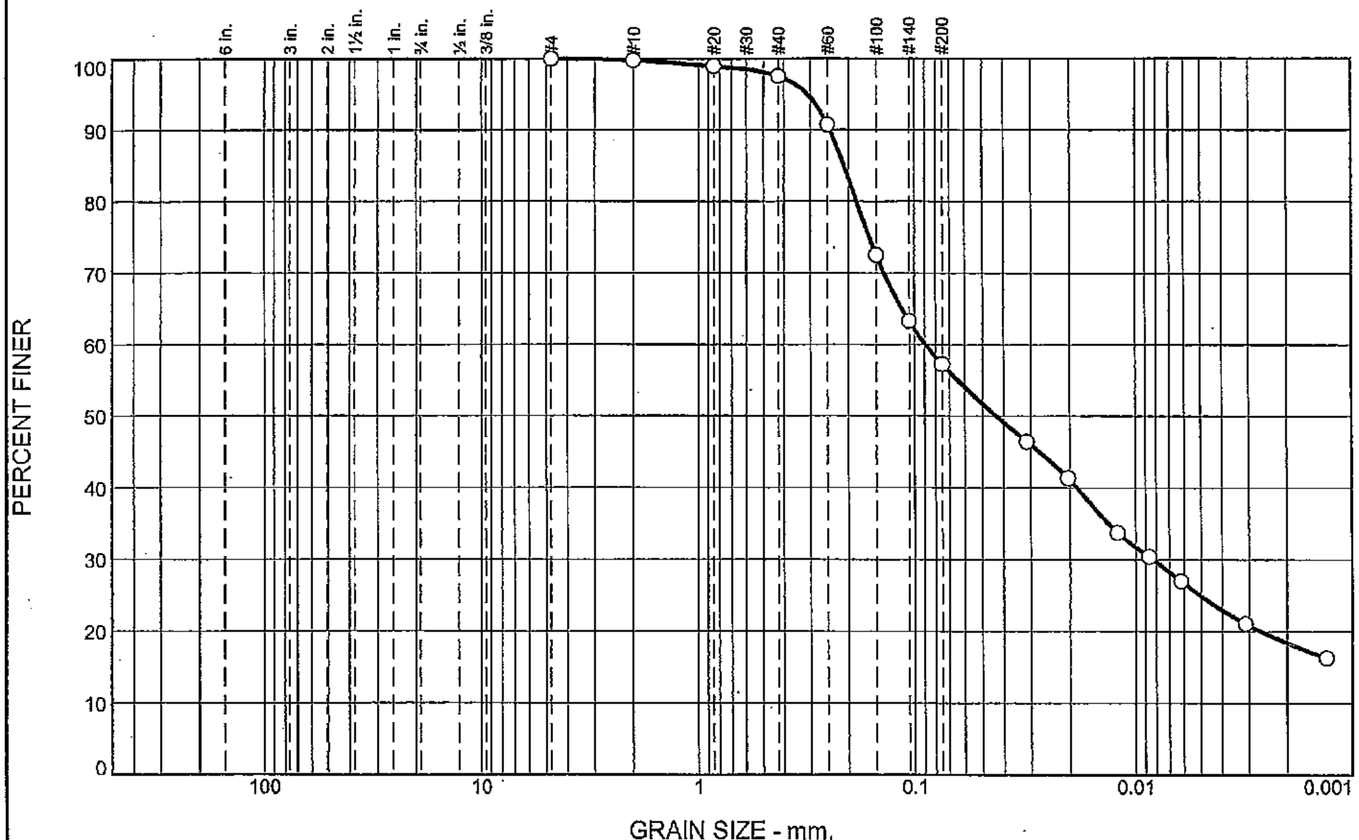


Client: E. ON U.S. Services, Inc.
Project: Tyrone Power Station
Location: B-6C **Depth:** 20-22
Project No.: 314310131701

MACTEC Engineering and Consulting, Inc.

Tested By: J. Alexander **Checked By:** D. Kopitsky

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	2.2	40.3	32.3	25.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#20	99.0		
#40	97.6		
#60	90.7		
#100	72.6		
#140	63.3		
#200	57.3		
0.0314 mm.	46.5		
0.0203 mm.	41.4		
0.0121 mm.	33.8		
0.0087 mm.	30.5		
0.0062 mm.	27.1		
0.0031 mm.	21.1		
0.0013 mm.	16.3		

* (no specification provided)

Soil Description

sandy lean clay

Atterberg Limits

PL= 16 LL= 26 PI= 10

Coefficients

D_{90}= 0.2436 D_{85}= 0.2094 D_{60}= 0.0890
D_{50}= 0.0431 D_{30}= 0.0082 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-4(3)

Remarks

Location: B-6C
Depth: 20-22
Date: 8-16-10

MACTEC Engineering and Consulting, Inc. Charlotte, North Carolina	**Client:** E. ON U.S. Services, Inc. **Project:** Tyrone Power Station **Project No:** 314310131701

Tested By: J. Alexander **Checked By:** D. Kopitsky

SUMMARY OF SLOPE STABILITY RESULTS

PCSTABL PLOTS

MACTEC

Tyrone Power Station		
3143-10-1317.01		
ALB	Date:	9/22/2010
NGC	Date:	9/24/2010

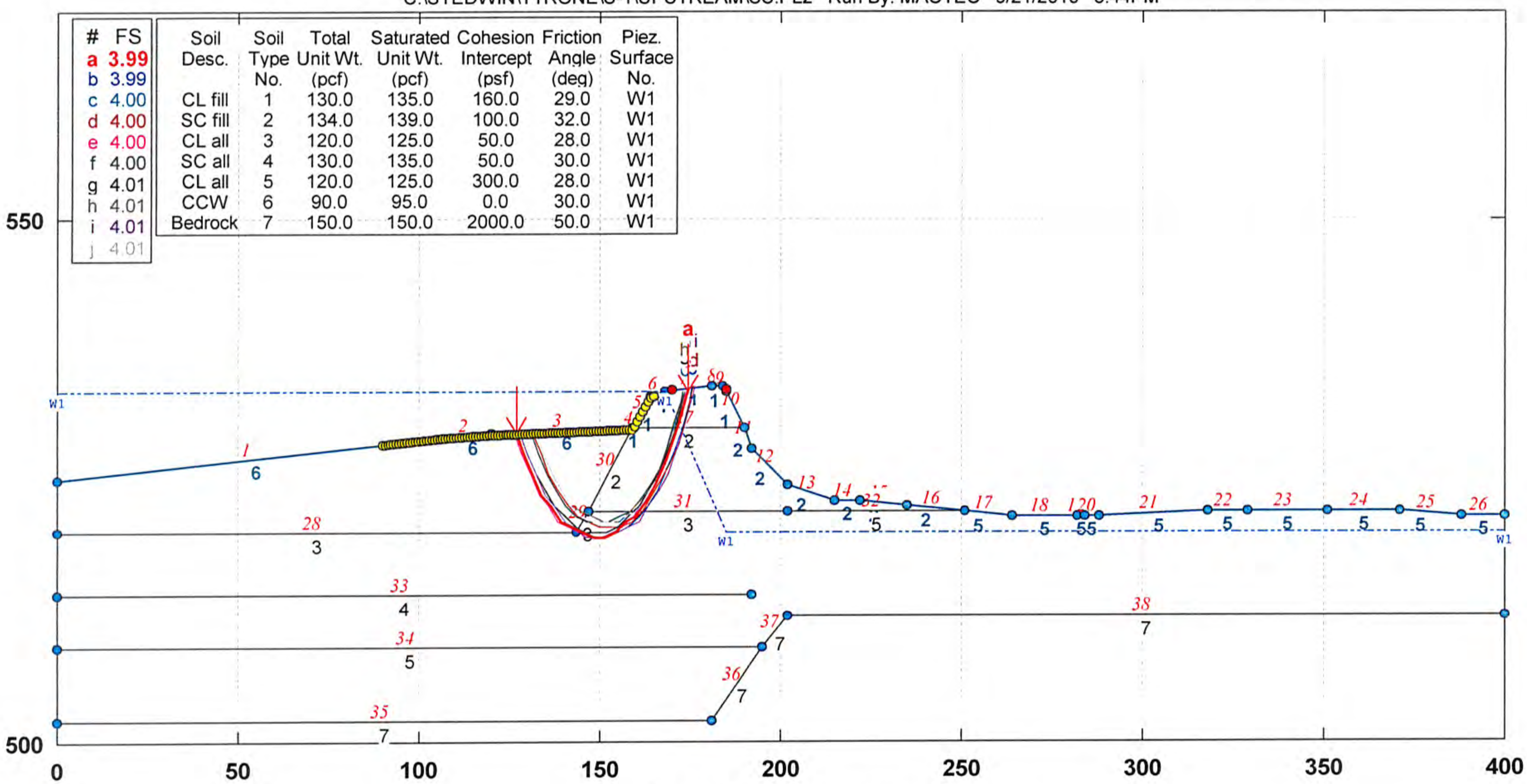
Results of Slope Stability Analyses - Tyrone Power Station Ash Pond

Critical Section	Upstream Slope (H:V)	Downstream Slope (H:V)	Long-Term Steady State/Max Surcharge Pool		Rapid Drawdown		Seismic	
			Target FOS*	FOS	Target FOS*	FOS	Target FOS*	FOS
1 Upstream	1.6 : 1.0	-	1.5	4.0	1.2	2.6	1.2	2.6
1 Downstream	-	1.3 : 1.0	1.5	2.3	1.2	2.3	1.2	2.0
2 Upstream	2.5 : 1.0	-	1.5	6.6	1.2	4.7	1.2	3.8
2 Downstream		2.3 : 1.0	1.5	3.1	1.2	3.1	1.2	2.7
3 Upstream	2.1 : 1.0	-	1.5	3.2	1.2	1.8	1.2	2.4
3 Downstream	-	2.3 : 1.0	1.5	3.3	1.2	3.3	1.2	2.8
4 Upstream	1.8 : 1.0	-	1.5	3.0	1.2	1.6	1.2	2.4
4 Downstream		3.0 : 1.0	1.5	2.4	1.2	2.4	1.2	2.0
5 Upstream	2.2 : 1.0	-	1.5	2.9	1.2	1.6	1.2	2.2
5 Downstream	-	2.2 : 1.0	1.5	2.2	1.2	2.2	1.2	1.9
6 Upstream	2.4 : 1.0	-	1.5	3.5	1.2	1.9	1.2	2.6
6 Downstream		1.6 : 1.0	1.5	2.0	1.2	2.0	1.2	1.8

*Target Factor of Safety References: Design Criteria for Dams & Associated Structures (401 KAR 4:030, KAR 4:040)
USACE EM 1110-2-1902: Slope Stability
MSHA Engineering and Design Manual

3143-10-1317 Tyrone Power Station Section 1: Upstream - SS/Max Flood

C:\STEDWIN\TYRONE\S-1\UPSTREAM\SS.PL2 Run By: MACTEC 9/21/2010 3:44PM



#	FS
a	3.99
b	3.99
c	4.00
d	4.00
e	4.00
f	4.00
g	4.01
h	4.01
i	4.01
j	4.01

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
SC fill	2	134.0	139.0	100.0	32.0	W1
CL all	3	120.0	125.0	50.0	28.0	W1
SC all	4	130.0	135.0	50.0	30.0	W1
CL all	5	120.0	125.0	300.0	28.0	W1
CCW	6	90.0	95.0	0.0	30.0	W1
Bedrock	7	150.0	150.0	2000.0	50.0	W1

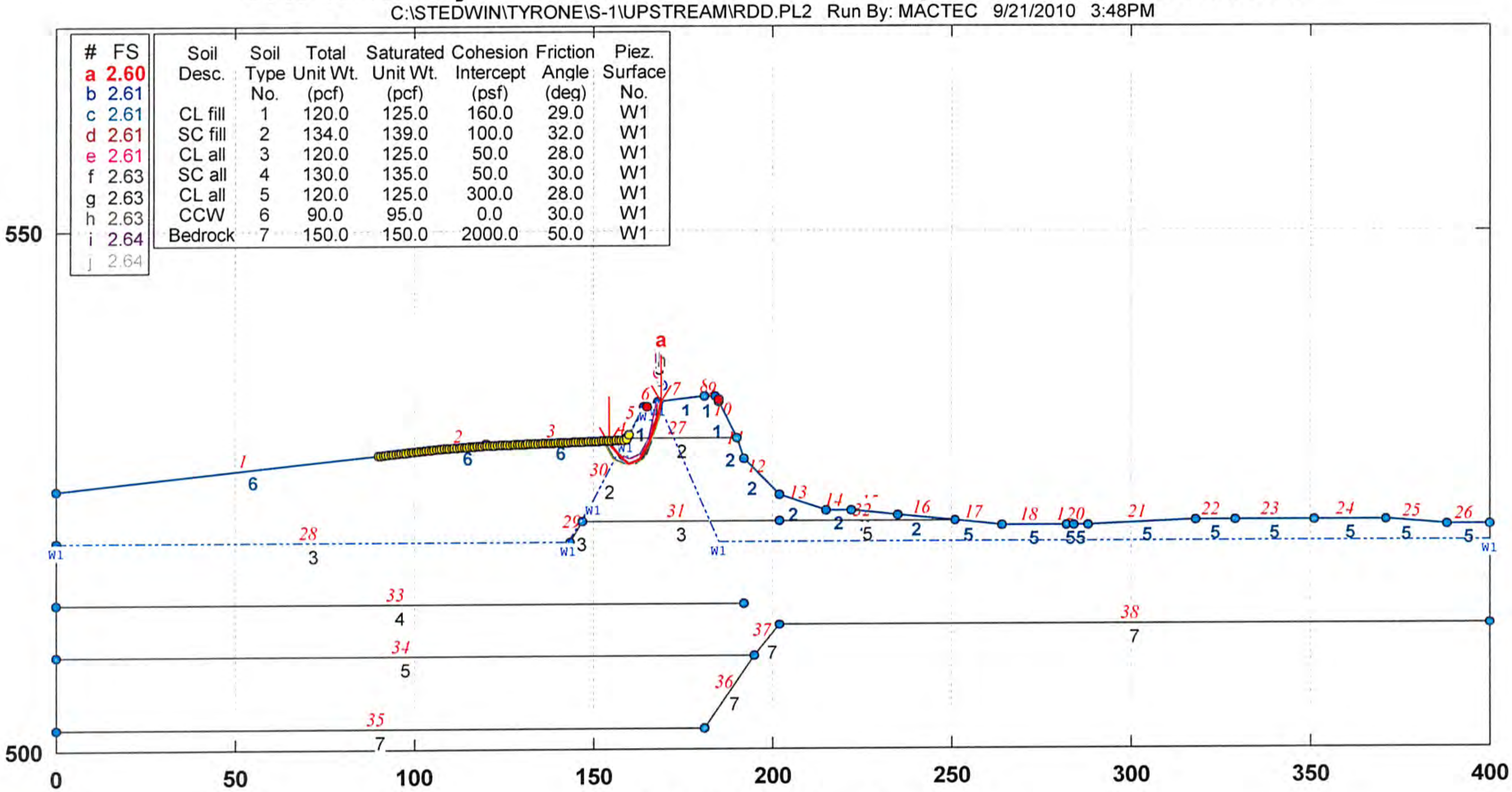
STABL6H FSmin=3.99

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 1: Upstream - Rapid Drawdown

C:\STEDWIN\TYRONE\S-1\UPSTREAM\RDD.PL2 Run By: MACTEC 9/21/2010 3:48PM



#	FS
a	2.60
b	2.61
c	2.61
d	2.61
e	2.61
f	2.63
g	2.63
h	2.63
i	2.64
j	2.64

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	120.0	125.0	160.0	29.0	W1
SC fill	2	134.0	139.0	100.0	32.0	W1
CL all	3	120.0	125.0	50.0	28.0	W1
SC all	4	130.0	135.0	50.0	30.0	W1
CL all	5	120.0	125.0	300.0	28.0	W1
CCW	6	90.0	95.0	0.0	30.0	W1
Bedrock	7	150.0	150.0	2000.0	50.0	W1

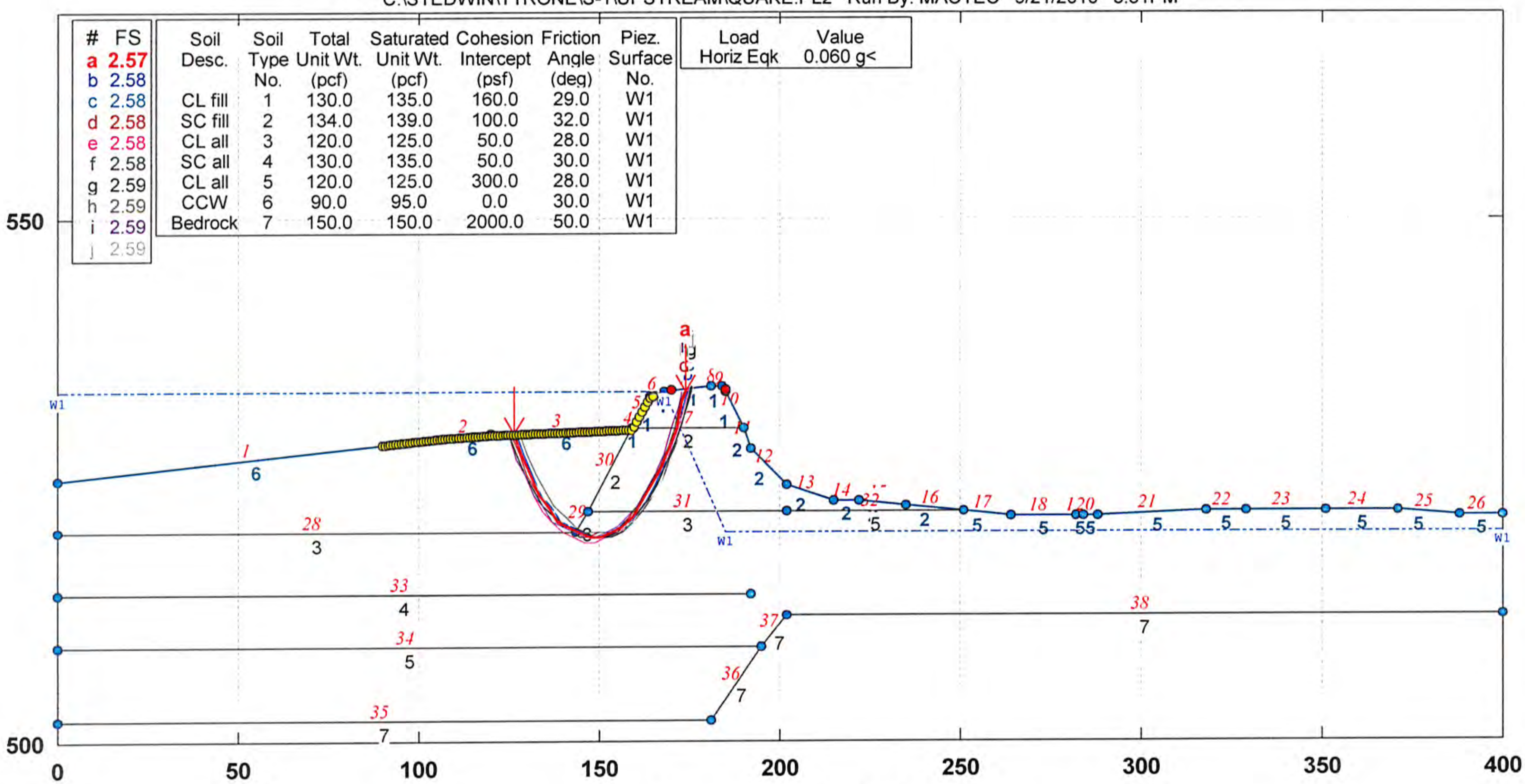
STABL6H FSmin=2.60

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 1: Upstream - Seismic

C:\STEDWIN\TYRONE\S-1\UPSTREAM\QUAKE.PL2 Run By: MACTEC 9/21/2010 3:51PM

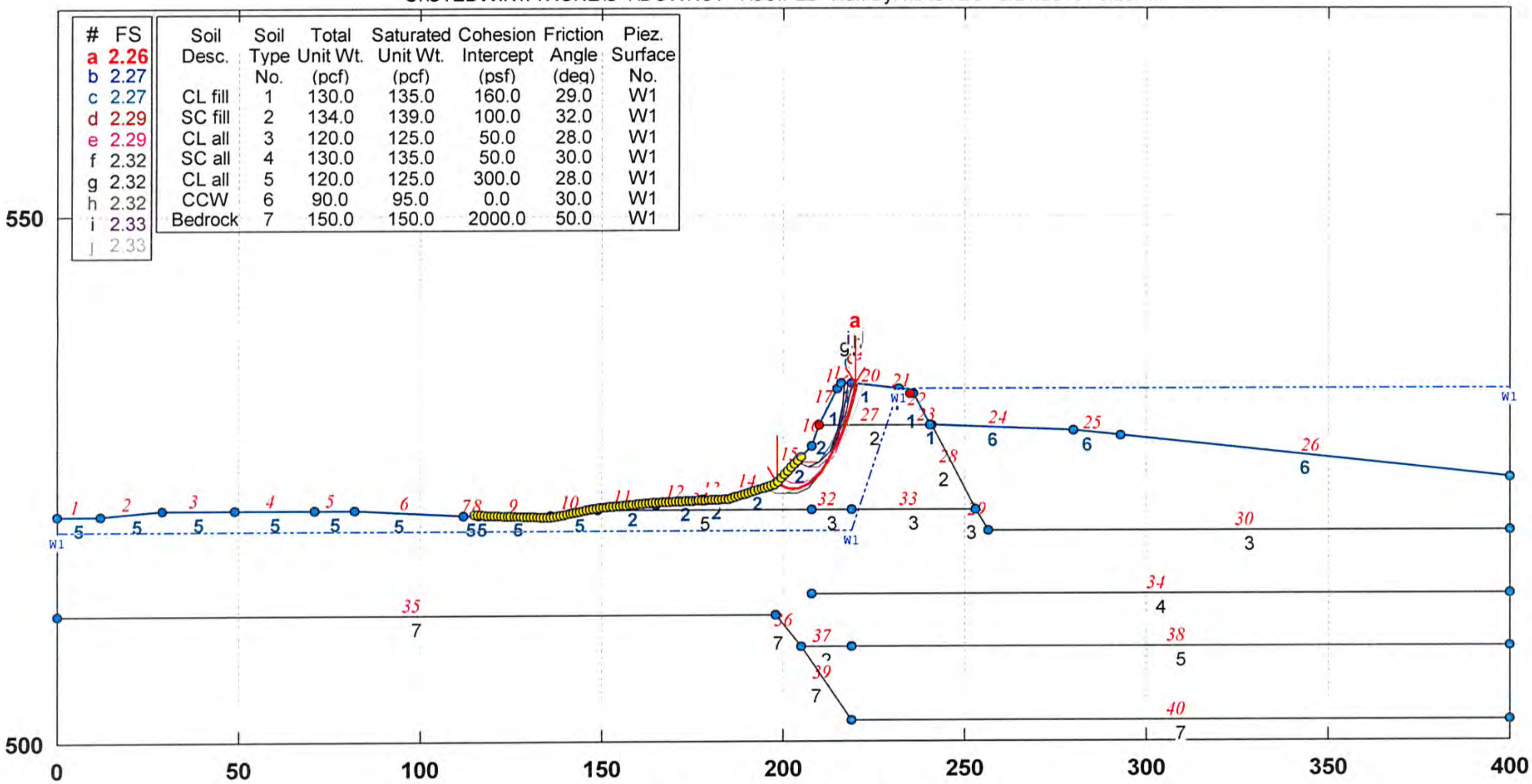


STABL6H FSmin=2.57

Safety Factors Are Calculated By The Modified Bishop Method

3143-10-1317 Tyrone Power Station Section 1: Downstream - SS/Max Flood

C:\STEDWIN\TYRONE\S-1\DOWNST~1\SS.PL2 Run By: MACTEC 9/21/2010 3:29PM



#	FS
a	2.26
b	2.27
c	2.27
d	2.29
e	2.29
f	2.32
g	2.32
h	2.32
i	2.33
j	2.33

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
SC fill	2	134.0	139.0	100.0	32.0	W1
CL all	3	120.0	125.0	50.0	28.0	W1
SC all	4	130.0	135.0	50.0	30.0	W1
CL all	5	120.0	125.0	300.0	28.0	W1
CCW	6	90.0	95.0	0.0	30.0	W1
Bedrock	7	150.0	150.0	2000.0	50.0	W1

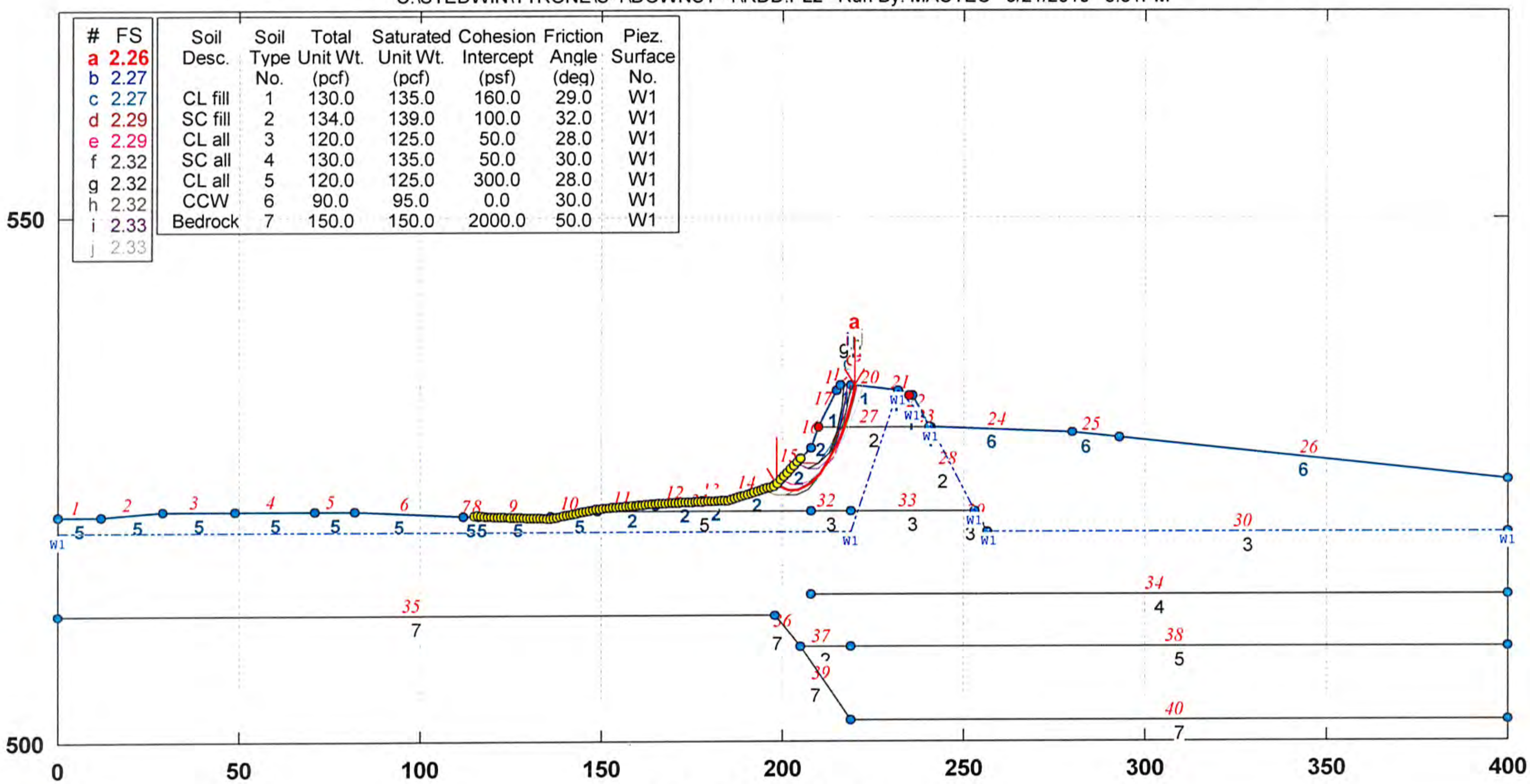
STABL6H FSmin=2.26

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 1: Downstream - Rapid Drawdown

C:\STEDWIN\TYRONE\S-1\DOWNST~1\RDD.PL2 Run By: MACTEC 9/21/2010 3:31PM



#	FS
a	2.26
b	2.27
c	2.27
d	2.29
e	2.29
f	2.32
g	2.32
h	2.32
i	2.33
j	2.33

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
SC fill	2	134.0	139.0	100.0	32.0	W1
CL all	3	120.0	125.0	50.0	28.0	W1
SC all	4	130.0	135.0	50.0	30.0	W1
CL all	5	120.0	125.0	300.0	28.0	W1
CCW	6	90.0	95.0	0.0	30.0	W1
Bedrock	7	150.0	150.0	2000.0	50.0	W1

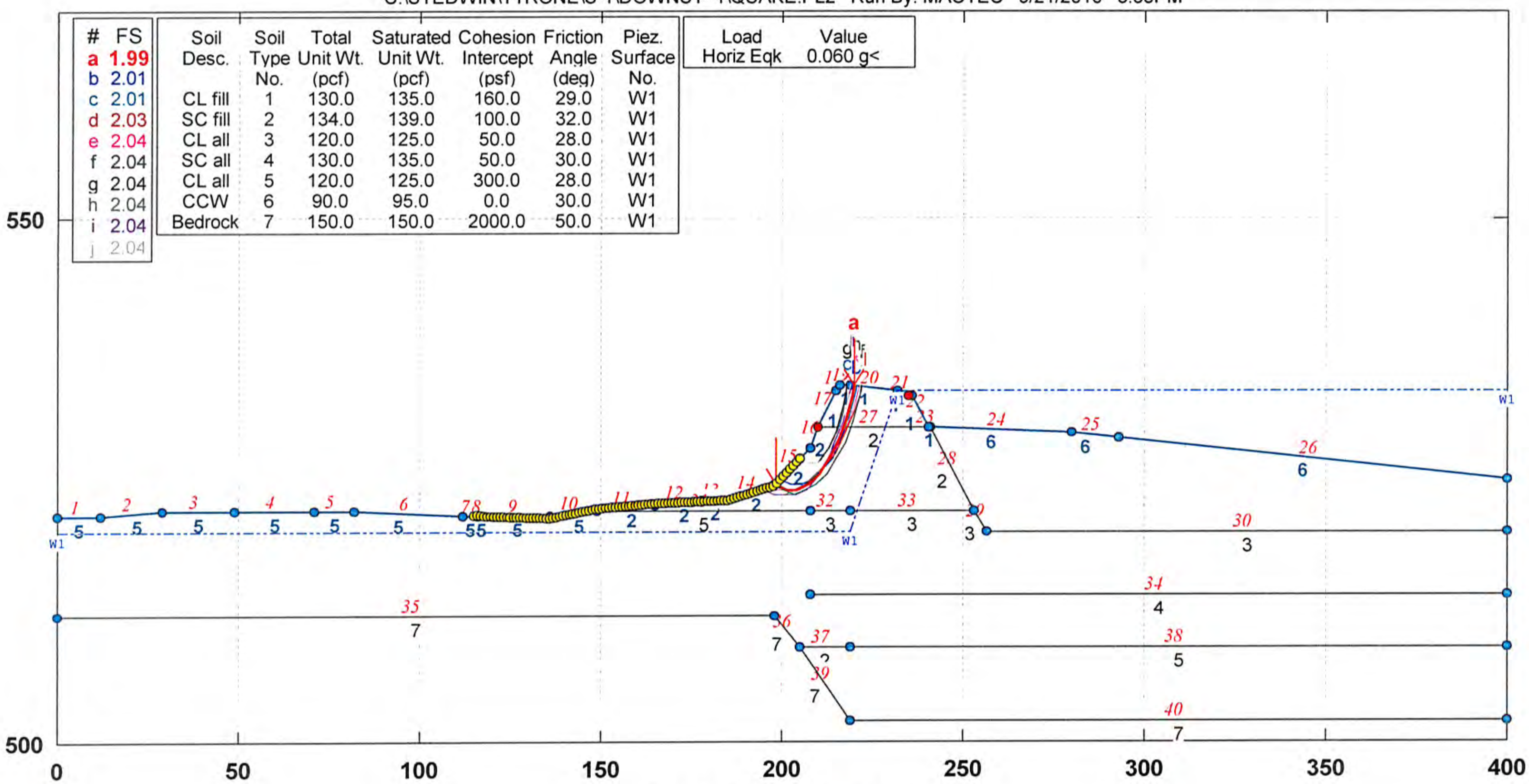
STABL6H FSmin=2.26

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 1: Downstream - Seismic

C:\STEDWIN\TYRONE\S-1\DOWNST~1\QUAKE.PL2 Run By: MACTEC 9/21/2010 3:35PM



#	FS
a	1.99
b	2.01
c	2.01
d	2.03
e	2.04
f	2.04
g	2.04
h	2.04
i	2.04
j	2.04

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
SC fill	2	134.0	139.0	100.0	32.0	W1
CL all	3	120.0	125.0	50.0	28.0	W1
SC all	4	130.0	135.0	50.0	30.0	W1
CL all	5	120.0	125.0	300.0	28.0	W1
CCW	6	90.0	95.0	0.0	30.0	W1
Bedrock	7	150.0	150.0	2000.0	50.0	W1

Load	Value
Horiz Eqk	0.060 g<

STABL6H FSmin=1.99

Safety Factors Are Calculated By The Modified Bishop Method

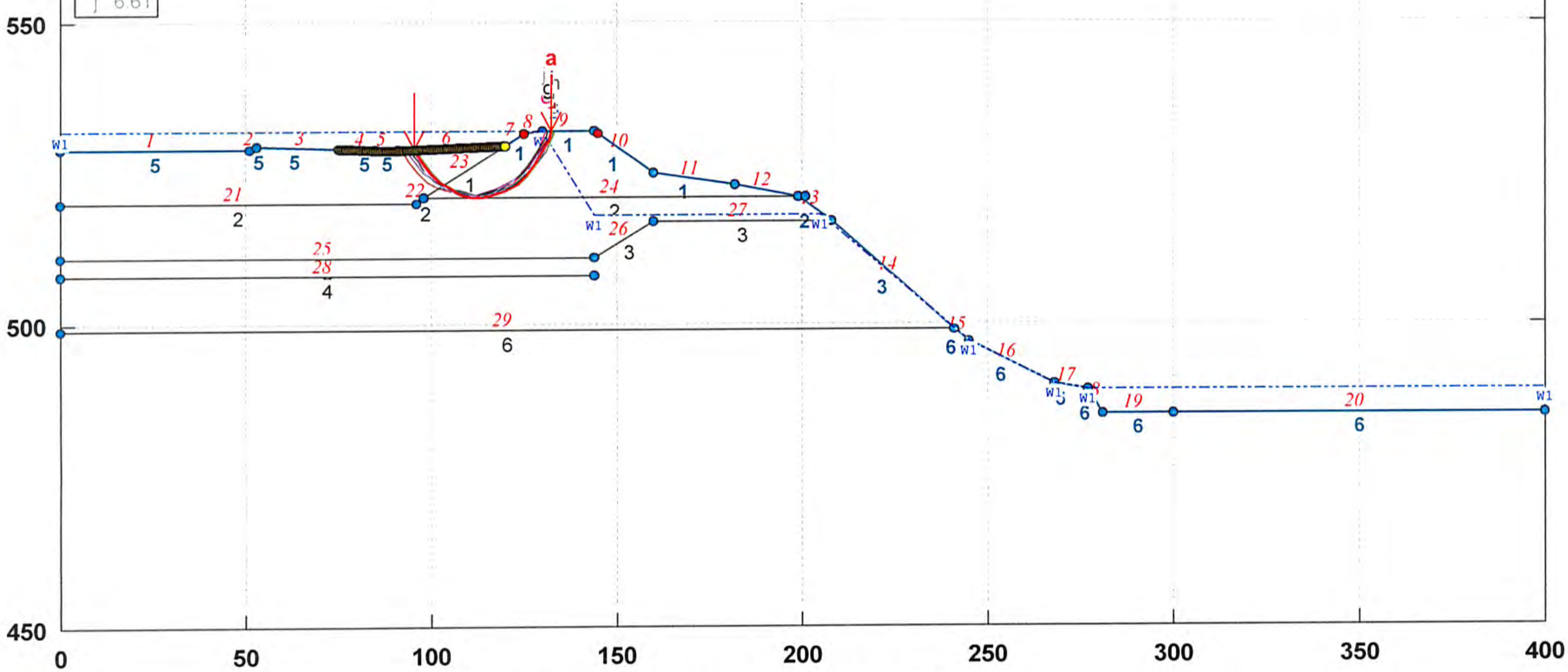
STED

3143-10-1317 Tyrone Power Station Section 2: Upstream - SS/Max Flood

C:\STEDWIN\TYRONE\S-2\UPSTREAM\SS.PL2 Run By: MACTEC albrenneman 9/7/2010 10:24AM

#	FS
a	6.56
b	6.57
c	6.58
d	6.58
e	6.59
f	6.60
g	6.60
h	6.61
i	6.61
j	6.61

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
CL all	2	120.0	125.0	300.0	28.0	W1
SM all	3	133.0	138.0	0.0	30.0	W1
CL all	4	120.0	125.0	300.0	28.0	W1
CCW	5	90.0	95.0	0.0	30.0	W1
Bedrock	6	150.0	150.0	2000.0	50.0	W1



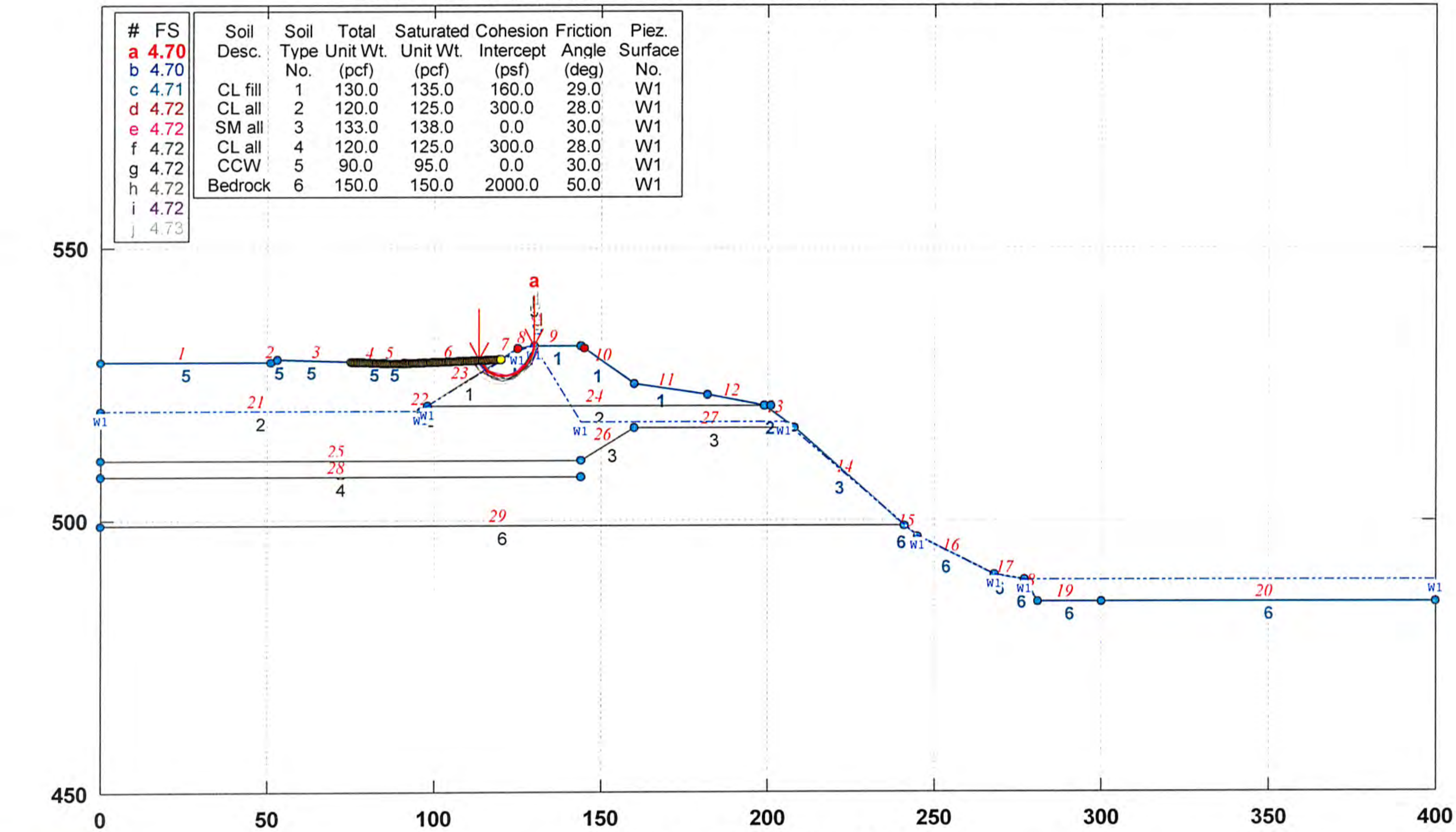
STABL6H FSmin=6.56

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 2: Upstream - Rapid Drawdown

C:\STEDWIN\TYRONE\S-2\UPSTREAM\RDD.PL2 Run By: MACTEC albrenneman 9/7/2010 10:29AM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
CL all	2	120.0	125.0	300.0	28.0	W1
SM all	3	133.0	138.0	0.0	30.0	W1
CL all	4	120.0	125.0	300.0	28.0	W1
CCW	5	90.0	95.0	0.0	30.0	W1
Bedrock	6	150.0	150.0	2000.0	50.0	W1

STABL6H FSmin=4.70
Safety Factors Are Calculated By The Modified Bishop Method

STED

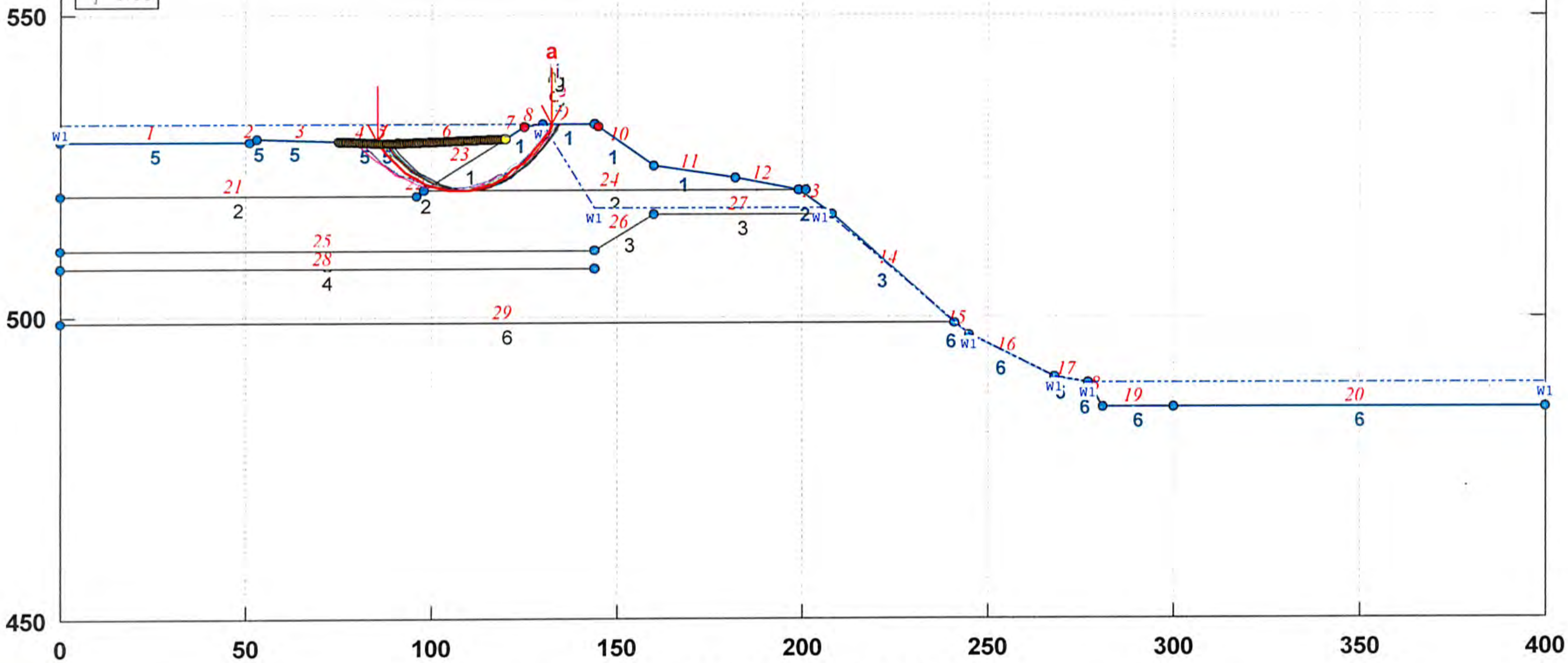
3143-10-1317 Tyrone Power Station Section 2: Upstream - Seismic

C:\STEDWIN\TYRONE\S-2\UPSTREAM\QUAKE.PL2 Run By: MACTEC albrenneman 9/7/2010 10:25AM

#	FS
a	3.79
b	3.81
c	3.82
d	3.82
e	3.82
f	3.82
g	3.83
h	3.83
i	3.83
j	3.83

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
CL all	2	120.0	125.0	300.0	28.0	W1
SM all	3	133.0	138.0	0.0	30.0	W1
CL all	4	120.0	125.0	300.0	28.0	W1
CCW	5	90.0	95.0	0.0	30.0	W1
Bedrock	6	150.0	150.0	2000.0	50.0	W1

Load	Value
Horiz Eqk	0.060 g<



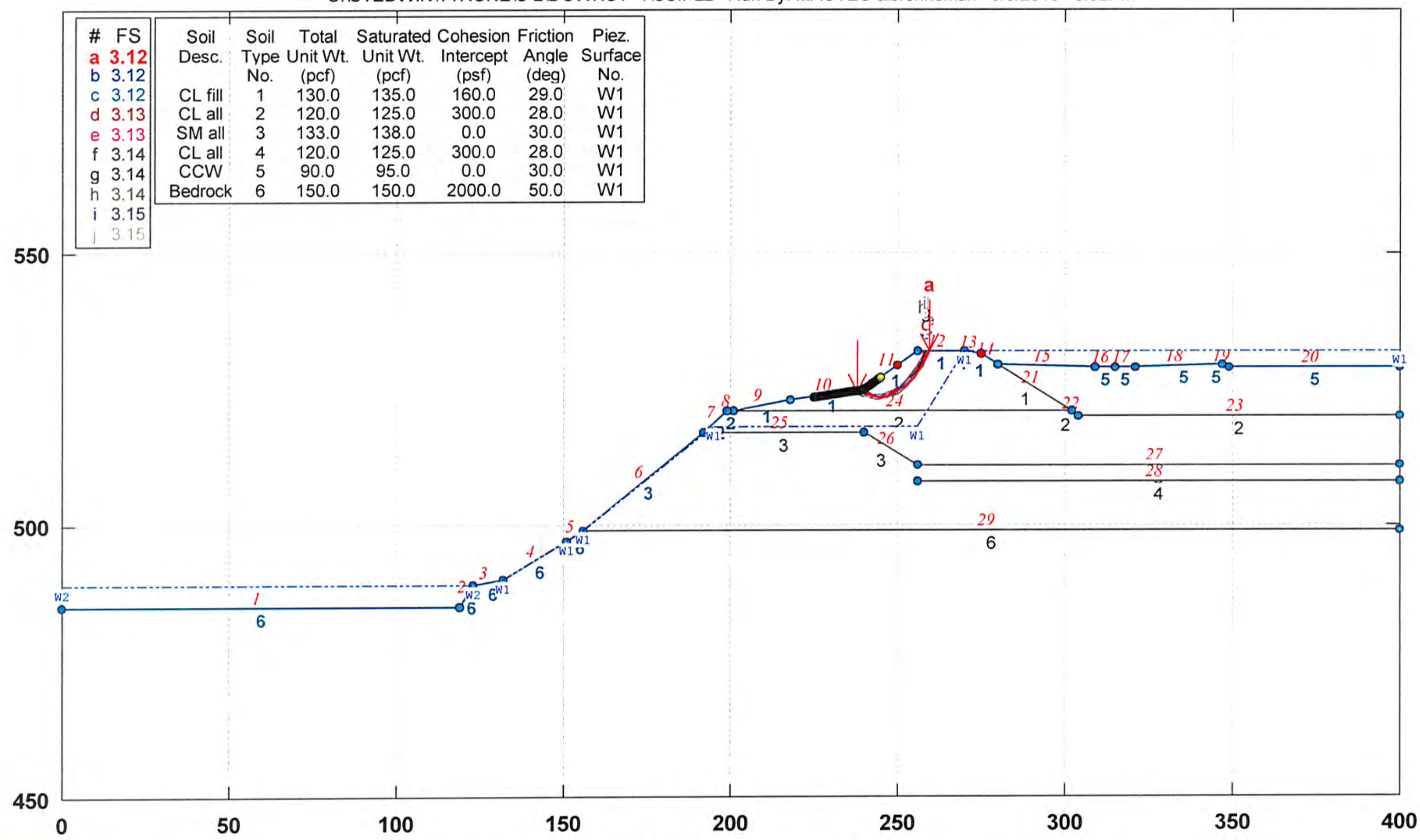
STABL6H FSmin=3.79

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 2: Downstream - SS/Max Flood

C:\STEDWIN\TYRONE\S-2\DOWNST~1\SS.PL2 Run By: MACTEC albrenneman 9/6/2010 6:02PM



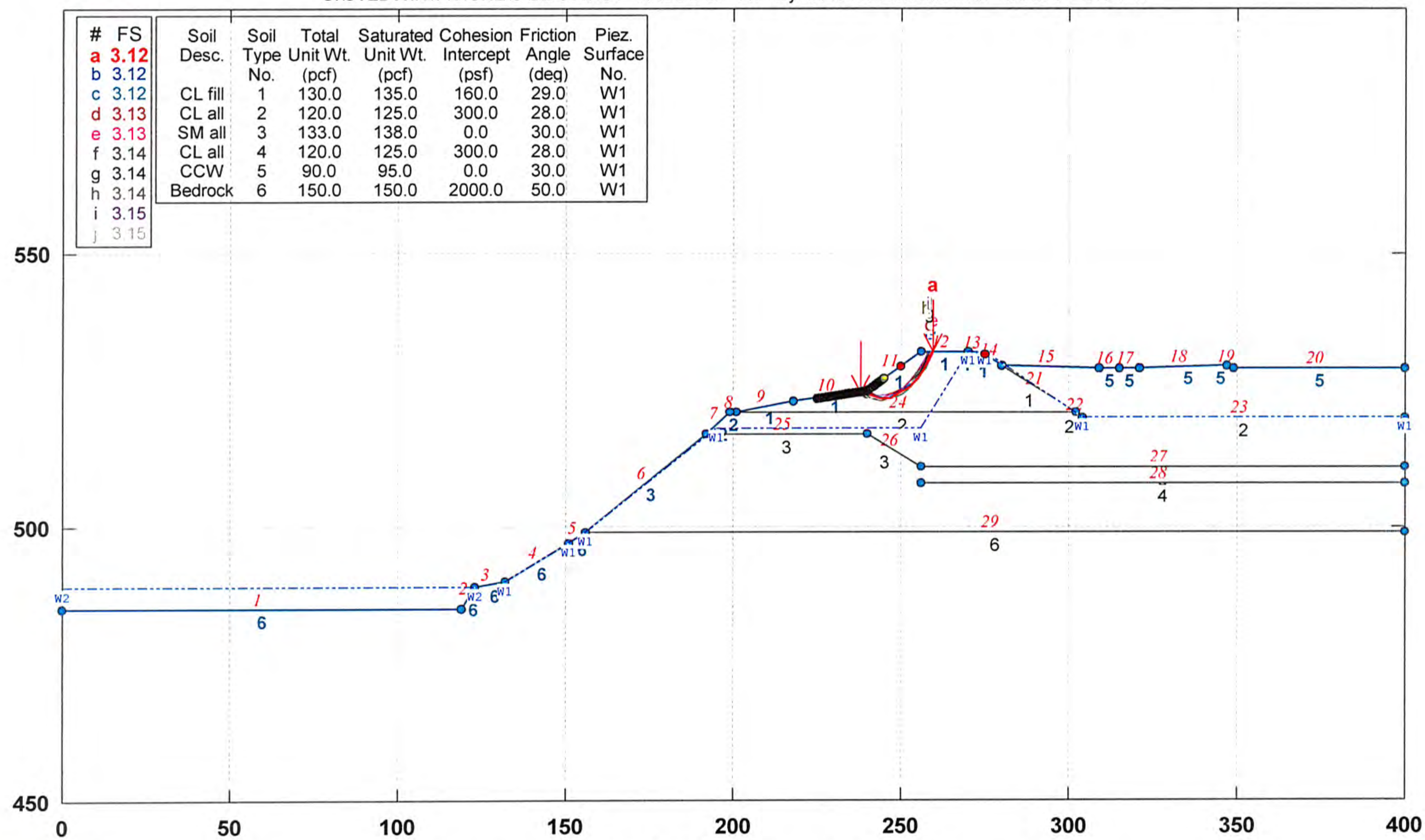
STABL6H FSmin=3.12

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 2: Downstream - Rapid Drawdown

C:\STEDWIN\TYRONE\S-2\DOWNST~1\RDD.PL2 Run By: MACTEC albrenneman 9/6/2010 6:05PM



#	FS
a	3.12
b	3.12
c	3.12
d	3.13
e	3.13
f	3.14
g	3.14
h	3.14
i	3.15
j	3.15

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
CL all	2	120.0	125.0	300.0	28.0	W1
SM all	3	133.0	138.0	0.0	30.0	W1
CL all	4	120.0	125.0	300.0	28.0	W1
CCW	5	90.0	95.0	0.0	30.0	W1
Bedrock	6	150.0	150.0	2000.0	50.0	W1

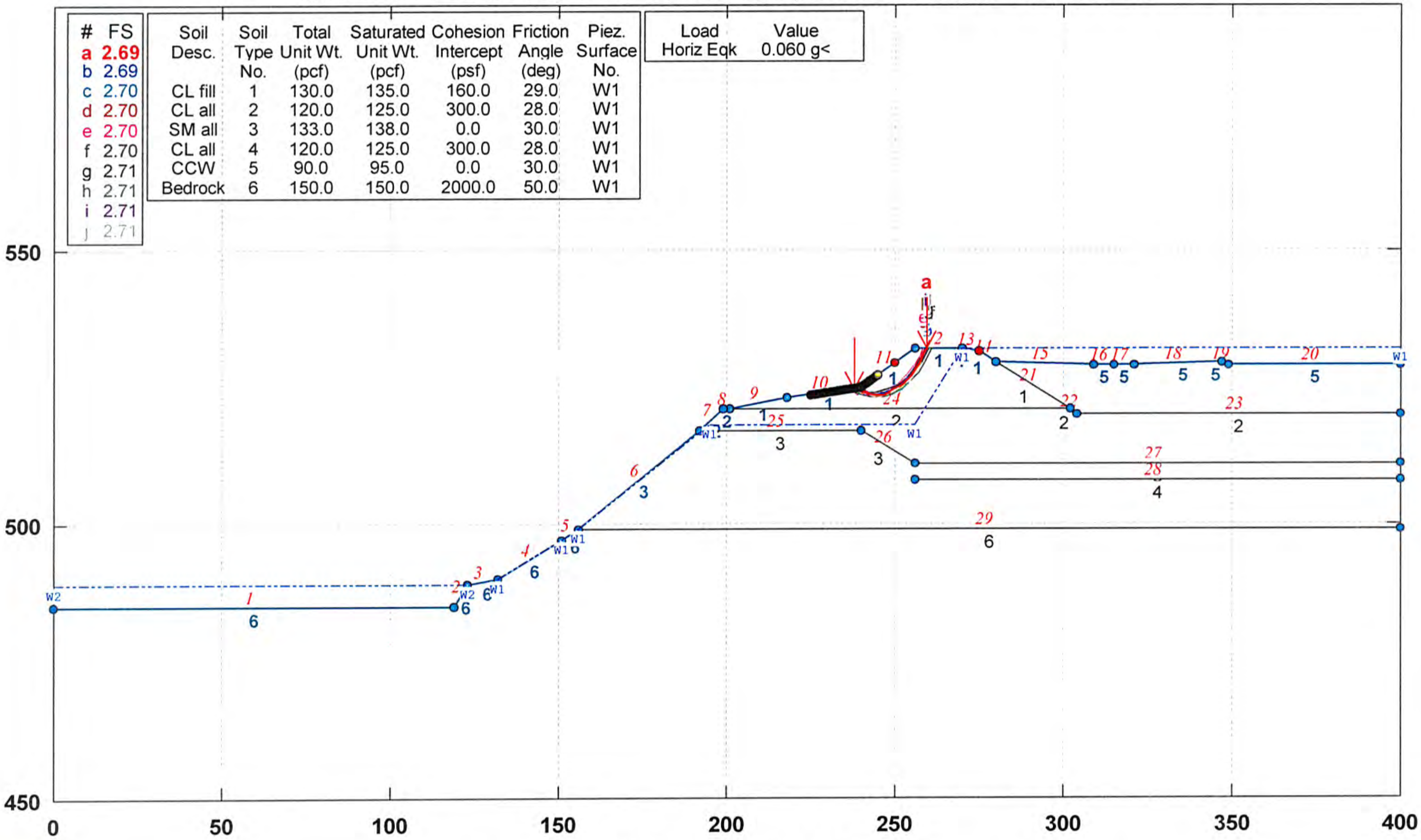
STABL6H FSmin=3.12

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 2: Downstream - Seismic

C:\STEDWIN\TYRONE\S-2\DOWNST~1\QUAKE.PL2 Run By: MACTEC albrenneman 9/6/2010 6:04PM



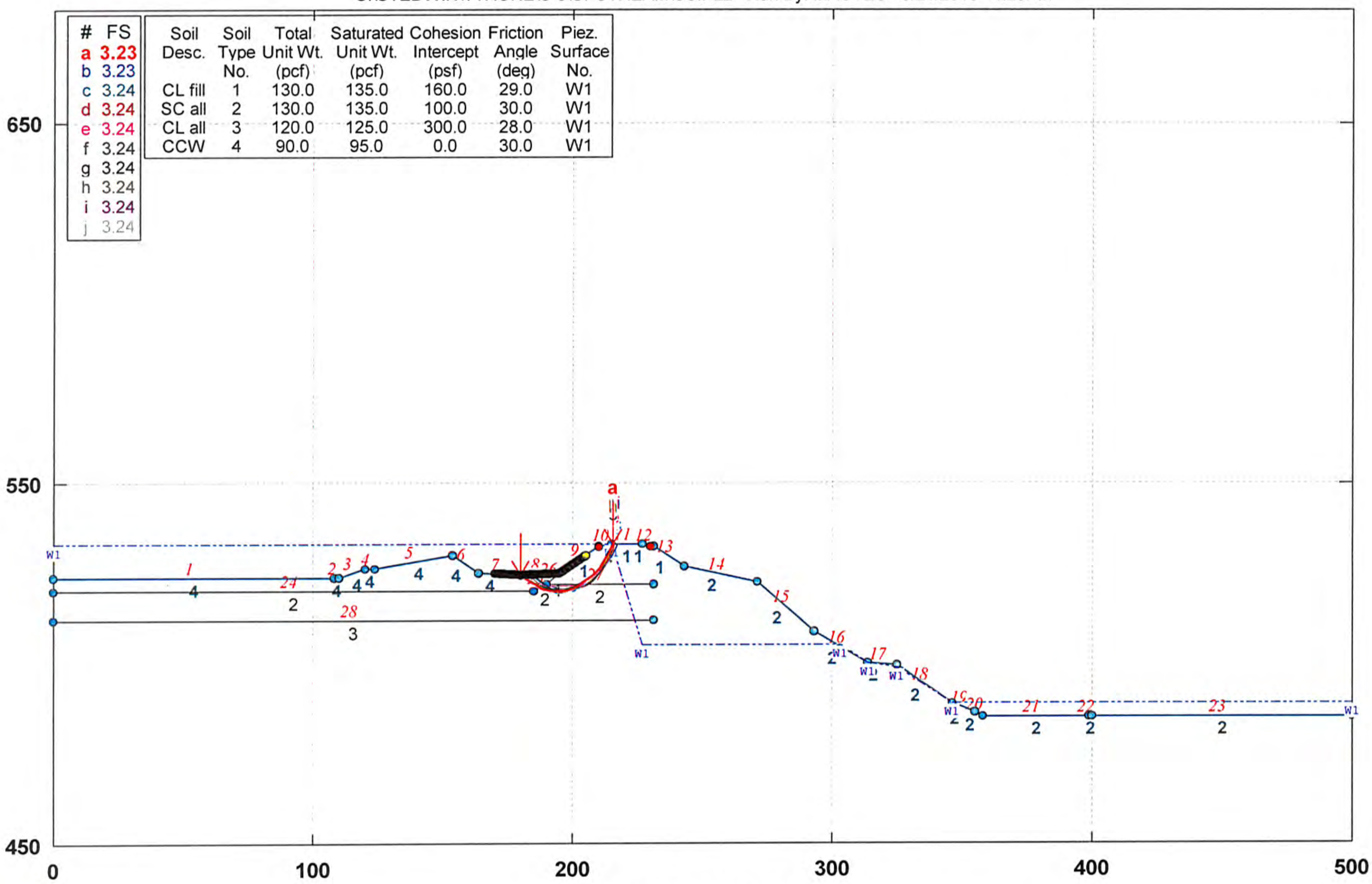
STABL6H FSmin=2.69

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 3: Upstream - SS/Max Flood

C:\STEDWIN\TYRONE\S-3\UPSTREAM\SS.PL2 Run By: MACTEC 9/21/2010 4:25PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
SC all	2	130.0	135.0	100.0	30.0	W1
CL all	3	120.0	125.0	300.0	28.0	W1
CCW	4	90.0	95.0	0.0	30.0	W1

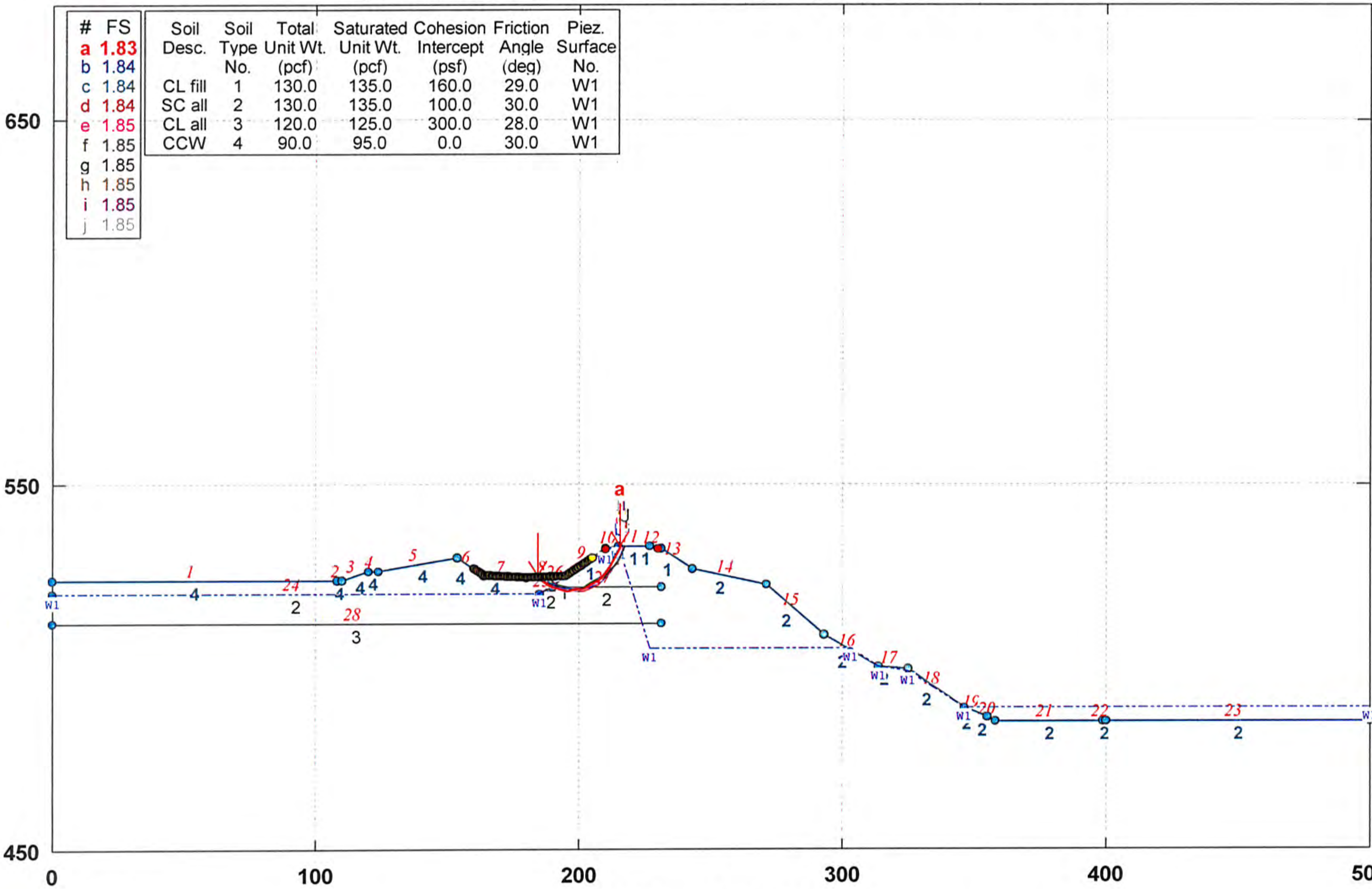
STABL6H FSmin=3.23

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 3: Upstream - Rapid Drawdown

C:\STEDWIN\TYRONE\S-3\UPSTREAM\RDD.PL2 Run By: MACTEC 9/21/2010 4:25PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
SC all	2	130.0	135.0	100.0	30.0	W1
CL all	3	120.0	125.0	300.0	28.0	W1
CCW	4	90.0	95.0	0.0	30.0	W1

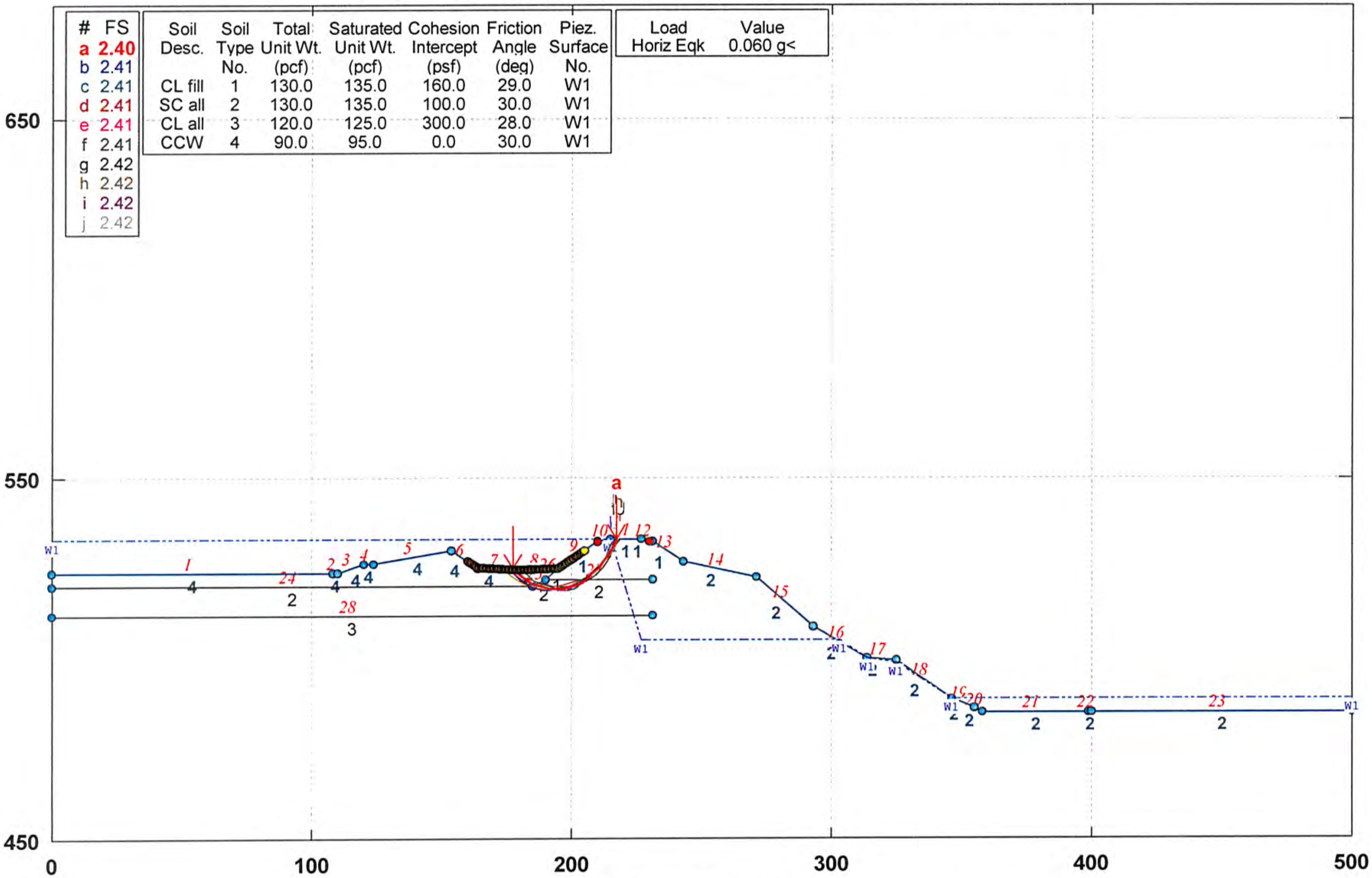
STABL6H FSmin=1.83

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 3: Upstream - Seismic

C:\STEDWIN\TYRONE\S-3\UPSTREAM\QUAKE.PL2 Run By: MACTEC 9/21/2010 4:26PM



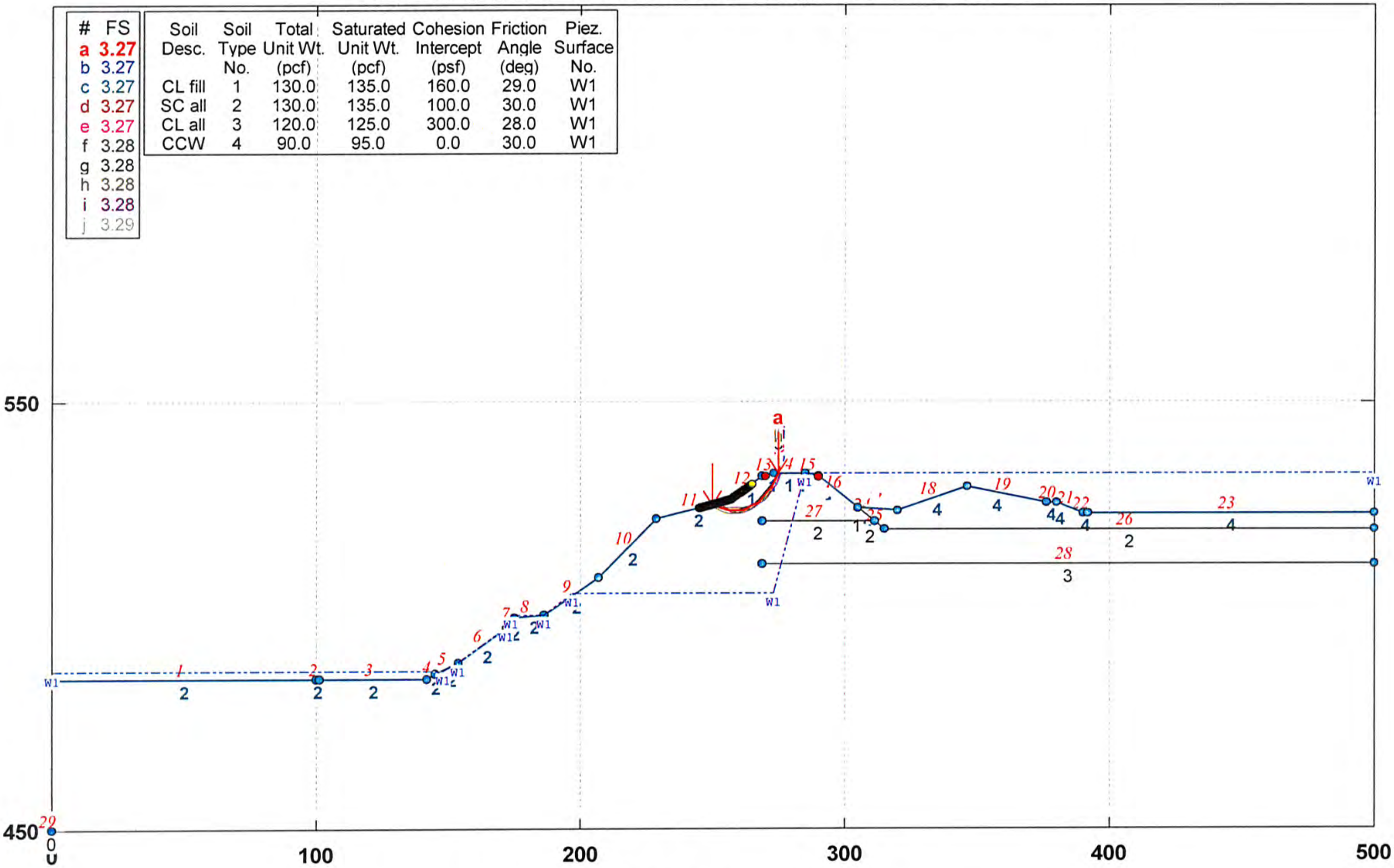
STABL6H FSmin=2.40

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 3: Downstream - SS/Max Flood

C:\STEDWIN\TYRONE\S-3\DOWNST~1\SS.PL2 Run By: MACTEC 9/21/2010 4:23PM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
SC all	2	130.0	135.0	100.0	30.0	W1
CL all	3	120.0	125.0	300.0	28.0	W1
CCW	4	90.0	95.0	0.0	30.0	W1

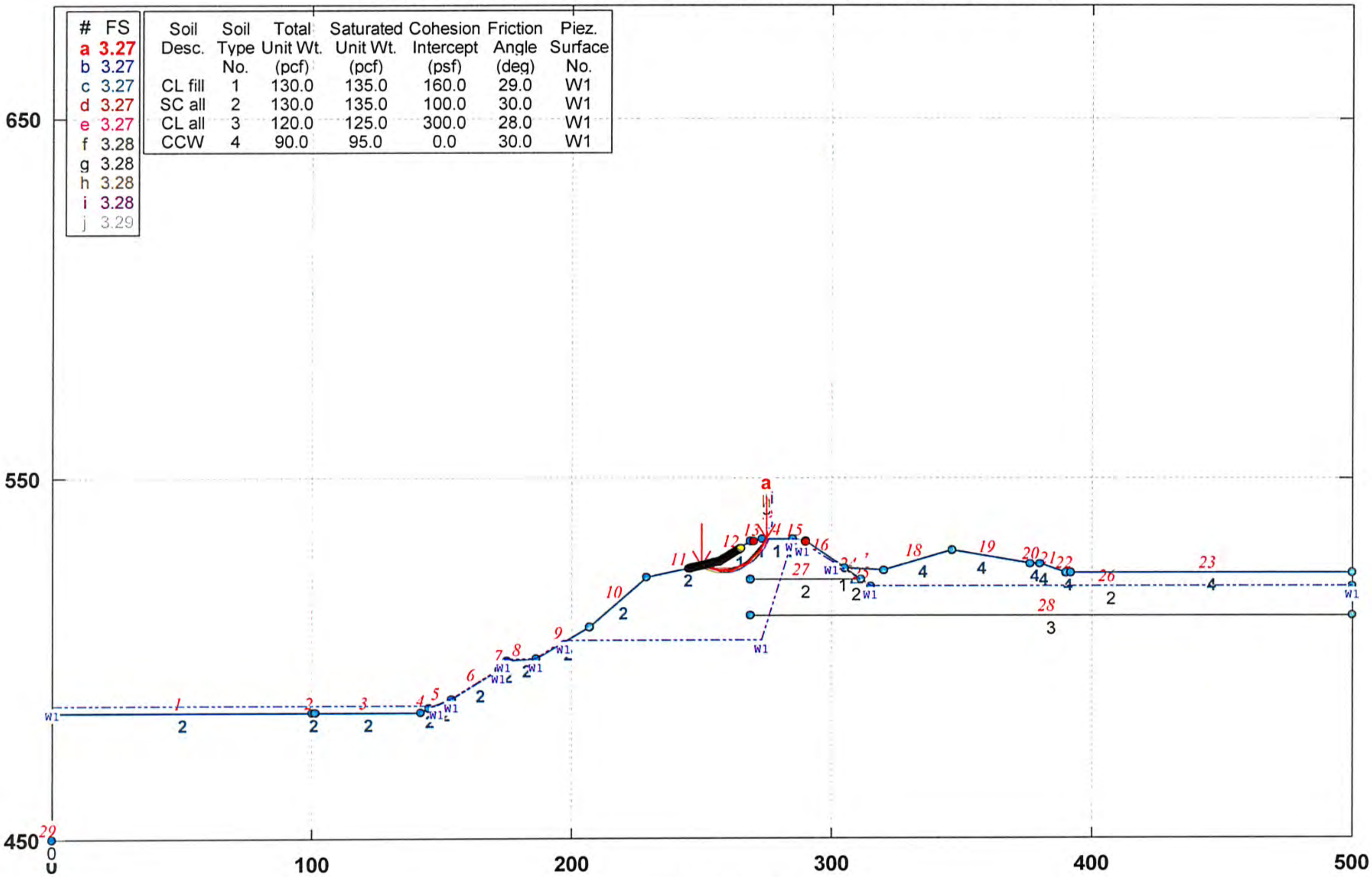
STABL6H FSmin=3.27

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 3: Downstream - Rapid Drawdown

C:\STEDWIN\TYRONE\S-3\DOWNST~1\RDD.PL2 Run By: MACTEC 9/21/2010 4:23PM



#	FS
a	3.27
b	3.27
c	3.27
d	3.27
e	3.27
f	3.28
g	3.28
h	3.28
i	3.28
j	3.29

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
SC all	2	130.0	135.0	100.0	30.0	W1
CL all	3	120.0	125.0	300.0	28.0	W1
CCW	4	90.0	95.0	0.0	30.0	W1

STABL6H FSmin=3.27

Safety Factors Are Calculated By The Modified Bishop Method

STED

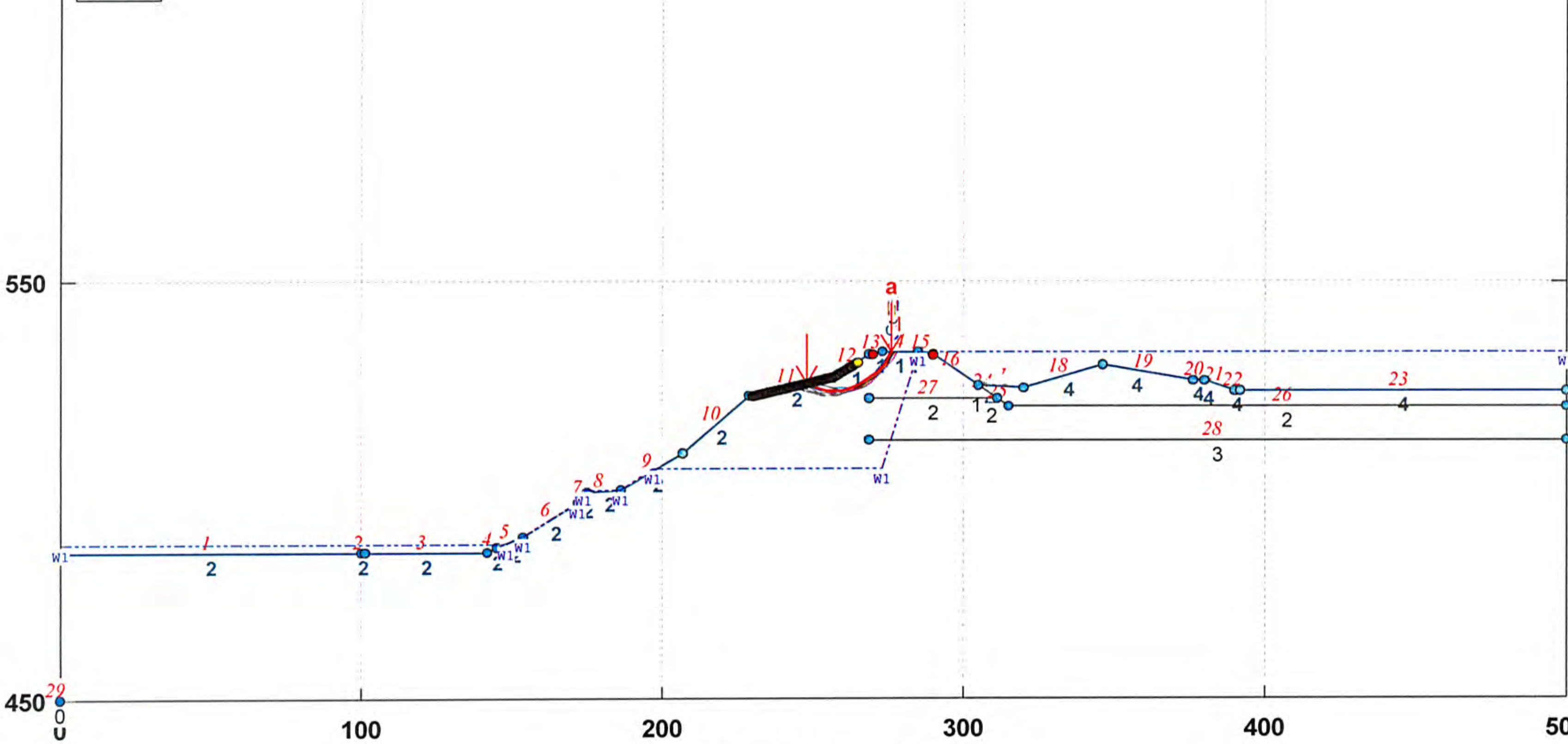
3143-10-1317 Tyrone Power Station Section 3: Downstream - Seismic

C:\STEDWIN\TYRONE\S-3\DOWNST~1\QUAKE.PL2 Run By: MACTEC 9/21/2010 4:24PM

#	FS
a	2.75
b	2.76
c	2.76
d	2.76
e	2.76
f	2.76
g	2.76
h	2.77
i	2.77
j	2.77

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
SC all	2	130.0	135.0	100.0	30.0	W1
CL all	3	120.0	125.0	300.0	28.0	W1
CCW	4	90.0	95.0	0.0	30.0	W1

Load	Value
Horiz Eqk	0.060 g<



STABL6H FSmin=2.75

Safety Factors Are Calculated By The Modified Bishop Method

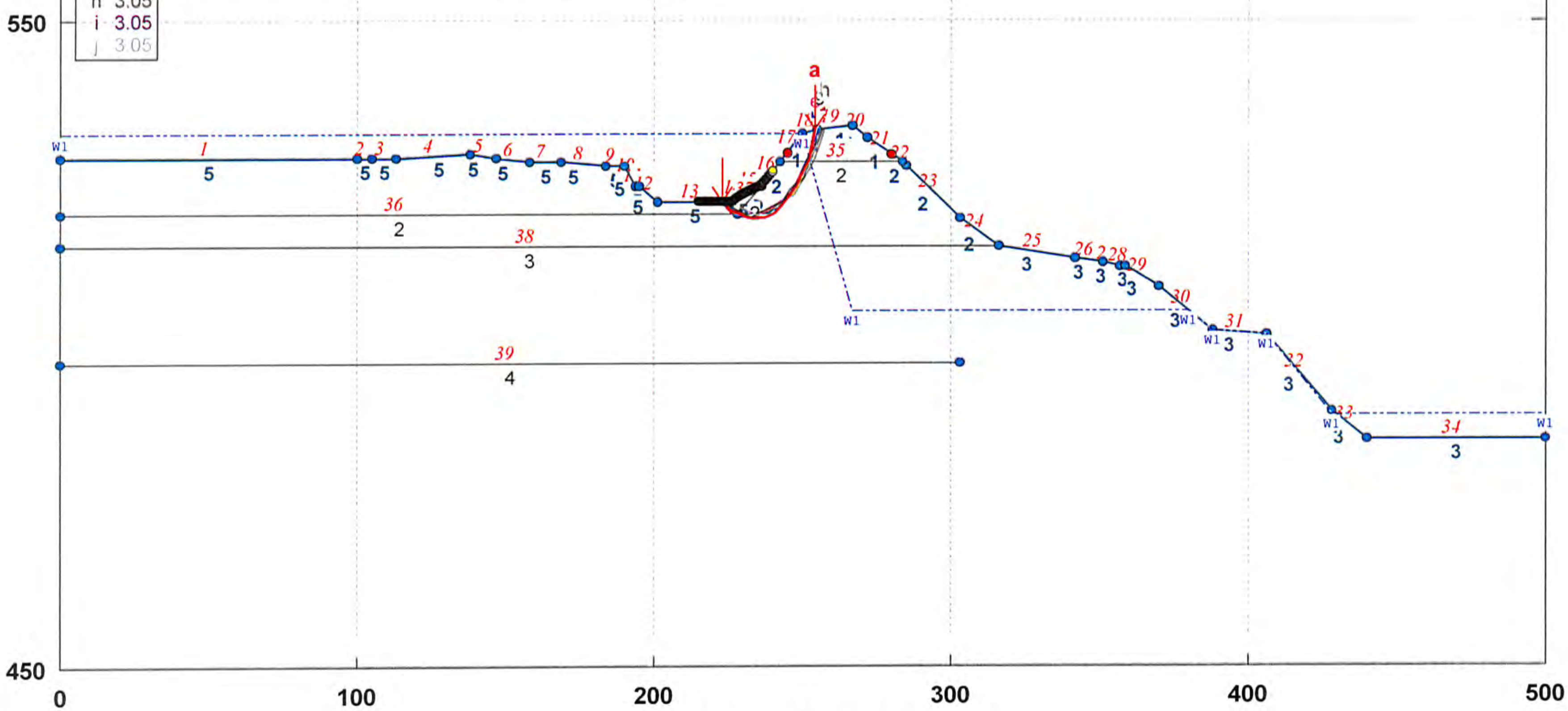
STED

3143-10-1317 Tyrone Power Station Section 4: Upstream - SS/Max Flood

C:\STEDWIN\TYRONE\S-4\UPSTREAM\SS.PL2 Run By: MACTEC 9/22/2010 11:49AM

#	FS
a	3.03
b	3.04
c	3.04
d	3.04
e	3.04
f	3.04
g	3.05
h	3.05
i	3.05
j	3.05

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
SM fill	1	135.0	140.0	200.0	24.0	W1
CL fill	2	130.0	135.0	160.0	29.0	W1
CL all	3	120.0	125.0	300.0	28.0	W1
SC all	4	130.0	135.0	100.0	30.0	W1
CCW	5	90.0	95.0	0.0	30.0	W1



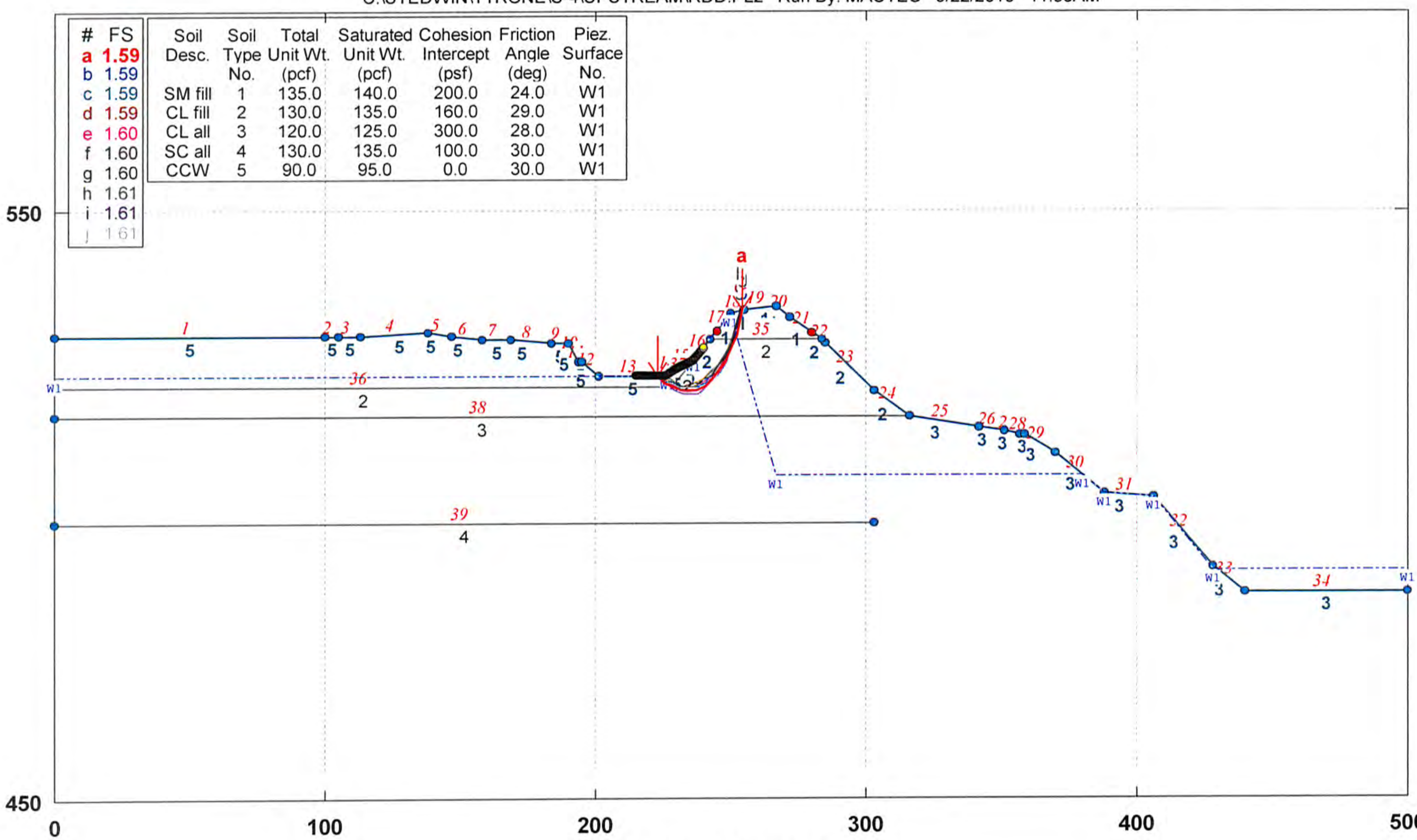
STABL6H FSmin=3.03

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 4: Upstream - Rapid Drawdown

C:\STEDWIN\TYRONE\S-4\UPSTREAM\RDD.PL2 Run By: MACTEC 9/22/2010 11:53AM



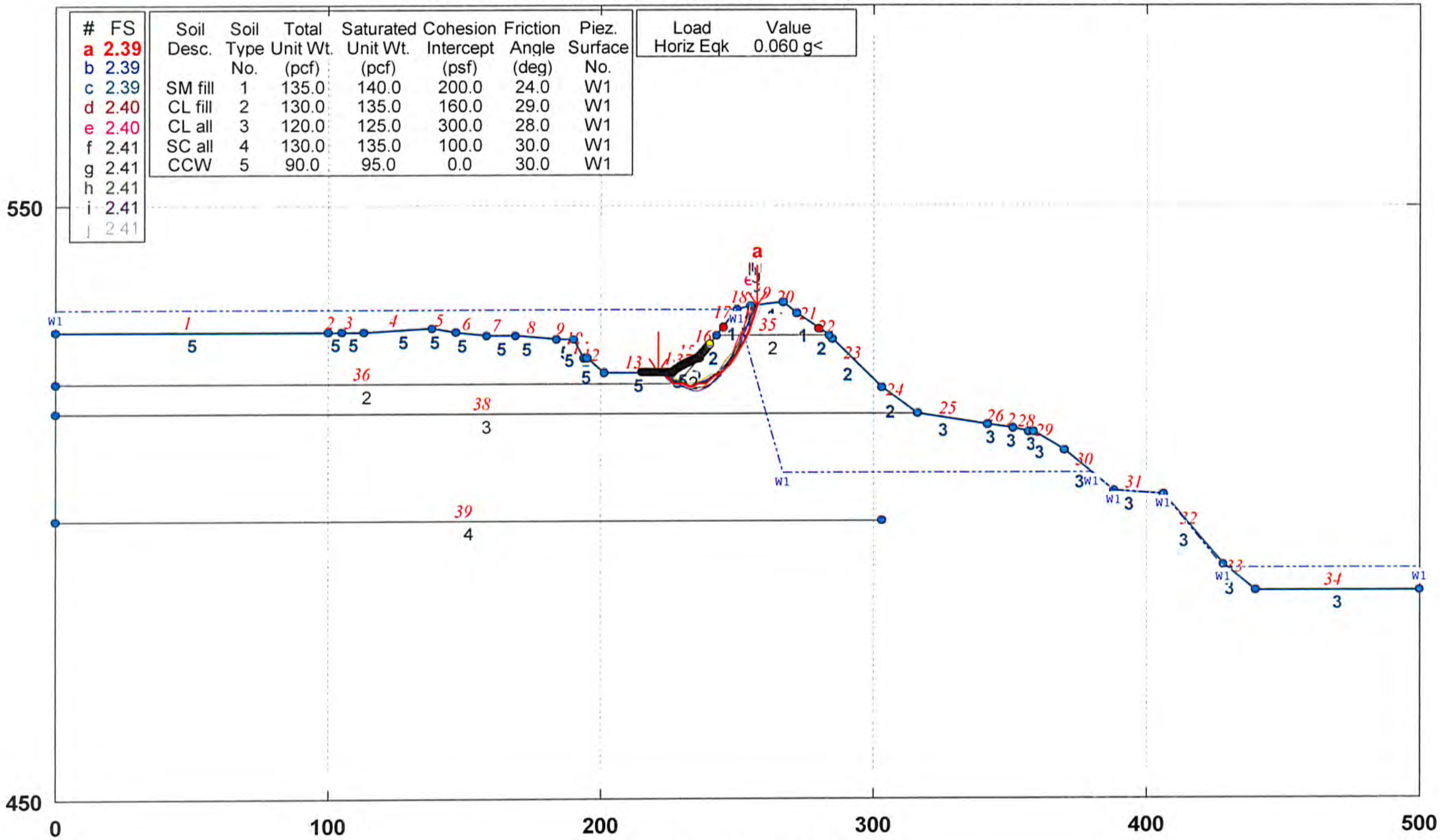
STABL6H FSmin=1.59

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 4: Upstream - Seismic

C:\STEDWIN\TYRONE\S-4\UPSTREAM\QUAKE.PL2 Run By: MACTEC 9/22/2010 11:52AM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
SM fill	1	135.0	140.0	200.0	24.0	W1
CL fill	2	130.0	135.0	160.0	29.0	W1
CL all	3	120.0	125.0	300.0	28.0	W1
SC all	4	130.0	135.0	100.0	30.0	W1
CCW	5	90.0	95.0	0.0	30.0	W1

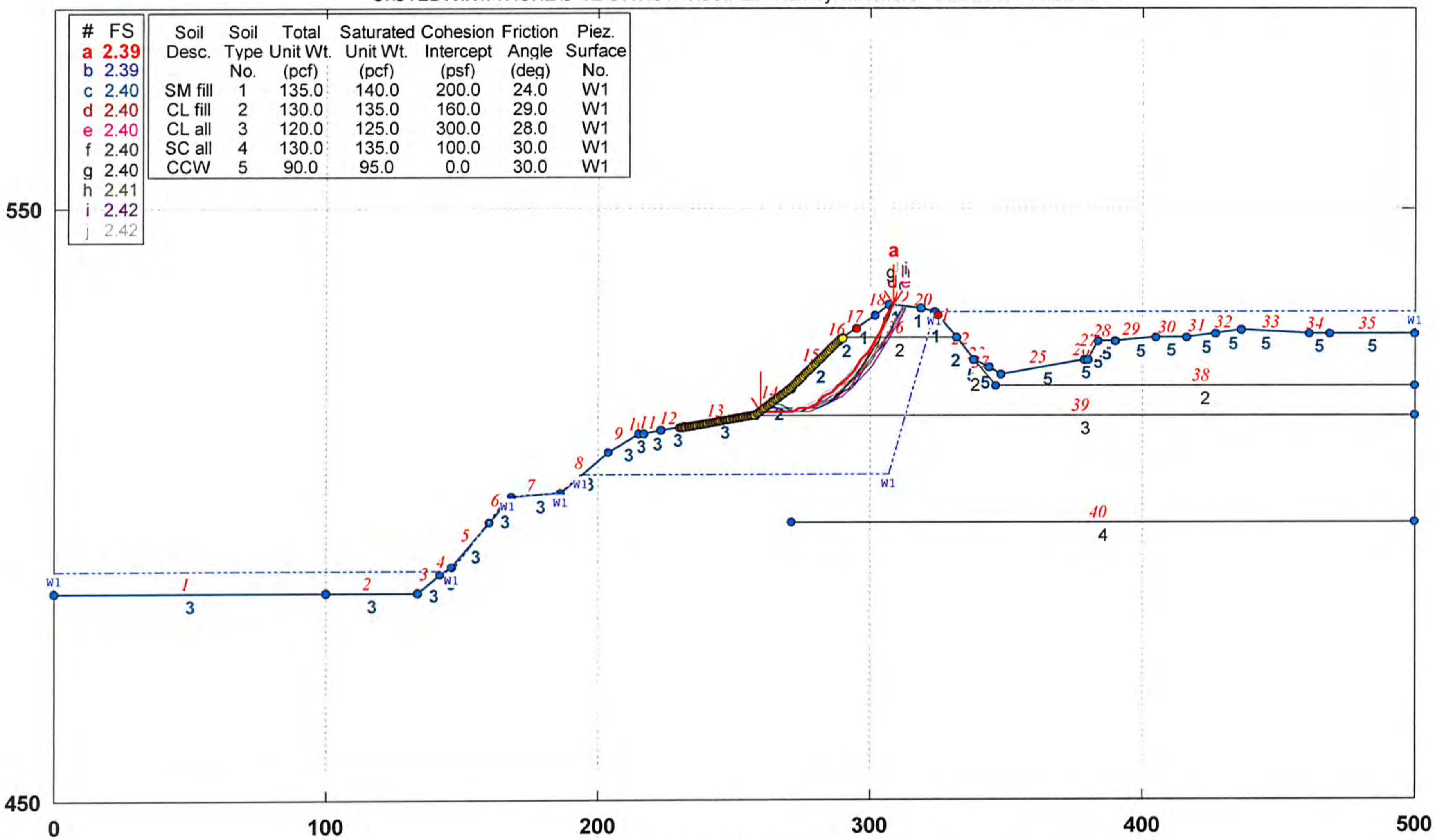
STABL6H FSmin=2.39

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 4: Downstream - SS/Max Flood

C:\STEDWIN\TYRONE\S-4\DOWNST~1\SS.PL2 Run By: MACTEC 9/22/2010 11:28AM



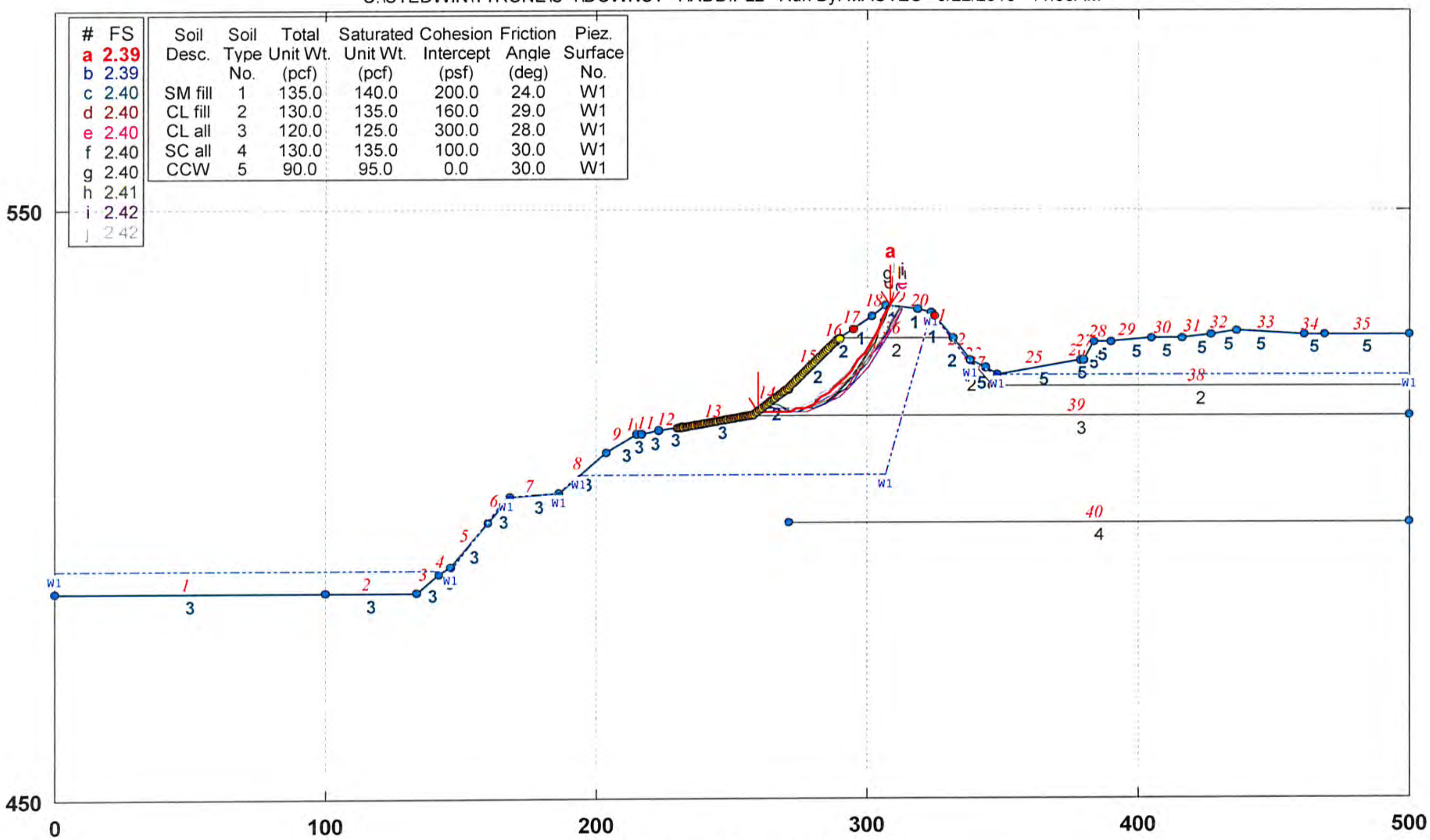
STABL6H FSmin=2.39

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 4: Downstream - Rapid Drawdown

C:\STEDWIN\TYRONE\S-4\DOWNST~1\RDD.PL2 Run By: MACTEC 9/22/2010 11:30AM



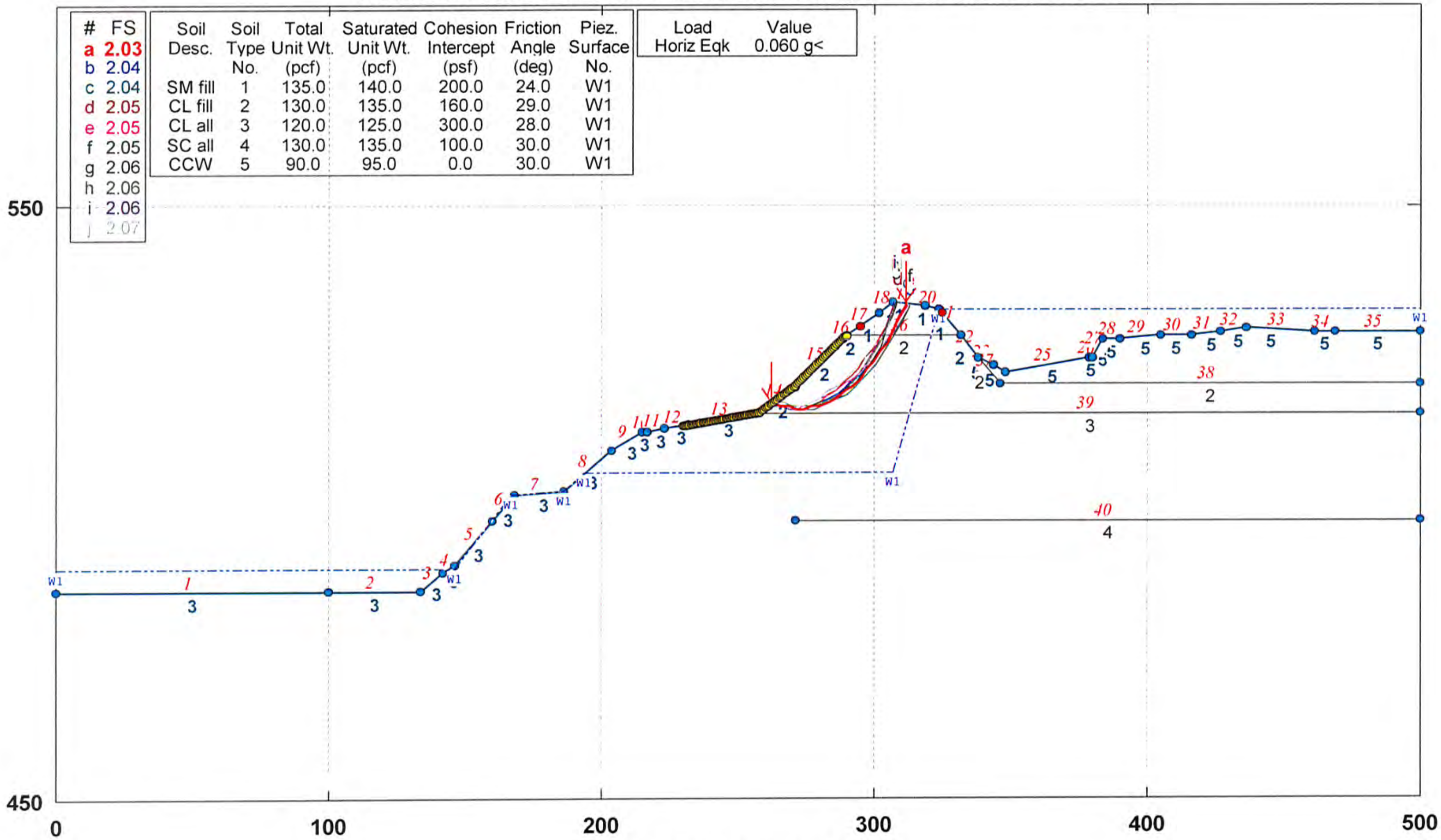
STABL6H FSmin=2.39

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 4: Downstream - Seismic

C:\STEDWIN\TYRONE\S-4\DOWNST~1\QUAKE.PL2 Run By: MACTEC 9/22/2010 11:29AM



STABL6H FSmin=2.03

Safety Factors Are Calculated By The Modified Bishop Method

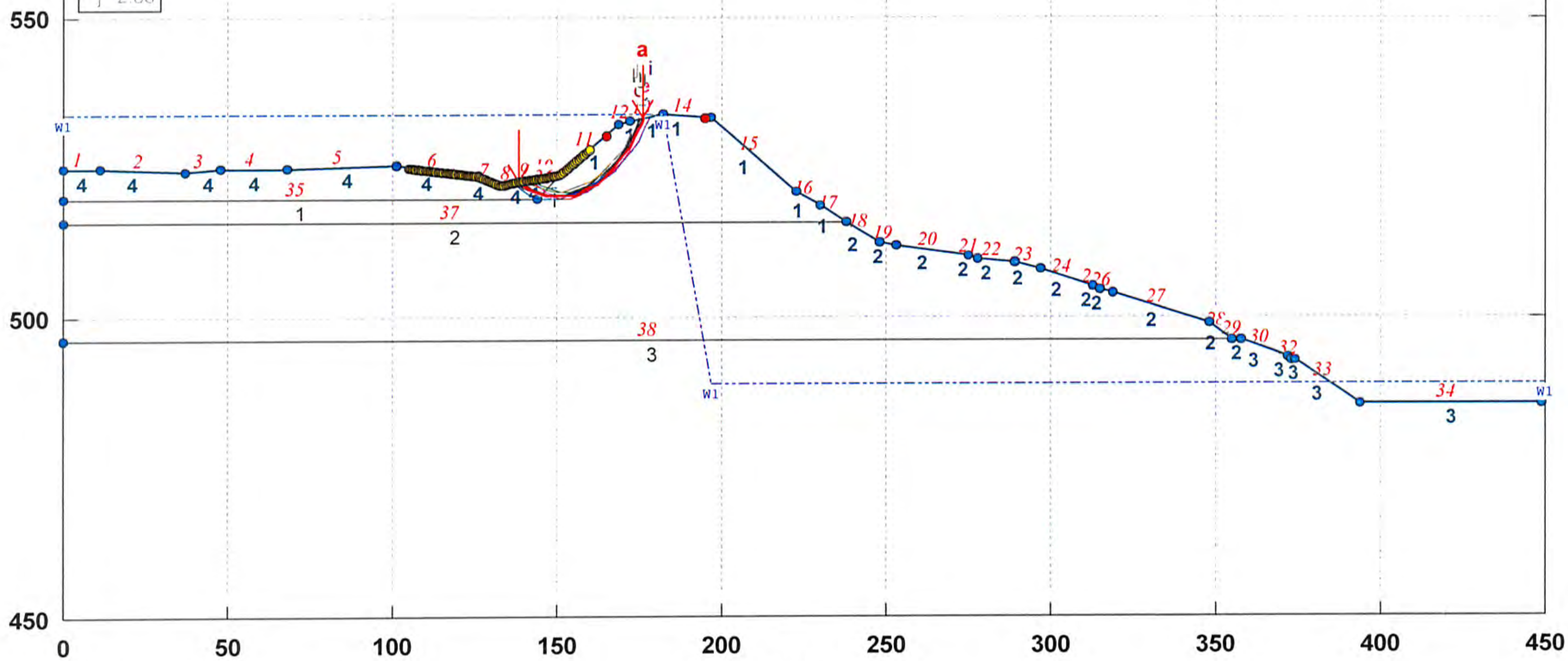
STED

3143-10-1317 Tyrone Power Station Section 5: Upstream - SS/Max Flood

C:\STEDWIN\TYRONE\S-5\UPSTREAM\SS.PL2 Run By: MACTEC albrenneman 8/26/2010 7:20PM

#	FS
a	2.86
b	2.86
c	2.86
d	2.87
e	2.87
f	2.87
g	2.88
h	2.88
i	2.88
j	2.88

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
SC fill	1	134.0	139.0	100.0	32.0	W1
CL all	2	120.0	125.0	300.0	28.0	W1
SC all	3	130.0	135.0	100.0	30.0	W1
CCW	4	90.0	95.0	0.0	30.0	W1



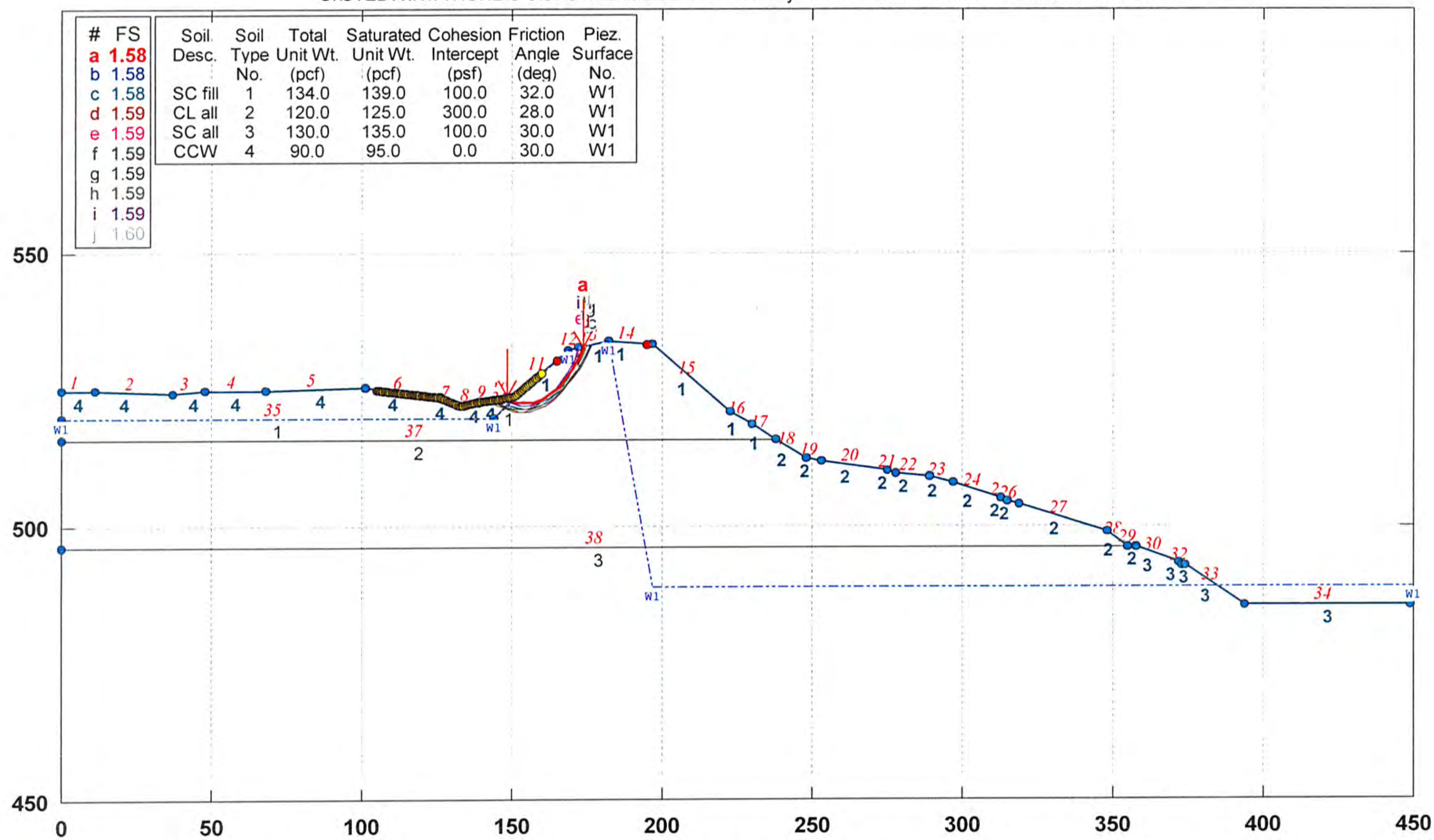
STABL6H FSmin=2.86

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 5: Upstream - Rapid Drawdown

C:\STEDWIN\TYRONE\S-5\UPSTREAM\RDD.PL2 Run By: MACTEC albrenneman 8/26/2010 7:22PM



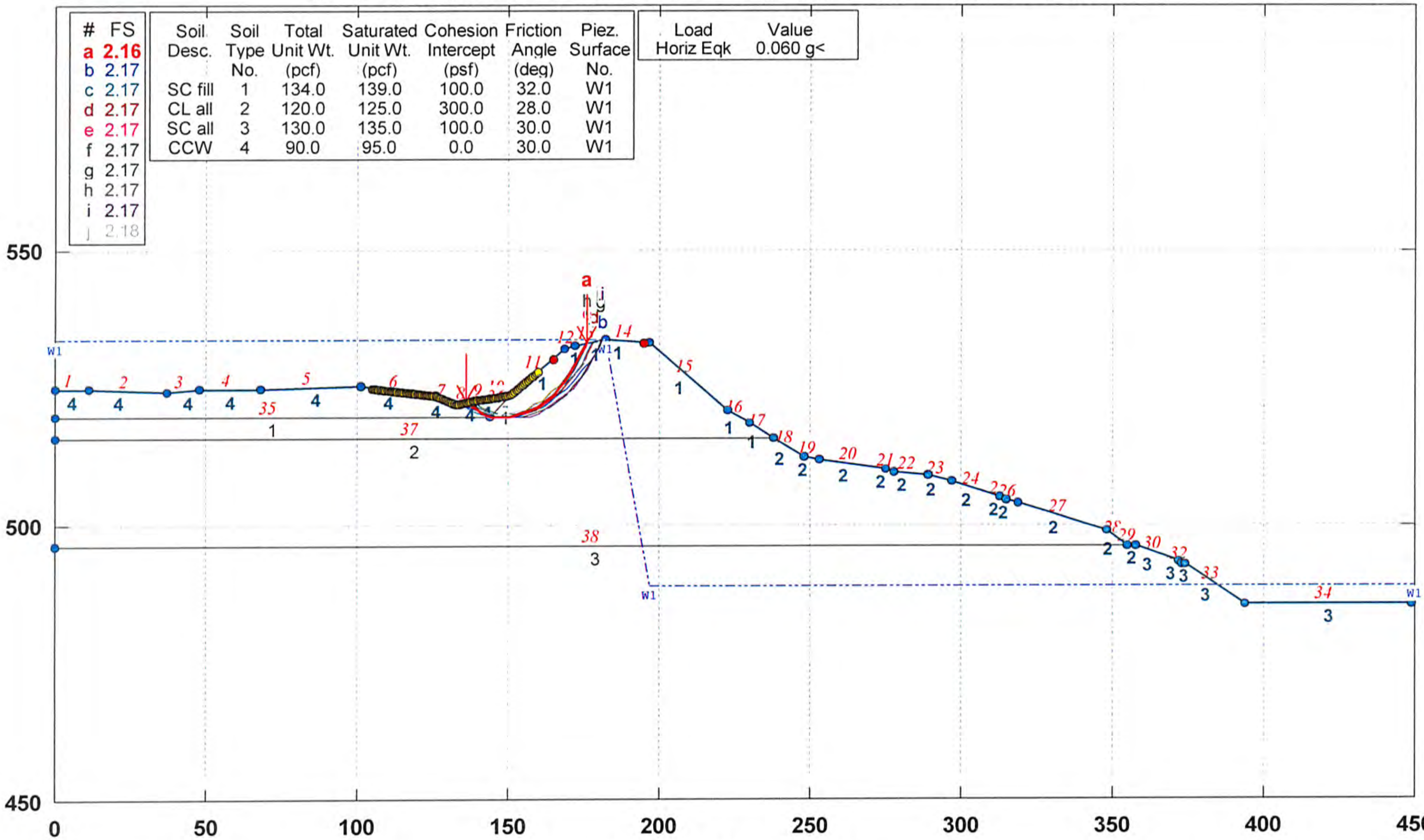
STABL6H FSmin=1.58

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 5: Upstream - Seismic

C:\STEDWIN\TYRONE\S-5\UPSTREAM\QUAKE.PL2 Run By: MACTEC albrenneman 8/26/2010 7:21PM



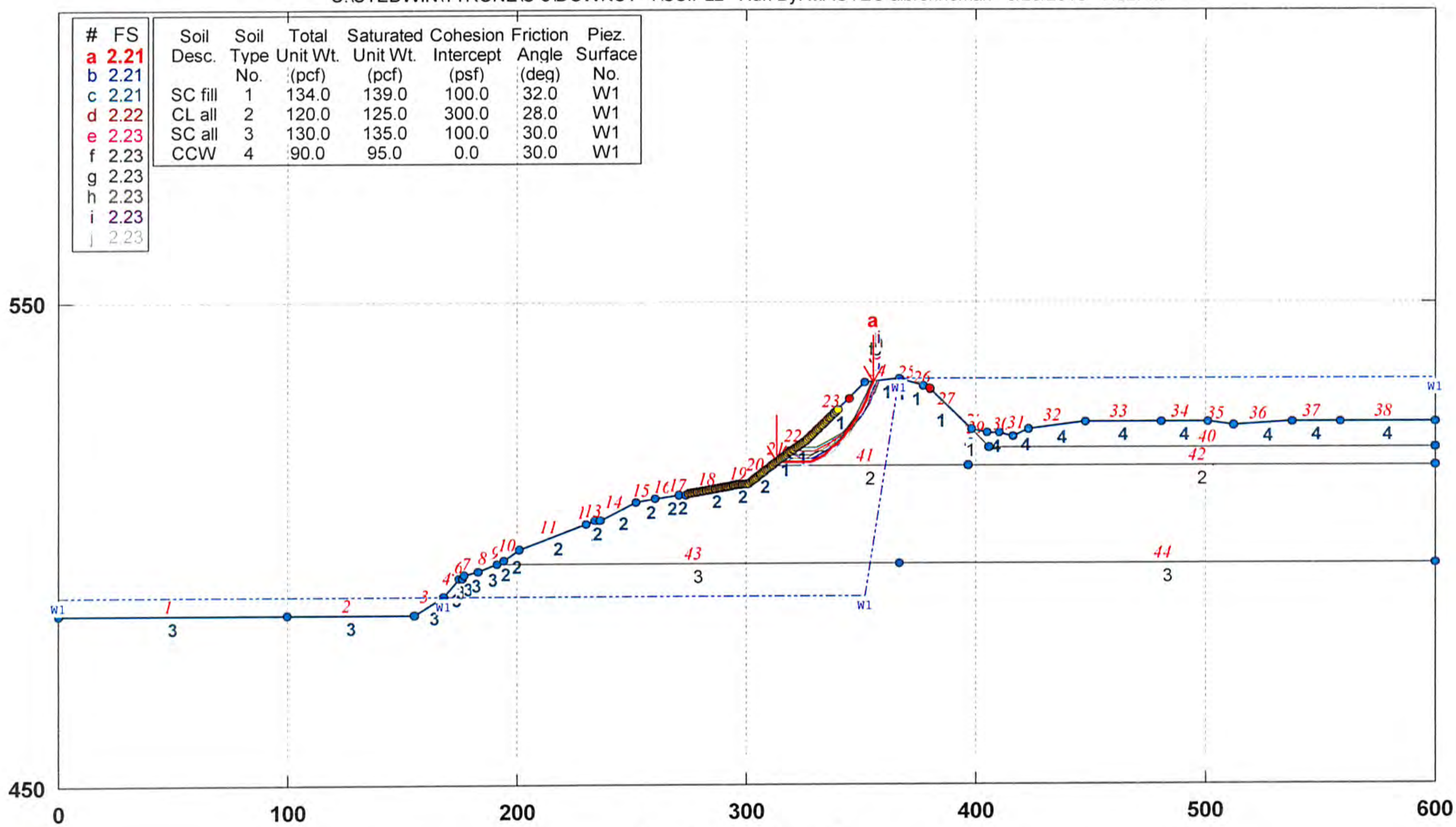
STABL6H FSmin=2.16

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 5: Downstream - SS/Max Flood

C:\STEDWIN\TYRONE\S-5\DOWNST~1\SS.PL2 Run By: MACTEC albrenneman 8/26/2010 7:02PM



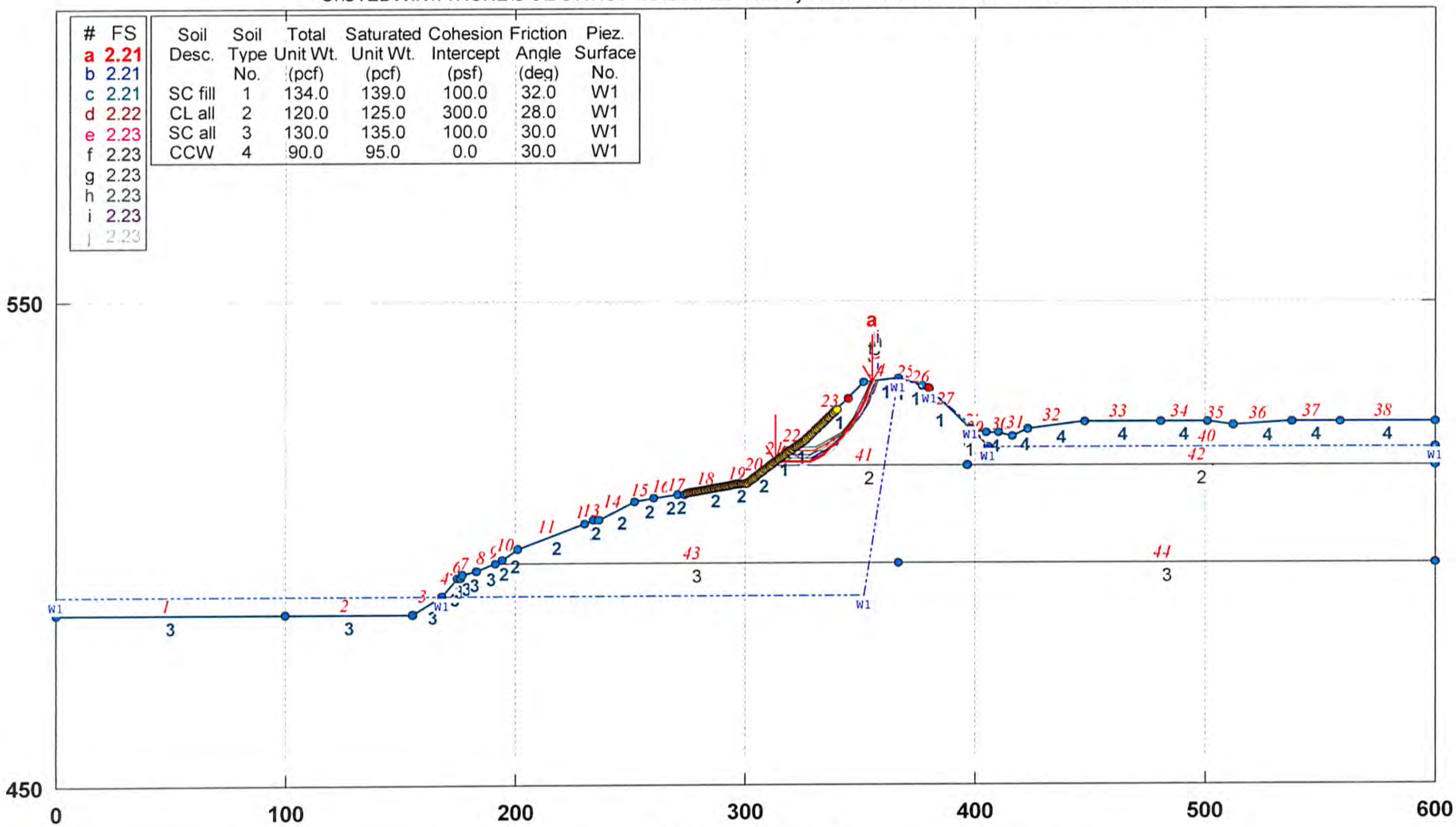
STABL6H FSmin=2.21

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 5: Downstream - Rapid Drawdown

C:\STEDWIN\TYRONE\S-5\DOWNST~1\RDD.PL2 Run By: MACTEC albrenneman 8/26/2010 7:05PM



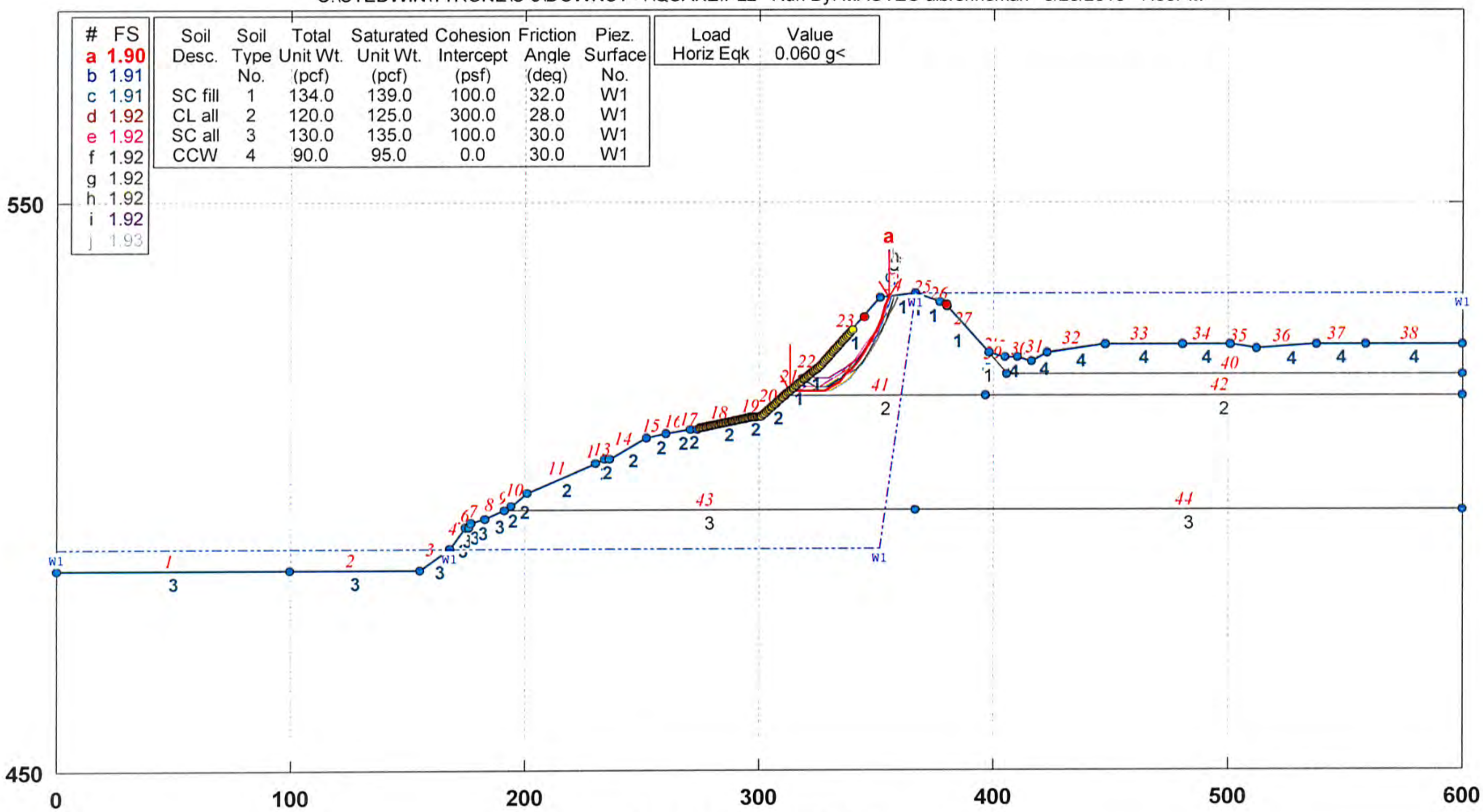
STABL6H FSmin=2.21

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 5: Downstream - Seismic

C:\STEDWIN\TYRONE\S-5\DOWNST~1\QUAKE.PL2 Run By: MACTEC albrenneman 8/26/2010 7:06PM



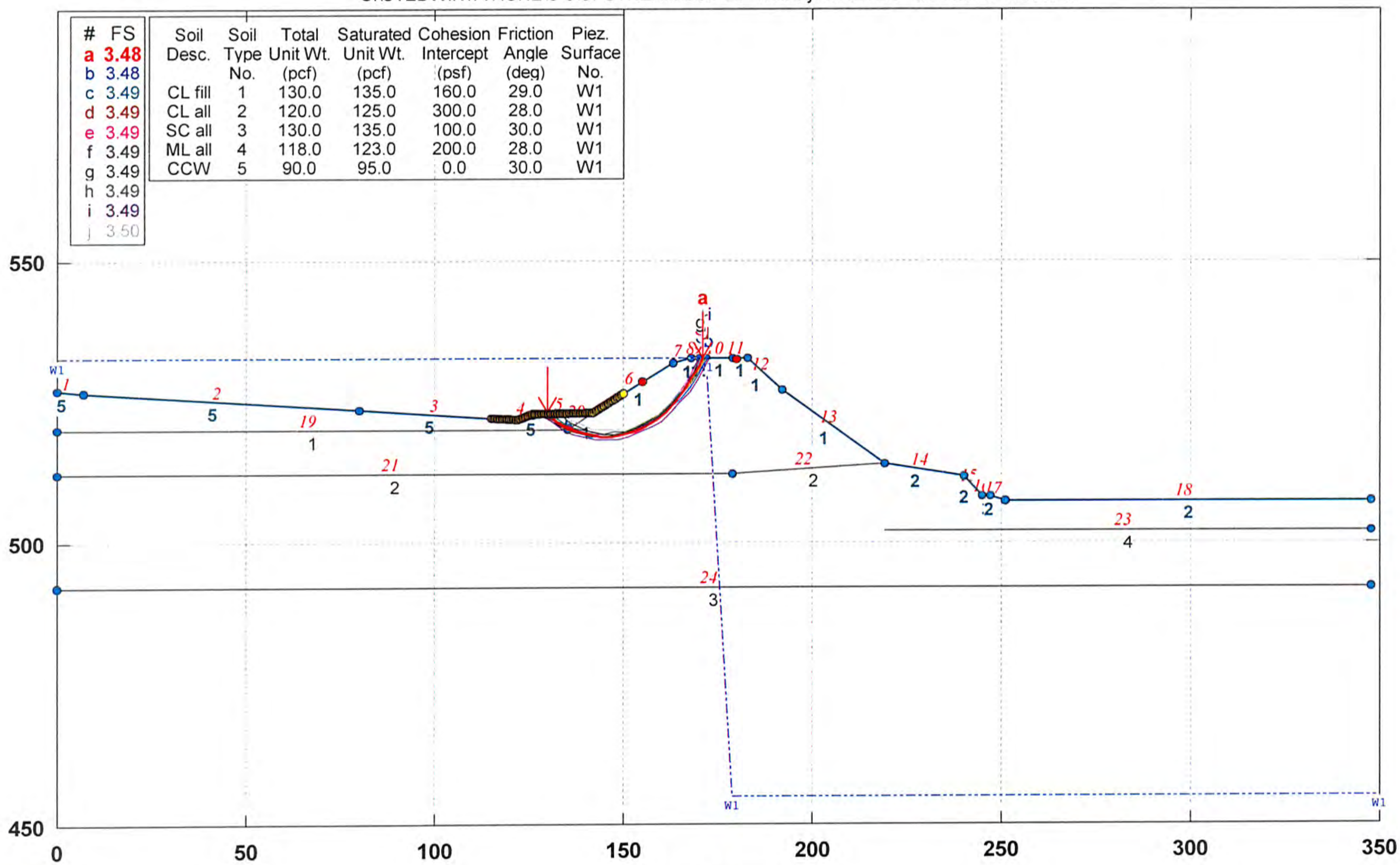
STABL6H FSmin=1.90

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 6: Upstream - SS/Max Flood

C:\STEDWIN\TYRONE\S-6\UPSTREAM\SS.PL2 Run By: MACTEC 9/22/2010 12:09PM



STABL6H FSmin=3.48

Safety Factors Are Calculated By The Modified Bishop Method

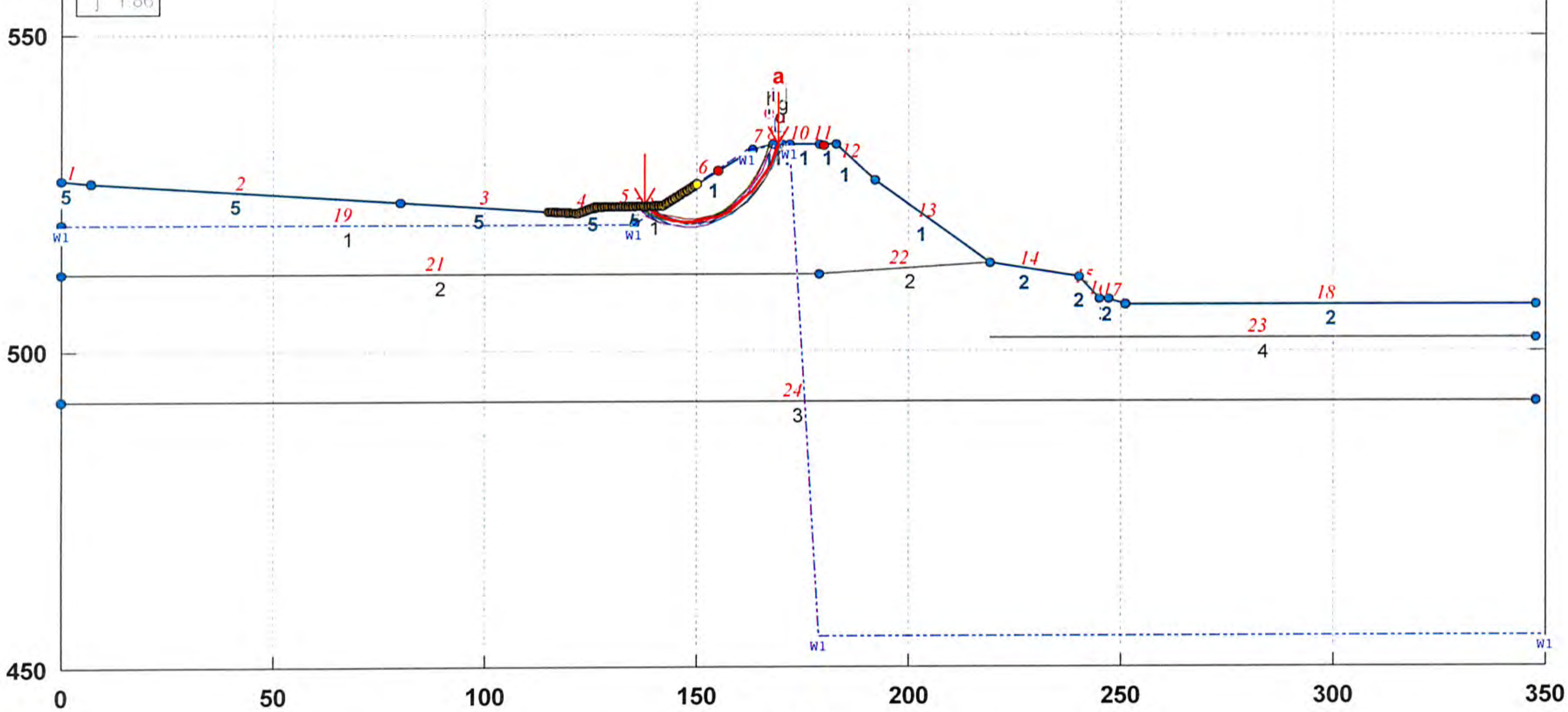
STED

3143-10-1317 Tyrone Power Station Section 6: Upstream - Rapid Drawdown

C:\STEDWIN\TYRONE\S-6\UPSTREAM\RDD.PL2 Run By: MACTEC 9/22/2010 12:10PM

#	FS
a	1.85
b	1.85
c	1.85
d	1.85
e	1.86
f	1.86
g	1.86
h	1.86
i	1.86
j	1.86

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
CL all	2	120.0	125.0	300.0	28.0	W1
SC all	3	130.0	135.0	100.0	30.0	W1
ML all	4	118.0	123.0	200.0	28.0	W1
CCW	5	90.0	95.0	0.0	30.0	W1



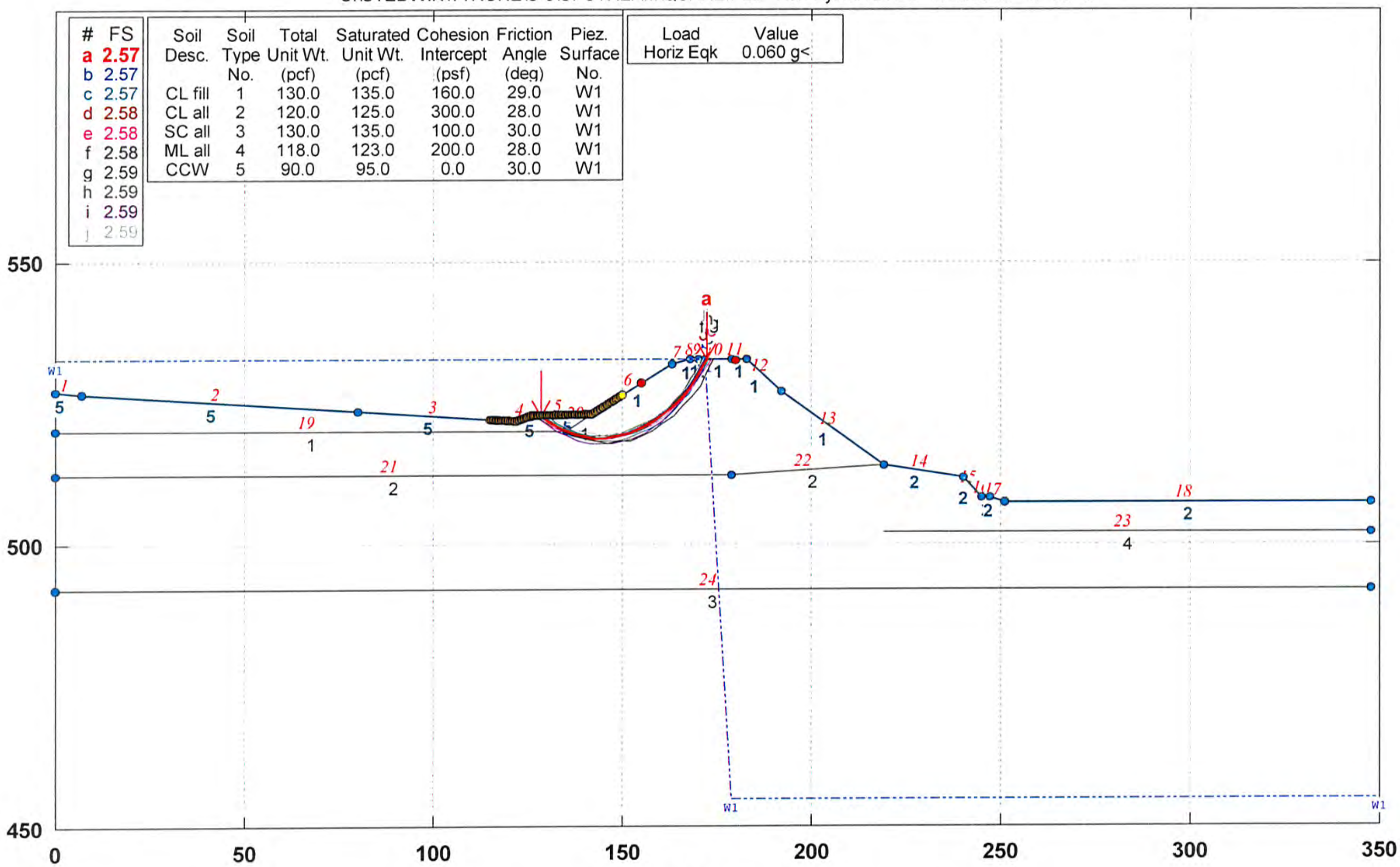
STABL6H FSmin=1.85

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 6: Upstream - Seismic

C:\STEDWIN\TYRONE\S-6\UPSTREAM\QUAKE.PL2 Run By: MACTEC 9/22/2010 12:10PM



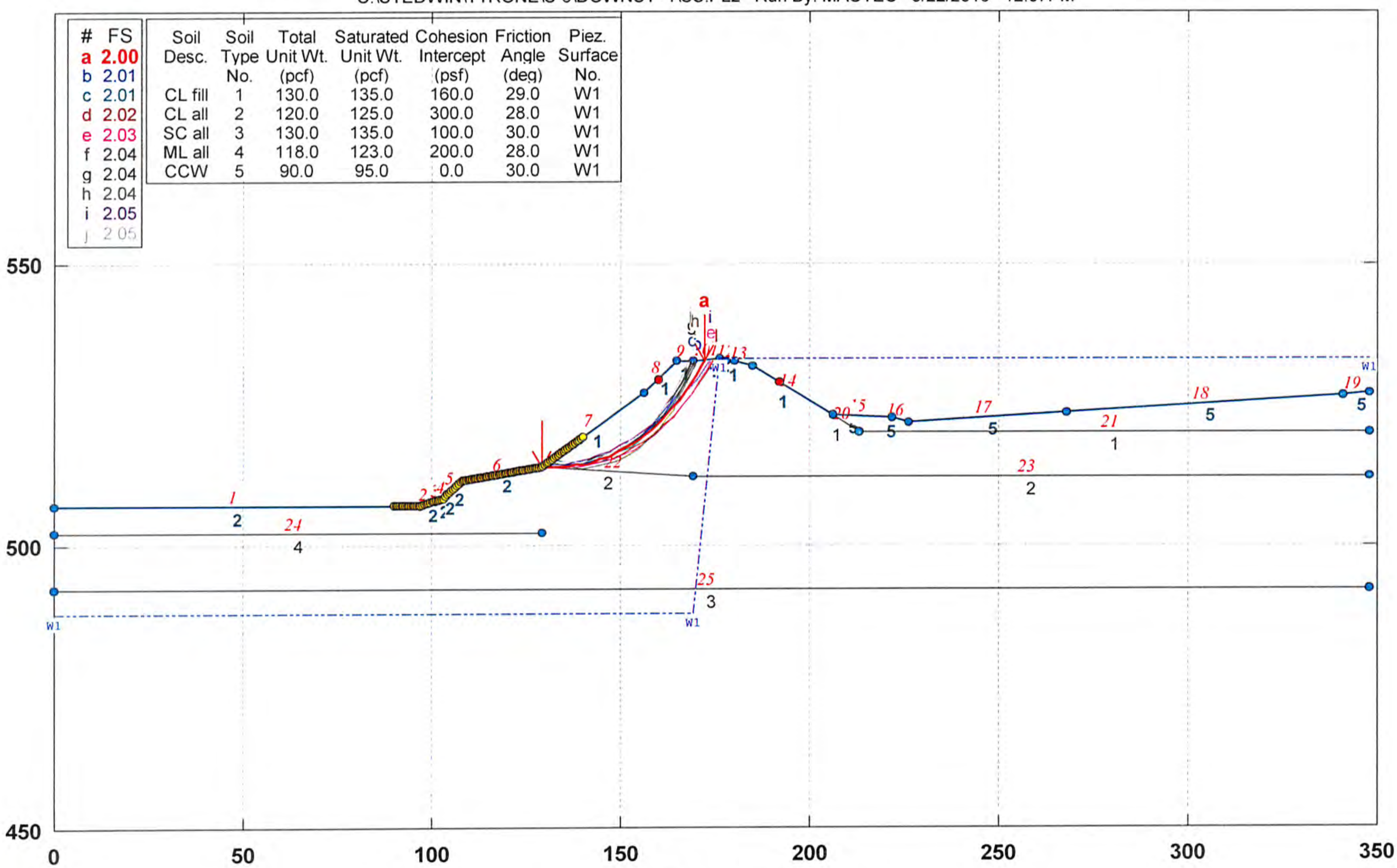
STABL6H FSmin=2.57

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 6: Downstream - SS/Max Flood

C:\STEDWIN\TYRONE\S-6\DOWNST~1\SS.PL2 Run By: MACTEC 9/22/2010 12:07PM



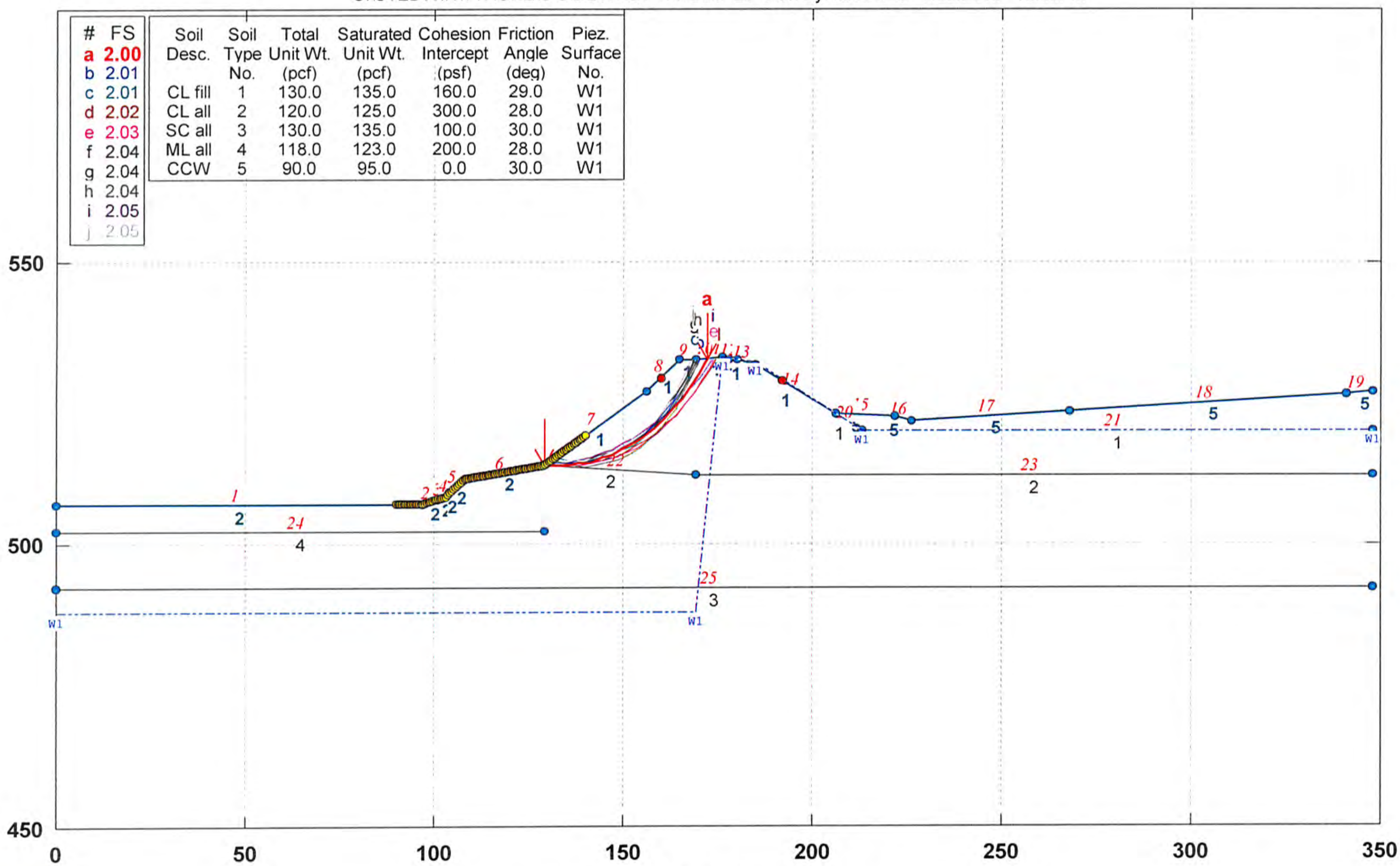
STABL6H FSmin=2.00

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 6: Downstream - Rapid Drawdown

C:\STEDWIN\TYRONE\S-6\DOWNST~1\RDD.PL2 Run By: MACTEC 9/22/2010 12:08PM



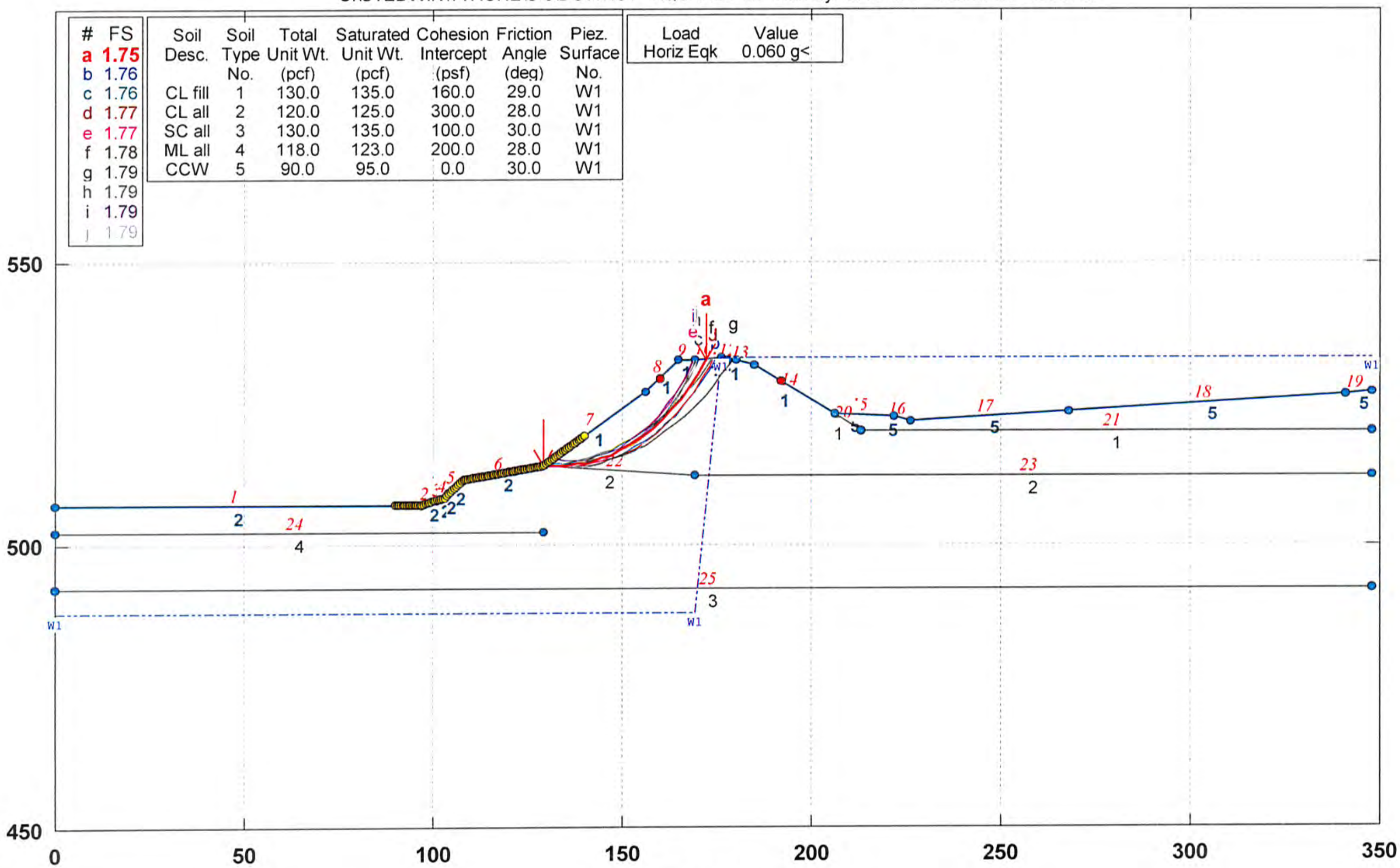
STABL6H FSmin=2.00

Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station Section 6: Downstream - Seismic

C:\STEDWIN\TYRONE\S-6\DOWNST~1\QUAKE.PL2 Run By: MACTEC 9/22/2010 12:08PM



STABL6H FSmin=1.75

Safety Factors Are Calculated By The Modified Bishop Method

MACTEC
engineering and constructing a better tomorrow

January 19, 2011

Mr. David J. Millay, P.E.
LG&E-KU Services Company, Inc.
220 West Main Street
Louisville, Kentucky 40202
Phone: 502-627-2468
Facsimile: 502-217-2850
Electronic mail: David.Millay@LG&E-KU.com

SUBJECT: Addendum A
Report of Geotechnical Exploration and Slope Stability Analyses
KU Tyrone Power Station – Ash Pond
Tyrone, Woodford County, Kentucky
MACTEC Project No. 3143-10-1317.01

Dear Mr. Millay:

MACTEC Engineering and Consulting, Inc. (MACTEC) is pleased to submit this Addendum to our *Report of Geotechnical Exploration and Slope Stability Analyses,* dated September 29, 2010. The purpose of this addendum is threefold:

1. Transmit updated piezometer data for the project
2. Transmit updated stability analysis data for the project
3. Provide responses and clarifications to Section 4.2.2, *Geotechnical and Stability Recommendations*, of the USEPA Dam Safety Assessment draft report issued by AMEC in September 2010

A discussion of each of the above items follows. Our services were provided in general accordance with our Master Agreement No. 31528, Contract No. 495429 dated August 23, 2010, and our Proposal No. PROP10LVLE Task 162.

Piezometer Data

Piezometer readings have been taken on two occasions since our report was issued. The attached Table 2 has been revised to include the additional data.

Stability Analyses

Information provided by you suggests it may be possible during normal operation of the ash pond that solids in the pond reach a maximum level near the upstream embankment crest elevation. We have performed additional stability analyses for the downstream embankment slopes for the original six cross sections that reflect this condition (i.e., "pond full"). The additional analyses are based on the Steady-State/Maximum Flood cross sections, with the modification of CCW solids extending to the upstream crest elevation. The results of the analyses are provided on the attached *Results of Slope Stability Analyses – Tyrone Power Station Ash Pond* table. In addition, the section geometry, input parameters, and stability analysis results are provided on the attached STABL6H output plots. Our analyses indicate the computed Factor of Safety against failure, which ranges from 2.0 to 3.3, exceeds the target Factor of Safety for each of the downstream embankment sections analyzed.

Response to AMEC Draft Report

AMEC's comments and recommendations in Section 4.2.2 of the referenced Dam Safety Assessment draft report were based, in part, on visual observation of site conditions and review of MACTEC's *Geotechnical Exploration and Slope Stability Analyses Data Package* for the Ash Pond at the KU Tyrone Power Station in Tyrone, Woodford County, Kentucky, dated August 27, 2010. We note that our *Report of Geotechnical Exploration and Slope Stability Analyses* for the Tyrone Ash Pond, which includes additional analyses as well as additional and revised information pertaining to MACTEC's activities on the project, was issued on September 29, 2010, subsequent to AMEC's draft dam safety assessment report.

Below is a listing of AMEC's comments and recommendations, each followed by our response or clarification.

1. "In the opinion of the assessing professional engineer, the criteria for minimum safety factors should be in accordance with USACE…as recommended by …MSHA.."

   MACTEC Response: The Tyrone Ash Pond is under the jurisdiction of the Kentucky Environment and Energy Cabinet. Therefore, the minimum factors of safety computed during our slope stability analyses were compared to the target factors of safety obtained from Commonwealth of Kentucky documents referenced on Page 4 of our report.

2. "The analysis should consider all critical stages over the life of the pond including pond full conditions."

   MACTEC Response: The stability of the selected cross sections at the Tyrone Ash Pond were originally evaluated under three conditions: steady-state/maximum flood, rapid drawdown, and dynamic (seismic) loading. The results of these analyses were provided in our *Report of Geotechnical Exploration and Slope Stability Analyses*. The ash profile was modeled based on the conditions provided to us at the time of our analyses, which reflect a partial load in the pond. Information provided recently by LG&E-KU suggests it may be possible during normal operation of the ash pond that solids in the pond reach a maximum level near the upstream embankment crest elevation. Therefore, we have performed additional stability analyses for the downstream embankment slopes for the original six cross sections that reflect the "pond full" condition. The results of these additional analyses have been included on the attached *Results of Slope Stability Analyses – Tyrone Power Station Ash Pond* table. In addition, the section geometry, input parameters, and stability analysis results are provided on the attached STABL6H output plots.

3. "The almost vertical phreatic surfaces shown in the analysis are not typical."

   MACTEC Response: The section geometry, including phreatic surface, along with the stability analysis results for each loading condition for each cross section analyzed are presented on the STABL6H plots which were included in our data report, as well as in our subsequent *Report of Geotechnical Exploration and Slope Stability Analyses.* To optimize the plot field, the STABL6H plots are not plotted at a natural scale. For this project, the vertical exaggeration varies with each section analyzed, but the exaggeration ranges from about

1.4H:1V to 2.9H:1V. This exaggeration causes the phreatic surface to appear steeper than modeled. The phreatic surfaces were modeled based on water level data from piezometers installed in the crest of the embankment, as well as observations of the downstream face and toe of the embankment.

4. "The friction angle value of 30 degrees used for the CCW (ash) in the analysis appears high for loose, saturated ash."

   MACTEC Response: Our rationale for selection of unit weight and shear strength values was provided in Section 5.3 of our *Report of Geotechnical Exploration and Slope Stability Analyses.* MACTEC has extensive experience with CCW at LG&E-KU facilities in Kentucky and with other similar facilities in the southeastern United States. Laboratory testing (both triaxial and direct shear tests) of CCW from other facilities indicated friction angles of 28 to over 42 degrees. We selected 30 degrees to provide, in our opinion, the appropriate level of conservatism.

5. "It appears odd that the moisture content at a depth of about 5 feet in Boring 6T is 79.9 percent, this soil and the material below is described as wet, and yet no water was encountered in the boring."

   MACTEC Response: The noted moisture content value was reported in error in our *Data Report*. The Boring B-6T boring log and laboratory summary included in our *Report of Geotechnical Exploration and Slope Stability Analyses* were corrected to reflect the actual value of 14.4 percent.

   We note that it is common for borings drilled through cohesive soils, such as those encountered in Boring B-6T, to be "dry," or to not encounter free water, when checked at the time of or shortly after drilling. Piezometers (groundwater observation wells) are required to obtain stabilized, long-term groundwater level data. Boring B-6T was not converted to a piezometer; it was backfilled upon completion. Therefore, long-term groundwater levels were not measured at that location.

6. "Consideration should also be given to allowing some time for water levels in the piezometers to develop and stabilize."

   MACTEC Response: Piezometers were installed in three crest borings (B-1C, B-3C, and B-5C) on August 11, 2010. Groundwater levels in the piezometers were initially measured on August 25, 2010, two weeks following installation, allowing measurement of stabilized groundwater levels. These readings were reported in both our *Draft Report* and our *Report of Geotechnical Exploration and Slope Stability Analyses.* Additional readings were taken in December 2010 and January 2011, subsequent to our geotechnical report. The piezometer readings for this project are presented on the attached *Table 2. Summary of Piezometer Readings.*

7. "Some of the analyses presented appear limited to a circular surface; different types of failure surfaces should be analyzed and optimized."

   MACTEC Response: A circular failure surface is the accepted industry standard and appropriate for this analysis. In addition, Table 4in our *Report of Geotechnical Exploration* *and Slope Stability Analyses* indicates that the calculated factors of safety are much greater than the minimum required by the Commonwealth of Kentucky.

8. "The completed analyses should include data sheets to show all input parameters, (and a) discussion on how each parameter was derived"

   MACTEC Response: The material input parameters (e.g., total and saturated unit weights, cohesion, and angle of internal friction) used for each loading condition for each cross section analyzed, as well as the horizontal acceleration for seismic loading, where applicable, are presented on the respective STABL6H plots included in our reports. The embankment geometry, including material layering and piezometric surface, is presented graphically on the respective STABL6H plots. Section 5.3 of our *Report of Geotechnical Exploration and Slope Stability Analyses* clearly describes the soil parameter selections.

We trust the information provided above along with the attachments to this letter sufficiently clarify AMEC's comments related to our *Report of Geotechnical Exploration and Slope Stability Analyses* for the Tyrone Ash Pond. Please let us know if additional assistance is required.

This Addendum should be attached to and made part of our *Report of Geotechnical Exploration and Slope Stability Analyses,* dated September 29, 2010. We appreciate the continued opportunity to work with you on this project. Please contact us if you have any questions regarding the information presented in this letter.

Sincerely,

MACTEC ENGINEERING AND CONSULTING, INC.

Melany L. Brite
Senior Professional

Nicholas G. Schmitt, P.E.
Senior Principal Engineer
Licensed Kentucky 10311

Attachments: Table 2. Summary of Piezometer Readings, Revised 1/18/2011
Results of Slope Stability Analyses – Tyrone Power Station Ash Pond, Revised 1/18/2011
STABL6H Output Plots

Table 2. Summary of Piezometer Readings

Piezometer ID	Date of Installation	Screened Interval Depth (ft)	Top of Ground Elevation (ft) NGVD	Bottom of Piezometer Elevation (ft) NGVD	Date of Reading					
					8/25/10		12/08/10		1/07/11	
					Depth	Elevation	Depth	Elevation	Depth	Elevation
					(ft)					
B-1C	8/11/10	20-30	534.7	504.7	14.7	520.0	20.7	514.0	21.5	513.2
B-3C	8/11/10	25-35	534.3	499.3	28.9	505.4	n/a*	n/a	n/a*	n/a
B-5C	8/11/10	25-35	534.4	499.4	Dry	n/a	34.3	500.1	dry	n/a

*Piezometer B-3C was damaged following the 08/25/2010 reading and subsequent readings were not possible.

Prepared By: *VM*
Checked By: *ALB*
Revised By: *MLB 1/18/11*
Checked By: *NGS 1/18/2011*

MACTEC

Tyrone Power Station		
3143-10-1317.01		
Prepared by: ALB	Date:	9/22/2010
Checked by: NGC	Date:	9/24/2010
Revised by: MLB	Date:	1/18/2011
Checked by: NGS	Date:	1/18/2011

Results of Slope Stability Analyses - Tyrone Power Station Ash Pond

Critical Section	Upstream Slope (H:V)	Downstream Slope (H:V)	Long-Term Steady State/Max Surcharge Pool		Rapid Drawdown		Seismic		Long-Term Steady State/Max Surcharge Pool /Max Solids**	
			Target FOS*	FOS	Target FOS*	FOS	Target FOS*	FOS	Target FOS*	FOS
1 Upstream	1.6 : 1.0	-	1.5	4.0	1.2	2.6	1.0	2.6	n/a	
1 Downstream	-	1.3 : 1.0	1.5	2.3	1.2	2.3	1.0	2.0	1.5	2.3
2 Upstream	2.5 : 1.0	-	1.5	6.6	1.2	4.7	1.0	3.8	n/a	
2 Downstream		2.3 : 1.0	1.5	3.1	1.2	3.1	1.0	2.7	1.5	3.1
3 Upstream	2.1 : 1.0	-	1.5	3.2	1.2	1.8	1.0	2.4	n/a	
3 Downstream	-	2.3 : 1.0	1.5	3.3	1.2	3.3	1.0	2.8	1.5	3.3
4 Upstream	1.8 : 1.0	-	1.5	3.0	1.2	1.6	1.0	2.4	n/a	
4 Downstream		3.0 : 1.0	1.5	2.4	1.2	2.4	1.0	2.0	1.5	2.4
5 Upstream	2.2 : 1.0	-	1.5	2.9	1.2	1.6	1.0	2.2	n/a	
5 Downstream	-	2.2 : 1.0	1.5	2.2	1.2	2.2	1.0	1.9	1.5	2.2
6 Upstream	2.4 : 1.0	-	1.5	3.5	1.2	1.9	1.0	2.6	n/a	
6 Downstream		1.6 : 1.0	1.5	2.0	1.2	2.0	1.0	1.8	1.5	2.0

* Target Factor of Safety Reference: Design Criteria for Dams & Associated Structures (401 KAR 4:030, KAR 4:040)

** Includes CCW solids to upstream crest elevation; factor of safety against failure checked for downstream embankment face only

3143-10-1317 Tyrone Power Station S-1, Downstream: SS/Max Fld/Max Solids

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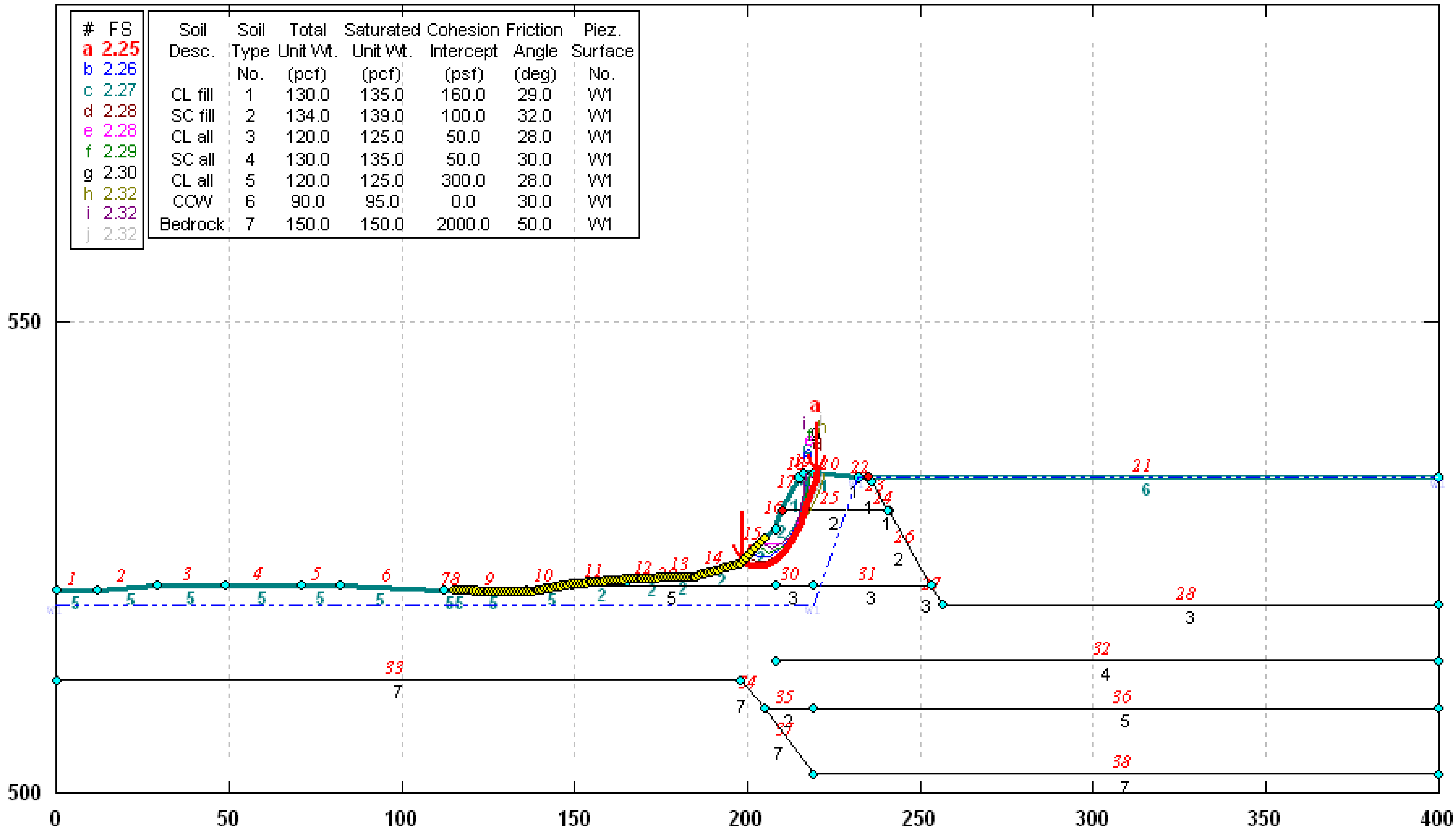

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Safety Factors Are Calculated By The Modified Bishop Method

STED

3143-10-1317 Tyrone Power Station S-2, Downstream: SS/Max Fld/Max Solids

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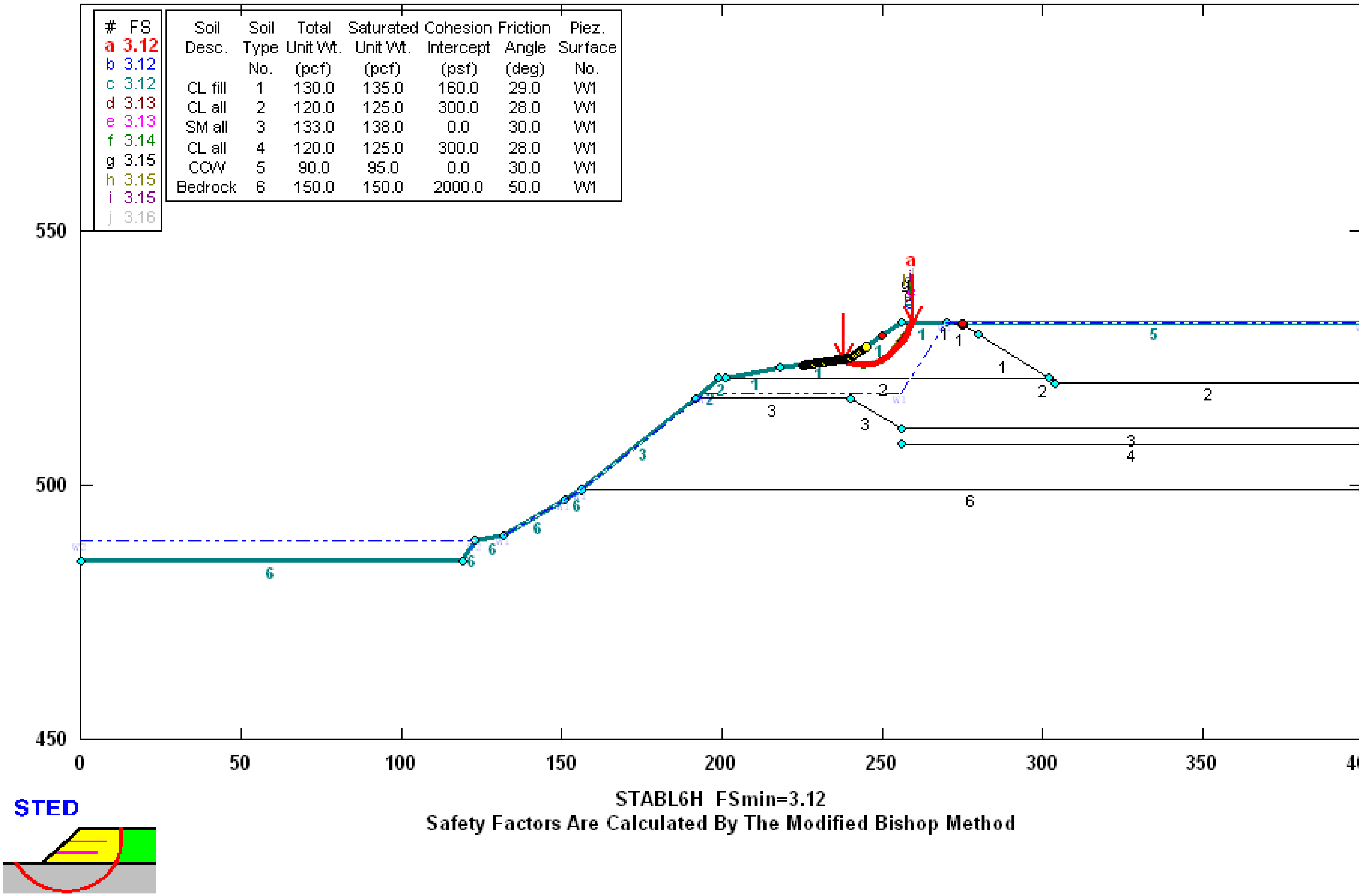

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Safety Factors Are Calculated By The Modified Bishop Method

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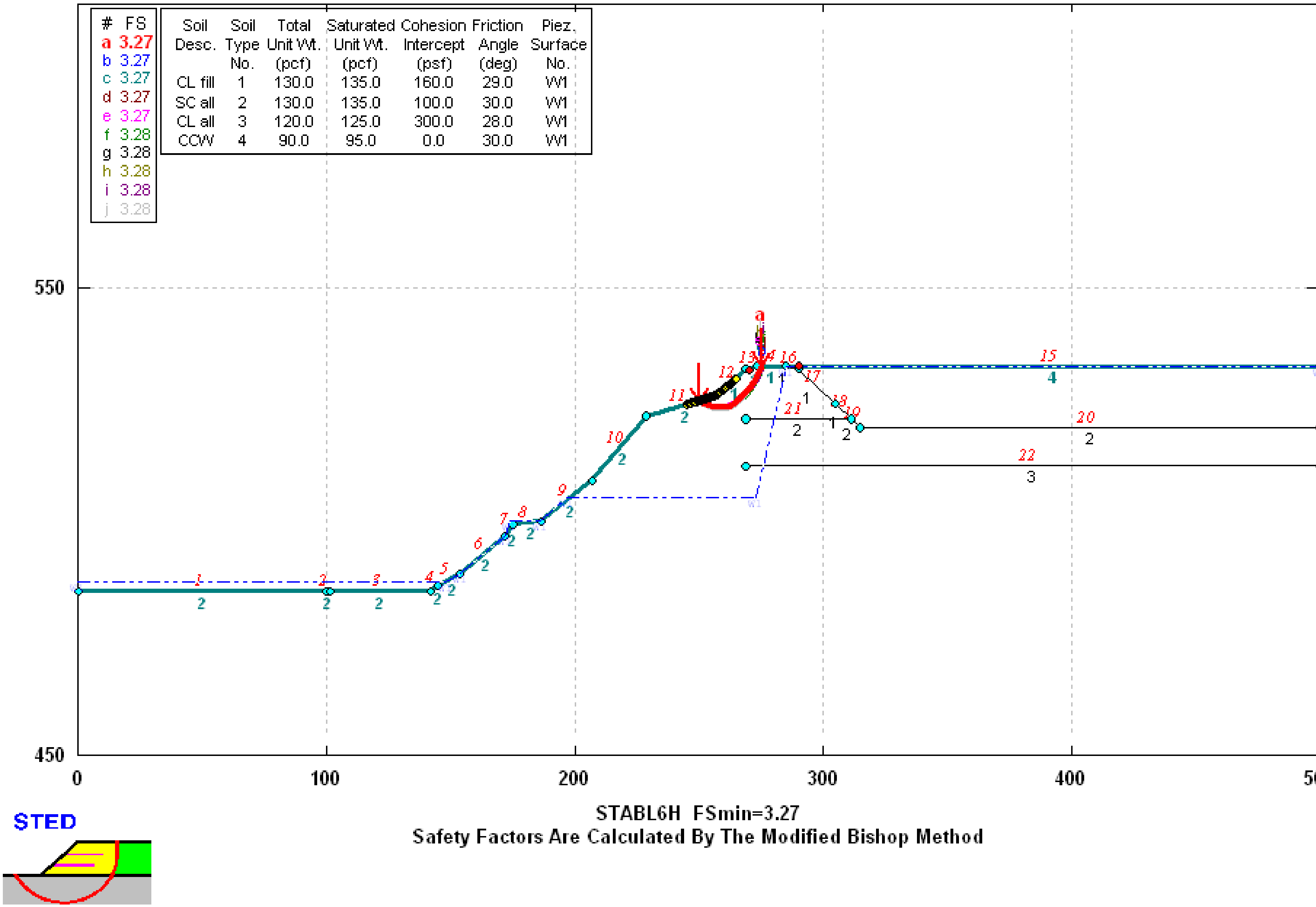
b	3.27
c	3.27
d	3.27
e	3.27
f	3.28
g	3.28
h	3.28
i	3.28
j	3.28

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
SC all	2	130.0	135.0	100.0	30.0	W1
CL all	3	120.0	125.0	300.0	28.0	W1
CCW	4	90.0	95.0	0.0	30.0	W1



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Safety Factors Are Calculated By The Modified Bishop Method

3143-10-1317 Tyrone Power Station S-4, Downstream: SS/Max Fld/Max Solids

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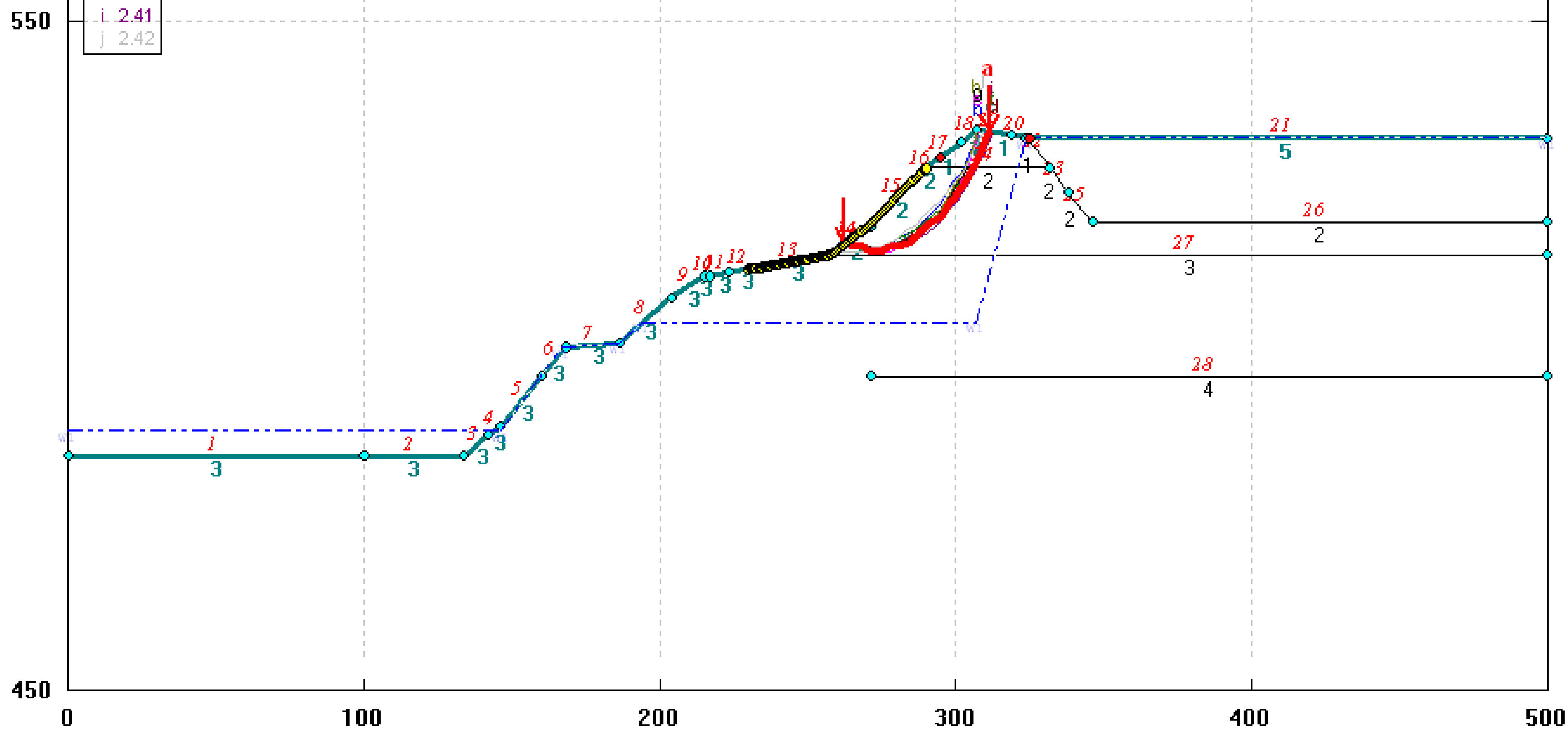
b	2.39
c	2.39
d	2.40
e	2.40
f	2.41
g	2.41
h	2.41
i	2.41
j	2.42

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
SM fill	1	135.0	140.0	200.0	24.0	W1
CL fill	2	130.0	135.0	160.0	29.0	W1
CL all	3	120.0	125.0	300.0	28.0	W1
SC all	4	130.0	135.0	100.0	30.0	W1
CCW	5	90.0	95.0	0.0	30.0	W1



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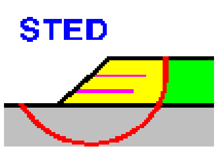
Safety Factors Are Calculated By The Modified Bishop Method



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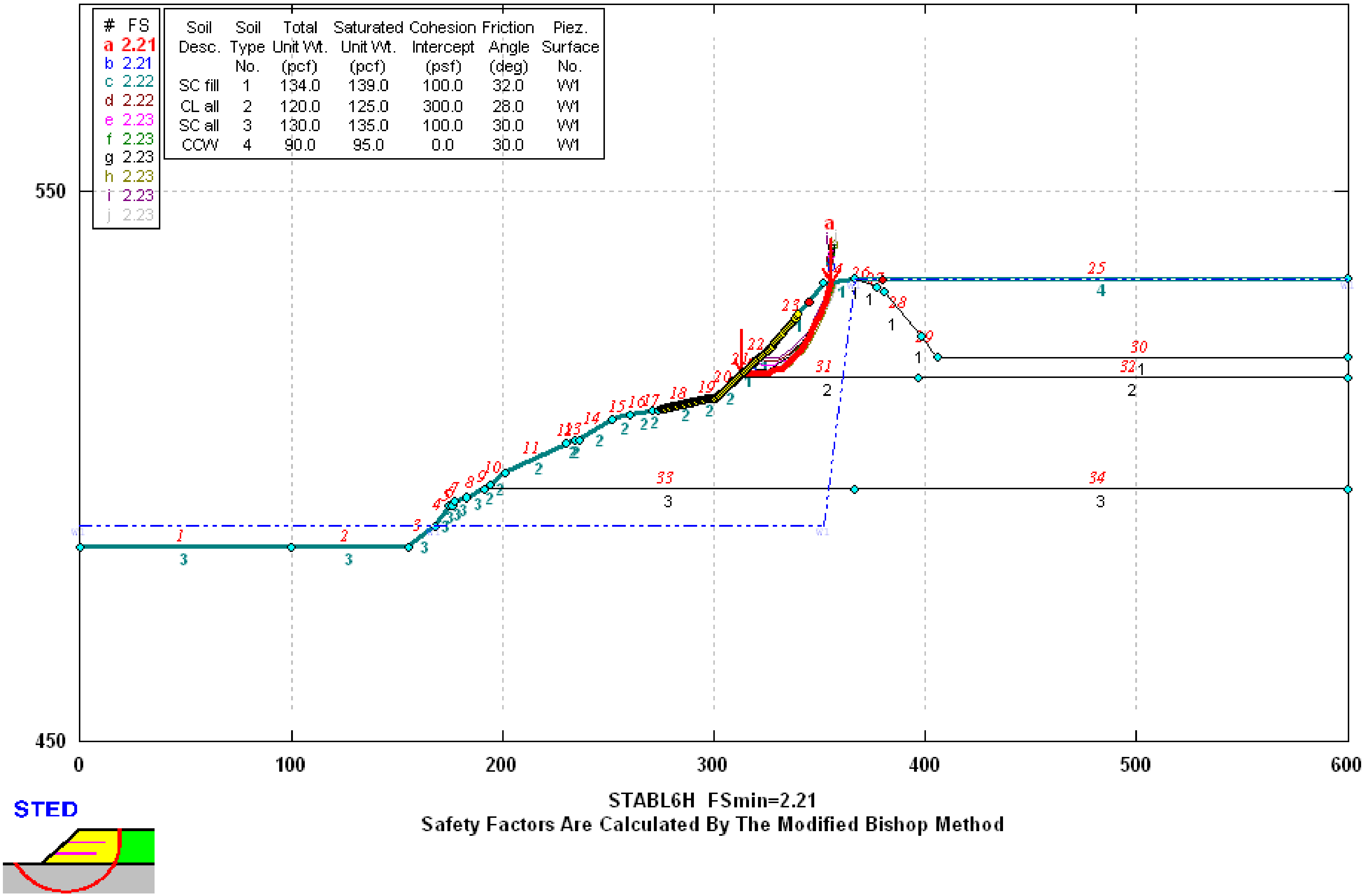

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Safety Factors Are Calculated By The Modified Bishop Method

3143-10-1317 Tyrone Power Station S-6, Downstream: SS/Max Fld/Max Solid

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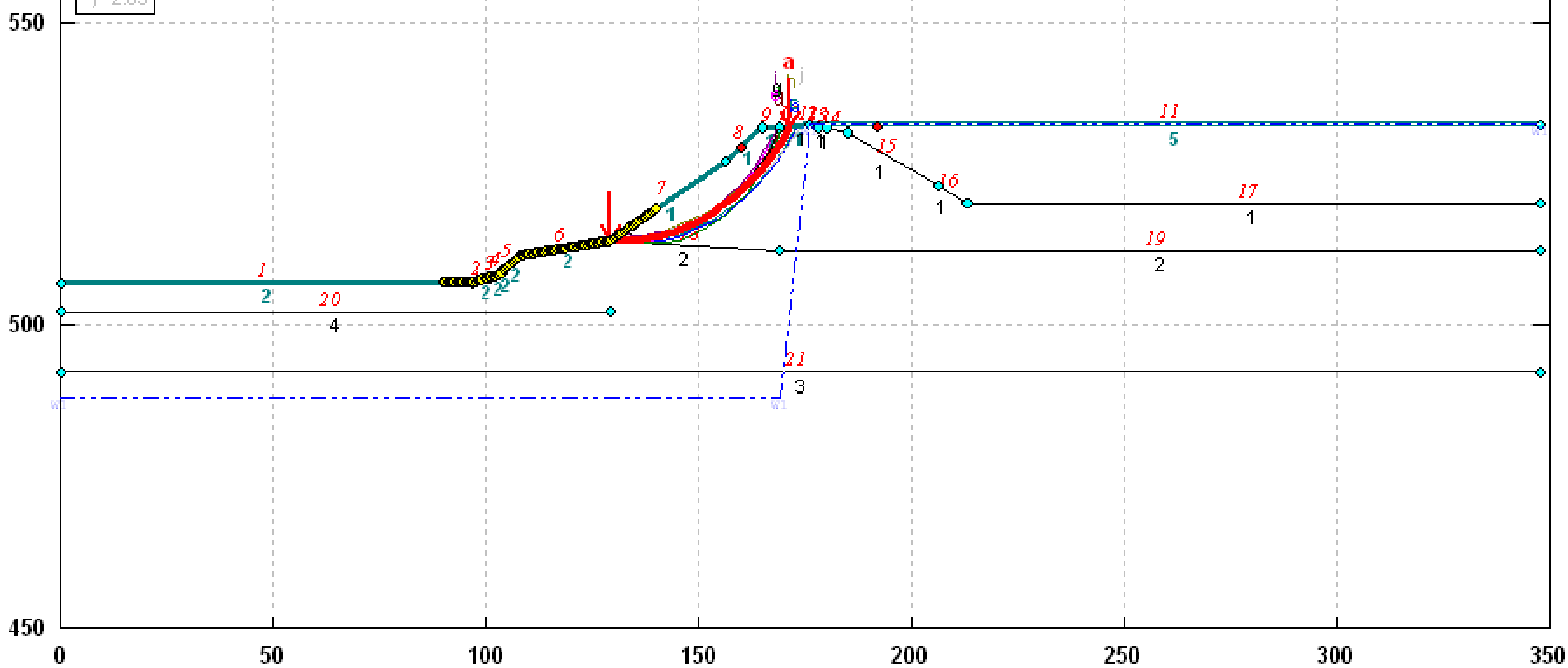
c	2.01
d	2.02
e	2.02
f	2.04
g	2.04
h	2.04
i	2.05
j	2.05

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CL fill	1	130.0	135.0	160.0	29.0	W1
CL all	2	120.0	125.0	300.0	28.0	W1
SC all	3	130.0	135.0	100.0	30.0	W1
ML all	4	118.0	123.0	200.0	28.0	W1
CCW	5	90.0	95.0	0.0	30.0	W1



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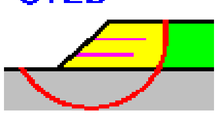
Safety Factors Are Calculated By The Modified Bishop Method



Attachment 3

KU Tyrone Ash Pond: Hydrologic and Hydraulic Assessment

January 11, 2011
LG&E and KU Services Company

LG&E KU
PPL companies

Generation Services

KU Tyrone Ash Pond: Hydrologic and Hydraulic Assessment

January 20, 2011

Submitted by:

Reta White, EIT
Civil Engineer
LG&E and KU Services Company

LG&E KU
PPL companies
Generation Services

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KU Tyrone Ash Pond: Hydrologic and Hydraulic Assessment

Executive Summary

A hydrologic and hydraulic study of the KU Tyrone Ash Pond was performed to evaluate the performance and safety of the pond and its structures during a rainstorm event. The ash pond receives coal combustion residuals from the KU Tyrone Generating Station as well as pumped runoff flows from the coal pile and substation areas. Minimum criteria set forth by the Kentucky Division of Water's (KDOW) Engineering Memorandum No. 5 were used to evaluate the study results.

On the basis of that evaluation, it was determined that the KU Tyrone Ash Pond meets KDOW's minimum criteria and performs sufficiently without overtopping during a significant rain event. Further, the ash pond can effectively operate at or below a pool elevation of 529.9 ft and continue to maintain a minimum freeboard of 3 feet or more.

1.0 Introduction and Site Description

1.1 Introduction

The following hydrologic and hydraulic analysis was developed to assess the performance of the Principal Spillway Structure for the Kentucky Utilities (KU) Tyrone Generating Station Ash Pond. The site is located in Woodford County, Kentucky, approximately seven miles west of the city of Versailles, Kentucky. A project location map is located in Appendix A.

1.2 Site Description

The Tyrone Ash Pond was constructed in 1977 to manage coal combustion residuals (CCRs), including fly ash and bottom ash produced through the coal combustion process at the power generating station. Along with receiving CCR from the station, the ash pond also receives pumped runoff flows from the plant parking lot, two substations immediately east of the ash pond, and the coal pile area via a coal pile runoff pond located on the westernmost portion of the station property. The station CCR flows and the pumped runoff flows discharge through multiple pipes which outlet to the west side of the ash pond. Areas A2, A3 and A4 of the drainage area map located in Appendix A encompass the coal pile basin and substation basins that pump to the ash pond.

The Tyrone Ash Pond has a side-hill configuration with earth embankments at the southwest, northwest and northeast limits. The embankments have a minimum crest elevation of approximately 533.5 North American Vertical Datum of 1988 (NAVD88). The drainage area map in Appendix A delineates the ash pond's drainage basin (area A1) and shows the topography of the site.

The principal spillway of the pond consists of a concrete riser box structure connected to a 15-inch corrugated metal pipe (CMP) set at a 1 percent slope (See Appendix B). The riser supports an adjustable skimmer and stop log unit which enables operators to adjust the water level and discharge rate of the structure. The 15-inch CMP discharges at the downstream toe of the embankment through a permitted discharge point to a rip-rap lined channel which conveys flows to the Kentucky River.

2.0 Methodology and Results

2.1 Methodology

Site topographic data developed by L.R. Kimball and Associates in January, 2010 was used to delineate the ash pond's watershed and create a stage-storage curve. Characteristics of the Tyrone Ash Pond basin are summarized in Table 1. The process flows from the generating station as well as the pumped runoff flows from the coal pile basin and substation basins were modeled as baseflow.

Table 1. Tyrone Ash Pond Basin Characteristics

Total Drainage Area (Acres)	Composite Curve Number	Time of Concentration (Minutes)	Baseflow (cfs)
19.05	72	9.89	7.47

A stage-discharge curve of the principal spillway structure was developed from original design drawings and current site topographic data developed by AGE Engineering Services in January 2011. The design drawings are located in Appendix B. All elevations noted in the design drawings reference the National Geodetic Vertical Datum of 1929 (NGVD29) and required a conversion to NAVD88 to be used in the analysis. The stage-discharge curve was calculated based on weir flow, orifice flow or pipe flow. Figures 1 and 2 show the stage-storage and stage-discharge curves respectively.

Figure 1. Tyrone Ash Pond Stage-Storage Curve

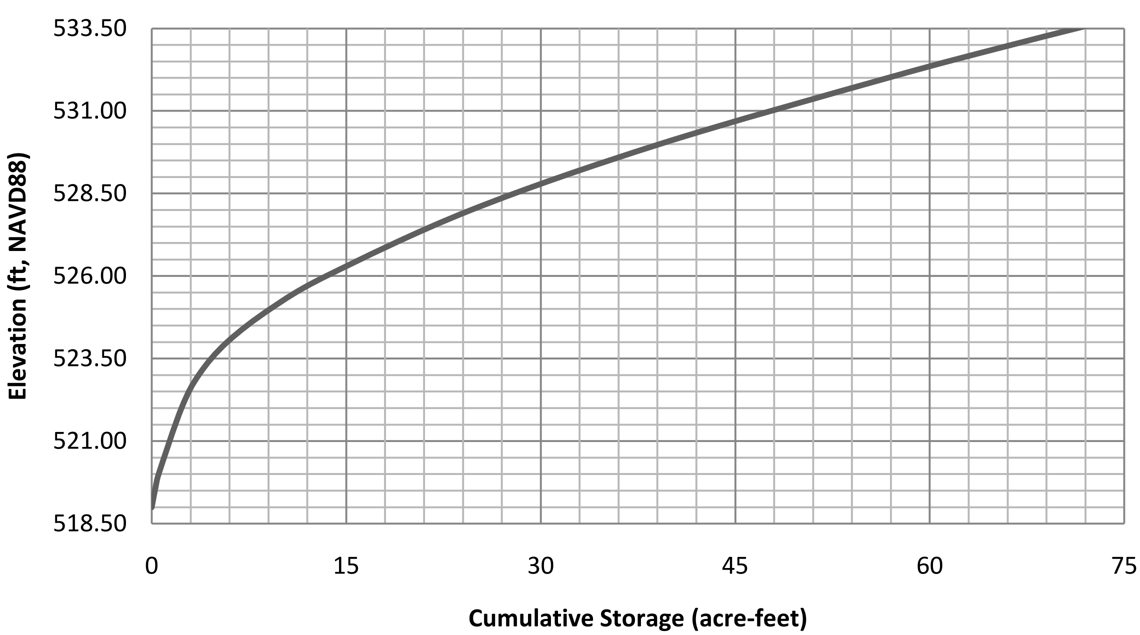
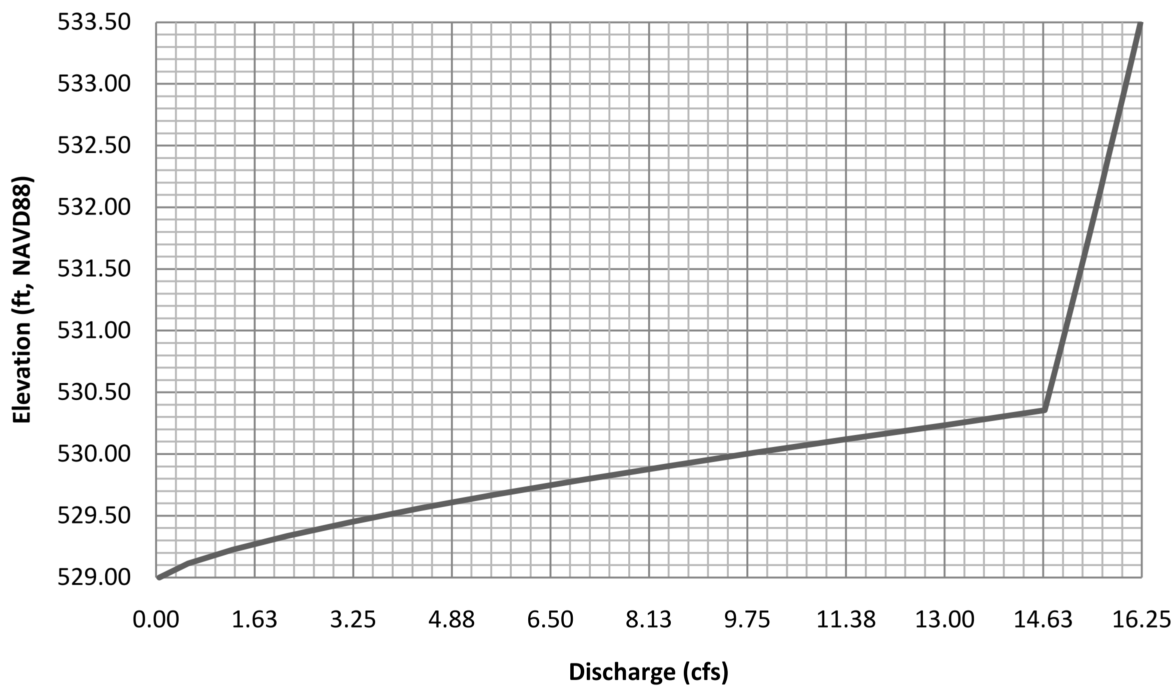


Figure 2. Tyrone Ash Pond Stage-Discharge Curve



Tyrone Ash Pond is classified as a Class (A) Low Hazard Dam according to regulations published by the Kentucky Department for Natural Resources and Environmental Protection's (KDEP) Division of Water (KDOW). Thus, for the purposes of this evaluation, hydrologic modeling was based on minimum hydrologic and hydraulic design criteria for a Class (A) Low Hazard Dam as set forth in KDOW's Engineering Memorandum No. 5. Precipitation values were obtained from KDOW Engineering Memorandum No. 2, "Rainfall Frequency Values for Kentucky." Storm criteria used for this analysis are outlined in Table 2.

Table 2. Summary of Hydrologic Criteria

Hydrograph	Frequency	Duration	Precipitation (inches)
Principal Spillway	100-Year	24-Hour	6.20
Emergency Spillway	100-Year	6-Hour	4.40
Freeboard	100-Year	6-Hour	7.24*

*Calculated according to KDOW Memo No.5 Class (A) dam criteria.

Although the Tyrone Ash Pond does not have an emergency spillway, an emergency spillway hydrograph was developed in order to evaluate the performance of the principal spillway structure. It is understood that KDOW has historically permitted structures with relatively small watersheds to operate without an emergency spillway if the principal spillway can adequately pass the emergency spillway hydrograph without overtopping the pond. The freeboard hydrograph precipitation was calculated according to the following equation provided for a Class (A) dam in KDOW's Memorandum No. 5:

$$P_A = P_{100} + 0.12 \times (PMP - P_{100})$$

P_A: Freeboard Hydrograph Precipitation
P_{100}: 6-hour, 100-year precipitation

All design parameter calculations were based on hydrologic design procedures contained in the NRCS National Engineering Handbook, Section 4 "Hydrology" (NEH-4).

2.2 Results

The HEC-HMS 3.5 program developed by the United States Army Corps of Engineers (USACE) was used to analyze the Tyrone Ash Pond site. Table 3 shows a summary of the modeling results. See Appendix C for complete HEC-HMS analyses output.

Table 3. Summary of HEC-HMS 3.5 Analysis

	Principal Spillway Hydrograph	Emergency Spillway Hydrograph	Freeboard Hydrograph
Pool Elevation (feet)*	529.9	529.9	529.9
Peak Inflow (cfs)	97.0	37.2	76.9
Peak Outflow (cfs)	10.7	10.3	12.2
Peak Elevation (feet)*	530.2	530.1	530.5
Freeboard (feet)	3.3	3.4	3.0

*Elevations listed reference NAVD88.

3.0 Recommendations

The principal spillway met all capacity requirements set forth by KDOW with a minimum freeboard of 3.0 feet or more maintained. Based on the analyses performed, the existing condition of the Tyrone Ash Pond and principal spillway adequately meet KDOW criteria and will not overtop during a significant rain event.

For operational purposes it is recommended that the maximum operating pool should not exceed an elevation of 529.9 NAVD88 in order to maintain a uniform freeboard of approximately 3 feet at all times within the pond.

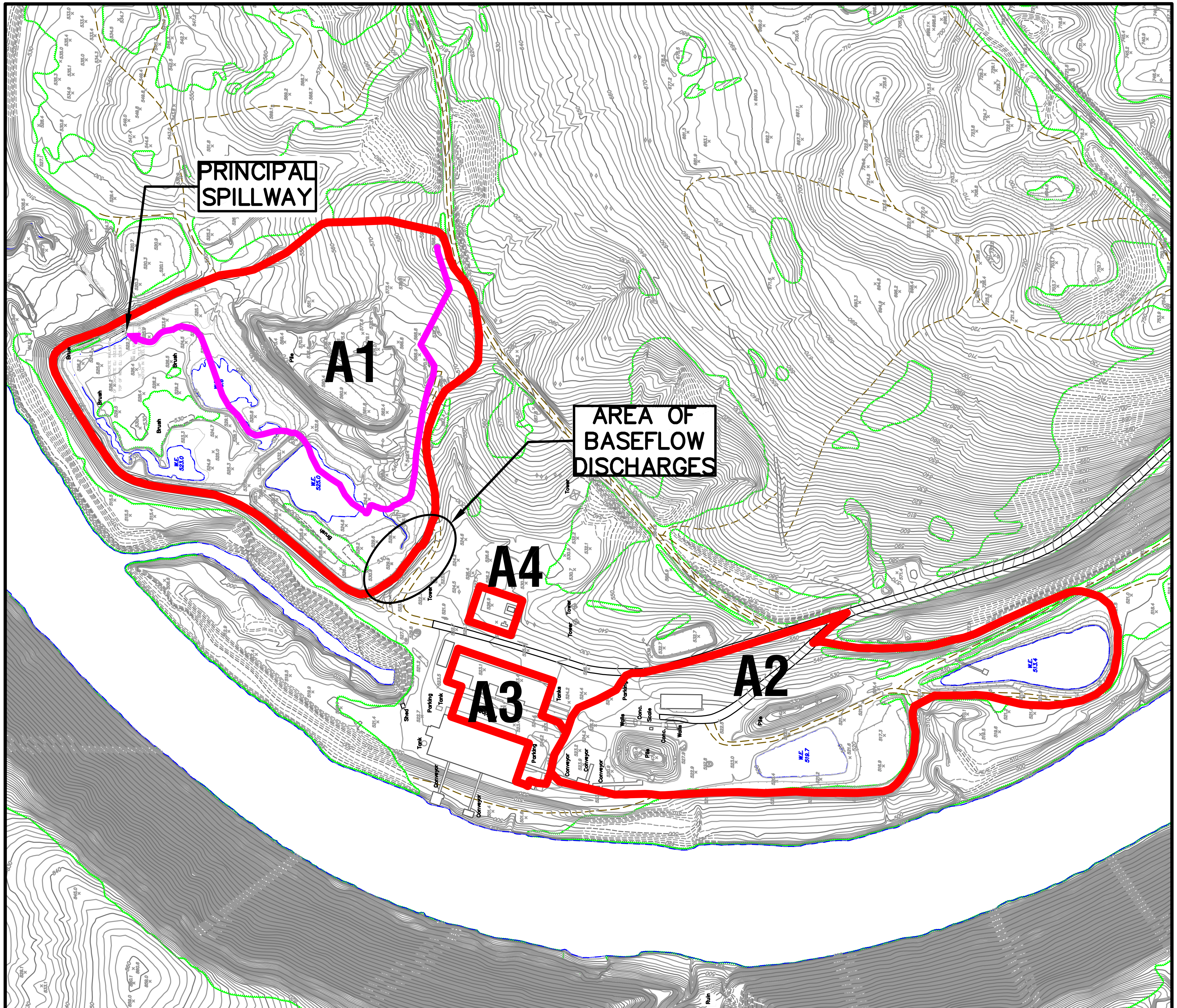
LG&E KU

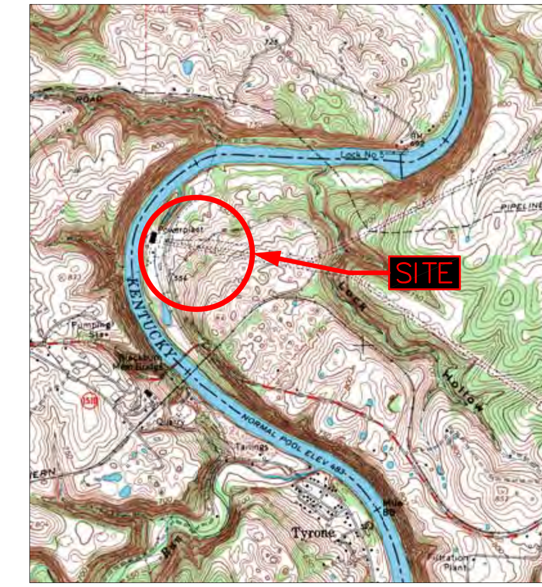
PPL companies

Generation Services

Appendices

A. Project Location & Drainage Area Map





LOCATION MAP

LEGEND

- Drainage Flow Path
- Obscured Contour
- Depression Contour
- Tree Line
- Brush Line
- Unpaved Road
- Edge of Water
- Stream
- Fence Line
- Utility Pole
- W.E. Water Elevation
- Photo Control Point
- Swamp

NOTES:

1. Source of Topographic Information: From ground control surveys dated December 22, 2009 and January 14, 2011 by L.R. Kimball Assoc., INC. and AGE Engineering Services, INC., respectively, and from aerial photography dated December 29, 2009.
2. Horizontal control is based on NAD83 Coordinates provided by L.R. Kimball Assoc., INC
3. Vertical control is based on an NAVD88 datum provided by L.R. Kimball Assoc., INC
4. Mapping scale of 1"=100' with 2' Contour Interval.

DRAINAGE AREAS (ACRES)	
A1	19.02
A2	12.44
A3	1.59
A4	0.32

Title:
ASH POND DRAINAGE AREA MAP

Location and Unit:
SCHEMATIC DIAGRAM
TYRONE GENERATING STATION
VERSAILLES, KENTUCKY

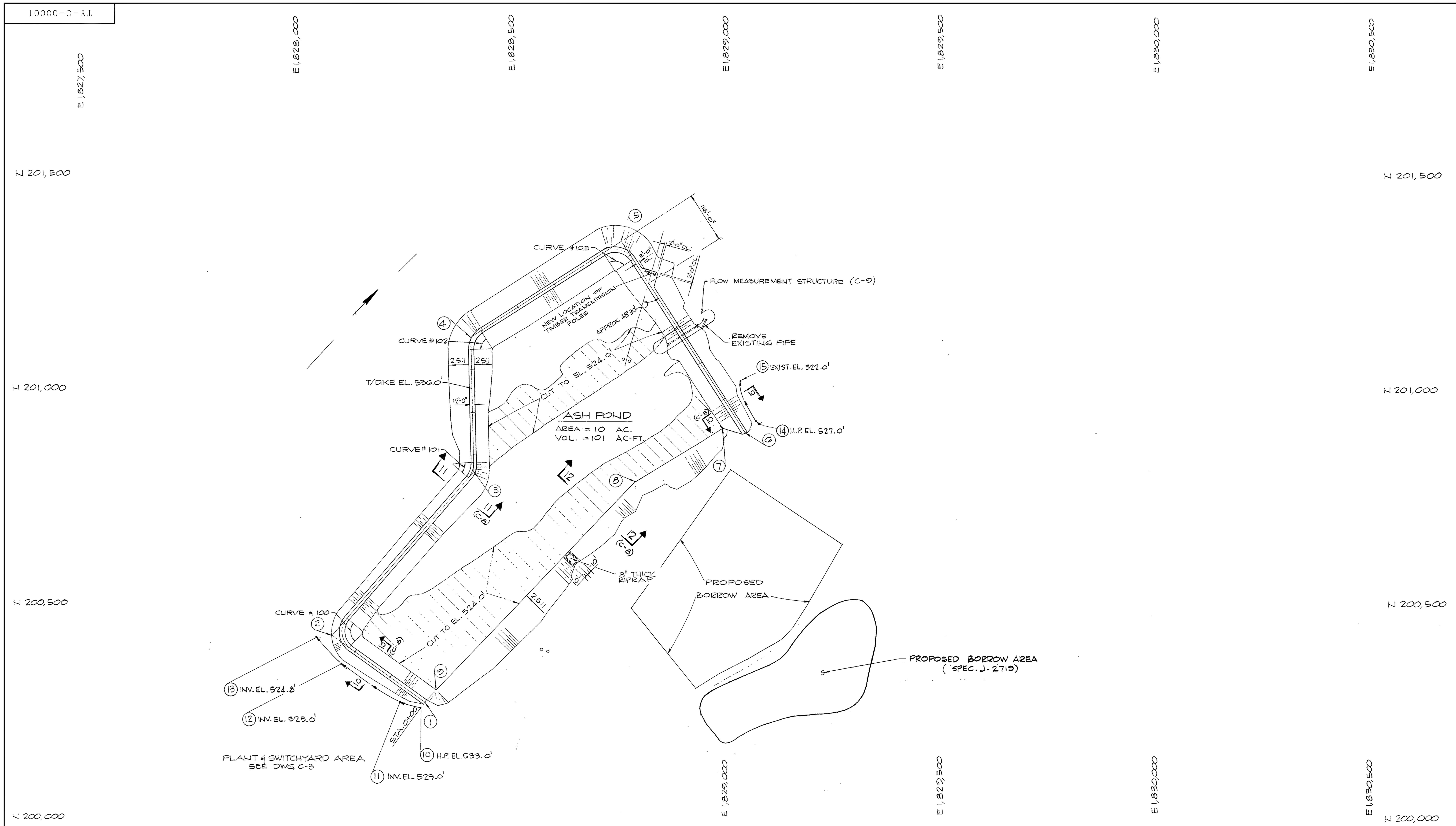
Scale: 1"=300'
Drawn: HDL
Drawn Date: 01/19/2011
Checked: R.W.
Checked Date: 01/19/2011
Approved: RETA_WHITE

KU Kentucky Utilities® Company

JOB NO.	DRAWING_NO	Rev.
125914	1	0

DMS_VERSION

B. Design Drawings



N 199,500

E 1,828,500

E 1,827,500

E 1,828,000

MATCH LINE N 199,860
(SEE DWG. C-2)

CURVE DATA - ASH POND

CURVE NO.	Δ	R	T	L	REMARKS
100					
101					
102	58°-37'-43"	50.0'	28.08'	51.16'	
103	89°-45'-39"	50.0'	49.79'	78.33'	

ASH POND COORDINATE LOC. SCHEDULE

COORD. NO.	NORTH	EAST
1	200,280	1,828,290
2	200,435	1,828,075
3		
4	201,130	1,828,395
5	201,355	1,828,745
6	200,908	1,829,035
7	200,920	1,828,980
8	200,795	1,828,780
9	200,307	1,828,315
10	200,267	1,828,280
11	200,280	1,828,235
12	200,366	1,828,098
13	200,430	1,828,040
14	200,535	1,829,060
15	201,030	1,829,022

NORTH

GENERAL NOTES

1. ALL WORK SHOWN ON THIS DRAWING AND OTHER DRAWINGS REFERRED TO THESE GENERAL NOTES SHALL BE DONE BY THE GENERAL WORK CONTRACTOR IN ACCORDANCE WITH PROJECT SPECIFICATION J-2717, UNLESS NOTED OTHERWISE.
2. ALL ELEVATIONS ARE REFERRED TO MEAN SEA LEVEL, U.S.G.S. 1929 ADJUSTMENT.
3. GRID IS BASED ON KENTUCKY STATE PLANE COORDINATE SYSTEM, NORTH ZONE.
4. ALL FILL AND CUT SLOPES, AND BOTTOM AND SIDE SLOPES OF DRAINAGE DITCHES SHALL BE PROVIDED WITH A COVER OF FOUR (4) INCHES SEEDED TOPSOIL.
5. ALL PIPES SHALL BE CORRUGATED METAL PIPES, UNLESS NOTED OTHERWISE.
6. ALL ELEVATIONS SHOWN FOR BERM, DIKES, GRADING AND DITCHES ARE FINISHED GRADE ELEVATIONS
7.
8. LEGEND:
   - INDICATES PIPE, FOR DETAILS SEE SCHEDULE (C-6)
   - INDICATES NEW DITCH
   - INDICATES EXIST. PIPES
   - INDICATES EXIST. PIPE TO BE PLUGGED
   - INDICATES NEW CULVERT
   - INDICATES EXIST. CULVERT
   - INDICATES NEW MANHOLE & VALVE
   - INDICATES EXIST DITCH

REFERENCE DRAWINGS

C-2	COAL PILE AREA - PLAN
C-3	PLANT & SWITCHYARD AREA - PLAN
C-8	ASH POND AREA - SECTIONS & DETAILS
C-9	FLOW MEASUREMENT STRUCTURE
S-17	FLOW MEASUREMENT STRUCTURE

REVISIONS

Rev.	Drawn Date:	Drawn By:	Revision Made
A	1/3/77	DQ	GENERAL WORK BIDS
B	3/22/77	AP	FOR CONSTRUCT.
C	5/6/77	DQ	REV. ASH DIKE
D	8/5/79	AP	ALIGN FOR CONSTRUCT.
E	1/6/06	RRW	NEW TITLE BLOCK

Title: PLANT & ASH POND AREA PLAN

Location and Unit: Tyrone Common

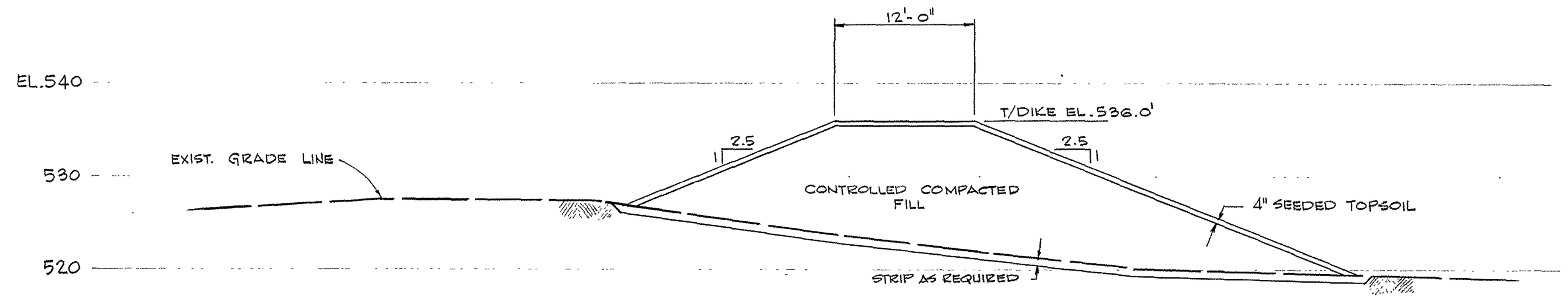
Scale: 1"=100'
Drawn:
Date: 01/03/77
Checked:
Approved:

Kentucky Utilities Company
A SUBSIDIARY OF LG&E ENERGY

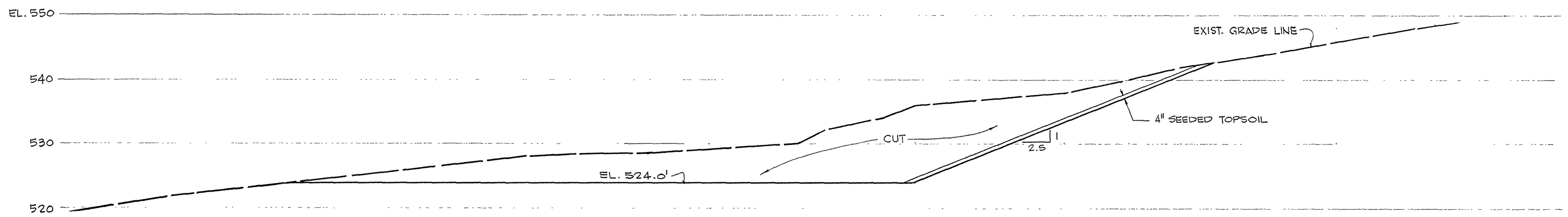
JOB NO.	JOB NO.	JOB NO.	JOB NO.
4974-00			
5928-00			

Drawing No: TY-C-00001 Rev. E

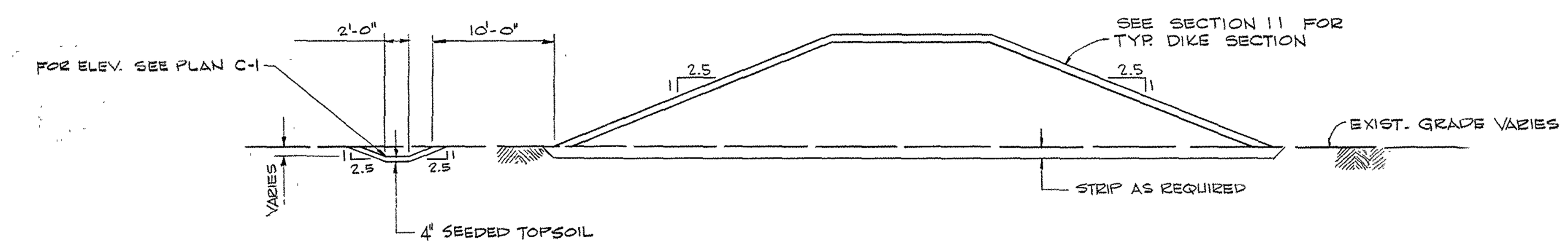
TY-C-00008



SECTION 11 (C-1)
SCALE: 1"=10'-0"



SECTION 12 (C-1)
SCALE: 1"=10'-0"



SECTION 10 (C-1)
SCALE 1"=10'-0"

NOTES

1. FOR GENERAL NOTES, SEE DRAWING C-1.

REFERENCE DRAWINGS

C-1	PLANT & ASH POND AREA - PLAN

STATE OF KENTUCKY
J. M. McLAUGHLIN
9039
REGISTERED PROFESSIONAL ENGINEER

REVISIONS

Rev.	Drawn Date:	Drawn By:	Revision Made
A	1/3/77	AO	GENERAL WORK BIDS
B	3/22/77	AO	FOR CONSTRUCTION
C	1/17/06	RRW	NEW TITLE BLOCK

Title: ASH POND AREA - SECTIONS & DETAILS

Location and Unit: Tyrone Common

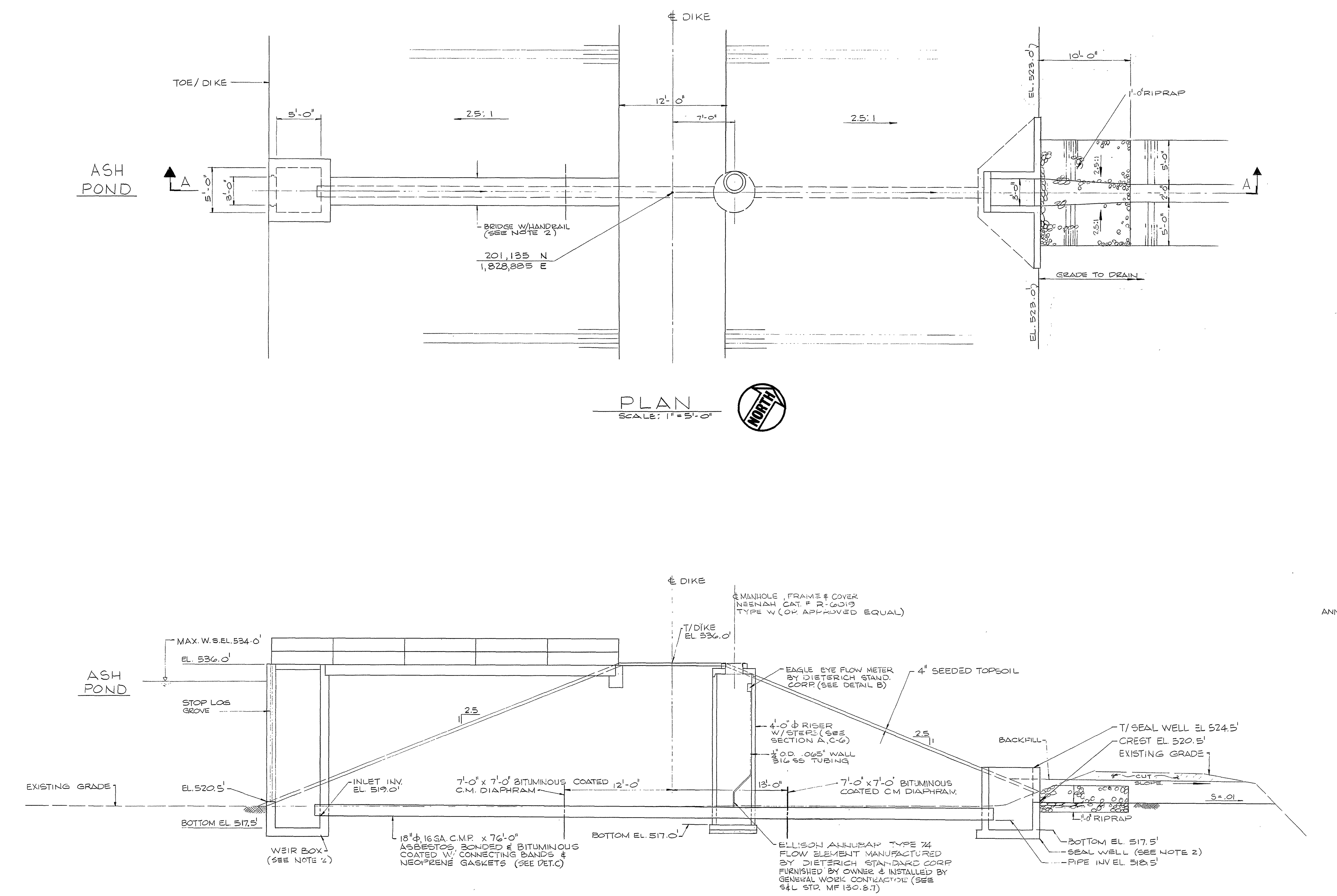
Scale: As Noted
Drawn:
Date: 01/03/77
Checked:
Approved:

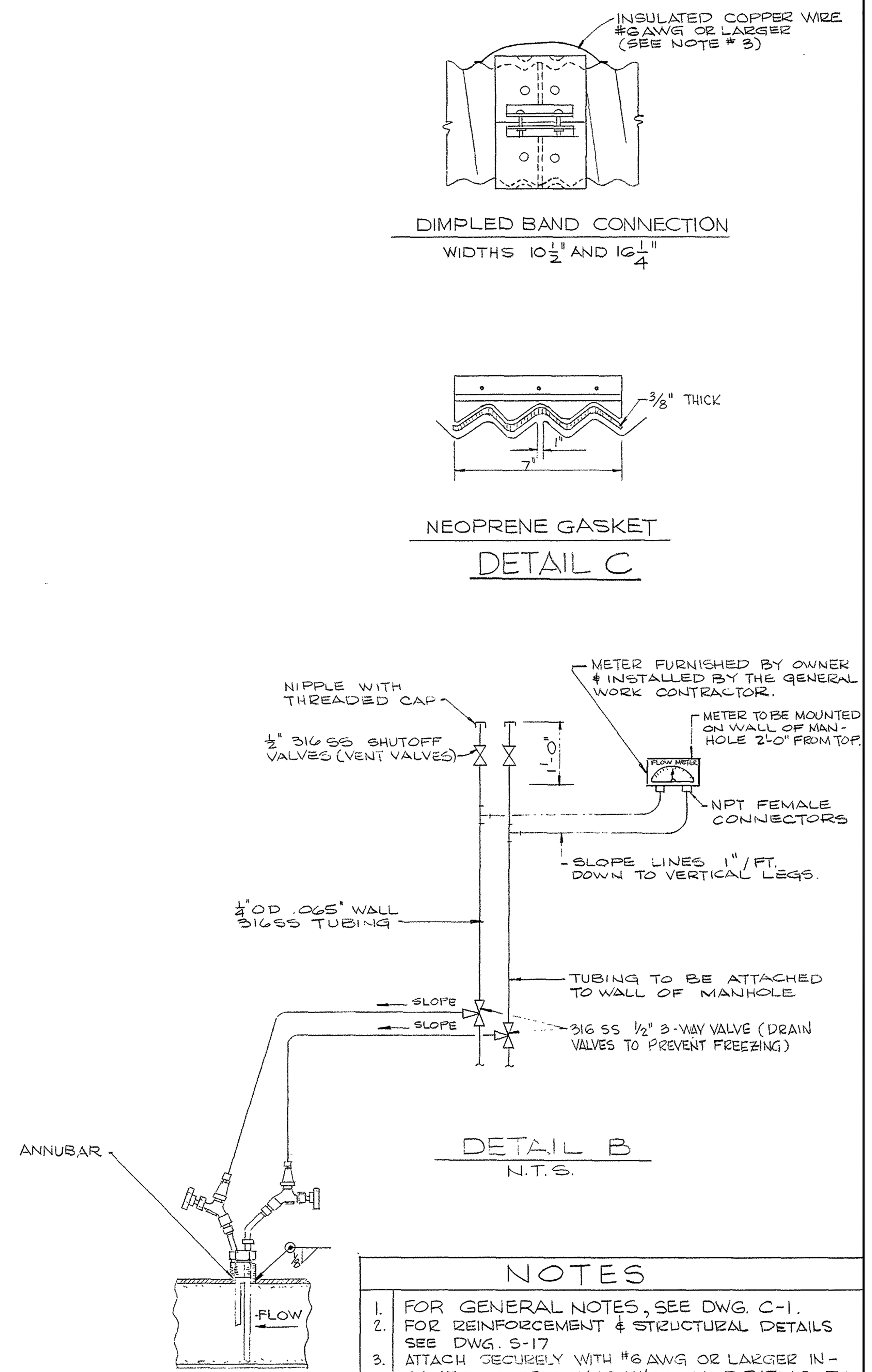
Kentucky Utilities Company
an e·on company

JOB NO.	JOB NO.	JOB NO.	JOB NO.
4974-00			

Drawing No: TY-C-00008
Rev.: C

DMS Version 2.0





NOTES

1. FOR GENERAL NOTES, SEE DWG. C-1.
2. FOR REINFORCEMENT & STRUCTURAL DETAILS SEE DWG. S-17
3. ATTACH SECURELY WITH #6 AWG OR LARGER INSULATED COPPER WIRE, W/600 VOLT RATING, TO UNCOATED PIPE METAL AT BOTH SIDES OF THE JOINT. BARE WIRE & EXPOSED PIPE METAL AT THE POINTS OF CONNECTION ARE TO BE THOROUGHLY COATED WITH A COATING EQUIVALENT TO THE ORIGINAL PIPE COATING.

REFERENCE DRAWINGS

C-1	PLANT & ASH POND AREA - PLAN

REVISIONS

Rev.	Drawn Date:	Drawn By:	Revision Made
A	1/3/77	MB	GENERAL WORK BIDS
B	3/22/77	MB	FOR CONSTRUCTION
C	4/18/77	AO	REV DETAIL B
D	1/3/77	RRW	NEW TITLE BLOCK

STATE OF KENTUCKY ★ J. M. McLAUGHLIN 9039 REGISTERED ★ PROFESSIONAL ENGINEER

Title
FLOW MEASUREMENT STRUCTURE – PLAN & SECTION

Location and Unit:
Tyrone Common

Scale: As Noted
Drawn:
Date: 01/03/77
Checked:
Approved:

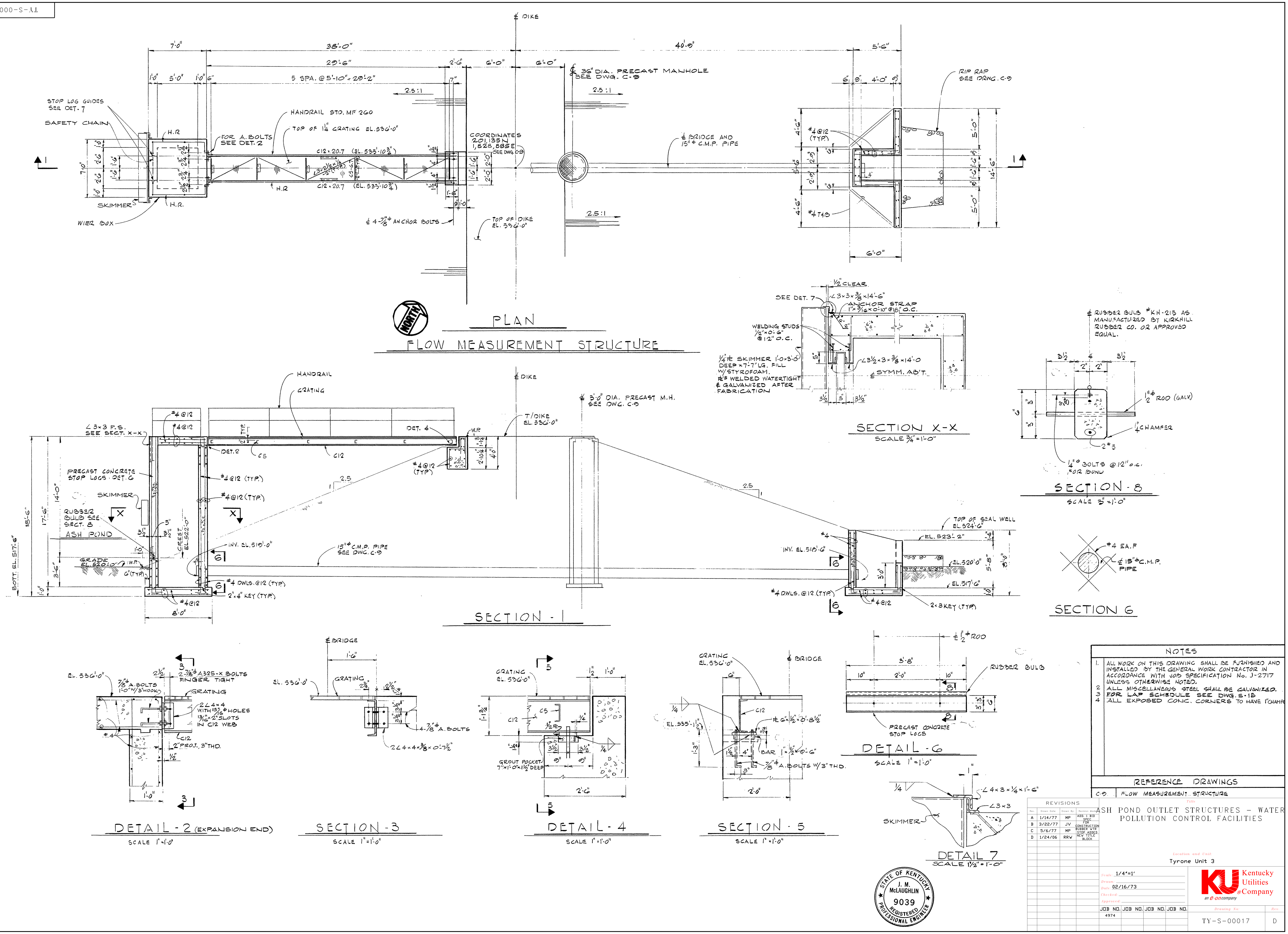
Kentucky Utilities Company
an e·on company

JOB NO.	JOB NO.	JOB NO.	JOB NO.
4974-00			

Drawing No: TY-C-00009
Rev.: D

DMS Version 2.0

TY-S-00017



NOTES

1. ALL WORK ON THIS DRAWING SHALL BE FURNISHED AND INSTALLED BY THE GENERAL WORK CONTRACTOR IN ACCORDANCE WITH JOB SPECIFICATION No. J-2717 UNLESS OTHERWISE NOTED.
2. ALL MISCELLANEOUS STEEL SHALL BE GALVANIZED.
3. FOR LAP SCHEDULE SEE DWG. S-15
4. ALL EXPOSED CONC. CORNERS TO HAVE 1" CHAMFER

REFERENCE DRAWINGS

C-9	FLOW MEASUREMENT STRUCTURE

REVISIONS

No.	Issue Date	Drawn By	Revision Made
A	1/14/77	MP	ADD. 1 BID SPEC
B	3/22/77	JV	FOR CONSTRUCTION
C	5/6/77	MP	RUBBER WTR STOP ADDED
D	1/24/06	RRW	NEW TITLE BLOCK

Title: ASH POND OUTLET STRUCTURES – WATER POLLUTION CONTROL FACILITIES

Location and Unit: Tyrone Unit 3

Scale: 1/4"=1'
Drawn:
Date: 02/16/73
Checked:
Approved:

JOB NO.	JOB NO.	JOB NO.	JOB NO.
4974			

Kentucky Utilities Company, an e·on company

Drawing No: TY-S-00017 Rev. D

DMS Version 2.0

C. HEC-HMS Output

Project: TY-HH Simulation Run: TY-Principal

Start of Run: 01Jan2011, 00:00 Basin Model: TY-HH
End of Run: 02Jan2011, 00:01 Meteorologic Model: TY-Principal
Compute Time: 18Jan2011, 13:16:23 Control Specifications: TY-Principal

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
TY-B	0.03	97.0	01Jan2011, 12:00	12.42
TY-P	0.03	10.7	01Jan2011, 14:35	11.59

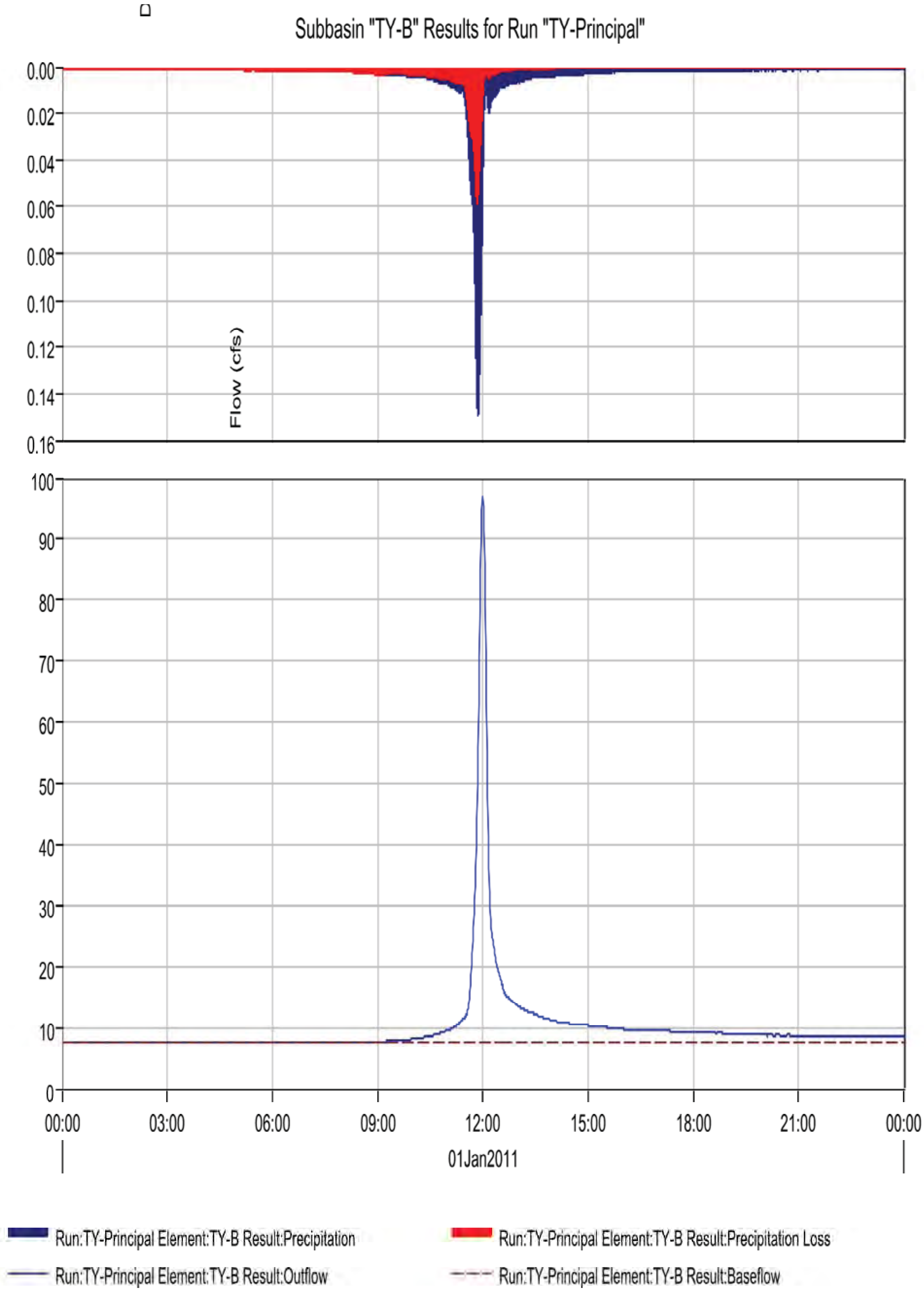
Project: TY-HH
Simulation Run: TY-Principal Subbasin: TY-B

Start of Run:	01Jan2011, 00:00	Basin Model:	TY-HH
End of Run:	02Jan2011, 00:01	Meteorologic Model:	TY-Principal
Compute Time:	18Jan2011, 13:07:49	Control Specifications:	TY-Principal

Volume Units: IN

Computed Results

Peak Discharge :	97.0 (CFS)	Date/Time of Peak Discharge :	01Jan2011, 12:00
Total Precipitation :	6.20 (IN)	Total Direct Runoff :	3.15 (IN)
Total Loss :	3.04 (IN)	Total Baseflow :	9.27 (IN)
Total Excess :	3.16 (IN)	Discharge :	12.42 (IN)



Subbasin "TY-B" Results for Run "TY-Principal"
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
Flow (cfs)
100
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Jan2011
Run:TY-Principal Element:TY-B Result:Precipitation
Run:TY-Principal Element:TY-B Result:Precipitation Loss
Run:TY-Principal Element:TY-B Result:Outflow
Run:TY-Principal Element:TY-B Result:Baseflow

Project: TY-HH

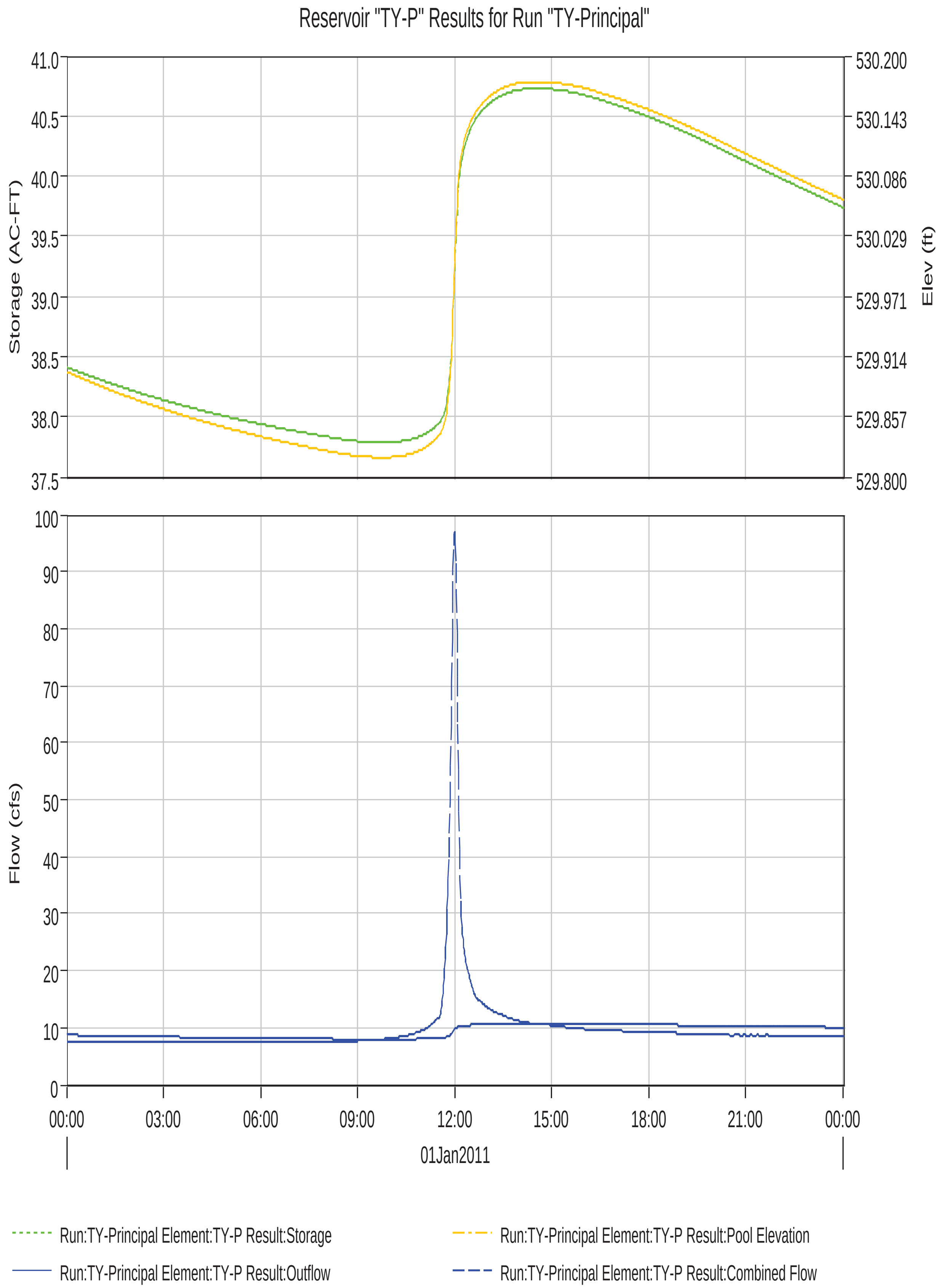
Simulation Run: TY-Principal Reservoir: TY-P

Start of Run:	01Jan2011, 00:00	Basin Model:	TY-HH
End of Run:	02Jan2011, 00:01	Meteorologic Model:	TY-Principal
Compute Time:	18Jan2011, 13:07:49	Control Specifications:	TY-Principal

Volume Units: IN

Computed Results

Peak Inflow :	97.0 (CFS)	Date/Time of Peak Inflow :	01Jan2011, 12:00
Peak Outflow :	10.7 (CFS)	Date/Time of Peak Outflow :	01Jan2011, 14:35
Total Inflow :	12.42 (IN)	Peak Storage :	40.7 (AC-FT)
Total Outflow :	11.59 (IN)	Peak Elevation :	530.2 (FT)



Reservoir "TY-P" Results for Run "TY-Principal"
Storage (AC-FT)
41.0
40.5
40.0
39.5
39.0
38.5
38.0
37.5
Elev (ft)
530.200
530.143
530.086
530.029
529.971
529.914
529.857
529.800
Flow (cfs)
100
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
01Jan2011
Run:TY-Principal Element:TY-P Result:Storage
Run:TY-Principal Element:TY-P Result:Pool Elevation
Run:TY-Principal Element:TY-P Result:Outflow
Run:TY-Principal Element:TY-P Result:Combined Flow

Project: TY-HH Simulation Run: TY-Emergency

Start of Run:	01Jan2011, 00:00	Basin Model:	TY-HH
End of Run:	01Jan2011, 06:01	Meteorologic Model:	TY-Emergency
Compute Time:	18Jan2011, 12:56:39	Control Specifications:	TY-Emergency

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
TY-B	0.03	37.2	01Jan2011, 02:32	4.04
TY-P	0.03	10.3	01Jan2011, 06:01	2.95

Project: TY-HH

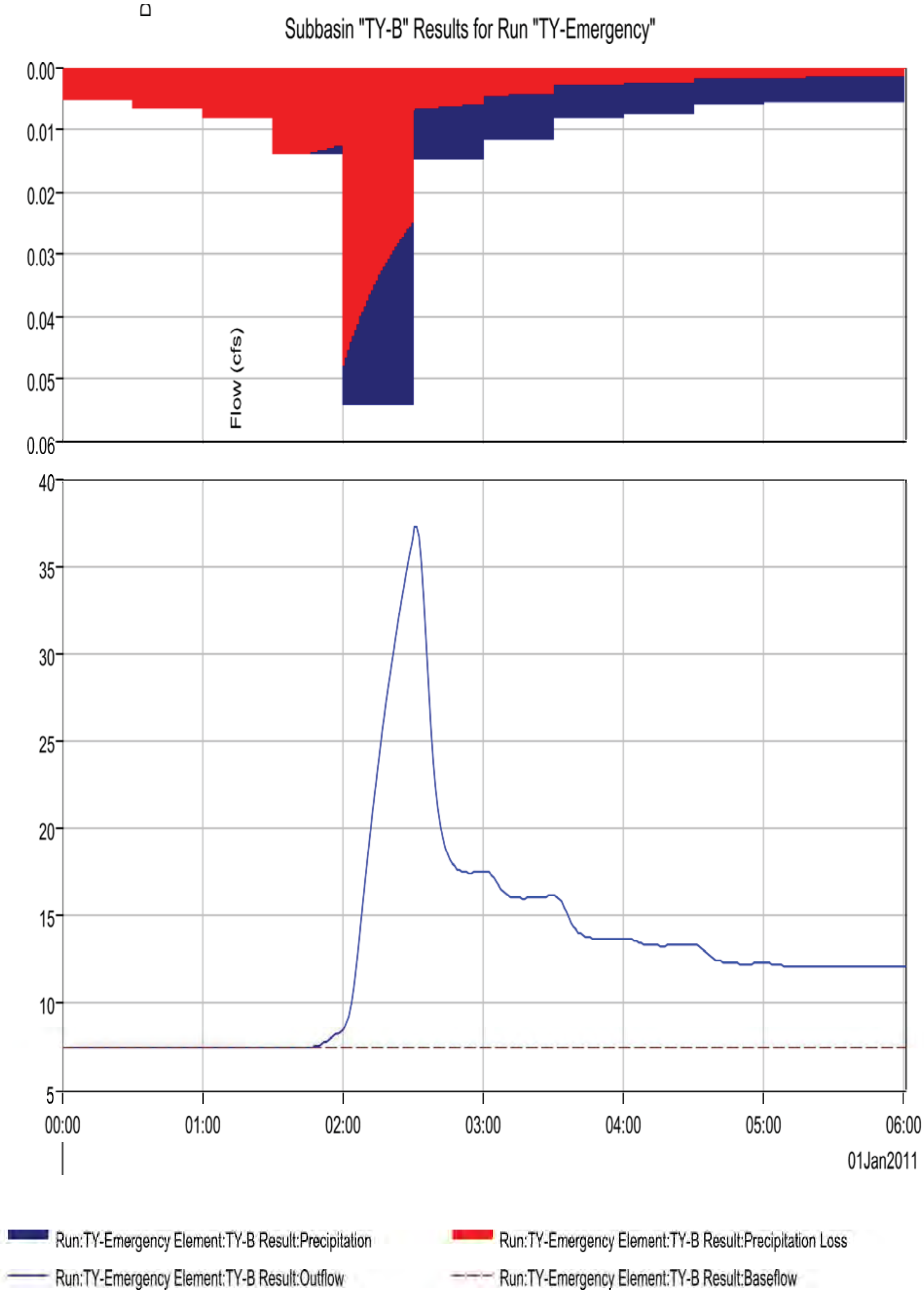
Simulation Run: TY-Emergency Subbasin: TY-B

Start of Run:	01Jan2011, 00:00	Basin Model:	TY-HH
End of Run:	01Jan2011, 06:01	Meteorologic Model:	TY-Emergency
Compute Time:	18Jan2011, 12:56:39	Control Specifications:	TY-Emergency

Volume Units: IN

Computed Results

Peak Discharge :	37.2 (CFS)	Date/Time of Peak Discharge :	01Jan2011, 02:32
Total Precipitation :	4.40 (IN)	Total Direct Runoff :	1.72 (IN)
Total Loss :	2.65 (IN)	Total Baseflow :	2.32 (IN)
Total Excess :	1.75 (IN)	Discharge :	4.04 (IN)


Subbasin "TY-B" Results for Run "TY-Emergency"
Flow (cfs)
0.00
0.01
0.02
0.03
0.04
0.05
0.06
40
35
30
25
20
15
10
5
00:00
01:00
02:00
03:00
04:00
05:00
06:00
01Jan2011
Run:TY-Emergency Element:TY-B Result:Precipitation
Run:TY-Emergency Element:TY-B Result:Precipitation Loss
Run:TY-Emergency Element:TY-B Result:Outflow
Run:TY-Emergency Element:TY-B Result:Baseflow

Project: TY-HH

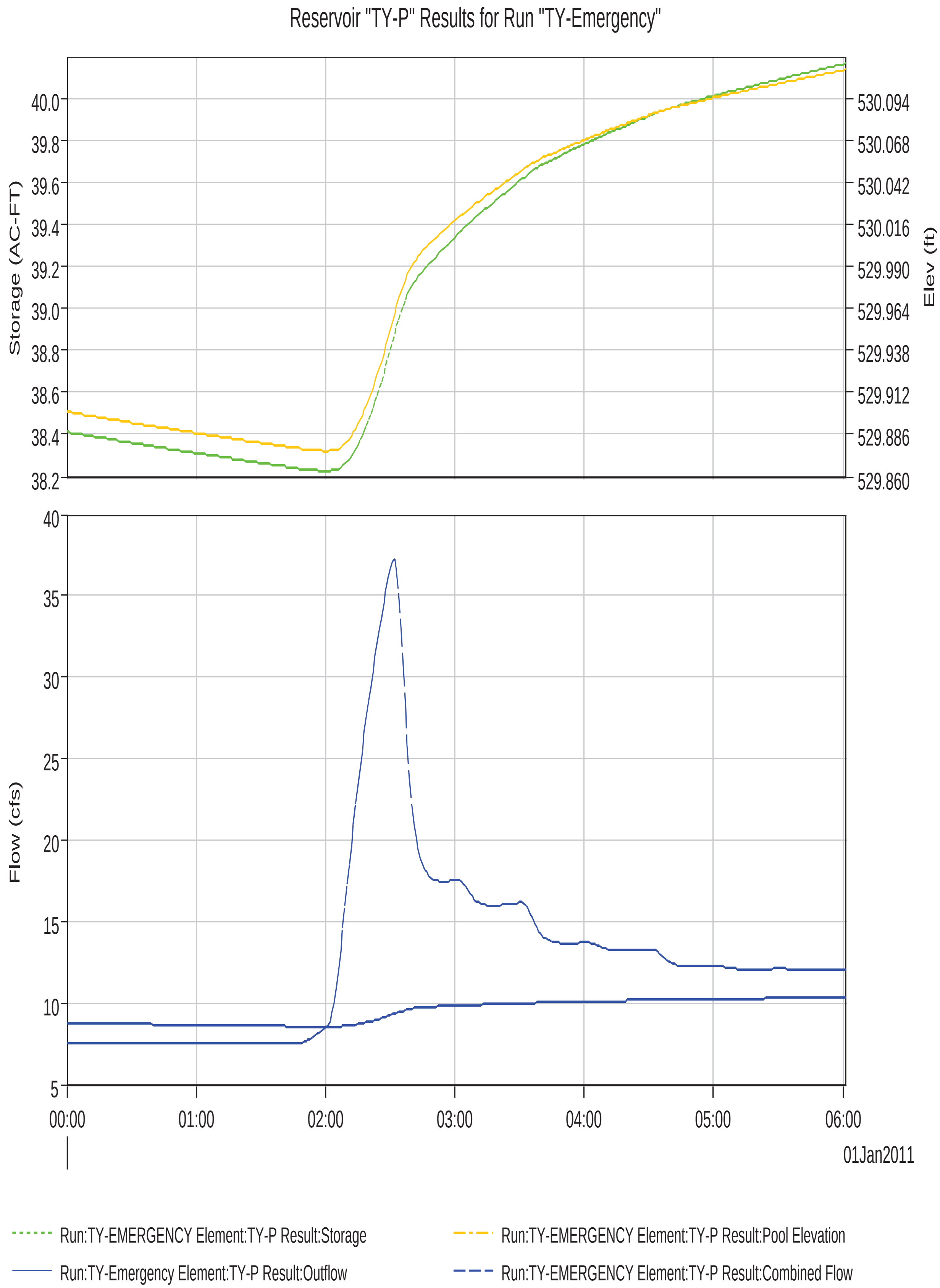
Simulation Run: TY-Emergency Reservoir: TY-P

Start of Run:	01Jan2011, 00:00	Basin Model:	TY-HH
End of Run:	01Jan2011, 06:01	Meteorologic Model:	TY-Emergency
Compute Time:	18Jan2011, 13:04:21	Control Specifications:	TY-Emergency

Volume Units: IN

Computed Results

Peak Inflow :	37.2 (CFS)	Date/Time of Peak Inflow :	01Jan2011, 02:32
Peak Outflow :	10.3 (CFS)	Date/Time of Peak Outflow :	01Jan2011, 06:01
Total Inflow :	4.04 (IN)	Peak Storage :	40.2 (AC-FT)
Total Outflow :	2.95 (IN)	Peak Elevation :	530.1 (FT)


Reservoir "TY-P" Results for Run "TY-Emergency"
Storage (AC-FT)
40.0
39.8
39.6
39.4
39.2
39.0
38.8
38.6
38.4
38.2
Elev (ft)
530.094
530.068
530.042
530.016
529.990
529.964
529.938
529.912
529.886
529.860
Flow (cfs)
40
35
30
25
20
15
10
5
00:00
01:00
02:00
03:00
04:00
05:00
06:00
01Jan2011
Run:TY-EMERGENCY Element:TY-P Result:Storage
Run:TY-EMERGENCY Element:TY-P Result:Pool Elevation
Run:TY-Emergency Element:TY-P Result:Outflow
Run:TY-EMERGENCY Element:TY-P Result:Combined Flow

Project: TY-HH Simulation Run: TY-Freeboard

Start of Run: 01Jan2011, 00:00 Basin Model: TY-HH
End of Run: 01Jan2011, 06:01 Meteorologic Model: TY-Freeboard
Compute Time: 18Jan2011, 13:07:32 Control Specifications: TY-Freeboard

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
TY-B	0.03	76.9	01Jan2011, 02:31	6.30
TY-P	0.03	12.2	01Jan2011, 06:01	3.25

Project: TY-HH

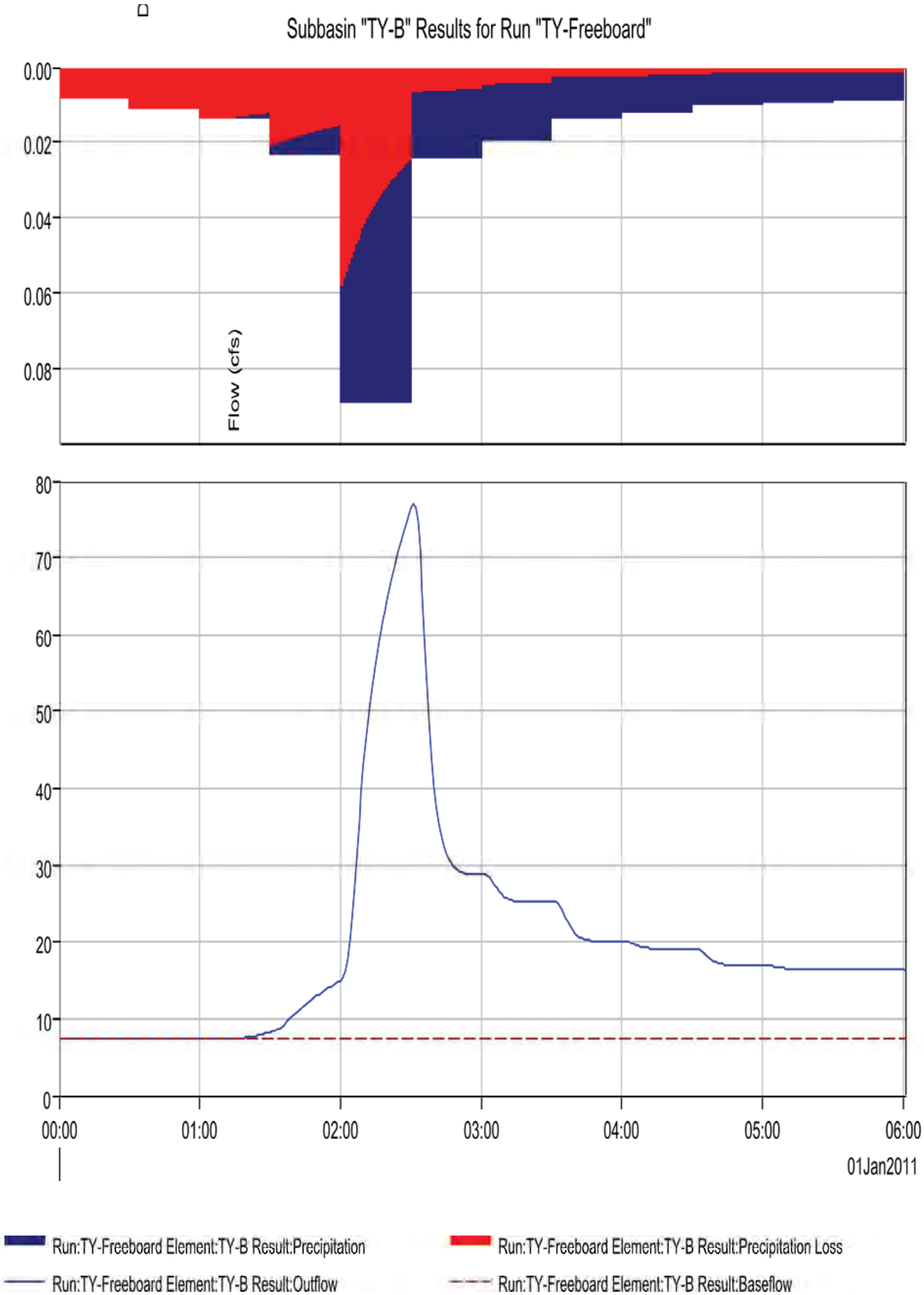
Simulation Run: TY-Freeboard Subbasin: TY-B

Start of Run:	01Jan2011, 00:00	Basin Model:	TY-HH
End of Run:	01Jan2011, 06:01	Meteorologic Model:	TY-Freeboard
Compute Time:	18Jan2011, 13:07:32	Control Specifications:	TY-Freeboard

Volume Units: IN

Computed Results

Peak Discharge :	76.9 (CFS)	Date/Time of Peak Discharge :	01Jan2011, 02:31
Total Precipitation :	7.24 (IN)	Total Direct Runoff :	3.98 (IN)
Total Loss :	3.21 (IN)	Total Baseflow :	2.32 (IN)
Total Excess :	4.03 (IN)	Discharge :	6.30 (IN)


Subbasin "TY-B" Results for Run "TY-Freeboard"
0.00
0.02
0.04
0.06
0.08
Flow (cfs)
80
70
60
50
40
30
20
10
0
00:00
01:00
02:00
03:00
04:00
05:00
06:00
01Jan2011
Run:TY-Freeboard Element:TY-B Result:Precipitation
Run:TY-Freeboard Element:TY-B Result:Precipitation Loss
Run:TY-Freeboard Element:TY-B Result:Outflow
Run:TY-Freeboard Element:TY-B Result:Baseflow

Project: TY-HH
Simulation Run: TY-Freeboard Reservoir: TY-P

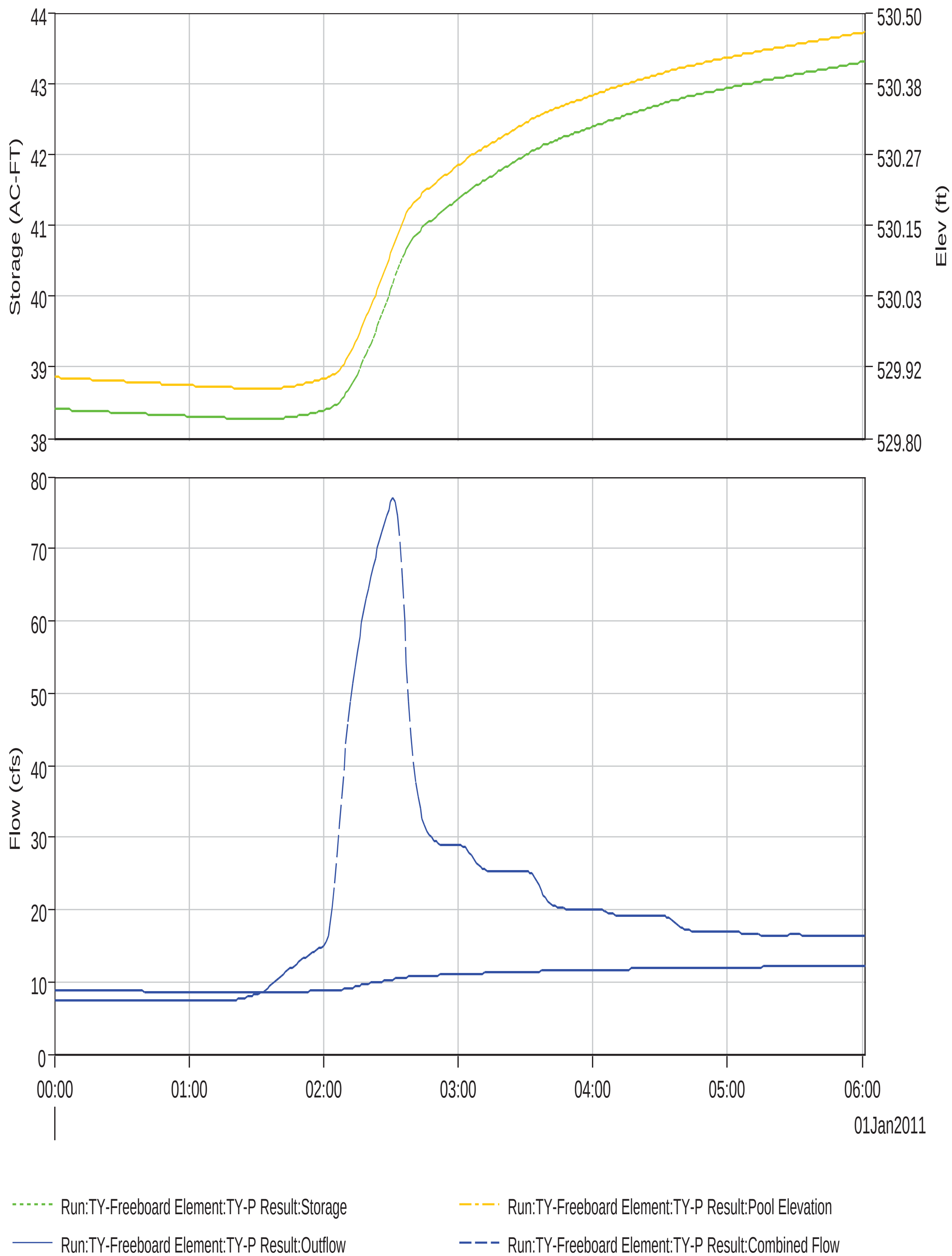
Start of Run:	01Jan2011, 00:00	Basin Model:	TY-HH
End of Run:	01Jan2011, 06:01	Meteorologic Model:	TY-Freeboard
Compute Time:	18Jan2011, 13:07:32	Control Specifications:	TY-Freeboard

Volume Units: IN

Computed Results

Peak Inflow :	76.9 (CFS)	Date/Time of Peak Inflow :	01Jan2011, 02:31
Peak Outflow :	12.2 (CFS)	Date/Time of Peak Outflow :	01Jan2011, 06:01
Total Inflow :	6.30 (IN)	Peak Storage :	43.3 (AC-FT)
Total Outflow :	3.25 (IN)	Peak Elevation :	530.5 (FT)

Reservoir "TY-P" Results for Run "TY-Freeboard"



Attachment 4

Cover pages, cover letter, appendices A and D of
2011 Pond Inspections Visual Site Assessment Report Six Impoundment Facilities

January 25, 2011
ATC Associates, Inc.

2011 Pond Inspections
Visual Site Assessment Report
Six Impoundment Facilities

KU Green River Station
KU Pineville Station
KU Tyrone Station

LG&E and KU Services Company

ATC Project No. 27.11000.1G37

January 25, 2011

Prepared For:

LG&E and KU Services Company
220 West Main Street
Louisville, Kentucky 40202

Attention: Mr. David Millay P.E.

2011 POND INSPECTIONS
VISUAL SITE ASSESSMENT REPORT
SIX IMPOUNDMENT FACILITIES

KU GREEN RIVER STATION
KU PINEVILLE STATION
KU TYRONE STATION

LG&E AND KU SERVICES COMPANY

ATC PROJECT NO. 27.11000.1G37

JANUARY 25, 2011

PREPARED FOR:

LG&E AND KU SERVICES COMPANY
220 WEST MAIN STREET
LOUISVILLE, KENTUCKY 40202

ATTENTION: MR. DAVID MILLAY P.E.

ATC ASSOCIATES INC.
Engineering Individual Solutions

11001 Bluegrass Parkway, Suite 250
Louisville, KY 40299
502-722-1401
Fax 502-267-4072
www.atcassociates.com

January 25, 2011

LG&E and KU Services Company
220 West Main Street
Louisville, Kentucky 40202
502-627-2468 office
502-693-0479 cell
David.Millay@lge-ku.com

Attention: Mr. David Millay P.E.
Civil Engineer

Re: **2011 Pond Inspections**
Visual Site Assessment Report
Six CCP Impoundment Facilities
KU Green River, KU Pineville, and KU Tyrone Stations
ATC Project No. 27.11000.1G37

Dear Mr. Millay:

ATC Associates Inc. (ATC) has completed Visual Site Assessments for a total of six Coal Combustion byProducts (CCP) pond facilities at the following power generation stations: four pond facilities at KU Green River Station, one pond facility at KU Tyrone Station, and one pond facility at KU Pineville Station. Previous assessments by ATC included one Finishing Pond at both the Tyrone and Green River Stations. The Finishing Ponds at both Tyrone and Green River were taken out of service in 2010 and no longer impound water. These ponds were not included during this assessment interval. This assessment report includes three pond facilities classified as "dams" by the Kentucky Energy and Environment Cabinet, Division of Water, Dam Safety Section (KDSS), and three ponds which are not classified and do not have a hazard rating or an identification number.

Our field observations were made during the month of January, 2011. These assessments were performed in general accordance with safety inspection protocols published in "Guidelines for Maintenance and Inspection of Dams in Kentucky" prepared by the Kentucky Natural Resources and Environmental Protection Cabinet, Division of Water, dated July 1985.

Report Terminology
The following terminology will be utilized in this report:

Pond: A facility consisting of an excavation, a soil embankment or a combination of both that impounds water or solids. A pond is typically composed of an area impounding water, an excavation slope or an impounding embankment and a spillway to discharge water. Descriptions of various pond configurations used by the US EPA are shown on Figure 1 (Appendix A); these descriptions will be utilized in this Assessment Report.

Embankment: A compacted earthen mound placed under controlled conditions that serve to impound water or solids. An embankment could be classified as either a dam or a berm depending of the height and volume of material retained.

Dam: An embankment that impounds water or solids that meets the KRS 151 definition. In general a dam is 25 or more feet in height or has an impounding capacity of fifty or more acre-feet at the lowest point on the top of the dam. Height is measured from the natural bed of the stream or watercourse at the downstream toe of the embankment to the low point in the top of the dam.

Berm: An embankment that impounds water or solids that does not meet the KY Department for Natural Resources and Environmental Protection definition of a dam.

Assessment Activities
The scope of these assessments was limited to an examination of readily observable surficial features of the ponds and a review of information provided to us. Our field team was accompanied by LG&E/KU. representatives at each site visit. Our assessments did not include any test drilling, material testing, precise physical measurements of pond features, detailed calculations to verify spillway capacities or embankment stability, or other engineering analyses. Although the visual assessments were conducted by experienced personnel in accordance with generally accepted methods, the assessments should not be considered as a warranty or guaranty of the future safety of the facilities.

All the ponds addressed by this assessment were located at existing or former power stations and generally consisted of an excavated pond enclosed on one or more sides with an earthen embankment. The ponds generally receive minimal storm water runoff, with the majority of water inflow resulting from the sluicing of CCP and other power generation process water into the impoundments. **Table 1** summarizes the facilities assessed by ATC during this phase of work.

Table 1- Summary of Assessed Ponds

		Pond Type 1	Secondary Spillway Present	No. Findings: 2011 Inspection	Condition Rating 2011 Inspection 2
Green River	Main Ash Pond	Side Hill	No	10	F
	Scrubber Pond	Side Hill/Diked	No	5	F
	Number 2 Pond	Side Hill	No	4	F
	Coal Runoff Pond	Side Hill	No	6	F
Pineville	Ash Pond	Side Hill	No	8	F
Tyrone	Ash Pond	Side Hill/Incised	No	14	F

S – Satisfactory
F – Fair
CP- Conditionally Poor
P – Poor
U – Unsatisfactory

Note 1: See Appendix A
Note 2: See Pond Assessment Forms

This summary report includes the following items for each pond assessed:

- Site Vicinity Map
- Findings and Recommendations Table
- Dam Assessment Form
- Photographs
- Site Plan with Photographs
- Site Plan with GPS Locations and Field Observations

Findings and Recommendations
The findings and recommendations summarized in the appendices to this report are grouped by Power Station and by pond facility. The findings and recommendations are categorized with a priority level of High, Moderate, or Normal (described in "Findings and Recommendations" Tables).

The recommendations provided in the Findings and Recommendations Tables are specific to each pond facility; however, we have developed four general recommendations that apply to all the facilities.

1. Prepare or update an Operation and Maintenance Manual for each facility. The manual will allow rapid assessments of any variations in the day to day operation of each facility, will assist in troubleshooting problems, and will provide a source of data for future plant personnel responsible for the management of the facility. **Normal Priority**

2. Continue regular facility inspections. These inspections will allow changes in the facility to be observed in a timely fashion and allow preventative measures to be taken as part of regular maintenance rather than on an emergency basis. The personnel conducting the inspections should receive training on the proper inspection techniques, the specific items that should be inspected, the frequency of inspections and the documentation that is required. The inspection regime should also include a regular (yearly) assessment by either outside consultants or LG&E and KU corporate personnel not routinely assigned to a power station. **High Priority**

3. Determine for each pond the maximum pool level that can be safely maintained to provide adequate freeboard capacity with the existing spillway configurations. The maximum elevation should then be surveyed and marked on each spillway inlet. Documentation of the maximum allowable water elevation should also be placed in the Operation and Maintenance Manual for each pond. **High Priority**

4. Evaluate each pond facility with an embankment to determine whether a redundant method to prevent or safely control impounded water from overtopping the embankment crest is needed. The Findings and Recommendations page for each pond describes whether the ponds have emergency or secondary spillways. Published literature indicates that progressive erosion of the embankment crest during an overtopping event is one of the most common causes of embankment failure. **Normal Priority**

Discussion
The appendices to this report contain a Findings and Recommendation Table for each pond assessed. Discussion and clarification of specific recommendations are provided below.

Three of the ponds addressed by this report are currently not classified by the KY Division of Water, Dam Safety Branch as "Dams", and therefore do not have a State Dam ID number. However 401 KAR 4:030, which is the regulation which dictates the engineering standards for "*dams and all other impounding obstructions which might create a hazard to life and/or property*", may apply to the three unclassified ponds, since most impound CCP or fluids using an obstruction and are not incised ponds.

Our Findings and Recommendations table for each structure include suggestions to "Evaluate" or "Monitor" specific items associated with each structure. In this report "Evaluate" should be interpreted to mean - additional data is required for a qualified individual such as an engineer to determine whether:

- Such an evaluation has been made previously,
- Past evaluations are valid for the current structure in its current configuration and use, and
- Additional engineering analyses are needed.

In this report "Monitor" should be interpreted to mean – observe that specific item during future follow-up assessments and during regular inspections to observe and document any changes noted from the preceding assessment.

We appreciate the opportunity to provide our assessment services to you. If you have any questions concerning information contained in this report, or if the condition of the facilities should change significantly from that described herein, please do not hesitate to call either of the undersigned.

Sincerely,

ATC Associates Inc.

Mark J. Schuhmann P.E.
Principal Engineer
KY License 12,500

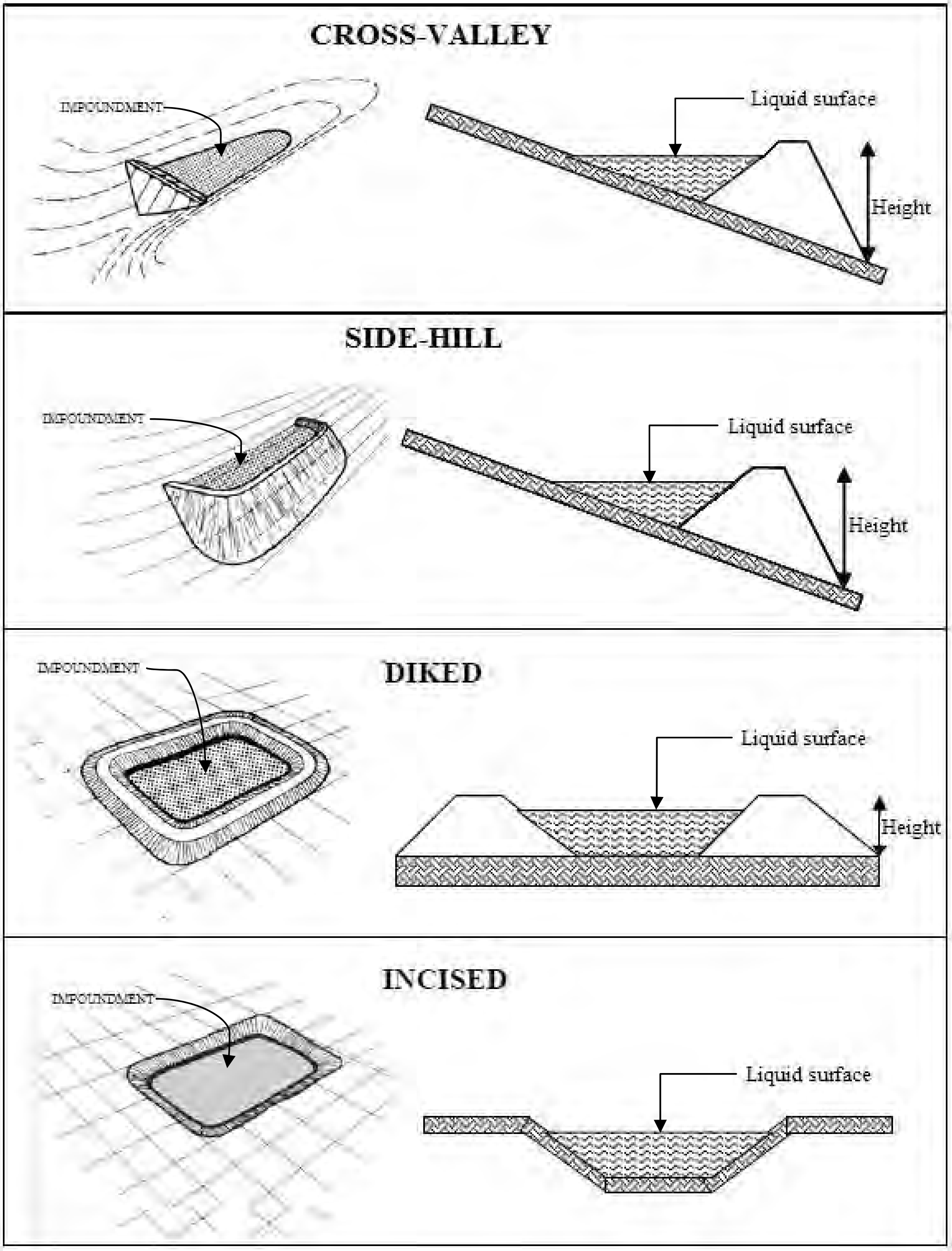
Josh English, E.I.T.
Staff Engineer

Appendix A
General Information

Appendix A
General Information

List of Contents

Pond Type Nomenclature



DAM/POND ASSESSMENT FORM

Name of Professional Conducting Inspection:	KY Professional License No.:
Company Name: ATC Associates Inc.	Phone:
Address:	
Inspection Preparation: Reviewed all pertinent technical documentation related to this dam and site in: the State's files Yes ☐ No ☐ ; and Owner's Files: Yes ☐ No ☐	
Comments:	

Dam/Pond Name:		Hazard Class:	Topographic Quad:	Date of Inspection:	
State Dam ID:	County:	Latitude	Longitude	Last Inspection:	
Power Station Name:					
Address:					
Site Contact:			Phone:		
Drainage Area (mi^2):	Surface Area(AC):	Height (Ft):	Crest Length (Ft):	Crest Width (Ft):	Crest Elevation
Slope (Ft): Interior: Exterior:	Principal Spillway Type:	Principal Spillway Size:	Spillway Control Elevation:	Feet Freeboard:	
CCP placed in Pond:	Emergency Spillway Type:	Emergency Spillway Size:	Spillway Control Elevation:	Feet Freeboard:	

FIELD CONDITIONS OBSERVED

CCP Above Crest:Yes:☐ None:☐	Location:	Max. Height above pool
Water Level (Below Dam Crest, Ft):		
Ground Moisture Condition: Dry ☐ Wet ☐ Snow cover ☐ Other:		
Monitoring: Yes ☐ None: ☐ (☐ Gage Rod ☐ Piezometers ☐Seepage Weirs ☐ Survey Monuments ☐ Other)		
Comments:		

A **INTERIOR SLOPE**	**Problems Noted**: ☐ None ☐ Riprap – Missing, Sparse ☐ Wave Erosion ☐ Cracks ☐ Sinkholes ☐ Appears Too Steep ☐ Depressions or Bulges ☐ Slides ☐ Animal Burrows ☐ Trees, Bushes, Briars ☐ Other
GOOD ☐	**Comments**:
ACCEPTABLE ☐	
DEFICIENT ☐	
POOR ☐	

B **CREST**	**Problems Noted**: ☐ None ☐ Ruts or Puddles ☐ Erosion ☐ Cracks ☐ Sinkholes ☐ Not Wide Enough ☐ Low Areas ☐ Misalignment ☐ Inadequate Surface Drainage ☐ Trees, Bushes, Briars ☐ Other
GOOD ☐	**Comments**:
ACCEPTABLE ☐	
DEFICIENT ☐	
POOR ☐	

CCP: Coal Combustion Products;
Spillway Size: Pipe Dia. for drop inlet; open channel width (typically emergency or (auxiliary) spillway) at the control section, Ft;.
Freeboard: vertical distance from the emergency spillway control section to the lowest point of the crest of the dam.

DAM/POND ASSESSMENT FORM

C EXTERIOR SLOPE	
GOOD ☐	**Problems Noted**: ☐ None ☐ Livestock Damage ☐ Erosion, Gullies ☐ Cracks ☐ Sinkholes ☐ Appears Too Steep ☐ Depression or Bulges ☐ Slide ☐ Soft Areas ☐ Trees, Bushes, Briars ☐ Animal Burrows ☐ Other
ACCEPTABLE ☐	**Comments**:
DEFICIENT ☐	
POOR ☐	

D SEEPAGE	
GOOD ☐	**Problems Noted**: ☐ None ☐ Saturated Embankment Area ☐ Seepage Exits on Embankment ☐ Seepage Exits at Point Source ☐ Seepage Area at Toe ☐ Flow Adjacent to Outlet
ACCEPTABLE ☐	**If Seepage**: ☐ Clear ☐ Muddy
DEFICIENT ☐	**Drain Outfalls Seen**: Yes ☐ No ☐ Flow: ☐ Clear ☐ Muddy ☐ Dry ☐ Obstructed
POOR ☐	**Comments**:

E PRINCIPAL SPILLWAY	
	Description:
GOOD ☐	**Problems Noted**: ☐ None ☐ Deterioration ☐ Separation ☐ Cracking ☐ Inlet, Outlet Deficiency ☐ Stilling Basin Inadequacies ☐ Trash Rack ☐ Other
ACCEPTABLE ☐	**Comments**:
DEFICIENT ☐	
POOR ☐	

F AUXILIARY SPILLWAY	
	Description:
GOOD ☐	**Problems Noted**: ☐ None ☐ No Auxiliary Spillway Found ☐ Erosion with Backcutting ☐ Crack with Displacement ☐ Appears to be Structurally Inadequate ☐ Appears too Small ☐ Inadequate Freeboard ☐ Flow Obstructed ☐ Concreted Deteriorated/Undermined ☐ Other
ACCEPTABLE ☐	
DEFICIENT ☐	
POOR ☐	
	Comments:

G MAINTENANCE AND REPAIRS	
GOOD ☐	**Problems Noted**: ☐ None ☐ Access Road Needs Maintenance ☐ Cattle Damage ☐ Spillway Obstruction ☐ Vegetation on Interior Slope, Crest, Exterior Slope, Toe ☐ Trees on Interior Slope, Crest, Exterior Slope, Toe ☐ Rodent Activity on Interior Slope, Crest, Exterior Slope, Toe ☐ Deteriorated Concrete –Facing, Outlet, Spillway ☐ Gate and/or Drawdown Need Repair ☐ Other
ACCEPTABLE ☐	
DEFICIENT ☐	
POOR ☐	
	Comments:

H IMPOUNDMENT AREA	
	Problems Noted: ☐ None ☐ Ponded Water within Ash ☐ Ash blocking spill way ☐ Signs of damage from dredging ☐ Ash deposits in spillway ☐ Other
GOOD ☐	
ACCEPTABLE ☐	**Impoundment receives surface water runoff in addition to sluiced ash**: Yes ☐ No ☐
DEFICIENT ☐	**Release of ponded water could cause overtopping of dam**: Yes ☐ No ☐ N/A ☐
POOR ☐	**Comments**:

DAM/POND ASSESSMENT FORM

I OVERALL CONDITIONS		Comments:
SATISFACTORY	☐	
FAIR	☐	
CONDITIONALLY POOR	☐	
POOR	☐	
UNSATISFACTORY	☐	

Summary of Findings and Recommendations in Attached Table

This visual dam assessment was conducted to assess the general overall condition of the reservoir/ash pond/dam, identify visible deficiencies, and recommend areas for monitoring, additional investigative studies and corrective actions. The assessment is based only on visible features/areas of the dam on the day of inspection; it does not constitute a formal safety inspection nor a review or evaluation from each specialist of an inspection team, such as geologists, civil, geotechnical, structural, or hydraulics engineer. The owner should verify the findings of this report and take corrective actions. This assessment does not relieve the owner/operator from their responsibility to conduct routine inspections, maintenance, repairs, modifications, monitoring, documentation, and/or investigative studies.

Professional Engineer's Signature: ______________________________ Date: __________

Reviewed by: ____ Date: __________

Owner/Owner Representative Signature

DAM/POND ASSESSMENT FORM

POND CONDITION GUIDELINES

Conditions Observed – Applies to Interior Slope, Crest, Exterior Slope, Principal Spillway , Auxiliary Spillway and Impoundment area			
Good In general, this part of the structure has a good appearance, and conditions observed in this area do not appear to threaten the safety of the dam	**Acceptable** Although general cross-section is maintained, surfaces may be irregular, eroded, rutted, spalled, or otherwise not in new conditions. Conditions in this area do not currently appear to threaten the safety of the dam.	**Deficient** Continued deterioration and/or unusual loading may threaten the safety of the dam.	**Poor** Conditions observed in this area appear to threaten the safety of the dam. Conditions observed in this area are unacceptable.
Conditions Observed – Applies to Seepage			
Good No evidence of uncontrolled seepage. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions do not appear to threaten the safety of the dam.	**Acceptable** Some seepage exposits at areas other than drain outfalls, or other designed drains. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions observed do not currently appear to threaten the safety of the dam.	**Deficient** Excessive seepage exists at areas other than drain outfalls and other designed drains. Seepage needs to be evaluated; increase flow and/or continued deterioration in seepage conditions may threaten the safety of the dam.	**Poor** Excessive seepage conditions observed appear to threaten the safety of the dam and is unacceptable. Examples: 1) Designed drain or seepage flow have increased without increase in reservoir level. 2) Drain or seepage flows contain sediment. 3) Widespread seepage, concentrated seepage or ponding appears to threaten the safety of the dam.
Conditions Observed – Applies to Maintenance and Repair			
Good Dam appears to receive effective on-going maintenance and repair, and only a few minor items may need to be addressed.	**Acceptable** Dam appears to receive maintenance, but some maintenance items need to be addressed. No major repairs are required.	**Deficient** Level of maintenance of the dam needs significant improvement. Major repairs may be required. Continued neglect of maintenance may threaten the safety of the dam.	**Poor** Dam does not receive adequate maintenance. One or more items needing maintenance or repair have begun to threaten the safety of the dam. Level of maintenance is unacceptable.

Overall Conditions				
Satisfactory No existing or potential dam safety deficiencies recognized. Safe performance is expected under all anticipated loading conditions, including such events as infrequent hydrologic and/or seismic events. Project files contain necessary hydrologic and other engineering calculations to verify dam safety and performance.	**Fair** No existing dam safety deficiencies are recognized for normal loading conditions. Infrequent hydrologic and/or seismic events would probably result in a dam safety deficiency.	**Conditionally Poor** A potential safety deficiency is recognized for unusual loading conditions which may realistically occur during the expected life of the structure. This designation may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency; further investigations and studies are necessary.	**Poor** A potential dam safety deficiency is clearly recognized for normal loading conditions. Immediate actions to resolve the deficiency are recommended; reservoir restrictions may be necessary until problem resolution.	**Unsatisfactory** A dam safety deficiency exists for normal conditions. Immediate remedial action is required for problem resolution.

SECTION B - STRUCTURE CLASSIFICATION

In determining structure classification, a number of factors must be considered. Consideration must be given to the damage that might occur to existing and future developments downstream resulting from a sudden breach of the earth embankment and the structures themselves. The effect of failure on public confidence is an important factor. State and local regulations and the responsibility of the involved public agencies must be recognized. The stability of the spillway materials, the physical characteristics of the site and valley downstream, and the relationship of the site to industrial and residential areas all have a bearing on the amount of potential damage in the event of a failure.

Structure classification is determined by the above conditions. It is not determined by the criteria selected for design.

1. CLASS OF STRUCTURES

The following broad classes of structures are established to permit the association of criteria with the damage that might result from a sudden major breach of the structure.

A. Class (A) - Low Hazard

This classification may be applied for structures located such that failure would cause loss of the structure itself but little or no additional damage to other property. Such structures will generally be located in rural or agricultural areas where failure may damage farm buildings other than residences, agricultural lands, or county roads.

B. Class (B) - Moderate Hazard

This classification may be applied for structures located such that failure may cause significant damage to property and project operation, but loss of human life is not envisioned. Such structures will generally be located in predominantly rural agricultural areas where failures may damage isolated homes, main highways or major railroads, or cause interruption of use or service of relatively important public utilities.

C. Class (C) - High Hazard

This classification must be applied for structures located such that failure may cause loss of life, or serious damage to houses, industrial or commercial buildings, important public utilities, main highways or major railroads. This classification must be used if failure would cause probable loss of human life.

The responsible engineer shall determine the classification of the proposed structure after considering the characteristics of the valley below the site and probable future development. Establishment of minimum criteria does not preclude provisions for greater safety when deemed necessary in the judgment of the engineer. Considerations other than those mentioned in the above classifications may make it desirable to exceed the established minimum criteria. A statement of the classification established by the responsible engineer shall be clearly shown on the first sheet of the plans.

II. STRUCTURES IN SERIES

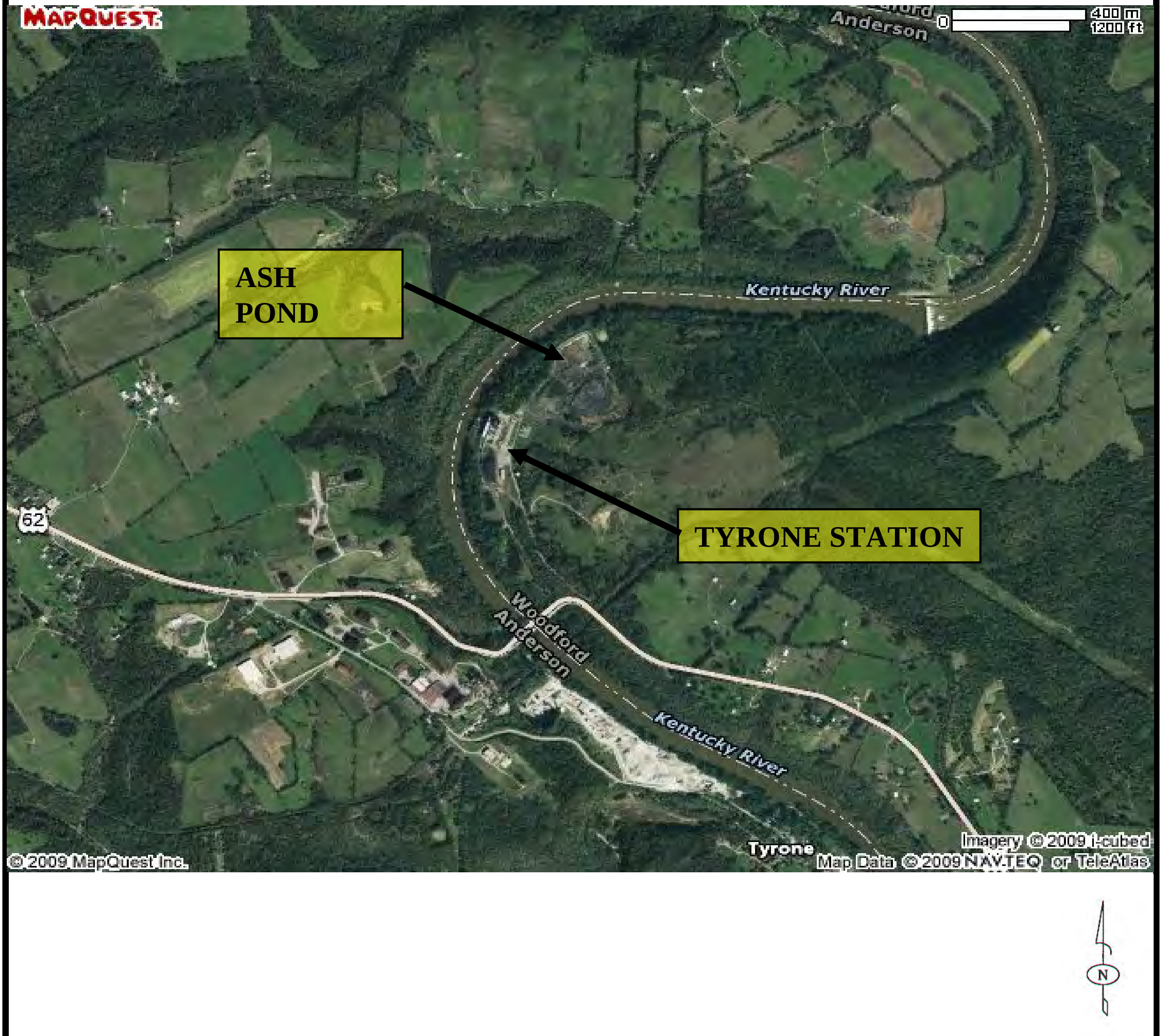
When structures are spaced so that the failure of an upper structure could endanger the safety of a lower structure, the possibility of a multiple failure must be considered assigning the structure classification of the upstream structure.

Additional safety can be provided in either structure by (1) increasing the retarding storage and/or (2) increasing the emergency spillway capacity.

Appendix D
KU Tyrone Station

Appendix D
KU Tyrone Station

List of Contents



ATC ASSOCIATES INC. 11001 Bluegrass Parkway, Suite 250 Louisville, KY 40299 (502) 722-1401	**SITE VICINITY MAP** KU TYRONE STATION LG&E and KU 2011 Pond Inspections Tyrone, KY Map provided by mapquest.com
PROJECT NO: 27.11000.1G37	

DESIGNED BY: RR	SCALE:N/A	REVIEWED BY: JE
DRAWN BY: RR	DATE: 1/17/11	FIGURE: D-1

Findings and Recommendations

Plant: Tyrone
Structure: Ash Pond
State ID# 956
Field date: 1/7/2011

Item #	Priority Rating	GPS Point	Photo #	Location Description	Action Item
1	High	TY1	1	PS	Clearly mark highest allowable stoplog elevation on principal spillway. Elevation determined by others. Include instruction in Operation manual for pond.
2	Moderate	TY1	1	PS	Rework spillway skimmer and stop logs to minimize joint leakage and prevent blockage of spillway inlet.
3	Moderate	-	2	Crest	Perform elevation survey of dam crest. Fill low areas to maintain consistent crest elevation and freeboard requirements of pond hydraulic study.
4	Moderate	TY2	3, 4	Exterior Slope	Repair erosion gullies along downstream slope of north embankment on east and west sides of principal spillway outlet
5	Moderate	TY3	3	Exterior Slope	Place fill along exterior toe of north embankment to restore consistent slope angle
6	Moderate	-	2	Interior Slope	Cut vegetation along north embankment west of principal spillway
7	Moderate	TY4,TY5, TY6	5, 6	Exterior Slope	Re-establish vegetation on exterior slope, numerous locations
8	Moderate	-	7	Interior Slope	Establish erosion protection on interior slopes from crest to below waterline, interior slopes on south end of west embankment are bare earth.
9	Moderate	TY7,TY8	8	Cooling Water Canal	Monitor all slopes below pond embankments for sloughs and scarps, several new scarps observed during January site walkover
10	Moderate	TY9,TY10	9, 10	Exterior Slope	Cut woody vegetation at toe of downstream slope and extend 10 feet below toe
11	Moderate	TY11	11	Cooling Water Canal	Seal off water flowing below monitoring pipe installed in May 2010.
12	Normal	TY12, TY13,TY14	12	Cooling Water Canal	Add rip rap erosion protection to existing ravines below west pond embankment toe, monitor groundwater seep near south end of canal for changes
13	Normal	TY4	6	Crest	Evaluate need for pipe cradle to contain pipe penetrations through slope and protect integrity of slope should a discharge line rupture.
14	Normal	TY15	13	Exterior Slope	Grout or remove abandoned pipe penetrating embankment at NE abutment

Priority:
High - Recommend that action item be addressed as soon as possible
Moderate - Recommend that action item be addressed during next construction season
Normal - Recommend that action item be as part of ongoing maintenance of the structure

Location:
Crest
Toe
Abutment
Principal Spillway
Emergency Spillway

DAM ASSESSMENT FORM

Name of Professional Conducting Inspection: Mark J. Schuhmann P.E.	KY Professional License No.: 12500
Company Name: ATC Associates Inc.	Phone: 502-722-1401
Address: 11001 Bluegrass Parkway, Suite 250, Louisville, KY 40299	
Inspection Preparation: Reviewed all pertinent technical documentation related to this dam and site in: the State's files Yes ☐ No ☒ ; and Owner's Files: Yes ☒ No ☐	
Comments: Side Hill/Incised Pond. Limestone rock exposed at SW and SE edge of pond. Finishing Pond north of Ash Pond filled in 2010.	

Dam/Pond Name: **Tyrone – Ash Pond**		Hazard Class: Low	Topographic Quad: Tyrone	Date of Inspection: 1/7/11	
State Dam ID: 956	County: Woodford	Latitude: 38° 3' 00.0"	Longitude: 84° 50' 42.5"	Last ATC Inspection: 10/15/09	
Power Station Name: **KU Tyrone Station**					
Address: 6800 Tyrone Pike, Versailles, KY 40383					
Site Contact: Steve Lanphierd			Phone: 859-265-6226		
Drainage Area (AC): 62	Surface Area(AC): 10	Height (Ft): 20	Crest Length (Ft): 1800	Crest Width (Ft): 13 to 20	Crest Elevation (Ft): 536
Slope (H:V): Upstream: 1.5 to 2.3:1 Downstream: 1.3 to 2.9:1	Principal Spillway Type: Drop Inlet	Principal Spillway Size (in): 18	Spillway Control Elevation (Ft): Varies	Freeboard (Ft): 4.3	
CCP placed in Pond: Bottom Ash, Fly, Pyrites	Emergency Spillway Type: None observed	Emergency Spillway Size (Ft): N/A	Spillway Control Elevation (Ft): N/A	Freeboard (Ft): N/A	

FIELD CONDITIONS OBSERVED

CCP Above Crest:Yes:☒ None:☐	Location: East of pond	Max. Height above pool (Ft): Visually estimated at 40 feet (east of pond)
Water Level (Below Dam Crest, Ft): 4.3		
Ground Moisture Condition: Dry ☐ Wet ☒ Snow cover ☐ Other:		
Monitoring: Yes ☒ None: ☐ (☐ Gage Rod ☒ Piezometers ☐Seepage Weirs ☐ Survey Monuments ☒ Other)		
Comments: *V-notch weir at principal spillway outlet. Approximately 25,000 CY of ash excavated from pond in November 2010. Generating station placed back in operation in June 2010. Piezometers installed on dam crest in 2010.*		

A **UPSTREAM SLOPE**		**Problems Noted**: ☐ None ☒ Riprap – Missing, Sparse ☐ Wave Erosion ☐ Cracks ☐ Sinkholes ☐ Appears Too Steep ☐ Depressions or Bulges ☐ Slides ☐ Animal Burrows ☐ Trees, Bushes, Briars ☒ Other
GOOD	☐	
ACCEPTABLE	☒	***Comments***: *Mow vegetation on north slope, establish erosion and wave protection from crest to below waterline on south and west slopes, bare earth on south embankment and south end of west embankment.*
DEFICIENT	☐	
POOR	☐	
B **CREST**		**Problems Noted**: ☐ None ☐ Ruts or Puddles ☐ Erosion ☐ Cracks ☐ Sinkholes ☐ Not Wide Enough ☒ Low Areas ☐ Misalignment ☒ Inadequate Surface Drainage ☐ Trees, Bushes, Briars ☐ Other
GOOD	☐	
ACCEPTABLE	☒	***Comments***: *South end of west embankment has low areas that should be raised in elevation*
DEFICIENT	☐	
POOR	☐	

CCP: Coal Combustion Products;
Spillway Size: Pipe Dia. for drop inlet; open channel width (typically emergency or (auxiliary) spillway) at the control section, Ft;.
Freeboard: vertical distance from the emergency spillway control section to the lowest point of the crest of the dam.

DAM ASSESSMENT FORM

C DOWNSTREAM SLOPE GOOD ☐ ACCEPTABLE ☒ DEFICIENT ☐ POOR ☐	**Problems Noted**: ☐ None ☐ Livestock Damage ☒ Erosion, Gullies ☐ Cracks ☐ Sinkholes ☐ Appears Too Steep ☐ Depression or Bulges ☐ Slide ☐ Soft Areas ☒ Trees, Bushes, Briars ☐ Animal Burrows ☒ Other ***Comments***: *Erosion gullies observed on downstream slope of north embankment, east and west of principal spillway outlet; north embankment toe requires minor fill placement to re-establish consistent slope; re-establish vegetation along exterior slopes in numerous locations*
D SEEPAGE GOOD ☐ ACCEPTABLE ☒ DEFICIENT ☐ POOR ☐	**Problems Noted**: ☐ None ☐ Saturated Embankment Area ☐ Seepage Exits on Embankment ☐ Seepage Exits at Point Source ☐ Seepage Area at Toe ☐ Flow Adjacent to Outlet **If Seepage**: ☐ Clear ☐ Muddy **Drain Outfalls Seen**: Yes ☐ No ☒ Flow: ☐ Clear ☐ Muddy ☐ Dry ☐ Obstructed ***Comments***: *Observed continued flow of clear groundwater into cooling water canal from multiple point sources in erosion gullies below toe of west embankment slope. Observed flow around seepage monitoring pipe recently installed by KU personnel.*
E PRINCIPAL SPILLWAY GOOD ☐ ACCEPTABLE ☒ DEFICIENT ☐ POOR ☐	**Description**: Concrete variable drop inlet principal spillway structure with stop logs for elevation control. **Problems Noted**: ☐ None ☐ Deterioration ☐ Separation ☐ Cracking ☒ Inlet, Outlet Deficiency ☐ Stilling Basin Inadequacies ☐ Trash Rack ☒ Other ***Comments***: *Spillway structure appears to be in good condition, but water is flowing through stop logs rather than over the top log indicating a poor seal between logs. Black plastic liner placed in front of logs to provide water seal. Stop log placement at spillway inlet could allow pond water to within 1 foot of crest elevation.*
F AUXILIARY SPILLWAY GOOD ☐ ACCEPTABLE ☐ DEFICIENT ☐ POOR ☐	**Description**: No auxiliary spillway observed **Problems Noted:** ☐ None ☒ No Auxiliary Spillway Found ☐ Erosion with Backcutting ☐ Crack with Displacement ☐ Appears to be Structurally Inadequate ☐ Appears too Small ☐ Inadequate Freeboard ☐ Flow Obstructed ☐ Concreted Deteriorated/Undermined ☐ Other ***Comments***: *None*
G MAINTENANCE AND REPAIRS GOOD ☐ ACCEPTABLE ☒ DEFICIENT ☐ POOR ☐	**Problems Noted**: ☐ None ☐ Access Road Needs Maintenance ☐ Cattle Damage ☐ Spillway Obstruction ☒ Vegetation on Upstream Slope, Crest, Downstream Slope, Toe ☐ Trees on Upstream Slope, Crest, Downstream Slope, Toe ☐ Rodent Activity on Upstream Slope, Crest, Downstream Slope, Toe ☐ Deteriorated Concrete –Facing, Outlet, Spillway ☐ Gate and/or Drawdown Need Repair ☒ Other ***Comments***: *Old erosion gullies on north exterior slope at spillway need to be filled; numerous areas of sparse vegetation need re-seeding to establish grass cover. Remove or plug old pipe at toe of north exterior slope east abutment.*
H IMPOUNDMENT AREA GOOD ☐ ACCEPTABLE ☒ DEFICIENT ☐ POOR ☐	**Problems Noted**: ☒ None ☐ Ponded Water within Ash ☐ Ash blocking spill way ☐ Signs of damage from dredging ☐ Ash deposits in spillway ☐ Other **Inflow sources**: ☒ Runoff ☒ Ash Sluicing ☒ Process Water ☐ Other **Release of ponded water could cause overtopping of dam**: Yes ☐ No ☒ N/A ☐ ***Comments***: *Dry stacked ash is placed just east of ash pond and is stacked at least 30 feet above pond and was observed in previous inspection. See ATC report dated September 11, 2009.*

DAM ASSESSMENT FORM

ATC ASSOCIATES INC.

I OVERALL CONDITIONS		*Comments: Substantial improvements made since last ATC inspection.*
SATISFACTORY	☐	*To obtain "Satisfactory" rating Address all High and Moderate priority action items listed in Findings and Recommendations Table and schedule to address all "Normal" priority action items.*
FAIR	☒	
CONDITIONALLY POOR	☐	
POOR	☐	
UNSATISFACTORY	☐	

Summary of Findings and Recommendations in Attached Table

This visual dam assessment was conducted to assess the general overall condition of the reservoir/ash pond/dam, identify visible deficiencies, and recommend areas for monitoring, additional investigative studies and corrective actions. The assessment is based only on visible features/areas of the dam on the day of inspection; it does not constitute a formal safety inspection nor a review or evaluation from each specialist of an inspection team, such as geologists, civil, geotechnical, structural, or hydraulics engineer. The owner should verify the findings of this report and take corrective actions. This assessment does not relieve the owner/operator from their responsibility to conduct routine inspections, maintenance, repairs, modifications, monitoring, documentation, and/or investigative studies.

Professional Engineer's Signature: [signature] Date: 1-25-11

Reviewed by: David A. Miller Date: 1-25-11
Owner/Owner Representative Signature

TYRONE ASH POND PHOTOS
January 7, 2011

Photo #1: Stop logs in main spillway, no maximum placement elevation noted on spillway inlet

Photo #2: Vegetation on north embankment upstream slope, low elevation areas on dam crest, looking south

TYRONE ASH POND PHOTOS
January 7, 2011

Photo #3: North Exterior slope, looking west
Note: erosion gullies and steep slope at toe

Photo #4: Erosion gullies north exterior slope at spillway, looking north

TYRONE ASH POND PHOTOS
January 7, 2011

Photo #5: Exterior slope area needing revegetation looking southwest

Photo #6: South exterior slope at recent repair, area needs vegetation established, looking east

TYRONE ASH POND PHOTOS
January 7, 2011

Photo #7: Interior slope west embankment, area needs erosion protection, looking north

Photo #8: Slope scarp above cooling water canal, below toe of pond embankment, looking north

TYRONE ASH POND PHOTOS
January 7, 2011

Photo #9: Woody vegetation at toe of embankment slope, west exterior slope, looking north

Photo #10: Woody vegetation at toe of embankment slope, west exterior slope, looking north

TYRONE ASH POND PHOTOS
January 7, 2011

Photo #11: New pipe installed at cooling water canal
Note: Seepage and erosion below pipe, looking south

Photo #12: Ravine below south end of pond above cooling canal.
Note: Erosion and water seepage, looking west

TYRONE ASH POND PHOTOS
January 7, 2011

Photo #13: Steel pipe penetrating north embankment slope at toe of east side of pond, looking south

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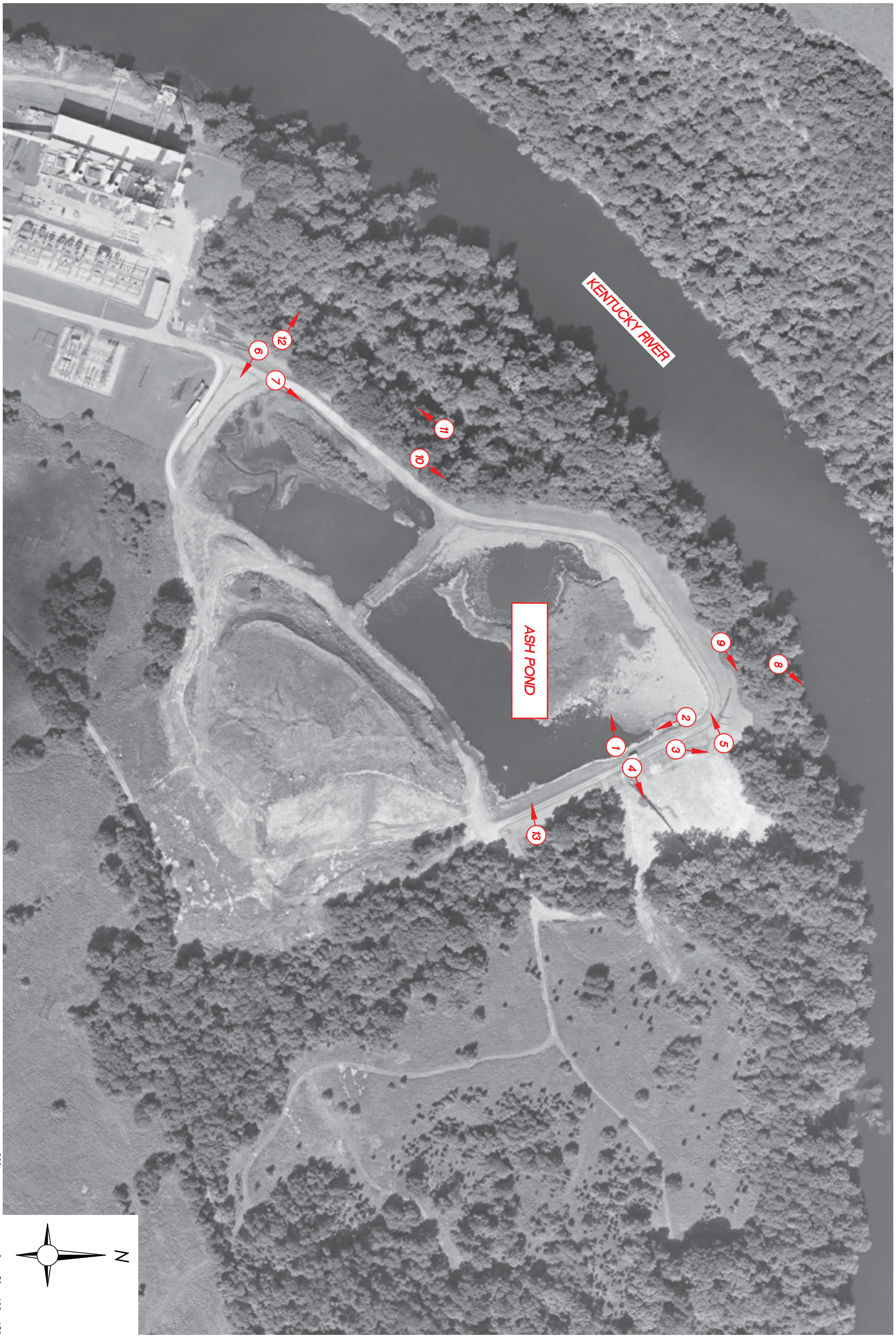
AUGUST 2010 AERIAL PHOTOGRAPHS PROVIDED BY:
L.R. KIMBALL ASSOCIATES INC.
615 WEST HIGHLAND AVENUE
EBENSBURG, PA 15931
STATE PLANE COORDINATE SYSTEM: KENTUCKY (FIPS 1600), NAD83



SCALE: 1" = 200'
200 0 50 100 150 200

LG&E - KU 2011 POND INSPECTIONS
KU TYRONE STATION - ASH POND
PLAN WITH PHOTOS

Date: 1/11
Scale: AS SHOWN
Figure: D-2

LEGEND:
LOCATION OF PHOTOGRAPH
10 — DIRECTION OF PHOTOGRAPH
PHOTO DESIGNATION

Project Number: 27.11000.1G37	Drn. By: SP
Drawing File: SEE LOWER LEFT	Ckd. By: JE
ATC ASSOCIATES INC.	App'd By: MS
	Ckd. Date: 1/11

ASH POND – FIELD OBSERVATIONS

GPS PT.	COORDINATES	DESCRIPTION
TY1	N38°3'3.4" W84°50'39"	PRINCIPAL SPILLWAY
TY2	N38°3'3.7" W84°50'38.4"	EROSION GULLIES NORTH EXTERIOR SLOPE
TY3	N38°3'4.6" W84°50'38.8"	NORTH EXTERIOR SLOPE TOE
TY4	N38°2'56" W84°50'48.8"	SOUTH EMBANKMENT AREA NEEDS VEGETATION
TY5	N38°3'5.4" W84°50'39"	SLOPE AREA NEEDING VEGETATION
TY6	N38°3'5.7" W84°50'41"	SLOPE AREA NEEDING VEGETATION
TY7	N38°2'59.8" W84°50'47.4"	SLOUGH ON CANAL BANK
TY8	N38°3'6.7" W84°50'40.9"	SLOUGH ALONG KY RIVER BANK
TY9	N38°3'5" W84°50'42.5"	WOODY VEGETATION ALONG TOE OF SLOPE
TY10	N38°3'0.2" W84°50'45.4"	WOODY VEGETATION ALONG TOE OF SLOPE
TY11	N38°2'59.5" W84°50'47.5"	GROUNDWATER MONITORING PIPE AT COOLING CANAL
TY12	N38°2'55.6" W84°50'50.2"	MONITOR EROSION GULLY, ADD EROSION PROTECTION
TY13	N38°2'56.1" W84°50'49.7"	MONITOR EROSION GULLY, ADD EROSION PROTECTION
TY14	N38°2'56.6" W84°50'49.4"	MONITOR EROSION GULLY, ADD EROSION PROTECTION
TY15	N38°3'1.5" W84°50'36.8"	PIPE EXITING NORTH EXTERIOR SLOPE AT TOE

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615 WEST HIGHLAND AVENUE
EBENSBURG, PA. 15931
STATE PLANE COORDINATE SYSTEM: KENTUCKY (FIPS 1600), NAD83

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LG&E - KU 2011 POND INSPECTIONS
KU TYRONE STATION - ASH POND
GPS COORDINATES/FIELD OBSERVATIONS

Date: 1/11
Scale: AS SHOWN
Figure: D-3

Project Number: 27.11000.1G37
Drawing File: SEE LOWER LEFT
Drn. By: SP
Ckd. By: JE
App'd By: MS
Ckd. Date: 1/11

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